

# Cravely: An AI-Powered Food Waste Reduction Platform for Climate Change Mitigation and Sustainable Consumption

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## Abstract

Food waste is a significant contributor to methane emissions and climate change. In the Philippines, many food establishments discard edible surplus food due to limited redistribution systems. This study aimed to design and develop Cravely, a secure and AI-integrated digital platform that promotes sustainable consumption and reduces food waste in selected barangays in Pampanga. The platform enables food establishments to redistribute surplus food at discounted prices while informing users about estimated methane emissions avoided through their purchases. Key features include surplus tracking, QR code-secured transactions, role-based user management, and an AI-driven methane estimation module for environmental impact analysis. A mixed-methods approach and iterative development process were utilized in developing and evaluating the system. Food business owners, residents, and IT professionals assessed the platform using software quality and user acceptance frameworks. Results showed high ratings in usability, efficiency, security, reliability, and perceived usefulness. The findings indicate that Cravely is a viable and scalable solution for reducing food waste, improving food accessibility, and increasing environmental awareness. The study highlights the potential of digital platforms in supporting sustainable practices and climate change mitigation efforts.

**Keywords:** AES encryption, AI-driven estimation, Surplus Redistribution, Food Waste Reduction, Surplus Redistribution, Methane Emissions, Sustainable Consumption, Climate Change Mitigation, Cravely Platform, Pampanga

## Introduction

### Background of the Study

Climate change, driven by human activities such as deforestation, excessive emissions, and unmanaged waste, remains a major global concern. Among greenhouse gases, methane is particularly significant due to its high global warming potential and its strong contribution to atmospheric heat retention (Caruther & Riva, 2025). One of the primary sources of methane emissions is the decomposition of food waste in landfills, where organic materials break down under anaerobic conditions and release methane into the

atmosphere (Environmental Protection Agency, 2025). Globally, more than one-third of all food produced for human consumption is lost or wasted each year, reflecting a persistent imbalance between food insecurity and inefficient consumption systems (United Nations Environment Programme, 2024). In addition, over one billion meals are wasted daily worldwide, further emphasizing the scale of global food inefficiency (United Nations Environment Programme, 2024).

Food systems also contribute significantly to greenhouse gas emissions, with varying environmental impacts depending on the type of food produced and wasted. Research shows that different food products generate different levels of greenhouse gas emissions per kilogram, highlighting the environmental burden of food production and waste throughout the supply chain (Poore and Nemecek, 2018). In the Philippines, approximately 2.95 million tons of food are wasted annually, with significant contributions coming from highly urbanized areas such as Metro Manila and Pampanga (BWorldOnline, 2024). Much of this food waste ends up in landfills, where it contributes to methane emissions and further intensifies environmental degradation.

This situation is further complicated by the persistent issue of food insecurity in the Philippines, where significant volumes of edible food are wasted while many Filipinos continue to experience hunger and limited food access. This contrast highlights inefficiencies in food distribution systems and underscores the need for improved mechanisms that can better connect surplus food supply with communities in need (Philippine Institute for Development Studies, 2023).

Despite increasing awareness of food waste and its environmental impacts, local and accessible solutions in the Philippine context remain limited. Existing global food redistribution platforms, such as Too Good To Go, demonstrate the potential of digital systems in reducing food waste; however, their limited presence in the country highlights a gap in localized implementation. Furthermore, many existing systems are not fully adapted to the needs of micro, small, and medium-sized food businesses, particularly in terms of accessibility, integration, and community-level usability (De Almeida Oroski & Da Silva, 2022). This gap underscores the need for context-specific approaches that can better address both environmental concerns and local operational realities.

### **Statement of the Objectives**

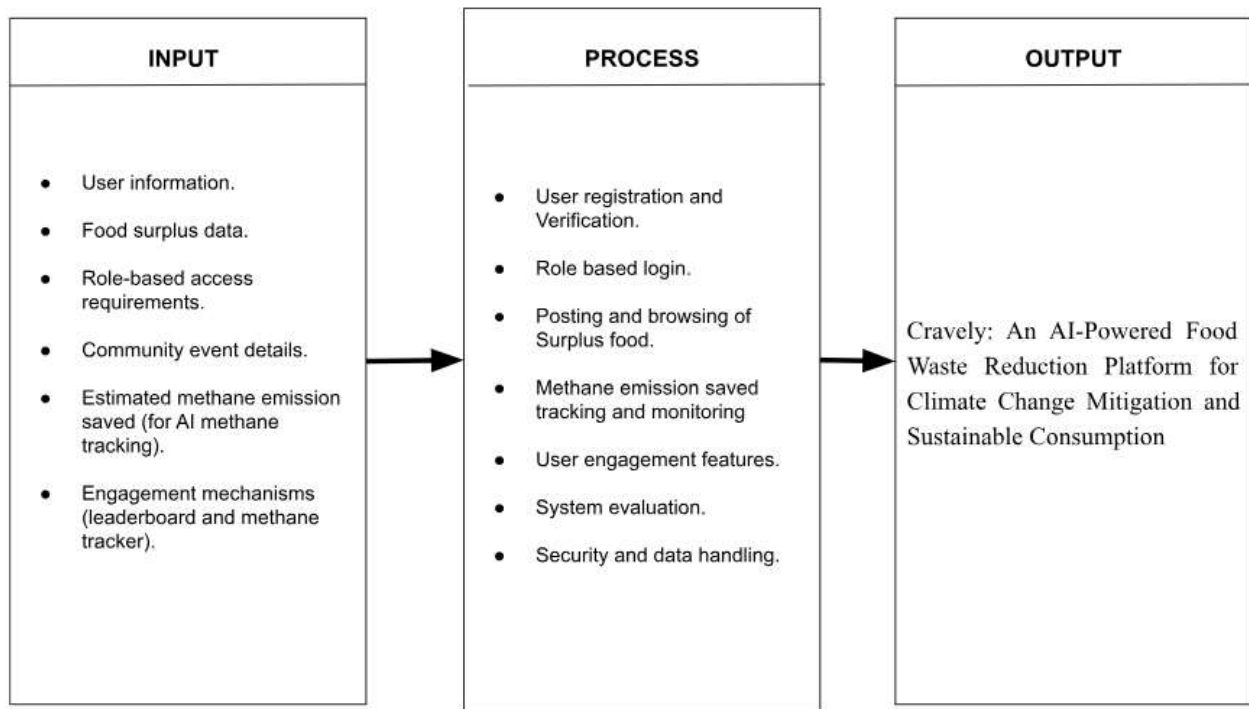
This study aims to design, develop, and evaluate Cravelly, a digital platform that facilitates the redistribution of surplus food at discounted prices in order to reduce food waste and mitigate methane emissions. Specifically, the study seeks to assess the overall quality and performance of the Cravelly platform based on evaluations conducted by IT experts, determine the level of user acceptance among intended users, and examine the behavioral and operational impact of the platform on food sellers, buyers, and community members. Furthermore, the study aims to identify the technical strengths and areas for improvement of the platform through expert assessment and evaluate the readiness of food businesses, as well as the challenges they may encounter, in adopting a digital food redistribution system.

### **Conceptual Framework**

Cravelly adopts the Input-Process-Output (IPO) model, where user information, role-based access, and surplus food data are treated as inputs. These inputs are processed through user registration and verification, role-based system interactions, and methane estimation functions. Within this process, sellers are able to post surplus food items, while buyers can browse and purchase available listings, all within a secured and structured system that supports user engagement and data protection. The resulting outputs

include the reduction of food waste, decreased methane emissions, improved access to affordable food options, enhanced awareness of sustainability practices, and strengthened support for local food businesses. In addition, user feedback is utilized to support continuous system evaluation and improvement.

**Figure 1. Conceptual Framework**



**Methods**

**Research Design and Model Used**

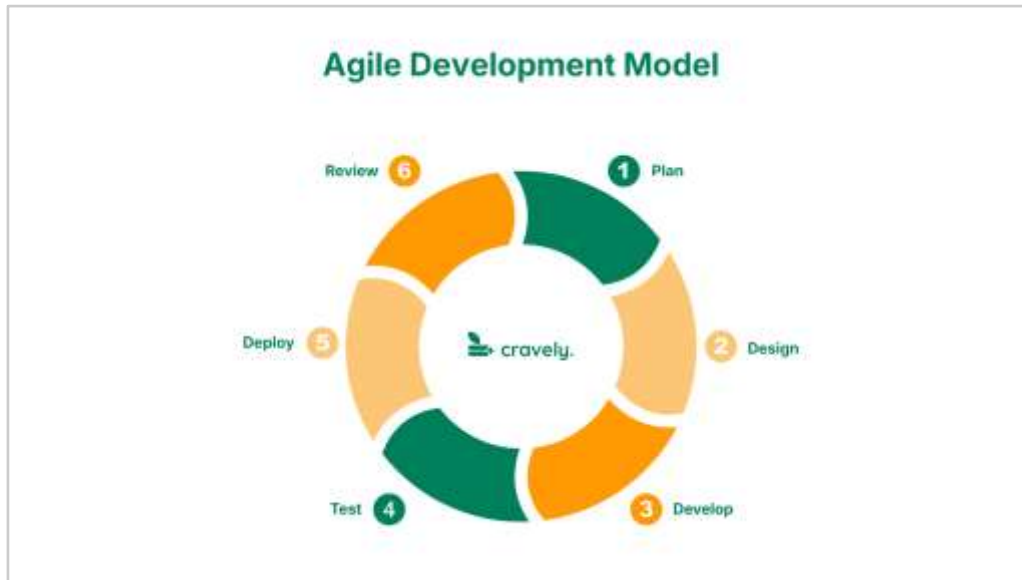
This study adopts a mixed-methods research design to guide the development of Cravely. The qualitative component involves interviews with food business owners and managers to explore current practices in food surplus management, challenges in reducing waste, and expectations for a digital platform. The quantitative component employs structured evaluation instruments, based on the ISO/IEC 25010 software quality model and the Technology Acceptance Model (TAM), administered to new users of the Cravely platform. These include purposely selected IT specialists and general users chosen through convenience sampling. The evaluations will quantitatively measure perceived usefulness, ease of use, efficiency, satisfaction, and overall acceptance of the platform. Integrating these methods ensures that Cravely is both informed by business needs and rigorously evaluated for usability, reliability, and adoption potential.

**System Development Methodology**

The Cravely platform was developed using the Agile Model within the System Development Life Cycle (SDLC) for its iterative and flexible approach, enabling continuous feedback and improvements. Development began with requirement gathering from food establishments, consumers, and IT experts to identify core features such as surplus tracking, marketplace listings, consumer engagement, and the AI-based emissions estimator. Requirements were refined and implemented in short iterative cycles, with prototypes reviewed and improved based on stakeholder feedback. Each sprint focused on specific

components, and testing was integrated into every iteration to ensure functionality, usability, and reliability. Deployment was incremental, with ongoing updates guided by user input, resulting in a functional, user-centered, and sustainable platform aimed at reducing food waste.

**Figure 2. Agile Development Model**



## Participants and Setting

Participants were selected from barangays in San Fernando, Pampanga, involving individuals engaged in food production, distribution, and consumption. From an estimated population of 59,972 residents and 1,200 food businesses, a total of 159 respondents were selected. These included 90 residents, 60 food business owners/managers, and 9 IT professionals. Purposive sampling was used for IT specialists, while convenience sampling was applied for general users and business participants. This composition ensured representation of diverse perspectives on food surplus management and system usability.

## Research Instrument

The study utilized a mixed-methods evaluation framework. Qualitative data were collected through semi-structured interviews with food business owners and managers to explore food waste practices, operational challenges, and system usability concerns. Quantitative data were gathered through post-use evaluation surveys based on the ISO/IEC 25010 software quality model and the Technology Acceptance Model (TAM), measuring perceived usefulness, ease of use, efficiency, satisfaction, and behavioral intention to use the platform. In addition, system-generated data such as surplus listings and transaction logs were analyzed to support evaluation findings.

## Data Collection Procedure and Analysis

Before data collection, formal approval was obtained from the appropriate authorities. Data collection was conducted in three phases. First, semi-structured interviews were carried out with selected food business owners and managers to gather qualitative insights on food surplus practices and system expectations. Second, participants were engaged in system testing of the Cravely platform to assess usability and

functionality. Third, post-use evaluation surveys were administered to general users and IT professionals to measure system performance and user acceptance.

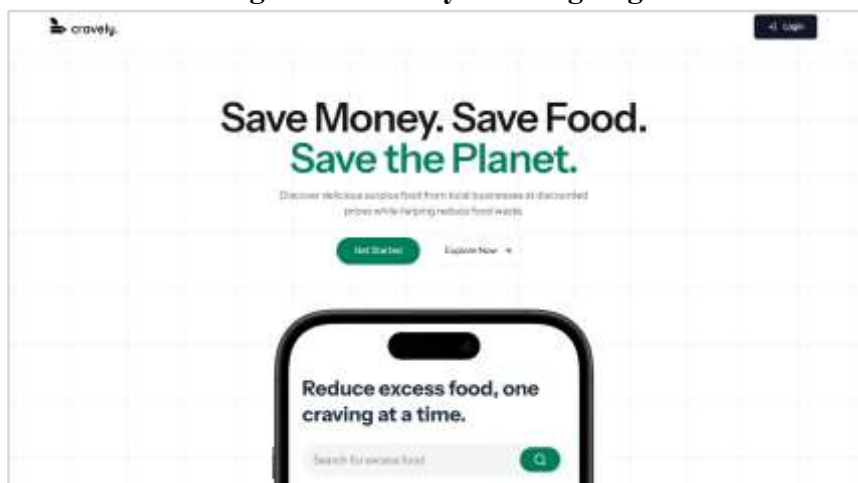
In addition, system-generated records, including surplus listings and transaction logs, were reviewed to triangulate findings and validate system behavior. Quantitative data were analyzed using descriptive statistics, specifically mean and standard deviation, based on a 4-point Likert scale. Qualitative data from interviews were analyzed using thematic content analysis, focusing on recurring patterns related to usability, adoption challenges, and perceived relevance of the system in addressing food waste issues. The combination of statistical and thematic analysis provided a comprehensive understanding of system effectiveness, usability, and adoption potential.

## Results and Discussions

The Cravely system is designed with a secure architecture and a suite of integrated features that collectively support efficient, transparent, and data-driven food surplus management and redistribution. Its architecture combines modular components that work together seamlessly, ensuring reliability, data security, and ease of use for both food business operators and end-users. Each feature from food listing and inventory monitoring to QR code-based transactions, role-based access control, and AI-driven food waste estimation addresses specific challenges commonly encountered in managing food surplus and reducing food waste. By presenting both the overall system framework and its key functionalities, this section highlights how Cravely improves coordination, minimizes food waste, and promotes sustainable and responsible consumption within the community.

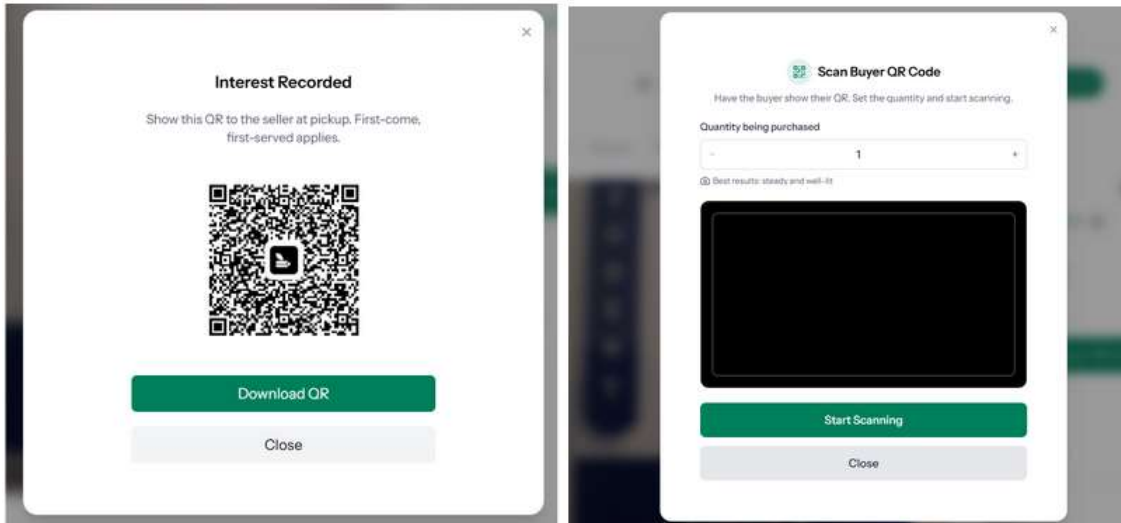
## System Architecture and Features

**Figure 3. Cravely Landing Page**



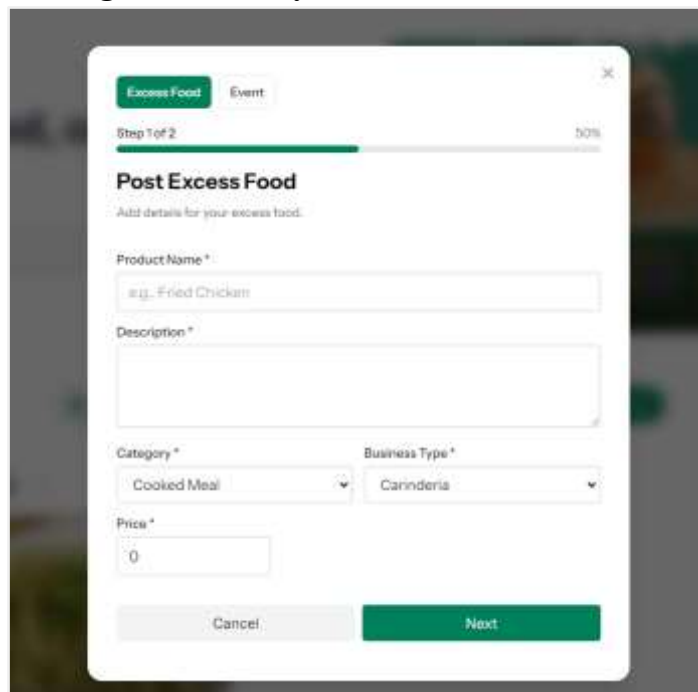
**Cravely Landing Page.** Serves as the platform's gateway, highlighting its mission of saving money, reducing food waste, and promoting sustainability. It features three primary calls to action: Get Started for registration, Explore Now for browsing surplus food listings, and Login for returning users to access their accounts.

Figure 4. Cravely QR Generation and Scanning



**QR Generation and Scanning.** Enables secure transaction validation through encrypted QR codes used for purchase verification and event participation. It enhances transaction accuracy, reduces manual errors, and improves system security and operational efficiency, while also allowing fast and reliable real-time verification of transactions between users within the platform.

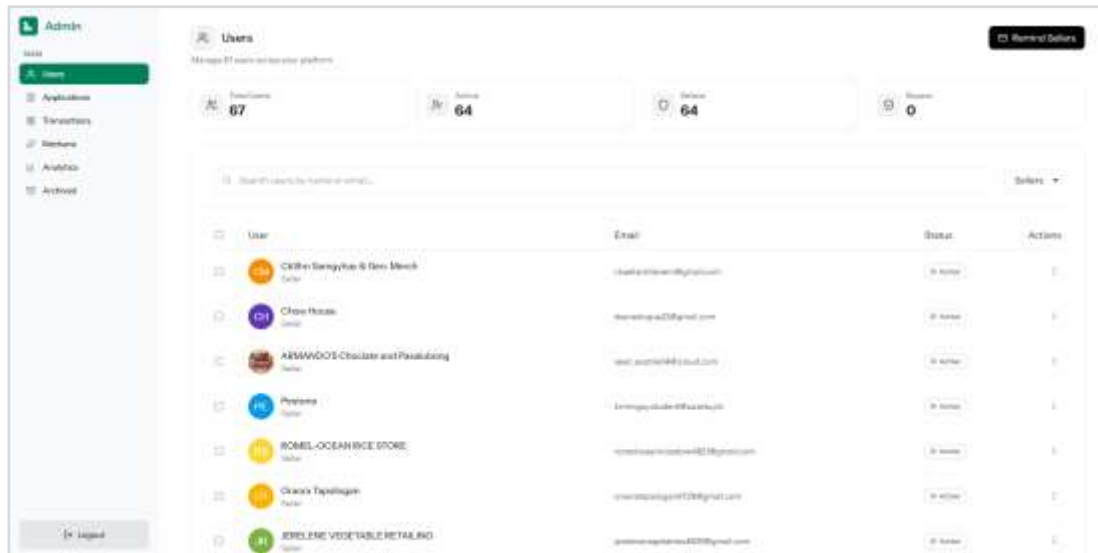
Figure 5. Cravely Seller’s Add Post Modal



**Seller’s Add Post Modal.** Allows sellers to create surplus food listings through a structured input form with image upload capability. It also integrates an AI-based methane estimation tool that evaluates product descriptions and weight to estimate environmental impact, supporting sustainability awareness, while ensuring that listings are properly organized, informative, and easily accessible to potential buyers within

the platform, thereby improving listing quality, decision-making, and overall user engagement in the system.

**Figure 6. Cravely Admin’s User Management**



**Admin’s User Management.** The dashboard provides administrative control over user accounts, seller approvals, transaction monitoring, and system analytics. It also includes environmental monitoring features that track estimated methane emission reductions from platform activities. It additionally supports centralized decision-making by consolidating operational and sustainability metrics into a single interface, allowing administrators to efficiently oversee system performance, ensure compliance, and maintain the overall integrity and reliability of platform operations.

**System Evaluation Results**

**Table 1: ISO/IEC 25010 Software Quality Framework Results for IT Professionals**

Characteristics	Mean	SD	Verbal Interpretation
Functional Suitability	3.85	0.37	Very High
Performance Efficiency	3.82	0.40	Very High
Reliability	3.82	0.40	Very High
Compatibility	3.82	0.40	Very High
Usability	3.76	0.39	Very High
Security	3.89	0.33	Very High
Maintainability	3.74	0.46	Very High
Portability	3.74	0.46	Very High
<b>Grand Mean:</b>	<b>3.81</b>	<b>0.40</b>	<b>Very High</b>

Table 1 presents the evaluation of the Cravely platform by IT professionals, focusing on ISO/IEC 25010 characteristics that require technical expertise, including functional suitability, compatibility, maintainability, and portability. The results show a grand mean of 3.81 (SD = 0.40), interpreted as “Very High,” indicating that IT professionals strongly agreed that the platform effectively meets its intended

functions, integrates well across environments, and is designed to support future modifications and deployment. These findings suggest that Cravely is technically sound, reliable, and maintains strong system quality from a software engineering perspective, further implying that the system is well-architected to support scalability, long-term sustainability, and potential enhancements in future iterations.

**Table 2: Technological Acceptance Model (TAM) Results For Users**

Construct	Mean	SD	Verbal Interpretation
Perceived Usefulness	3.65	0.50	Very High
Perceived Ease of Use	3.66	0.50	Very High
Behavioral Intention to Use	3.69	0.49	Very High
<b>Grand Mean:</b>	3.67	0.50	Very High

The results of the Technology Acceptance Model (TAM) for users, as presented in Table 2, evaluate perceived usefulness, perceived ease of use, and behavioral intention to use the Cravely platform. The findings yielded a grand mean of 3.67 (SD = 0.50), interpreted as “Very High,” indicating that users strongly perceive the platform as useful, easy to use, and supportive of continued engagement. These results demonstrate a high level of user acceptance, suggesting that Cravely is well-positioned for sustained adoption within the community.

**Table 3: Technological Acceptance Model (TAM) Results for IT Professionals**

Construct	Mean	SD	Verbal Interpretation
Perceived Usefulness	3.93	0.22	Very High
Perceived Ease of Use	3.71	0.45	Very High
Behavioral Intention to Use	3.85	0.29	Very High
<b>Grand Mean:</b>	3.83	0.32	Very High

Table 3 presents the Technological Acceptance Model (TAM) results for IT professionals, focusing on perceived usefulness, perceived ease of use, and behavioral intention to use. The results show a grand mean of 3.83 (SD = 0.32), which is verbally interpreted as “Very High,” indicating that IT professionals strongly agree that the Cravely platform is useful, easy to operate, and likely to be adopted in professional practice. These findings suggest strong acceptance of the system from a technical user perspective.

## Conclusion and Recommendations

### Conclusion

This study successfully developed Cravely, a technology-driven food waste reduction platform, using a mixed-methods research design and the Agile system development model. By integrating qualitative insights from food business stakeholders with quantitative evaluations from users and IT professionals, the study ensured that the system was both contextually relevant and technically robust. The iterative

nature of Agile development facilitated continuous refinement through stakeholder feedback, resulting in a platform that effectively supports usability, security, and system reliability.

The implemented features, including surplus food listing, inventory and user management, QR code-based secure transactions using AES encryption, and an AI-driven methane emission estimation module, demonstrate the capacity of digital systems to address food waste and sustainability challenges. In particular, the methane estimation feature enhances environmental awareness by translating food surplus reduction into measurable climate impact, thereby strengthening user understanding of the relationship between consumption behavior and greenhouse gas emissions.

Evaluation results further confirm the effectiveness of the system, with consistently high ratings in both ISO/IEC 25010 software quality characteristics and the Technology Acceptance Model (TAM), indicating strong system quality and user acceptance across stakeholder groups. Although Cravely does not entirely eliminate the broader structural issues surrounding food waste, it provides a scalable and secure framework that promotes responsible consumption and community-based food redistribution.

Overall, the study demonstrates that combining software engineering methodologies with sustainability-oriented design can produce systems that are not only functional but also socially and environmentally meaningful. Cravely contributes to ongoing efforts in leveraging information systems and artificial intelligence to support climate-conscious behavior and sustainable food systems at the community level.

## Recommendations

To address the gaps identified in the study and enhance community involvement in food waste reduction, a set of specific recommendations is presented. These suggestions are intended to improve awareness, foster trust, and ensure that Cravely effectively assists both residents and food businesses in minimizing food waste and reducing methane emissions.

1. **Mobile Application Development.** Develop a mobile app version of Cravely to increase accessibility for users who rely primarily on smartphones rather than desktop devices.
2. **Build Trust and Safety.** Ensure strict verification of sellers, display safety policies, and highlight food quality assurance to address liability concerns.
3. **Gamification and Incentives.** Expand the rankings feature by introducing rewards or incentives for top buyers and sellers to encourage greater participation and consistent food waste reduction practices.
4. **Scalability and Expansion.** Extend the platform beyond the initial study area to cover more districts and eventually the wider region, customizing features to local community needs.
5. **Integrate Logistics Support.** Explore partnerships with local couriers, community riders, or cooperative delivery systems to help sellers efficiently redistribute surplus food and expand buyer access.
6. **AI and Smart Predictive Features.** Investigate the integration of AI for features such as expiry prediction, food safety alerts, and demand forecasting. These innovations may improve platform efficiency and support smarter surplus management.

By implementing these strategies, Cravely can evolve from a localized initiative into a cornerstone platform for sustainable consumption, empowering communities to minimize food waste, reduce environmental impact, and actively contribute to climate change mitigation.

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ightful comments, and valuable recommendations, which significantly improved the overall quality and direction of this study.

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