Halbuy-Now as a marketplace for surplus food supporting a sustainable halal agri-food supply chain through waste minimization

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A B S T R A C T

HalBuy-Now is a mobile application designed to address food waste and enhance sustainability in the Indonesian agri-food sector. This application connects consumers with halal-certified restaurants offering surplus food at discounted prices. With the growing global demand for halal products and the persistent issue of food waste, HalBuy-Now provides an innovative solution for redistributing surplus food that would otherwise be discarded. The application also promotes sustainable consumption habits, offers cost-saving opportunities for consumers, and supports local food businesses. Through features such as real-time inventory management and location-based ordering, HalBuy-Now effectively minimizes food waste, reduces carbon emissions, and fosters a circular food economy. Additionally, the application empowers consumers to make well-informed purchasing decisions, contributing to the national goals of sustainability, food security, and the promotion of halal-certified products. By combining technology with sustainable agricultural practices, HalBuy-Now plays a key role in advancing Indonesian efforts to reduce food waste while strengthening its position in the global halal food market.

ARTICLE INFO

1 Introduction

Indonesia is a rapidly developing country with extensive agricultural resources and immense potential for innovation in agri-food sector. According to Badan Pusat Statistik (BPS), there are approximately 40.64 million farmers in 2022, signifying the sector's substantial workforce. Indonesia's agricultural sector is a strategic and important component of the national economy because it produces a large part of the country's gross domestic product (GDP), generates a large proportion of export revenue, and provides employment to millions of people (Gina *et al.* 2023). In 2022, this sector was ranked the third largest contributor to Indonesian GDP, accounting for 12.4%, following trade and manufacturing. This shows the importance of the agricultural sector in the archipelago's economic growth. With the high potential of agricultural land resources, increasing demand for food, and the need for sustainable practices, Indonesia offers numerous opportunities to enhance productivity, efficiency, and sustainability through innovation. Recognized as the backbone of the economy, the government prioritizes the agricultural sector by focusing on food crop commodities to ensure national food security (Bukhtiarova *et al.* 2019). However, the global food industry faces challenges such as food fraud, contamination, and inefficient supply chain management, suggesting the need for innovative solutions to enhance safety, integrity, and transparency in supply chain.

To meet increasing consumers demand and regulatory requirements, it is necessary to add more value to agricultural food products by ensuring quality and compliance with halal standards. In Indonesia, halal certification has become mandatory for all traded products, and many consumers now adopt halal principles as part of their lifestyle. Halal consumption remains a significant concern for the Muslim community, particularly in multireligious and multicultural countries such as Malaysia, the United Kingdom (UK), and other European countries. Halal Product Guarantee Agency (BPJPH) estimated that global Muslim spending on halal products was nearly $2 trillion (approximately 29.8 quadrillion IDR). This marked a significant rise from $1.62 trillion in 2012 to $2.29 trillion in 2022, driven by the younger Muslim generation and a growing global population exceeding 2 billion Muslim consumers (SGIE 2023). Halal status of food product is determined by the suitability of raw materials, production process, and transportation from the upstream stages to the final consumers (Ma'rifat & Rahmawan 2018). Empowering agri-food sector is crucial to establishing Indonesia as the global hub of halal industry by 2024. These efforts provide consumers with affordable, high-quality halal food while ensuring the effective utilization of surplus items (Stangherlin *et al.* 2021).

The concept of halal in Islam categorically distinguishes between halal (permissible) and haram (forbidden), leaving no room for levels or percentages of halal status. Halal, an Arabic term meaning permissible, is mostly associated with Muslim communities and pertains to foods and products that comply with Islamic law, and contain no prohibited ingredients (Nawawi *et al.* 2020). For halal-certified products, maintaining consistent halal practices is essential. This requirement extends beyond production activities to the implementation of halal supply chains, ensuring that products remain halal in their journey. The efficiency of halal supply chains depends not only on the traceability provided by a single company but also on transparent agreements between supply chain participants. A lack of transparency at any point can disrupt the integrity of the entire supply chain (Hu *et al.* 2013; Lavelli 2013). Furthermore, halal supply chain must correlate with market requirements and the unique characteristics of products. While agri-food sector offers immense potential and shows the importance of halal supply chain in Indonesia, it is equally important to address the market demand, regulatory updates, and the perishable characteristics of agri-food products. Agri-food system is one of the largest waste-generating sectors in the world, particularly at the industrial level, where residues accumulate during processing (Chiaraluce *et al.* 2023).

2 Methodology

This research adopted a design and development method to create, refine, and evaluate the HalBuy-Now mobile application, aimed at reducing

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food waste and promoting sustainable consumption in the Indonesian agri-food sector. The methodology involved five key stages, including (1) Identifying the Problem: The issue of food waste in halal-certified restaurants was identified through interviews, surveys, and statistical analysis. This step outlined the challenges and found opportunities to improve. (2) HalBuy-Now was made with a design that followed a user-centered framework. It aimed to be simple, accessible, and relevant. Important features were added like managing inventory in real time, making orders based on location, secure payments, and offering a surprise box for extra food. (3) The application was developed using an agile method. This allowed step-by-step progress and made it work across different platforms. HalBuy-Now was designed to be strong and flexible. (4) Tests were done to check usability, along with focus group discussions and beta testing. These were done with halal restaurants and some consumers. The feedback was used to improve the features and how the application worked. (5) The application's impact was checked through pilot research. This analyzed data about reducing food waste, how users engaged with the application, and their satisfaction. The results gave insights about how well HalBuy-Now helped reduce waste and supported sustainable food practices. This iterative and user-driven process ensured the application's practical effectiveness in fostering responsible consumption, minimizing food waste, and supporting a sustainable food system in Indonesia.

3 System Overview and User Interaction

The proposed system aimed to reduce food waste through an application that facilitated the redistribution of halal food, thus addressing both food waste and food poverty. The application allowed restaurants to offer surplus halal food at discounted prices that would otherwise go to waste. The food that was collected was sold to people at cheaper rates. The application was designed for both the Android and iOS platforms. The Android version can be developed using Java and XML on Android Studio, requiring an Internet connection, whereas the iOS version can be developed using Objective-C, a primary language for OS X and iOS that enhances C with object-oriented features and a dynamic runtime (Seymour *et al.* 2014). The user interface is simple and user-friendly, making it accessible to all iOS and Android users. The application specifically targets the issue of food waste in Indonesia, particularly focusing on foodstuffs (Elavarasan & Nesakumar 2019). This platform allows restaurants and customers to register within the system. Restaurants wishing to participate must register on the application by providing the necessary details, including their halal certification and food hygiene certificates. Upon approval, an acceptance notification was sent and stored in the backend database. Once listed, customers could order discounted food directly through the application.

By creating personalized accounts, users engaged with the interface of the application and navigate through the activated selection of offers. After selecting desired items, users could place orders based on their location, with digital receipts generated automatically to streamline the transaction process. Orders were collected discreetly at specified locations using a designated pick-up time system. The main page showed halal food products listed by the server, including discounts, available portions, and pick-up details. Payments were processed securely in the application, ensuring that all listed food products met quality standards, were properly stored, and remained unaltered. Additionally, the application offered "surprise boxes", which were packages from partners with content revealed only upon receipt, providing an exciting way for consumers to discover new items. Previous investigations reported that the market for online food application was highly competitive, making consumers' satisfaction crucial. According to Rahim & Yunus (2021), consumers often selected online food application based on their level of satisfaction, which was enhanced by access to comprehensive information (Alalwan 2020). Providing access to essential details and ensuring strong security measures were the key to attracting and retaining users.

4 Market and Consumers Benefits of HalBuy-Now Application Features

HalBuy-Now uses modern communication methods to manage food waste by allowing stakeholders in the agri-food chain to sell surplus food items at affordable prices. Technological innovations, such as digital platforms and social networks, are increasingly employed not only to prevent losses but also to recover and recycle food. A mobile application was added to food waste management, and it gave several benefits to businesses. These benefits included helping them get noticed more, giving better marketing chances, and improving brand reputation by showing a commitment to sustainability. The application also helped in managing operations better, like keeping track of inventory in real-time, predicting demand, and improving supply chain systems, thereby reducing waste across industries. By engaging consumers with information about sustainable practices, offering discounts on surplus items, and encouraging responsible consumption, the application contributed to cost savings while fostering new revenue streams in the framework of a circular economy (Moldovan *et al.* 2024).

The mobile application addressed broader challenges, such as improving food security and promoting sustainable manufacturing systems, by highlighting halal restaurants offering discounted food. A user-friendly interface was essential for a positive user experience, including responsive design, gesture control, location-based restaurant selection, in-app tutorials, real-time or offline support, user notifications, and feedback options. Furthermore, the application provided valuable data on food waste, educational resources, and features that enabled users to make informed decisions about food consumption, storage, and disposal. This method was in line with the research of Zhang *et al.* (2019), who found that adopting a holistic user-centered design in food waste application enhanced engagement and effectiveness by addressing food waste and promoting sustainable consumption practices.

For consumers, HalBuy-Now offered various benefits, such as discounts, vouchers, and the opportunity to explore new culinary options through features like surprise "end-of-day" boxes. The mobile application provided cost-saving opportunities and special deals on surplus or near-expiry food, thereby enhancing purchasing power. HalBuy-Now raised awareness, educated users, and promoted responsible consumption habits, contributing to the fight against food waste.

5 Sustainable Food Practices

Reducing food waste could be achieved using several key strategies. One effective method involved adopting sustainable packaging such as biodegradable or recyclable materials for agricultural products. This method significantly minimized waste by ensuring packaging did not contribute to environmental harm. Additionally, improving storage methods, including cold storage and refrigeration, could effectively extend the shelf life of perishable products, reducing spoilage. Another effective method was food donation and redistribution, where collaboration with food banks and charities ensured that surplus food reached those in need, enhancing food security and reducing waste. Educating consumers about the impact of food waste and promoting mindful consumption habits could further empower them to minimize waste.

The government has a big role in sustainable farming. They can give grants for things like vertical farming or subsidies for composting tools. This helps farmers do things in a more sustainable way. Putting money into research and development (R&D) can also help make circular farming and vertical farming better. Partnerships between the government, private companies, and NGOs can support sustainable agriculture. These partnerships help create a stronger and better food system.

6 Mission and Vision

The research mission is centred on inspiring and empowering people to combat food waste with the goal of saving excess food. This mission originated from the growing problem of food waste, which is becoming increasingly significant, not only for food businesses but also for households. It was previously understood that food waste harms the planet, as both food production and packaging use natural resources. When food is discarded, these resources are wasted, failing to address hunger and causing financial losses to businesses. Additionally, improperly disposed food contributes to the generation of harmful greenhouse gases, which further harm the environment. The true challenge was to develop a modern solution that would make it easier for people to participate in a movement focused on prevention (Lewandoski 2023).

To achieve sustainable agriculture and food supply chains and solve several problems, there must be a collaboration between many stakeholders. For instance, farmers, producers, distributors, and consumers play essential roles to support sustainable practices. Bachev (2018) said that stakeholder collaboration is essential for achieving sustainable agriculture by fostering shared knowledge, diverse participation from farmers, government bodies, NGOs, and consumers, enhancing information exchange, optimizing resource use, and improving productivity. The analysis further highlight the need for supportive policies and address challenges such as conflicting interests and trust-building, ultimately concluding that effective collaboration is essential for advancing sustainable agricultural practices. Farmers can minimize food loss during production through sustainable practices. Producers can leverage new technologies and efficient processes to extract the highest value from waste products. Distributors significantly reduce food spoilage during transportation by implementing appropriate handling and storage techniques. Finally, consumers could contribute by making informed food choices, avoiding impulse purchases, and practicing efficient food storage and consumption. This solution was implemented effectively and efficiently through the aspect of collaboration that existed among stakeholders. This research aimed to design Halbuy-Now mobile application to maximize the impact of food waste reduction efforts.

7 Consumers' Benefits and Behavioral Impact of Halbuy-Now Application

Halbuy-Now was regarded as a mobile application designed to tackle food waste by connecting users to restaurants and food stores with excess food which would otherwise be discarded. A significant feature of this application was the offering of a "surprise meal" filled with leftover food. The customer's reservation was secured when Halbuy-Now confirmed its order with a reservation confirmation. In the application, the consumer could filter results based on product availability, pickup time, or the type of products in "surprise meal" bag. The pickup window typically ranged from 10 to 30 min but might vary (Matisen & Johansen 2022). Consumers placed orders for these bags in advance and collect them during a designated time slot, usually towards the end of the day. When ordering, consumers did not know the exact contents of the bags, which could lead to unexpected discoveries, such as receiving a large number of breads in one bag. The contents of the surprised meals were based on the available surplus food each day. This model of selling leftover food with an element of surprise was termed "surprise clearance." (Van der Haar & Zeinstra 2019).

The benefits for consumers were clear, as their food expenses would be reduced with discounted items, contributing to the reduction of global food waste. Halbuy-Now was a great way to contribute to less food waste in Indonesia, and using the application regularly would keep this aspect of food waste top-of-mind. By using this application, consumers would notice a change in knowledge or awareness about food waste, which often translated into long-term positive habits in food waste prevention.

8 Conclusion

In conclusion, the Indonesian commitment to reducing agricultural waste through circular and vertical farming represented a promising step toward a more sustainable future. These efforts were in line with the country's broader initiatives to implement sustainability practices and realize their potential benefits. Circular agriculture was categorized into three key practices. The first was composting and biogas production, which involved transforming agricultural organic waste into valuable resources. For instance, anaerobic digestion produced biogas for energy. The second practice was integrated pest management, which showed natural pest control through beneficial insects, crop rotation, and other sustainable strategies. The third focused on closed-loop systems, which promoted the reuse and recycling of agricultural resources to minimize waste.

As a rapidly developing country, Indonesia could achieve its goal of reducing agricultural waste by adopting circular agriculture and vertical farming. These innovative methods not only reduce organic waste but also significantly lower water and energy consumption. Additionally, food waste could be minimized through the use of recyclable packaging, improved storage methods, and responsible food donation practices to redistribute surplus items. Recycling food waste and adhering to proper storage standards prevent spoilage, improving environmental sustainability while creating a resilient and secure food system for the country.

The development of HalBuy-Now represented a strategic step in addressing food waste and enhancing sustainability in Indonesia. By linking consumers with restaurants offering surplus halal food, the application not only reduced waste but also provided affordable food options to the public. Tackling challenges related to food security and climate change required collaborative efforts among all stakeholders, including farmers, producers, distributors, and consumers. Through the integration of sustainable agricultural practices and the promotion of halal certification, Indonesia could solidify its position as a leading player in the global halal food market.

HalBuy-Now served as an innovative application empowering users to make informed decisions, thereby contributing to a more sustainable and food-secure future. By leveraging technology and fostering responsible consumption, the application was in line with the country's commitment to circular agriculture and vertical farming. These combined efforts showed Indonesian potential to reduce agricultural waste, strengthen food security, and lead the way toward a resilient agricultural future.

Conflict of Interest

The authors declare no conflict of interest.

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