

Sagip pagkain: A collaborative platform for food bank management and distribution system

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Abstract

This study aimed to design and implement a web-based platform to improve the recovery, coordination, and equitable distribution of surplus food through local food banks in selected municipalities in Laguna, Philippines. The system was developed using a developmental-descriptive design. Data were gathered via surveys, interviews, and observations from food donors, food bank coordinators, and beneficiaries. Features such as geo-mapping, real-time inventory monitoring, and a Decision Support System (DSS) powered by the Multi-objective Bee Colony Algorithm were integrated to optimize food donation allocation. The platform was functional, user-friendly, and compatible across devices. Stakeholders appreciated its ability to track donations, manage beneficiaries, and reduce manual errors. System evaluation based on ISO 25010 standards and the Technology Acceptance Model (TAM) revealed positive feedback across perceived usefulness, ease of use, and behavioral intention to use. The system was piloted only in three municipalities and lacked integration with logistics or automated data entry, affecting scalability and real-time applicability. Future iterations should expand geographic coverage and include automation tools to enhance accuracy and efficiency.

Keywords: *food security, community food distribution, decision support systems, optimization algorithms, GIS applications, data-driven decision-making*

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1. Introduction

Food insecurity and food waste remain urgent challenges despite global advances in technology and sustainability. Recent estimates highlight that more than one-third of food produced worldwide is lost or wasted each year, while hundreds of millions of people remain undernourished (Food and Agriculture Organization [FAO], 2020). This absurdity is particularly evident in low- and middle-income countries, where limited infrastructure and fragmented logistics intensify the gap between surplus and scarcity (Ghahremani-Nahr et al., 2022). The Philippines mirrors this global issue. Studies show that about 30% of Filipino households experience moderate to severe food insecurity, while significant volumes of edible food are wasted annually, much of which could be recovered and redistributed (Rosales et al., 2024). The mismatch between surplus food and hungry populations largely persists due to the absence of systematic, data-driven food redistribution mechanisms (Hasnain et al., 2021).

Food banks play a critical role in bridging this gap. They serve as community-based organizations that collect, store, and redistribute surplus food from donors such as retailers, farms, and institutions to low-income families (Nosratabadi et al., 2020). However, operational problems such as poor inventory management and manual record-keeping often lead to inefficiencies. For example, traditional food banks without digital tools can experience inventory discrepancies that reach up to 20%, which reduces the effectiveness of outreach programs (Raihan, 2024). In the Philippines, many local food banks still rely on paper-based coordination, making real-time tracking and equitable allocation difficult. During emergencies or disasters, these limitations result in slow mobilization and underserved households (Matias, 2021).

The Sagip Pagkain system was developed as a web-based platform designed to strengthen food recovery, coordination, and redistribution in the municipalities of Santa Maria, Siniloan, and Pagsanjan, Laguna. These sites were chosen because they represent diverse community contexts, rural and semi-urban, with existing food-relief programs, active cooperatives, and documented challenges in managing food surpluses. Such diversity makes them suitable for assessing system scalability across varying socio-economic conditions. The system integrates real-time inventory tracking, geo-mapping, and a Decision Support System (DSS) powered by a Multi-objective Bee Colony Algorithm. Inspired by bee foraging behavior, this algorithm optimizes allocation by balancing urgency, distance, and expiration, ensuring that surplus food is matched to the most appropriate recipients efficiently (Hasnain et

al., 2021; Ghahremani-Nahr et al., 2022). Through these features, Sagip Pagkain aims to minimize food waste, expand access to food for vulnerable communities, and provide a scalable model for food banks in developing regions.

Beyond operational improvements, this contributes to both academic and social development. Theoretically, it illustrates how prescriptive analytics, optimization algorithms, and geospatial data can be leveraged to address food security, a field still underexplored in low- and middle-income countries (Dubey & Tanksale, 2023). Practically, it demonstrates the potential of digital transformation to enhance outdated, manual processes and provide equitable food distribution. Furthermore, the study aligns with the United Nations Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger) and SDG 12 (Responsible Consumption and Production), by promoting responsible resource use and inclusive community engagement (United Nations, 2022).

The evaluation of the Sagip Pagkain platform involves both technical and user-centered approaches. From a software perspective, it is assessed using the ISO/IEC 25010 quality standards, which measure critical attributes such as functionality, usability, and portability in software tools. From the user's perspective, the Technology Acceptance Model (TAM) provides insights into how stakeholders, including donors, coordinators, and beneficiaries, perceive its usefulness, ease of use, and their intention to adopt the system (Rosales et al., 2024; Matias, 2021). By merging these evaluation frameworks, the study ensures a comprehensive assessment that not only validates the system's technical capabilities but also its acceptance and sustainability in real-world settings.

The system offers a replicable framework for community-driven food recovery that can be applied to similar municipalities across the Philippines and other developing regions. By combining optimization algorithms, digital tools, and inclusive practices, the system demonstrates how technology can meaningfully contribute to reducing food waste, improving food access, and supporting long-term food security goals.

2. Literature Review

2.1. Food Security and the Limits of Current Distribution Systems

Food security remains a critical issue in the Philippines despite longstanding efforts from both public and private sectors. A notable example occurred in early 2025, when the

government declared a food security emergency on rice as retail prices surged. This declaration enabled the release of half of the National Food Authority's 300,000-metric-ton buffer stock to stabilize prices. While this alleviated immediate pressures, it highlighted the government's reliance on reactive emergency measures rather than proactive, sustainable strategies for food distribution (Arroyo, 2025). This underscores the structural fragility in ensuring long-term, equitable food access.

Another challenge lies in the mismatch between suggested retail prices (SRP) and actual market prices of essential commodities such as rice. Despite government efforts to set SRPs, for instance, NFA rice at PHP 35 per kilo and imported rice capped at PHP 45 per kilo, retail prices often exceed these levels due to structural inefficiencies in transportation, weak market integration, and fragmented supply chains. These systemic issues persistently burden low-income households, who end up spending a large portion of their income on food (Department of Agriculture, 2025; Philippine Institute for Development Studies, 2024).

To counteract food insecurity, programs like the "Walang Gutom" initiative were developed by the Department of Social Welfare and Development. The program offers food credits to vulnerable households, which may be redeemed for essentials at accredited stores. However, access remains limited by technological constraints such as low digital literacy, insufficient device access, and patchy internet connectivity, especially in remote areas (Asian Development Bank, 2025). These issues complicate program enrollment and hinder monitoring efficiency. In response, NGOs and community-driven efforts have emerged to fill distribution gaps. Organizations like Rise Against Hunger Philippines and the Philippine Business for Social Progress have launched food surplus and redistribution efforts focused on food banks, but these are often constrained by lack of coordination and real-time data (Food and Agriculture Organization, 2023). Without centralized systems for surplus tracking and beneficiary mapping, even the best-intentioned efforts risk inefficiency and overlap.

Scholars argue that integrating digital technologies and predictive analytics could address many of these system-level problems. A study by Dela Cruz et al. (2024) highlights the importance of using data-driven models to forecast household food insecurity, streamline resource allocation, and improve program targeting. By applying machine learning algorithms to household and geographic data, the study demonstrated how predictive analytics can support decision-making and enhance resilience in food distribution during crises such as pandemics or natural disasters.

2.2. Food Bank Systems and Community-Based Distribution Models

Food distribution systems have transitioned from centralized models to more localized, digital approaches. During the COVID-19 pandemic, community pantries emerged as powerful grassroots responses to immediate food insecurity. The Maginhawa Community Pantry, established in April 2021 by Ana Patricia Non, epitomized the Bayanihan spirit, “give according to your ability, take according to your need,” and sparked hundreds of similar initiatives nationwide (Espartinez, 2021; Macaraan, 2022). However, these community-led efforts revealed significant limitations. While flexible and quick to mobilize, pantries lacked formal inventory systems and suffered from inconsistent food supply. Many relied on manual tracking methods, which hampered efforts to scale operations or systematically reach remote populations (Del Castillo & Maravilla, 2021). Moreover, without logistical planning tools, many areas were underserved despite overall abundance.

On the global stage, digital transformation is reshaping food bank operations. Programs like Feeding America’s MealConnect platform allow donors to log surplus food, automatically matching it with nearby food banks and optimizing pick-up routes via cloud-based algorithms (Feeding America, 2022). This innovation led to a 53% increase in produce surplus within a month, routing millions of pounds of food efficiently to where it was needed most (Olavsrud, 2022). Advanced analytics and transparency tools further enhance system resilience. Feeding America’s Service Insights app lets partner food banks collect user data in real time, supporting more equitable resource distribution and improving response speed (Feeding America, 2023). Meanwhile, integrations like Smarter Sorting enrich supply data with inventory validation, reducing food spoilage during transport (Ruggles, 2022).

A hybrid model that combines community engagement with digital innovation is ideal. By integrating basic inventory tracking, route planning apps, and volunteer coordination tools into community pantries, local networks can become more reliable and scalable. This dual approach maintains the spirit of Bayanihan while introducing technological accuracy, enabling responsive and equitable food access during both emergencies and long-term hunger challenges.

Predictive analytics has become a basis in modern food supply chain management, enabling organizations to forecast demand accurately and minimize food waste. Analyzing historical data, consumption patterns, and external factors such as weather and economic shifts, predictive models provide actionable insights that allow food banks and distribution systems

to improve efficiency and responsiveness. Research shows that applying predictive analytics in food supply chains can significantly reduce inefficiencies by anticipating demand surges and shortages. Big data and machine learning are now widely used for demand forecasting in supply chains, especially for perishable items like food. For example, Seyedan and Mafakheri (2020) reviewed how supply chain forecasting methods using artificial intelligence incorporate core variables such as seasonality, market trends, and consumer behavior. Douaioui et al. (2024) provided an updated view of the latest machine learning and deep learning models used in demand forecasting across supply chains. These methods collectively help improve accuracy, reduce waste, and enable better planning in food systems.

For food banks and NGOs, predictive analytics has been used to forecast demand and coordinate food distribution efficiently, ensuring indigent populations receive adequate assistance without excess inventory accumulation (Feeding America, 2022). The Philippines, facing unique challenges in food distribution due to geographic diversity and frequent disasters, has started to embrace predictive analytics for food security. Research from the Department of Science and Technology – Advanced Science and Technology Institute (DOST-ASTI) demonstrates how geo-mapping and AI analytics are being operationalized in disaster contexts. For example, the DATOS Project provides near-real-time hazard and flood extent maps that guide local government units (LGUs) and policymakers in resource allocation (DOST-ASTI, n.d.). Similarly, the PhilSensors app enables live monitoring of rainfall, water levels, and other parameters critical during emergencies (DOST-ASTI, 2023). ASTI has also advanced AI-driven flood detection models using multi-temporal Sentinel radar imagery (DOST-ASTI, 2020) and incorporated NovaSAR-1 satellite data to refine predictive flood mapping services (Dumalag et al., 2024). While these initiatives primarily focus on disaster response, they showcase the potential of combining geo-mapping, AI, and real-time dashboards as decision-support tools. This integration can be extended to food security systems, where predictive insights and spatial analytics could shift operations from reactive distribution toward proactive, evidence-driven planning.

Combining predictive analytics with DSS enhances the capability of food banks to simulate scenarios, allocate resources efficiently, and adapt to real-time changes. Studies highlight how integrating DSS with predictive analytics improves decision-making processes in complex supply networks, enabling stakeholders to balance supply and demand dynamically while minimizing food loss (Büyüközkan & Göçer, 2018). Predictive analytics does not

operate in isolation but enhances DSS tools by providing foresight into demand, which, when layered with geo-mapping insights, ensures that projections are geographically grounded and operationally actionable.

2.3. Decision Support Systems (DSS) in Food Banking

DSS plays an essential role in improving the efficiency and responsiveness of food bank operations. These systems assist in organizing and analyzing complex data sets to guide informed decisions, particularly in logistics, supply chain management, and beneficiary prioritization. As food insecurity continues to challenge many nations, DSS provides tools to predict food demand, plan distributions, and ensure that food assistance is delivered timely and equitably. Shim et al. (2002) explain that DSS has evolved to include real-time processing and integration with geographic and demographic data, making it highly adaptable to the dynamic needs of food distribution systems.

In practice, organizations like Feeding America have successfully implemented DSS tools to improve their food redistribution process. MealConnect, a digital platform powered by DSS, matches surplus food from retailers with local food banks, ensuring that perishable goods are utilized before spoilage occurs. This reduces food waste while increasing access for food-insecure households (Feeding America, 2023). The system relies on real-time data to match supply with need and provides a model for how technology can bridge logistical gaps in charitable food systems.

The World Food Programme has demonstrated the value of DSS through its Optimus system, which applies mixed-integer programming to optimize food basket composition and supply chain logistics. This tool has been deployed in contexts such as Iraq, South Sudan, and the COVID-19 response, yielding over USD 150 million in savings and supporting millions of food-insecure individuals (Peters et al., 2022).

At the local level, digital platforms have been increasingly adopted to manage food assistance during the COVID-19 pandemic, using data-driven systems to track distribution, avoid duplication, and prioritize underserved areas. Such digital tools, including GIS-enabled dashboards and online food-sharing applications, demonstrate how technology can optimize relief delivery and strengthen food security frameworks in crisis contexts (Makov et al., 2023).

Advanced analytics integrated into DSS are pushing food banks toward predictive and proactive capability. Machine learning and statistical models now forecast demand patterns,

identify seasonal spikes, and recommend inventory strategies to minimize spoilage (Feeding America, 2022). Research from Ruan (2024) demonstrates how machine learning approaches can guide food banks in optimizing their location and service reach, while Reusken et al. (2023) highlight that decision-support models within food bank supply chains can maximize food assistance by improving investments in transport, storage, and distribution. Similarly, academic work in the Philippines has explored predictive models for food insecurity (Fraiberger et al., 2021). These examples show that DSS, when layered with real-time monitoring and analytics dashboards, evolves from a reactive system into a forward-looking decision engine. By combining DSS with geo-mapping insights and predictive analytics, food banks can move beyond reactive distribution toward proactive, evidence-driven planning. Real-time dashboards and analytics further enrich this integration by providing transparency, coordination, and foresight, directly informing the system proposed in this study.

The reviewed literature highlights that while food insecurity and food waste persist due to systemic inefficiencies, digital innovations offer powerful pathways toward more equitable and efficient redistribution. Geo-mapping provides spatial awareness of food needs, while predictive analytics enables foresight into demand. These insights become operational through Decision Support Systems (DSS), which guide planning and allocation strategies. The integration of real-time dashboards and advanced analytics further strengthens these systems by providing continuous monitoring, predictive capabilities, and transparent reporting, allowing stakeholders to adapt quickly to emerging needs. Together, these tools form a complementary ecosystem: geo-mapping validates forecasts geographically, predictive analytics projects future demand, DSS translates these insights into action, and dashboards ensure accountability and agility in execution. This integration shifts food banks from reactive crisis management toward proactive, evidence-driven operations. Such a holistic, technology-enabled model not only enhances coordination among stakeholders but also builds long-term resilience in food security systems.

3. Methodology

3.1. Research Design

This study used a combined developmental and descriptive research design to build and evaluate the Sagip Pagkain system. For development we used a prototype-based, iterative approach with stakeholder feedback to refine features, following Agile principles where

planning, development, and testing happen in short cycles to improve usability and functionality (López et al., 2021). For evaluation we used descriptive methods to collect users' experiences through surveys and interviews and applied the Technology Acceptance Model to measure perceived usefulness, ease of use, and behavioral intention (Rosli et al., 2022). This combination helped us assess both technical performance and user acceptance.

3.2. Participants of the Study

The study involved 300 participants across three stakeholder groups: food donors (100); food bank coordinators (45); and beneficiary households (155). Participants were purposively selected from the municipalities of Santa Maria, Siniloan, and Pagsanjan, Laguna. These municipalities were chosen based on their active food relief programs, presence of cooperatives, and documented issues related to food surplus and hunger. Participants were identified and approached in coordination with LGUs, community cooperatives, and non-governmental organizations. For household beneficiaries, considerations such as gender, age group, and socioeconomic status were monitored to ensure representation of vulnerable sectors, although these factors were not used as strict selection criteria. This approach supported diversity and provided a realistic profile of stakeholders in local food bank operations.

3.3. Instrumentation and Data-Gathering Process

Three instruments were used for data collection: survey questionnaires to assess system usability, portability, and acceptability based on ISO 25010 and TAM; interview guides for qualitative feedback from coordinators and donors; and observation checklists to monitor user–system interactions during pilot testing. The instruments were reviewed by three experts: one faculty researcher in information systems, one ICT coordinator from an LGU, and one NGO program officer. Their feedback on clarity, relevance, and scope was incorporated, ensuring both face and content validity before deployment.

The data-gathering process involved several steps, beginning with coordination with LGUs and partner organizations such as PULSO and local cooperatives. This was followed by the distribution of informed consent forms to ensure ethical compliance. A pilot testing of the system was then conducted in three municipalities to evaluate its functionality and effectiveness. After system usage, surveys and interviews were administered to gather

participant feedback and insights. Finally, the responses were retrieved, tabulated, and prepared for analysis.

3.4. Data Analysis

Quantitative data were analyzed using both descriptive and inferential statistics. Mean and standard deviation were computed to evaluate usability and system quality across ISO 25010 metrics. Analysis of Variance (ANOVA) tested differences in user acceptance among stakeholders based on TAM constructs. Data from surveys were processed using SPSS software. Qualitative responses from interviews were subjected to thematic coding, focusing on recurring themes such as ease of use, system responsiveness, and areas for improvement.

3.5. Research Ethics

Ethical compliance was observed throughout the study. Approval to conduct the research was obtained from the LSPU College of Computer Studies Research Office. All participants received informed consent forms outlining the purpose of the study, their rights as participants, and assurances of voluntary participation and confidentiality. Data were anonymized, stored securely, and used solely for academic purposes. Participants were informed that they could withdraw at any time without consequences. Special precautions were taken to ensure digital safety and privacy, especially for household beneficiaries and volunteers with limited technological literacy.

4. Findings and Discussion

This section presents the results of the system development, pilot testing, and evaluation of the Sagip Pagkain platform. The discussion is organized according to the study objectives and integrates both system demonstration (Figures) and user evaluation (Tables).

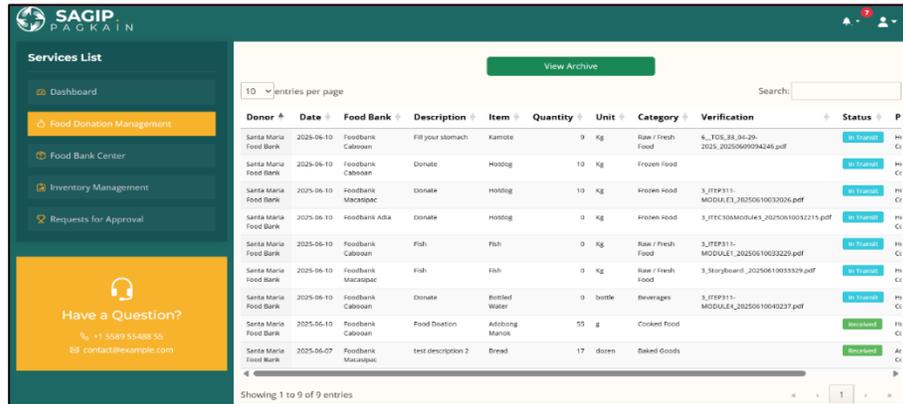
4.1 System Features and Implementation

The Sagip Pagkain platform was developed as a web-based system integrating food bank management, donor coordination, geo-mapping, and decision support functionalities. The design followed an Agile methodology with iterative refinement, ensuring features aligned with stakeholder needs. The interface allows administrators to organize and track donations across food banks. It displays key information such as donor details, donation items, quantities,

and status, enabling efficient monitoring and accurate record-keeping. The system reduces errors, enhances accountability, and supports streamlined donation management.

Figure 1

Food donation management

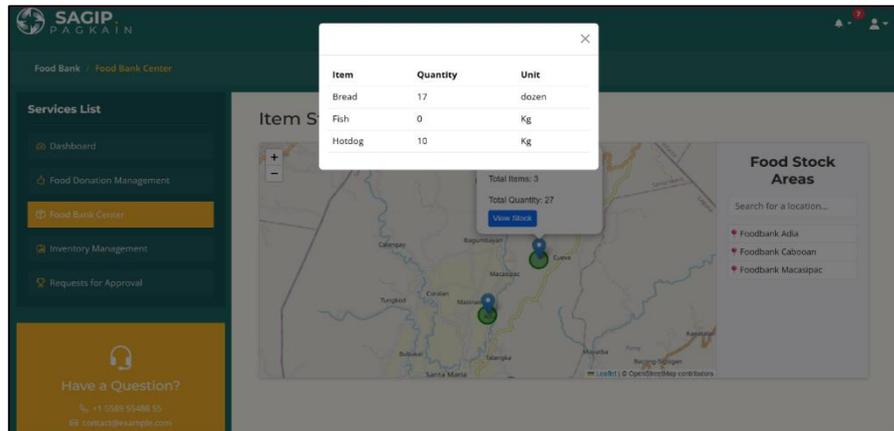


Doner	Date	Food Bank	Description	Item	Quantity	Unit	Category	Verification	Status	P
Santa Maria Food Bank	2025-06-10	Foodbank Cabooan	Fill your stomach	Kamote	9	Kg	Raw / Fresh Food	s_TOS_38_30-20_2025_20250609094246.pdf	In Transit	PH, CI
Santa Maria Food Bank	2025-06-10	Foodbank Cabooan	Donate	Hotdog	10	Kg	Frozen Food		In Transit	PH, CI
Santa Maria Food Bank	2025-06-10	Foodbank Macaspac	Donate	Hotdog	10	Kg	Frozen food	3_ITFP311-MODULE3_20250510032026.pdf	In Transit	PH, CI
Santa Maria Food Bank	2025-06-10	Foodbank Adla	Donate	Hotdog	0	Kg	Frozen food	3_ITFC308Module3_20250610032215.pdf	In Transit	PH, CI
Santa Maria Food Bank	2025-06-10	Foodbank Cabooan	Fish	Fish	0	Kg	Raw / Fresh Food	3_ITFP311-MODULE1_20250510033229.pdf	In Transit	PH, CI
Santa Maria Food Bank	2025-06-10	Foodbank Macaspac	Fish	Fish	0	Kg	Raw / Fresh Food	3_StorageId_20250610033329.pdf	In Transit	PH, CI
Santa Maria Food Bank	2025-06-10	Foodbank Cabooan	Donate	Bottled Water	0	bottle	Beverages	3_ITFP311-MODULE4_20250510040237.pdf	In Transit	PH, CI
Santa Maria Food Bank	2025-06-10	Foodbank Cabooan	Food Donation	Adobong Manok	55	g	Cooked Food		Received	PH, CI
Santa Maria Food Bank	2025-05-07	Foodbank Macaspac	test description 2	Bread	17	dozen	Baked Goods		Received	PH, CI

This feature (Figure 2) provides an interactive map of food bank centers and their inventory. Administrators can view stock levels, monitor item availability, and coordinate allocations. Geospatial mapping supports better logistical planning and equitable distribution of resources, reducing waste and improving operational efficiency.

Figure 2

Food bank locations and inventory



Item	Quantity	Unit
Bread	17	dozen
Fish	0	Kg
Hotdog	10	Kg

Inventory management (Figure 3) ensures systematic tracking of food supplies across multiple centers. The system categorizes items by type, quantity, and expiration, enabling

administrators to prevent spoilage, redistribute excess donations, and optimize stock allocation. This structured approach strengthens transparency and operational control.

Figure 3
Inventory Management

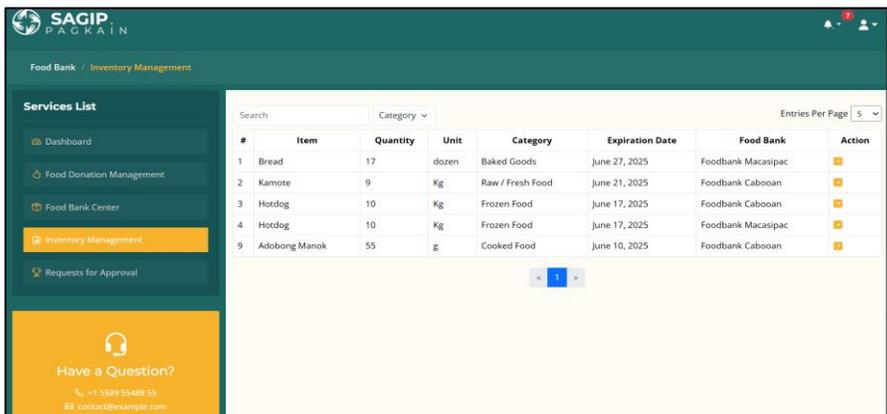
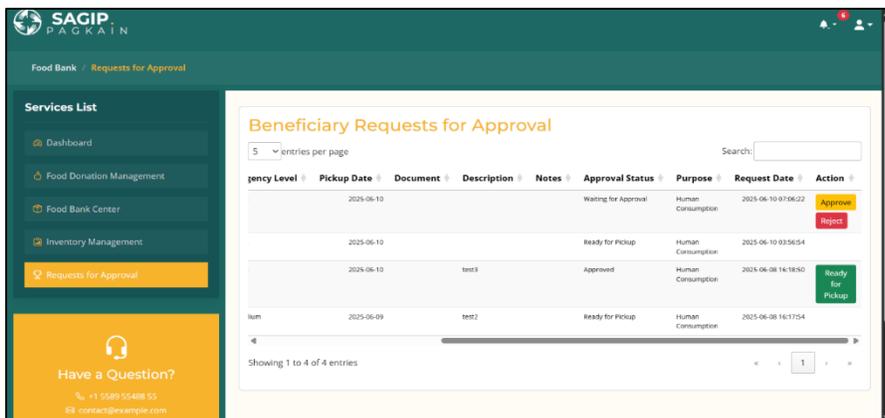


Figure 4 module manages requests for food assistance from beneficiaries. Administrators can evaluate and approve requests based on urgency, location, and availability. The DSS optimizes allocation by matching requests to the nearest capable food bank, ensuring timely, fair, and need-based distribution.

Figure 4
Beneficiary request and approval

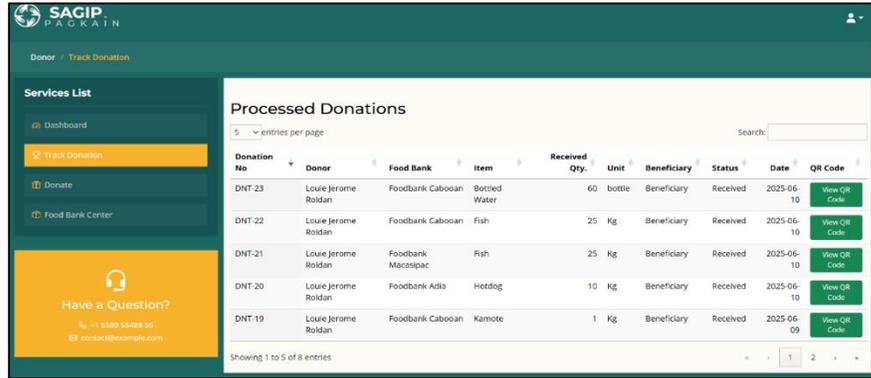


Donors can track the status of their contributions in real-time as shown in Figure 5. The interface provides details on donations, receiving food banks, and beneficiaries. This

transparency fosters trust and encourages continued participation while ensuring accountability throughout the donation process.

Figure 5

Donor monitoring and tracking



Donation No.	Donor	Food Bank	Item	Received Qty.	Unit	Beneficiary	Status	Date	QR Code
DNT-23	Louie Jerome Roldan	Foodbank Cabocan	Bottled Water	60	bottle	Beneficiary	Received	2025-06-10	View QR Code
DNT-22	Louie Jerome Roldan	Foodbank Cabocan	Fish	25	Kg	Beneficiary	Received	2025-06-10	View QR Code
DNT-21	Louie Jerome Roldan	Foodbank Macaspac	Fish	25	Kg	Beneficiary	Received	2025-06-10	View QR Code
DNT-20	Louie Jerome Roldan	Foodbank Adla	Hotdog	10	Kg	Beneficiary	Received	2025-06-10	View QR Code
DNT-19	Louie Jerome Roldan	Foodbank Cabocan	Kamote	1	Kg	Beneficiary	Received	2025-06-09	View QR Code

4.2 Advanced System Features: Geo-Mapping and Decision Support

The Sagip Pagkain platform integrates advanced tools to improve food surplus management in Santa Maria, Siniloan, and Pagsanjan.

Figure 6

Geo-mapping feature for food bank centers

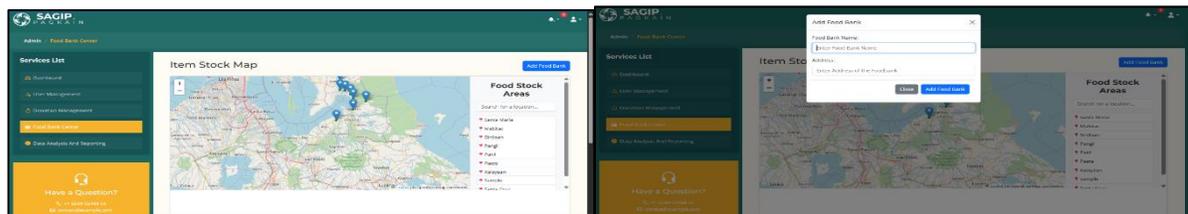


Figure 6 displays the Geo-Mapping Feature for Food Bank Centers, which serves as a centralized hub for managing food bank locations and tracking available food supplies. The interface features an Item Stock Map, visually highlighting food-stock areas across various locations with blue location pins. This enables users to navigate food bank locations efficiently and understand supply distribution at a glance. Additionally, the Food Stock Areas List provides a structured overview of specific food banks as well as an integrated search bar to quickly locate nearby centers. The system incorporates a DSS that automatically maps stock availability to the appropriate food bank based on beneficiary location and demand, optimizing allocation and reducing logistical inefficiencies (Yang, 2025). GIS-enabled mapping and

spatial decision support have been shown to improve equitable food access and resource distribution in food bank networks (Kaza, 2025).

Figure 7

Decision support system for optimized allocation

```

import math
# Haversine formula to calculate distance between lat/lon points
def calculate_distance(lat1, lon1, lat2, lon2):
    R = 6371 # km
    d_lat = math.radians(lat2 - lat1)
    d_lon = math.radians(lon2 - lon1)
    a = math.sin(d_lat / 2)**2 + math.cos(math.radians(lat1)) * \
        math.cos(math.radians(lat2)) + math.sin(d_lon / 2)**2
    c = 2 * math.atan2(math.sqrt(a), math.sqrt(1 - a))
    return R * c

# Example donation info (e.g., from a farm)
donation = {
    "type": "vegetables",
    "quantity": 100,
    "location": (14.5350, 121.0771) # Lat/Lon of donor
}

# List of foodbanks with lat/lon, demand, and capacity
foodbanks = [
    {"name": "Santa Maria", "location": (14.8190, 120.9567), "demand": 80, "capacity": 200, "stock": 50},
    {"name": "Siniloan", "location": (14.4197, 121.4881), "demand": 120, "capacity": 180, "stock": 90},
    {"name": "Pagsanjan", "location": (14.2611, 121.4503), "demand": 60, "capacity": 150, "stock": 70}
]

# Evaluate and rank foodbanks based on proximity, demand gap, and available capacity
def score_foodbank(fb):
    distance = calculate_distance(donation["location"], fb["location"])
    demand_score = max(0, fb["demand"] - fb["stock"])
    capacity_score = fb["capacity"] - fb["stock"]
    # Weighted scoring: prioritize demand > capacity > distance
    score = (0.5 * demand_score) + (0.3 * capacity_score) - (0.2 * distance)
    return score

# Rank and select best match
ranked = sorted(foodbanks, key=lambda fb: score_foodbank(fb), reverse=True)
best_match = ranked[0]

# Output suggested allocation
print(f"Suggested foodbank for allocation: {best_match['name']}")
    
```

The screenshot displays the Sagip Pagkain web application interface. The top section, titled "Available Food Items", features a search bar and a table with columns for Item, Quantity, Unit, Category, and Food Bank. The table lists items such as Adobong Manok, Bread, Hotdog, and Kamote. Below the table, there is a "Suggested Items to Request" section based on previous request trends. The bottom section shows a "Request for Assistance" form with fields for Beneficiary ID, Request Type, Items Needed (with a scrollable list including Hotdog, Bread, Fish, Kamote, and Talong), Urgency Level, Preferred Pickup Date, Recommended Food Bank (Foodbank Macaspac), and Purpose (Human Consumption).

Figure 7 shows the DSS workflow within Sagip Pagkain, which enhances how donated goods are assessed and allocated across participating food banks. The system processes input from diverse contributors, such as farms, establishments, and individuals, and helps administrators make informed decisions on distribution based on demand, stock levels, and

beneficiary need. This module's primary goal is to support fair and data-driven resource management. By applying a knowledge-driven DSS model, supported by the Multi Bee Colony Algorithm, the platform simulates collaborative decision-making to identify optimal food bank matches. The algorithm evaluates multiple factors, item type, availability, current demand, and capacity, to suggest the best possible allocation path. Through iterative refinement, the system reduces overstocking, minimizes gaps in assistance, and increases responsiveness to shifting needs.

The decision support system (DSS) is designed to connect smoothly with the inventory management tools already used by food banks. This connection allows the system to check stock levels in real time, keep track of shelf life, and monitor available items to ensure that decisions on allocating donations are well-informed and practical (Herteux et al. (2023).

Figure 8

Integration with inventory management systems

The screenshot displays the SAGIP PAGKAIN Inventory Management system. The top section shows a list of food items with columns for Item, Quantity, Unit, Category, Expiration Date, and Food Bank. The bottom section shows a detailed view of donation entries with columns for Donor, Date, Food Bank, Description, Item, Quantity, Unit, Category, Verification, and Status.

#	Item	Quantity	Unit	Category	Expiration Date	Food Bank	Action
1	Bread	17	dozen	Baked Goods	June 27, 2025	Foodbank Macaspac	[Icon]
2	Kamote	9	Kg	Raw / Fresh Food	June 21, 2025	Foodbank Cabooan	[Icon]
3	Hotdog	10	Kg	Frozen Food	June 17, 2025	Foodbank Cabooan	[Icon]
4	Hotdog	10	Kg	Frozen Food	June 17, 2025	Foodbank Macaspac	[Icon]
9	Adobong Manok	55	g	Cooked Food	June 10, 2025	Foodbank Cabooan	[Icon]

Donor	Date	Food Bank	Description	Item	Quantity	Unit	Category	Verification	Status	P
Santa Maria Food Bank	2025-06-10	Foodbank Cabooan	Fill your stomach	Kamote	9	Kg	Raw / Fresh Food	4_105_93_04-29-2025_20250609094246.pdf	In Transit	Hs Ci
Santa Maria Food Bank	2025-06-10	Foodbank Cabooan	Donate	Hotdog	10	Kg	Frozen Food		In Transit	Hs Ci
Santa Maria Food Bank	2025-06-10	Foodbank Macaspac	Donate	Hotdog	10	Kg	Frozen Food	3_ITFP911-MODULE3_20250610032026.pdf	In Transit	Hs Ci
Santa Maria Food Bank	2025-06-10	Foodbank Adia	Donate	Hotdog	0	Kg	Frozen Food	3_ITFC300Module3_20250610032215.pdf	In Transit	Hs Ci
Santa Maria Food Bank	2025-06-10	Foodbank Cabooan	Fish	Fish	0	Kg	Raw / Fresh Food	3_ITFP911-MODULE1_20250610033229.pdf	In Transit	Hs Ci
Santa Maria Food Bank	2025-06-10	Foodbank Macaspac	Fish	Fish	0	Kg	Raw / Fresh Food	3_Storyboard_20250610033329.pdf	In Transit	Hs Ci
Santa Maria Food Bank	2025-06-10	Foodbank Cabooan	Donate	Bottled Water	0	bottle	Beverages	3_ITFP911-MODULE4_20250610040237.pdf	In Transit	Hs Ci
Santa Maria Food Bank	2025-06-10	Foodbank Cabooan	Food Donation	Adobong Manok	55	g	Cooked Food		Received	Hs Ci
Santa Maria Food Bank	2025-06-07	Foodbank Macaspac	test description 2	Bread	17	dozen	Baked Goods		Received	Ar Ci

4.3 System Evaluation Using ISO 25010

The system was evaluated based on functionality, usability, and portability using the ISO 25010 framework.

Table 1*ISO/IEC 25010 evaluation summary – sagip pagkain system (N = 300)*

Quality Characteristic	Weighted Mean	Verbal Interpretation
Functionality	4.49	Good
Reliability	4.44	Good
Portability	4.30	Good
Usability	4.43	Good
Performance Efficiency	4.57	Very Good
Security	4.67	Very Good
Compatibility	4.70	Very Good
Maintainability	4.69	Very Good

Functionality and usability achieved "Good" ratings, reflecting the platform's effective support for donation tracking, user tasks, and interface clarity. Reliability and portability also performed well, though future improvements in fault recovery and seamless replacement could enhance their performance further. Performance efficiency, security, compatibility, and maintainability received "Very Good" evaluations. These characteristics validate the system's technical resilience, data protection features, integration capabilities, and structural integrity for long-term use. These findings are consistent with recent studies (e.g., Herteux et al. 2023; Angeles-Agdeppa et al., 2023) demonstrating that the application of ISO/IEC 25010 significantly improves the evaluation and reliability of civic technology platforms. Overall, the consolidated weighted mean scores ranging from 4.30 to 4.70 confirm that the Sagip Pagkain system is technically robust, operationally efficient, and user-aligned for deployment in food donation and distribution networks.

4.4 User Acceptance (Technology Acceptance Model – TAM)

User acceptance was measured using TAM constructs. The results show that the system performs at a consistently high level across all ISO/IEC 25010 domains. Functionality and usability achieved "Good" ratings, reflecting the platform's effective support for donation tracking, user tasks, and interface clarity. Reliability and portability also performed well, though future improvements in fault recovery and seamless replacement could enhance their performance further. Performance efficiency, security, compatibility, and maintainability received "Very Good" evaluations. These characteristics validate the system's technical

resilience, data protection features, integration capabilities, and structural integrity for long-term use.

Table 2

Summary of TAM evaluation results across stakeholder groups

Municipality	Stakeholder Group	PU (M)	PEOU (M)	ATU (M)	BIU (M)
Santa Maria	Food Donors	4.22	4.12	4.20	4.10
	Food Bank Coordinators	4.47	4.40	4.45	4.50
	Beneficiary Households	4.01	3.85	3.78	3.70
Siniloan	Food Donors	4.30	4.08	4.10	4.05
	Food Bank Coordinators	4.55	4.35	4.38	4.42
	Beneficiary Households	4.10	3.92	3.85	3.75
Pagsanjan	Food Donors	4.17	4.22	4.15	4.08
	Food Bank Coordinators	4.50	4.30	4.40	4.48
	Beneficiary Households	4.09	3.89	3.80	3.80

These findings are consistent with recent studies (e.g., Estdale & Georgiadou, 2018; Stefani et al., 2023) demonstrating that the application of ISO/IEC 25010 significantly improves the evaluation and reliability of civic technology platforms. Overall, the consolidated weighted mean scores ranging from 4.30 to 4.70 confirm that the Sagip Pagkain system is technically robust, operationally efficient, and user-aligned for deployment in food donation and distribution networks.

4.5 Statistical Analysis of Stakeholder Feedback

A Kruskal-Wallis's test was used to compare results among donors, coordinators, and beneficiaries.

Table 3

Summary of TAM results and significance test across stakeholder groups

TAM Construct	Highest Mean Score (Group/Municipality)	Lowest Mean Score (Group/Municipality)	Kruskal-Wallis H	p-value	Decision
PU	4.55 – Coordinators, Siniloan	4.01 – Beneficiaries, Santa Maria	0.478	0.791	Retain H_0 (NS)
PEOU	4.40 – Coordinators, Santa Maria	3.85 – Beneficiaries, Santa Maria	1.232	0.540	Retain H_0 (NS)
ATU	4.45 – Coordinators, Santa Maria	3.78 – Beneficiaries, Santa Maria	0.694	0.707	Retain H_0 (NS)
BIU	4.50 – Coordinators, Santa Maria	3.70 – Beneficiaries, Santa Maria	1.154	0.562	Retain H_0 (NS)

Legend: H_0 = Null hypothesis, NS = Not significant ($p > 0.05$)

Despite observable differences in mean scores, especially with food bank coordinators consistently rating the system higher, the results indicate no statistically significant differences in system acceptability across the three stakeholder groups for all four TAM constructs (PU, PEOU, ATU, and BIU). This finding highlights the platform's inclusive design and equitable user experience, regardless of user role or municipality. It also validates that the system was effective in addressing the diverse digital competencies and expectations of its users.

The results validate the effectiveness of the *Sagip Pagkain* system in addressing gaps between surplus food and food scarcity. The system represents a scalable, technology-enabled model for improving food security in local communities.

5. Conclusion

This study developed and evaluated Sagip pagkain, a collaborative platform for food bank management and distribution system, to address the growing need for a digitized solution that enhances food security, reduces surplus food waste, and streamlines coordination among donors, food banks, and beneficiaries. The platform successfully met its objectives by providing a web-based tool that supports real-time inventory tracking, donor-recipient matching, and data-driven decision-making through an integrated Decision Support System (DSS). Designed for multiple user roles, donors, coordinators, administrators, and beneficiaries—the system simulates real-world workflows, automates inventory processes, and generates reports that improve transparency and responsiveness.

Evaluation of the system using ISO 25010 and the Technology Acceptance Model (TAM) indicated strong functionality, usability, maintainability, and security. Expert assessments confirmed that the platform meets quality standards, while user feedback highlighted high acceptability, particularly from food bank coordinators. Although beneficiaries showed slightly lower ease-of-use scores, the majority found the system practical and relevant to their needs. Statistical testing using the Kruskal-Wallis H test further confirmed no significant difference in user acceptance across stakeholder groups, supporting the system's inclusive and equitable design.

The findings demonstrate that digital transformation in food redistribution is both feasible and impactful when designed around the needs of community stakeholders. This research contributes to the body of knowledge by illustrating how data analytics, decision-

support features, and stakeholder feedback can converge to create sustainable and scalable civic technologies. The results addressed the primary research questions on system effectiveness, usability, and user acceptance, confirming that Sagip Pagkain is technically robust and socially adaptable within diverse community contexts. Nonetheless, the study had some limitations. Implementation was restricted to three municipalities, and challenges in user onboarding were reported, particularly among beneficiaries with limited digital exposure. Additionally, while the platform performed well technically, integration with logistics and broader supply chain systems remains an area for future development.

In response to these findings, several recommendations are proposed. Improving the onboarding process through tutorials, local language support, and visual guides would increase adoption among less tech-savvy users. Enhancing the DSS with predictive analytics and scenario simulations could optimize food distribution, particularly during emergencies. Establishing LGU-level admin control, integrating offline functionality, and expanding partnerships with additional donors and local government units would support broader deployment. Finally, implementing regular updates and feedback mechanisms will help maintain system relevance, security, and community responsiveness. These steps will guide the evolution of Sagip Pagkain into a scalable national model for food bank digitization, promoting equitable food access and effective hunger reduction.

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AI Declaration

The author declares the use of Artificial Intelligence (AI) in writing this paper. In particular, the author used ChatGPT to assist in structuring content, summarizing findings, and drafting portions of the manuscript. Quillbot was utilized for paraphrasing ideas and improving sentence flow, while Grammarly was used to check for grammar, spelling, and clarity issues throughout the paper. The author takes full responsibility for reviewing, editing, and ensuring the accuracy, coherence, and ethical standards of all AI-assisted content used in the manuscript.

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