Chapter 1

INTRODUCTION

This chapter provides an overview of the project context, purpose and description of the study, objectives of the project, significance of the study, scope, and limitations of the project, and the project dictionary of the capstone project, "SurplusHub: A Sustainable Web and Mobile-Based Marketplace for Surplus Foods."

1.1 Project Context

In the past few years, growing awareness of ecological problems and the need to conserve resources has driven a surge in demand for sustainable practices. Consumerism and mass production cause excessive waste, and this waste heavily burdens landfills and natural resources [10]. The global challenge of waste generation and overproduction has reached critical levels, with mountains of discarded food contributing to environmental degradation and a large loss of valuable resources. While surplus food can help reduce food insecurity, challenges such as overproduction, limited storage, and inefficient distribution systems often lead to wastage. In the Philippines, the issue of surplus foods is particularly relevant. According to a food research study conducted by the University of the Philippines Los Baños, over 13 million people struggle to afford three meals a day, despite the nation wasting about 308,000 tons of food annually [2]. Globally, one-third of food is wasted, while 820 million people suffer from malnutrition. This imbalance is a critical issue that needs immediate attention [3]. Factors such as market fluctuations and excess production contribute to food surpluses, highlighting the urgent need for more effective systems to redistribute surplus food, thereby reducing waste and benefiting both sellers and consumers.

The rise of e-commerce has transformed how people buy and sell products, offering convenience and broader market access. However, ineffective selling platforms make it difficult for sellers in the Philippines to reach a broad audience and for buyers to find specific items aligned

with their limited budget. Online sellers experience challenges such as fair pricing, ensuring security, and seamless transactions. Additionally, a study on online food delivery identified that trust in e-commerce platforms is crucial for user acceptance and use. Factors such as perceived risk and the need for safety measures influence consumers' trust and their willingness to engage in online transactions. Buyers naturally verify the sellers' details and the authenticity of its products, with particular attention to the associated shipping costs. According to a 2023 survey conducted in the Philippines, approximately 54.45 percent of respondents found it challenging to do online shopping as there was no guarantee of product quality and security. Additionally, around 40 percent were concerned about the high shipping costs associated with online shopping [1]. These challenges highlight the need to help both buyers and sellers overcome the difficulties of using social commerce platforms. As a result, the researchers are working to create a web and mobile-based platform that will be able to build a reliable and efficient marketplace through product verification, secure payment options, and smooth buyer-seller communication.

In this study, the web and mobile-based platform will provide an efficient and transparent system for selling and buying surplus food within the Rinconada area—a district in Camarines Sur, Bicol Region, Philippines, which includes the towns of Baao, Balatan, Bato, Buhi, Bula, Iriga, and Nabua. The platform will feature various surplus food products, including items with minor packaging defects from manufacturers, excess produce from local farmers, and food nearing its 3-expiration date from grocery stores. To ensure consumer health and safety, the platform will implement clear policies aligned with national food safety regulations. Specifically, it will adhere to the Philippine National Standard (PNS) ISO 22000:2018 on Food Safety Management Systems, adopted by the Department of Trade and Industry's Bureau of Philippine Standards (DTI-BPS). This standard outlines requirements for organizations in the food chain to demonstrate their ability to control food safety hazards and ensure that food is safe for consumption [11]. Furthermore, all food products sold through the platform will comply with the Food Safety Act of 2013 (Republic

Act No. 10611), strengthening the country's food safety regulatory system to protect consumer health and support local food businesses. Food Safety Act of 2013 (Republic Act No. 10611) is an Act to strengthen the Food Safety Regulatory System in the Country to Protect Consumer Health and Facilitate Market Access to local foods and food products and for other purposes [12]. By aligning with these regulations, the platform aims to build consumer trust by ensuring that all surplus food products meet established safety and quality guidelines. Clear labeling and proper expiration dating will help buyers make informed purchasing decisions, addressing common concerns about the safety of surplus food.

Additionally, by creating a reliable marketplace where excess food from local farmers, manufacturers, and grocery stores can be sold instead of discarded, the platform reduces food waste. This not only benefits businesses by minimizing losses but also makes food more accessible to consumers at affordable prices. Ultimately, the platform supports a more sustainable food distribution system in the Rinconada area by promoting resource efficiency, reducing environmental impact, and encouraging responsible consumption.

1.2 Purpose and Description of the Project

This study seeks to address the issues related to surplus food and assess its effective distribution and consumption. This is influenced by the presence of various stores and warehouses in the Rinconada area that may have surplus food supplies. By developing the SurplusHub: A Sustainable Web and Mobile-Based Marketplace for Surplus Foods, it will reduce food waste and potentially enhance food security in the Rinconada area. This project will create a secure, trustworthy, and user-friendly digital marketplace that connects buyers and sellers. The system will help sellers reach their target market while ensuring buyers can access quality food products at discounted prices. Key features include seller verification, requiring compliance with food safety regulations through proper labelling, certifications, and expiration dates. To ensure secure

transactions, the system will include payment management to protect users from fraud. A messaging system will facilitate buyer-seller communication, and notifications will keep users informed about orders, listings, and promotions. This streamlined approach improves accessibility, security, and engagement within the marketplace.

Aside from its role as a marketplace, SurplusHub will also contribute to community engagement and sustainability, where the system will provide users with educational content on food waste reduction, proper food storage, and sustainability practices, encouraging sustainable consumption. Also, the reports management feature will generate statistics of sales performance, customer behavior, system behavior, marketing performance, and product performance. SurplusHub is not simply an online marketplace; it is a sustainable solution that uses technology to minimize food waste, offer affordable food choices, and cultivate a trustworthy and dependable marketplace. By incorporating trust-enhancing features, an easy-to-navigate search system, secure payment options, and community-focused participation, SurplusHub aspires to make a significant difference in surplus food distribution in the Rinconada area.

1.3 Objectives of the Project

The main goal of the project is to develop a localized web and mobile-based surplus food management platform. The study specifically seeks to:

1. Determine the challenges encountered by the local food industry in terms of handling surplus food;
2. Develop a localized web and mobile-based food management system;
3. Test the system using black box testing methods:
    3.1 Functional Testing
    3.2 Load Testing
    3.3 Security Testing

4. Deploy the web and mobile application.

1.4 Significance of the Study

The researchers conducted this study to provide a sustainable digital marketing platform for surplus foods. The SurplusHub's web and mobile-based application will benefit the customers by giving them a clear, protected, and well-organized platform for buying and selling surplus foods. The effectiveness of this research expands to the following:

Local Government Units (LGU). This research will provide significant benefits for Local Government Units (LGUs), specifically the Rinconada Area—a district of Camarines Sur, Bicol, Philippines, by offering them a structured and efficient system for managing surplus food. By utilizing the insights from this study, LGUs can enhance food distribution at the community level and reduce food waste. By creating an organized and well-regulated digital marketplace for surplus food will help strengthen the local economies and foster collaboration among businesses and organizations. This system will also support LGUs in helping them achieve the environmental and sustainable development goals more effectively.

Consumers. This study will benefit the consumers by providing them a platform that guarantees safe agreements through the implementation of seller verification and buyer review systems.

Food Business Industry. This research will contribute to the growth of food businesses of different models, such as the digital-based and physical-based, by building them a platform that is more secure and transparent transactions. By placing surplus food transactions into an organized, regulated, and established marketplace, the research seeks to form a platform through which buyers and sellers can easily be connected, giving a huge leap in changing the food business environment.

Researchers. This study allows them to hone their skills in web and mobile application development that will satisfies environmental and economic desires. This research contributes to academic understanding and foster further innovation in the field of surplus management.

Future Researchers. This research provides a starting point for future research on digital marketplaces, e-commerce security, and sustainability. Researchers seeking to advance online platforms, refine security protocols, and create sustainable commerce solutions can leverage this research to improve and innovate further.

1.5 Scope and Limitations of the Project

This study aims to address and provide a solution to the challenges encountered by food businesses in handling surplus foods by developing a web and mobile-based application marketplace that makes it easier for people in the Rinconada Area to trade excess foods. The food businesses in the platform will enlist their excess products with important information about them, while the buyers will check and purchase the available products they want. The system includes essential modules, including Login Module, User Management Module, Product Management Module, Search and Discovery Module, Messaging Module, Transaction Module, Reports Management Module, and Community Engagement Module. These features will work together to develop a sustainable and efficient environment for surplus foods transactions. Transparency, security, and user-friendliness will be prioritized as the system manages seamless transactions between buyers and sellers. The researchers will utilize black box testing to evaluate the system, such as functional testing, load testing, and security testing.

However, this study will only focus on five (5) participating local food businesses within Rinconada area. The system requires internet connection to access, it will not directly manage the transportation or storage of food. Instead, the platform will implement the pickup of product in stores only. In terms of payment, it has an option of cash on pickup and online payment gateways. Additionally, the mobile application will only support Android devices, limiting access for iOS users. The legal and regulatory aspects of food distribution and safety are not the subject of this study.

1.6 Project Dictionary

The following are the key technical terms relevant to this study, both conceptually and operationally, to establish clear and effective communication between the researchers and readers.

Black Box Testing. It involves testing a system with no prior understanding of its internal workings. A tester offers an input and observes the output produced by the system being tested [13]. In this project, it refers to the technique to be used to test and evaluate this proposed project.

Circular Economy. It is a model in which materials are never discarded as waste and nature is restored. In a circular economy, products and materials remain in circulation through methods such as maintenance, reuse, refurbishment, remanufacturing, recycling, and composting [14]. This study implements the circular economy idea by facilitating the buying and selling of surplus, hence minimizing waste and optimizing resource efficiency.

Digital Commerce. It refers to the online transactions of goods and services, encompassing various activities such as internet shopping, online banking, digital marketing, and electronic payment systems [4]. This system functions as a digital commerce platform where users interact via an online interface for product browsing, transactions, and communication.

Electronic Commerce (E-Commerce). It is buying and selling of products and services online [15]. This system operates as an e-commerce platform where users can browse, purchase, and list surplus foods with secure online transactions.

Functional Testing. It is defined as a type of testing that verifies that each function of the software application works in conformance with the requirement and specification [5]. In SurplusHub, this involves checking that all features of the platform—such as user authentication, product listings, ordering, payment processing, and notifications—work properly according to the specified system requirements. This process guarantees that buyers and sellers can use the system efficiently without running into any functional issues.

Load Testing. It is the type of testing that determines the application's behavior when multiple users use it simultaneously. It measures the system's response under varying load conditions [6]. load testing will assess the platform's ability to handle numerous users conducting transactions simultaneously, which includes various buyers exploring products, placing orders, and managing payments during busy periods. This procedure will determine if the system can maintain optimal performance during high user traffic.

PNS ISO 22000:2018. It is a globally recognized standard that outlines the criteria for a food safety management system (FSMS). Its purpose is to guarantee that entities within the food supply chain can reliably deliver safe products and services [16]. In SurplusHub, this standard guarantees that surplus food items available on the platform comply with food safety management guidelines. It offers instructions for vendors on how to uphold cleanliness, proper management, and storage of excess food products, guaranteeing their safety for eating. Adhering to this standard fosters trust between consumers and encourages accountable food redistribution

Security Testing. It plays a crucial role in software testing by identifying and addressing security vulnerabilities before they pose risks to you and your users [9]. In SurplusHub, security testing will be used to identify the security vulnerabilities before it pose risks to the end users and developers.

Surplus. It refers to the amount of an asset or resource that surpasses what is necessary and utilized. It can apply to income, profits, capital, and goods. A surplus occurs when products that have not been sold remain on store shelves or when income received is greater than the expenses incurred [7]. In SurplusHub, surplus refers to items listed on the platform by sellers as excess inventory, overstock available for resale.

Sustainability. It aims to avoid the exhaustion of natural or physical resources, ensuring their availability for the future [8]. This system will promote sustainability by enabling users to buy and sell surplus foods, reducing landfill waste and encouraging resource-efficient transactions.

Notes

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Chapter 2

REVIEW OF RELATED LITERATURE AND SYSTEMS

This chapter includes the related literature and systems from local and international sources relevant to the study 'SurplusHub: A Sustainable Web and Mobile-Based Marketplace for Surplus Foods. Furthermore, it contains the Synthesis of the State-of-the-Art, which will give an understanding of the key findings and their implications to the research. Finally, the Gap-Bridged by the Study uncovers the relevance and edge of our proposed system from the existing research undertakings.

2.1 Related Literature and Systems

The following articles will help gain a clearer picture of surplus food management and the digital marketplaces that help in sustainable consumption, which will be useful for the present study. This review will also include both international and local literature and systems that will look at the strategies, technologies, and platforms that are used in reducing food waste and sustainability. These insights will aid in the development of SurplusHub: A Sustainable Web and Mobile-Based Marketplace for Surlus Foods.

2.1.1 Implementation of Digital Marketplace in the Food Industry

Digital marketplaces in the food industry transformed traditional supply chains by enhancing market efficiency, transparency, and accessibility. In the study of Suali, A.S., Srai, J.S. and Tsolakis, N. [2024] from University of Cambridge, Cambridge, UK, digital marketplaces have played a crucial role in ensuring food supply chain continuity and improving market agility during the COVID-19 pandemic [19]. The researchers emphasized that supermarkets, food retailers, and suppliers leveraged e-commerce platforms to maintain operations and respond to shifting consumer demands, demonstrating the importance of digitalization in the modern food industry. Moreover,

digital food platforms provide a highly customizable, multisided marketplace, allowing businesses to aggregate product offerings and customers, thereby creating shared value across the network. The study also emphasized that one of the key transformations enabled by digital marketplaces is platform-induced disintermediation, which reduces reliance on traditional middlemen by allowing direct transactions between farmers, suppliers, retailers, and consumers. This system enables faster transactions, cost savings, and improved efficiency, as businesses no longer have to go through multiple intermediaries. Additionally, real-time data exchange between supply chain partners helps businesses track inventory, demand, and pricing, ensuring more accurate decision-making. It was also highlighted that the platforms also play a critical role in food safety and compliance by monitoring product origins, storage conditions, and delivery processes, which is particularly essential for supermarkets and food retailers.

In the Philippines, the growing adoption of online platforms has allowed farmers, food manufacturers, and consumers to engage in more direct and transparent transactions, reducing reliance on intermediaries. Briones et al. [2023] in their study "Transforming Philippine Agri-Food Systems with Digital Technology: Extent, Prospects, and Inclusiveness", examined the integration of digital marketplaces within the Philippine agriculture sector [3]. The researchers' findings highlight how these platforms enhance market efficiency and accessibility, particularly for smallholder farmers, by improving price transparency, logistics, and reducing post-harvest losses. Digitalization in agriculture supports market expansion and creates new economic opportunities, reinforcing the importance of continuous technological adoption to sustain growth in the food industry.

Building on these findings, Duldulao, Concepcion, and Duldulao [2023] examine the development of a multi-vendor e-commerce platform designed to empower smallholder farmers in Quirino Province, Philippines [4]. Their research highlights that while Quirino Province is a major

food producer, farmers face significant challenges in transportation, market access, and surplus management, particularly during crises such as the COVID-19 pandemic. To address these issues, the researchers developed a platform that enables farmers to establish online stores, manage product listings, and access transport services, including flat-rate shipping and local pickup options. The platform integrates various digital payment methods, including cash on delivery, DragonPay, Globe GCash, and UnionPay, ensuring accessibility for both farmers and consumers. The system, evaluated using ISO 25010 software quality standards, demonstrated high compliance, confirming its technical readiness for deployment. Furthermore, the study recommends future improvements such as data analytics integration, mobile application development for iOS and Android, and the exploration of diverse business models to enhance the scalability and sustainability of the platform. These findings emphasize the potential of digital marketplaces in revolutionizing the agricultural sector, particularly in bridging the gap between rural farmers and broader consumer markets.

The impact of digital marketplace adoption in the food industry was further highlighted during the COVID-19 pandemic, which accelerated the need for alternative sales channels. Oblena and Anapi [2023] examined how farmers in Naic, Cavite leveraged e-commerce platforms to sustain sales during the pandemic [15]. Their research highlights that digital marketplace served as a crucial sales channel for farmers, allowing them to sell products directly to consumers despite movement restrictions. The study utilized the Technology Acceptance Model (TAM) to analyze factors that influenced farmers' engagement with e-commerce solutions, emphasizing that successful implementation depended on user-friendly platforms, transaction security, and logistical support. These findings reinforce the idea that digital marketplace adoption is not only a technological shift but also requires strategic implementation to maximize accessibility and usability for smallholder farmers.

Beyond improving market access, digital marketplaces are also instrumental in reducing food waste and enhancing food access. A study by Ayala, V et, al. [2023] examined how mobile applications facilitate surplus food redistribution [2]. The researcher underlined that over an 11-month period, the initiative involved 50 food businesses and successfully recovered 43,900 pounds of food, delivering it to 34 community sites and providing approximately 28,400 meals. The research highlights how mobile technology and strategic partnerships can effectively divert food waste while ensuring food reaches those in need. These findings reinforce the importance of user-friendly platforms and collaborations in addressing food surplus challenges through digital solutions.

2.1.2 Web and Mobile-Based Business Application

The rapid advancement in web and mobile technology has revolutionized the way businesses operate, particularly in the food industry. Companies are no longer limited to traditional brick-and-mortar establishments or third-party marketplaces like social media. Instead, dedicated web and mobile applications provide businesses with greater control over their operations, branding, and customer engagement. These applications allow food businesses to develop tailored experiences, optimize logistics, and improve sales strategies beyond what social media platforms can offer. One significant advantage of web and mobile applications is their ability to support direct-to-consumer (DTC) models in the food business. While social media platforms such as Facebook Marketplace or Instagram Shops provide exposure, they lack features like automated order processing, real-time inventory tracking, and integrated logistics. Dedicated web and mobile applications, on the other hand, offer full e-commerce functionalities, allowing food businesses to manage orders efficiently, implement loyalty programs, and provide seamless customer service.

The utilization of web and mobile-based applications has played a crucial role in modernizing business operations and enhancing profitability in the food industry. Putra et al. [2023]

explored this impact in their study titled "Website and Mobile-Based Application Utilization to Increase & Upscale MunchUp Selling Margin", presented at the 2023 10th International Conference on ICT for Smart Society (ICISS). The study examined how integrating digital platforms into food businesses can significantly improve sales margins and operational efficiency [17]. The findings indicate that web and mobile-based applications enable businesses to optimize their marketing strategies, enhance customer engagement, and implement data-driven decision-making through real-time analytics. The researchers emphasizes that dedicated applications provide greater control over branding, customer interactions, and inventory management compared to third-party platforms. Furthermore, it highlights how digital tools support automated order processing, customer loyalty programs, and personalized recommendations, leading to higher consumer retention and business scalability. Therefore, the insights from Putra et al. [2023] contributes to the growing evidence that mobile applications are essential for modernizing food commerce, supporting sustainability, and improving surplus food management by increasing market accessibility and improving sales performance. Additionally, the study aligns with other literature advocating for real-time data integration and digital transaction security, which are critical for optimizing digital food marketplaces.

Expanding on the findings of Putra et al. [2023], Muñoz [2020] further emphasizes the transformative power of mobile technology for local producers, particularly in agricultural sectors. In her study entitled "System Development of Market Mobile Application for Sustainable Local Industry in The Philippines," mobile technology is presented as a tool that enables farmers and fishermen to engage directly with consumers through a DTC marketplace [14]. This approach is especially relevant as it allows producers to bypass intermediaries, optimizing sales transactions and enhancing economic opportunities for local food producers. The findings underscore the importance of mobile applications in reducing poverty, fostering digital entrepreneurship, and

promoting sustainable economic growth. Similar to Putra et al. [2023], Muñoz [2020] highlights how dedicated mobile platforms offer more structured transaction systems, real-time inventory updates, and secure payment channels compared to social media-based selling, ensuring a more stable and profitable marketplace. Thus, both studies contribute to the growing adoption of DTC models in the food industry, showcasing how customized mobile applications provide greater control over business operations, customer engagement, and revenue generation.

Adding to this discussion on digital tools in food distribution, particularly in reducing waste and promoting sustainability, a study conducted by Eriksson and Stenius [2024], it highlights how mobile applications enhance surplus food distribution by offering real-time inventory updates, automated discounting, and personalized recommendations [5]. The study applies a research model integrating Technology Acceptance Model (TAM) and Behavioral Intention Theory to analyze user behavior. The authors highlight key determinants such as perceived usefulness, ease of use, trust, and environmental awareness, which drive consumer engagement with surplus food apps. The findings from Eriksson and Stenius [2024] support the growing role of mobile applications in reducing food waste and optimizing food distribution. In the food industry, particularly for surplus food marketplaces, mobile apps provide a direct-to-consumer (DTC) model that enhances efficiency compared to traditional retail or social media-based selling. Unlike third-party marketplaces, dedicated apps provide greater efficiency, stronger customer engagement, and trust-building features such as secure payments and verified seller reviews. Additionally, these apps support sustainability efforts through incentives like carbon footprint tracking, reinforcing their advantage over social media platforms in facilitating surplus food commerce.

Furthermore, Magno and Cassia [2024] study investigated the key determinants that drive restaurants to maximize using food online platforms for the purpose of distribution of their surplus food. Their study also employs Partial Least Squares Structural Equation Modeling (PLS-SEM)

and Necessary Condition Analysis (NCA) to identify factors such as economic benefits, ease of use, platform reliability, and environmental commitment as critical predictors of sustained engagement with surplus food applications [11]. The findings reveal that while financial incentives play a crucial role, restaurants are also influenced by perceived platform effectiveness, trust, and sustainability goals, reinforcing the necessity for well-designed digital solutions in food redistribution. Furthermore, the study compares various predictive models to enhance the accuracy of forecasting restaurant behavior in surplus food technology adoption. This study strengthens the argument that web and mobile-based platforms are indispensable tools in reducing food waste and promoting a circular economy in the food industry.

2.1.3 System Testing Through Black Box Testing

Black box testing is a system testing approach that evaluates a running application externally, without relying on internal details like source code or configurations. In web application security testing, it involves simulating user interactions and access scenarios to analyze how the system responds to different inputs and authentication states. A key strategy is crawling the application from various user perspectives, identifying legitimate access points, and systematically testing access controls for potential bypasses. Techniques such as multiple crawlers, advanced filtering mechanisms, and content similarity validators help detect vulnerabilities while minimizing false positives. This methodology is highly adaptable across different web technologies and frameworks with minimal configuration. This continuous testing model aligns with Marculescu et al. [2022] findings, in which the study aims to identify faults in four major categories Configuration and Execution Faults stem from issues in web framework setup, mocking structures, or external systems. Schema Conflicts arise from mismatches between the OpenAPI schema and the analyzed system [9]. The researchers highlighted how black box testing serves as a crucial method for identifying these security risks, reinforcing the importance of comprehensive testing strategies in

web application development. The study of Duarte Felício et al., [2022] entitled RapiTest: Continuous Black-Box Testing of RESTful Web APIs an open-source black-box testing tool for RESTful web APIs, ensuring robustness, security, and reliability [6]. The researchers implemented black-box testing for RESTful web APIs by automating test generation and utilizing Test Specification Language (TSL) for structured test cases. By verifying security and correctness every 24 hours, the system maintains API robustness and reliability. This approach underscores the importance of continuous monitoring in web application development.

To illustrate the application of black box testing in validating software functionality through specific techniques, a study conducted by Ningrum et al. [2022], entitled "Black Box Testing on the Best Sales Selection System Application Using Equivalence Partitions Techniques", Black box testing ensures that the program functions as intended, matching the assigned requirements [12]. The researchers demonstrate how black-box testing verifies software functionality, ensuring it meets assigned requirements. This method highlights its role in confirming software correctness while recognizing its limitations in broader performance and security assessments. The study evaluates the system's accuracy in monitoring facilities and infrastructure, measures error gaps in system menus, and assesses overall software performance. By identifying and minimizing troubleshooting issues, black-box testing helps ensure the system is stable and safe for use.

In line with these studies, Maryona Septiara et al. [2023] also emphasize the importance of functional testing in ensuring the accuracy of software applications. Their research entitled "Black Box Testing Using the Equivalence Partitions Technique to Test the Functionality of the Ternaku.id Website" underscores the significance of executing software tests to identify bugs and validate correct functionality [1]. By employing black-box testing methods, the researchers aim to detect issues such as incorrect functions, interface inconsistencies, performance flaws, and errors in data

structures, initialization, and termination. Their approach further supports the earlier studies by emphasizing the importance of rigorous testing to ensure that software performs as intended, particularly in applications where functionality and usability are critical.

Building on the importance of black box testing for system functionality, Jasmine Aulia Mumtaz et al. [2024, titled “Functional Testing of the JivaJoy Online Product Stock Management and Ordering System Software Using Black Box Testing”, the study evaluates the functionality of JivaJoy, an online platform for inventory management and order processing [13]. The researcher examines core features, including profile management, CRUD operations for administrative and customer accounts, inventory control, shopping cart functionality, order processing, and AI-based counseling. Black box testing was conducted to assess these components without considering internal code architecture. The results show that most features function as expected, but issues were found in input validation, such as email formats, phone number lengths, file uploads, and inventory management. Additionally, order management and AI counseling exhibited flaws in error handling and validation. The study recommends improvements in input validation, inventory management, shopping cart operations, and AI counseling to enhance reliability and user satisfaction. This practical application mirrors the broader trends identified in the previous studies, reinforcing how black-box testing continues to play a pivotal role in ensuring functionality and usability across various software systems.

The researchers aim to evaluate the TEA feature within the QM Mobile application for Android, ensuring its functionality through manual black box testing. This method, combined with state transition testing, examines how the application responds to valid and invalid inputs across different states. Similarly, black box testing of SurplusHub assesses usability, functionality, and performance, verifying expected input-output behavior based on system requirements. Key areas tested include product listing accuracy, bidding and purchasing efficiency, and system reliability.

By identifying usability issues, security vulnerabilities, and functional inconsistencies, this approach enhances SurplusHub's overall reliability and user experience.

2.1.4 Adoption of Extreme Programming Methodology

The systematic review of Extreme Programming (XP) methodology highlights its extensive use across different development settings because of its flexibility and ability to adjust to evolving project needs. Organizations have adopted XP mainly for its ability to improve customer satisfaction and guarantee software quality by maintaining ongoing user engagement and feedback. This method is especially beneficial in settings were needs change quickly. The document also underscores the successful application of XP across various case studies, stressing its real-world uses in different environments. Moreover, it highlights particular motivations for adoption, including enhanced project management and efficiency, making XP a favored option for teams aiming to tackle the intricacies of software development in contemporary methods. In general, the results show the effective incorporation of XP in multiple research projects, highlighting its significance and efficiency in addressing modern development issues [18].

Building on these findings, one of the practical applications of XP in healthcare-related systems, Purna et al. [2025] conducted a study that aims to develop a web-based Dental Clinic Information System using the Laravel framework and the Extreme Programming (XP) method as its development approach. The system is specifically designed to manage essential functions such as electronic medical records, examination schedules, medicine stock, and patient billing efficiently [16]. The researchers emphasized the development of a web-based Dental Clinic Information System utilizing the Extreme Programming (XP) methodology to effectively address the operational challenges faced by small to medium-sized dental clinics. This system aims to enhance operational efficiency by streamlining key functions such as electronic medical records

management, examination scheduling, medicine stock control, and patient billing, ultimately reducing manual errors and improving administrative processes.

Further extending the role of XP, Sihombing [2024] investigates its application in improving field service management within construction projects, in which the study aims to enhance efficiency in field service management within construction projects by applying the Extreme Programming (XP) methodology. The research specifically seeks to address the inherent challenges related to the complexities and dynamics of construction environments, which often lead to inefficiencies and operational bottlenecks [8]. By adopting XP, the study demonstrates how the methodology improves operational efficiency through features such as real-time monitoring, adaptive planning, task management, and field change notifications. The research also emphasizes the importance of field service management in maintaining quality execution, customer satisfaction, and the overall reputation of construction projects, which mirrors the findings from Purna et al. (2025), where XP is applied to improve operational processes in a healthcare setting.

In contrast to the field service management context, a study by Hidayatuloh et al. (2024), titled “Implementation of Extreme Programming in the Design of Hospital Daily Report Recapitulation System”, aims to address the challenges posed by manual data handling methods currently in use, by utilizing the Extreme Programming (XP) methodology to create an effective software solution [7]. The researchers emphasized the critical need for hospitals to transition from manual data processing methods to an automated system for handling daily reports, as current practices are inefficient and prone to errors. This is similar to the operational challenges faced by dental clinics, as highlighted in Purna et al. [2025]. The comparison shows that XP’s flexibility is beneficial not only in managing clinical data but also in enhancing reporting and administrative processes in different settings, further validating its wide applicability.

Moving towards another domain, Laleb et al. [2022], aims to develop a web-based information system for the Mutiara Timor Waste Bank that enhances the management of waste data. The study seeks to address the inefficiencies associated with the current manual waste management practices, which lead to data redundancy and errors [10]. The researchers emphasize the urgent need for effective waste management in Kupang City, which is increasingly burdened by waste due to population growth and consumption patterns. They pointed out the limitations of the current manual data management system utilized by Mutiara Timor Waste Bank, which results in inefficiencies such as data mismanagement and redundancy, alongside a higher risk of human error. The adoption of the Agile development methodology, particularly using Extreme Programming (XP), is emphasized as an appropriate approach to ensure the system can adapt to changing customer requirements and facilitate iterative enhancements.

Lastly, the adoption of XP in educational settings also shows significant potential for improving system efficiency, a study by Supriyatna and Puspitasari [2021] entitled "Implementation of Extreme Programming Method in Web Based Digital Report Value Information System Design", aims to develop a web-based digital report card information system to address the challenges faced by schools in the processing of student grade data. The system is intended to provide a solution that facilitates the work of teachers and school administrators, allowing for more efficient, accurate, and timely management of student grades, ultimately enhancing the educational process. The researchers emphasize the importance of developing a web-based digital report card information system using the Extreme Programming (XP) methodology. They highlight the need for faster, more precise, and accurate processing of student grades, which can alleviate the workload of teachers and improve the accessibility of academic information. The goal is to enhance the efficiency and effectiveness of information management within educational institutions [20].

2.2 Synthesis of the State-of-the-Art

After reviewing the related literature and conducting system analysis, this synthesis connects key technological developments across multiple domains. It mainly discusses the similarities and differences in various research topics, such as digital marketplaces, web and mobile applications, system testing methodologies, and specialized technologies. Rather than repeating research findings, it aims to enhance understanding of current innovations and their interconnections. Digital marketplaces have developed traditional food supply chains by enhancing efficiency, transparency, and accessibility. Suali et al. [2024] showed how these platforms ensured food supply chain continuity during the COVID-19 pandemic, enabling supermarkets, sellers, and suppliers to maintain operations despite disruptions. Their research highlights a critical transformation: platform-induced mediation, which allows direct transactions between farmers, suppliers, sellers, and consumers without traditional intermediaries. In the Philippines, Briones et al. [2023] examined how digital marketplaces enhance market efficiency for smallholder farmers by improving price transparency and reducing post-harvest losses. This is complemented by Duldulao et al. [2023], who developed a multi-vendor e-commerce platform for farmers in Quirino Province, addressing transportation challenges and market access limitations. Their platform integrates various digital payment methods and meets ISO 25010 software quality standards. The COVID-19 pandemic enhanced digital marketplace adoption, as shown by Oblena and Anapi [2023], who studied how farmers in Naic, Cavite leveraged e-commerce platforms during movement restrictions. Beyond improving market access, Ayala et al. [2023] demonstrated how digital platforms reduce food waste, highlighting how mobile applications facilitated the recovery of 43,900 pounds of food over an 11-month period, providing approximately 28,400 meals.

Compared to traditional or third-party platforms, web and mobile applications offer more control over branding, customer engagement, and logistics, revolutionizing business operations in

the food industry. Through data-driven decision-making via real-time analytics and optimized marketing strategies, Putra et al. [2023] discovered that these applications dramatically increase sales margins and operational efficiency. According to Muñoz [2020], mobile technology is a game-changing tool that enables local producers to interact directly with consumers, reducing the need for middlemen and expanding economic opportunities for farmers and fishermen. Secure payment methods, real-time inventory updates, and structured transaction systems are all provided by this direct-to-consumer (DTC) business model.

Magno and Cassia [2024] investigated what motivates restaurants to keep using surplus food platforms, and they found that economic benefits, ease of use, platform reliability, and environmental commitment are important predictors of sustained engagement. Eriksson and Stenius (2024) recently studied how mobile applications improve surplus food distribution through real-time inventory updates, automated discounting, and personalized recommendations. Their research connected the Technology Acceptance Model (TAM) with Behavioral Intention Theory to identify key factors driving consumer engagement.

Black box testing evaluates software functionality by focusing on input-output relationships without examining internal code structure. Marculescu et al. [2022] identified four major fault categories in web applications: configuration and execution faults, schema conflicts, data integrity faults, and business logic faults. This approach is valuable for detecting errors but has limitations regarding response validation, endpoint workflows, load testing, and security vulnerability assessment. Ningrum et al. [2022] applied black box testing with equivalence partitions techniques to evaluate a sales selection system, uncovering discrepancies between expected and actual system behaviors. Their research emphasized the importance of comprehensive testing to identify error gaps in application forms. Jasmine Aulia Mumtaz et al. [2024] conducted black box assessment of JivaJoy software, an online platform for inventory management and order

processing. Their testing uncovered concerns regarding input validation for email formats, telephone number lengths, file upload protocols, and inventory management. The study recommended enhancements in validation protocols to improve reliability and user experience. Black box testing proves particularly valuable for evaluating marketplace platforms like SurplusHub, focusing on the accuracy of product listings, efficiency of bidding processes, and overall system reliability without examining internal code structure.

Extreme Programming (XP) methodology has been widely adopted across different development settings due to its flexibility and responsiveness to evolving project requirements. Organizations primarily adopt XP for its ability to enhance customer satisfaction and ensure software quality through continuous user engagement and feedback. Sihombing's research demonstrated XP's successful application in improving operational efficiency and user satisfaction in construction projects, with 85% of users expressing high satisfaction with the resulting system. Features like real-time monitoring, adaptive planning, and task management significantly enhanced project coordination. Hidayatuloh, Syahidin, and Yunengsih employed XP in healthcare settings, leveraging its flexibility to address changing user requirements in dynamic environments. Their implementation tackled specific issues related to patient information management while enhancing processes where accuracy and reliability are essential. Laleb, Sudarmadji, and Malimahi adopted the XP method to address inefficiencies in the manual waste management system of the Mutiara Timor Waste Bank. They chose XP for its iterative nature and strong emphasis on customer involvement, allowing for rapid adjustments to changing client demands and ensuring alignment with specific user needs.

2.3 Gap Bridged by the Study

There's a limited number of studies focusing on digital marketplaces specifically designed for surplus food in the Philippines. While researchers like Briones et al. [2023] and Duldulao et al. [2023] have explored digital marketplace implementation for agricultural producers very few studies address the unique challenges faced by food businesses dealing with surplus inventory in the Philippines. The Philippine context presents particular challenges due to rising food waste concerns combined with limited technological infrastructure, yet research specifically targeting this intersection remains scarce.

Current literature shows insufficient integration of web and mobile-based applications for surplus food management. Existing studies by Putra et al. [2023] and Muñoz [2020] explored mobile applications for food businesses but primarily focused on primary sales channels rather than secondary markets for surplus inventory. Research by Eriksson and Stenius [2024] identified factors affecting consumer adoption but provided limited insight into how businesses can effectively implement integrated web and mobile solutions specifically for surplus food redistribution, particularly in the Philippine context where unique cultural and logistical factors may affect adoption.

Legal implications regarding surplus food platforms remain largely unexplored in current research, especially in the Philippine setting. Studies have not adequately addressed the regulatory frameworks, liability concerns, and food safety compliance issues that impact the development and operation of surplus food marketplaces. These considerations are particularly relevant in the Philippines, where food security concerns, food safety regulations, and evolving policies related to food waste need to be taken into account. This gap is particularly problematic as legal considerations significantly influence both platform design and adoption by businesses and

consumers in the local context, yet developers lack clear guidance on navigating these complex legal landscapes.

Limited research exists on testing methodologies specifically designed for food surplus platforms, particularly in developing countries like the Philippines. Current testing approaches documented by Marculescu et al. [2022] and Ningrum et al. [2022] fail to address unique requirements such as time-sensitive inventory management, food safety verification, and quality assurance for perishable goods in tropical climates. Jasmine Aulia Mumtaz et al. [2024] identified general testing concerns for inventory systems but didn't provide specialized protocols for platforms dealing with perishable products where expiration dates and food quality are critical factors in the context of the Philippines' hot and humid climate. There's a significant lack of tailored agile development frameworks for surplus food applications. While existing literature demonstrates the effectiveness of Extreme Programming in various contexts, current research fails to provide frameworks specifically adapted for surplus food marketplace development in countries with evolving technological infrastructures like the Philippines. The literature lacks guidance on adapting agile methodologies to accommodate rapid development cycles necessary for platforms handling perishable inventory while still incorporating feedback from multiple stakeholders, including local food businesses, consumers, and regulatory bodies.

This study, SurplusHub: A Web and Mobile-Based Marketplace for Surplus Food in the Philippines, will bridge these identified research gaps by developing an integrated digital platform specifically designed for surplus food management in the Philippine context. By implementing a tailored Extreme Programming methodology to accommodate the unique requirements of perishable inventory management, incorporating comprehensive black box testing protocols for food marketplace applications, and addressing legal considerations for food redistribution under Philippine law, SurplusHub provides a holistic solution that advances beyond existing literature.

The platform not only addresses the technological integration challenges identified in previous studies but also creates a localized practical implementation model that can serve as a foundation for future research on digital surplus food management systems in developing markets like the Philippines.

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CHAPTER 3
TECHNICAL BACKGROUND

This chapter provides a comprehensive discussion of the technical foundation of SurplusHub, a sustainable web and mobile-based marketplace designed to facilitate the distribution of surplus foods in the Rinconada area. It outlines the resources, hardware specifications, software specifications, program specifications, functional requirements, nonfunctional requirements, system flowchart, system architecture, programming environment, and testing plan essential for the successful deployment and operation of the system. The technical elements presented here support the platform's functionalities such as user management, product listings, transaction handling, communication tools, and administrative oversight ensuring a secure, efficient, and scalable environment.

3.1 Overview of Current Technologies to be Used in the System

SurplusHub integrates a range of current technologies to deliver a responsive, secure, and user-friendly experience for buyers, sellers, and administrators. It is accessible through both a responsive web application and a dedicated Android mobile application. These platforms share a unified backend infrastructure to ensure real-time synchronization of user accounts, product listings, messages, transaction records, and review data. This guarantees consistency across devices and platforms, supporting the seamless operation of key user flows from registration to product browsing, purchasing, and reviewing.

Database Management is central to the platform's core processes. A robust database system is used to store and manage structured data, such as user profiles, product information, order history, shipping details, and reviews. The database is optimized for fast

and reliable search queries, enhancing the responsiveness of search functions used by buyers and sellers when browsing surplus items or managing listings.

Security and Access Control are integral to maintaining user trust and protecting sensitive information. The platform stores passwords using secure hashing algorithms. For financial transactions, SurplusHub integrates with reputable third-party payment gateways that comply with industry standards for secure payment processing. Additionally, the system implements Role-Based Access Control (RBAC) to regulate access permissions. This ensures that users whether buyers, sellers, or administrators can only access features relevant to their role, safeguarding system integrity and preventing unauthorized actions. The platform also includes tools for creating reports on sales patterns, and marketplace trends. These reports help system managers track how well the platform is working and make smart choices for improving it.

Communication Features are built into the system to streamline buyer-seller interactions. A messaging system allows direct communication regarding product inquiries, orders, or logistics. In parallel, the system's notification service delivers timely updates via email such as order confirmations, and promotional announcements enhancing engagement and responsiveness among users.

To support product quality and transparency, SurplusHub enables sellers to upload necessary documentation, such as food safety certificates and detailed product descriptions. This process builds buyer confidence and upholds the platform's commitment to food safety and sustainability.

All these technologies are structured into a unified, scalable architecture that supports the full user lifecycle account registration, browsing, communication, order

placement, payment, and review. By aligning the technology stack with the functional requirements of the system, SurplusHub is well-positioned to deliver a reliable and impactful solution to surplus food management challenges in the Rinconada region.

3.2 Resources

This section outlines the essential resources required for the development and implementation of SurplusHub: A Sustainable Web and Mobile-Based Marketplace for Surplus Foods. It includes details on the necessary hardware, software, and other specifications to ensure the system's functionality, security, and user-friendliness.

3.2.1 Hardware Specifications

This section details the essential hardware components required for the efficient deployment of SurplusHub: A Sustainable Web and Mobile-Based Marketplace for Surplus Foods. These specifications ensure optimal performance, reliability, and scalability of the system across both web and mobile platforms.

Table 1 provides a comprehensive list of hardware tools required for the implementation of the system. These components including processor, memory, storage, and development devices work together to enable the functioning of the marketplace and support its various features and operations.

Table 1: Hardware Specifications

Hardware Tool	Specification
Processor	Intel Core i5 or higher
Memory	8GB RAM or higher

Storage	512GB Solid State Drive (SSD)
Input Device	Keyboard, Mouse, Touchscreen (for testing)
Output Device	Monitor (1080p resolution or higher)
Mobile Devices	Android smartphones (Android 8.0 or higher)

The system's processor must be an Intel Core i5 or higher, providing sufficient processing power for multitasking, data management, and application development. The recommended memory (RAM) is 8GB or higher to ensure seamless execution of applications, especially those requiring high computational resources [17]. This combination of processor and memory helps maintain system responsiveness and minimize lag during operations.

For storage, a 512GB Solid State Drive (SSD) is specified to enhance system speed and efficiency compared to traditional hard drives. SSDs offer faster boot times, quick data access, and better durability, making them ideal for high-performance computing environments [17].

The input devices include a keyboard, mouse, and touchscreen (for testing purposes), ensuring compatibility with various input methods. An output device such as a monitor with at least 1080p resolution is essential for clear visuals, aiding in efficient system navigation and user experience [19].

SurplusHub requires compatibility with mobile devices, particularly Android smartphones running Android 8.0 or higher, to ensure smooth mobile-based interactions [20]. By adhering to these hardware specifications, SurplusHub can maintain a robust,

scalable, and high-performance computing environment that supports various business operations and technological advancements.

3.2.2 Software Specifications

The software specifications outline the necessary platforms, frameworks, and tools required for system development. This includes operating systems, database management systems, and security protocols essential for seamless operation.

Table 2 highlights the software tools that monitor the evolving system, as well as their specifications.

Table 2: Software Specifications

Software Tool	Specification
Programming Language Web	PHP v8.2.12
Programming Language App	JavaScript
Scripting Language	HTML5, CSS3, and JavaScript
Framework Web	CodeIgniter v4.6.0.
Framework App	React Native v0.78, Node.js v22.14.0
Database and Server	XAMPP 8.2.4 (server), MySQL,
Android Version	Android 8.0 or higher
Browser	Any browser preferably Google Chrome
Development Tools	Visual Studio Code (Web and App), Android Studio (App)

Table 2 presents the software tools utilized by the developers in designing and implementing the SurplusHub system. The system is designed to be compatible with Windows 10 or later versions, ensuring stability, security, and access to the latest software

features. PHP 8.2.12 serves as the primary backend programming language due to its enhanced performance, better error handling, and security improvements [16]. JavaScript is used for application development, ensuring interactivity and dynamic functionality [21].

Visual Studio Code and Android Studio are the main development environments, offering powerful tools and extensions for efficient coding [4, 7]. CodeIgniter v4.6.0 is used as the web framework, providing a secure and scalable backend architecture [22]. React Native v0.78 is employed for mobile application development [23]. Node.js v22.14.0 is utilized for server-side scripting and backend services, offering high performance, non-blocking I/O operations, and a vast ecosystem of libraries and packages [24].

For scripting, the system utilizes HTML5, CSS3, and JavaScript to ensure a structured, visually appealing, and responsive interface [3]. XAMPP 8.2.4 and MySQL are used for database management and server-side operations [25]. The system also ensures compatibility with Android smartphones running version 8.0 or higher [20].

Google Chrome is one of the recommended browsers for accessing the system [11]. By integrating these software tools, SurplusHub ensures efficient performance, maintainability, and scalability, facilitating seamless interactions between users and the system.

3.2.3 Program Specifications

The Program Specifications section details the essential technical and functional features of the SurplusHub, guaranteeing its dependability and effectiveness as a digital platform for surplus food trading. It outlines the system's architecture, main elements, and vital modules, highlighting how every component collaborates to facilitate seamless functioning, user engagement, and immediate oversight. This part also outlines the

essential needs for peak performance and compatibility. By setting these criteria, the study offers a solid basis for the system's execution, emphasizing its importance in advancing sustainability, minimizing food waste, and enhancing accessibility in the surplus food market.

Functional Requirements

Functional requirements outline the key operations and functionalities that the SurplusHub system must execute to fulfill its primary goal of enabling surplus food exchanges. These consist of user and product management, transaction handling, real-time interaction, and access control based on roles. Every function aims to enhance marketplace operations, minimize waste, and encourage sustainability by facilitating effective and clear exchanges between purchasers and vendors. By specifying these criteria, the system can provide an organized, easy-to-use, and dependable platform for handling surplus food exchanges. Table 3 presents the functional requirements for the SurplusHub.

Table 3: Functional Requirements

FUNCTIONAL REQUIREMENT	DESCRIPTION
Product Listing and Management	Allows sellers to upload, edit, and manage surplus food items with relevant details.
User Registration and Authentication	Enables users to register, log in, and maintain secure access to their accounts.
Role-Based Access Control	Assigns specific permissions to admins, sellers, and buyers based on their roles.
Order Processing	Handles product selection, order placement, and order status tracking from checkout to fulfillment.
Payment Processing	Integrates secure payment gateways to manage transactions, verify payments, and ensure the safety of financial information.
Messaging System	Provides direct communication between buyers and sellers within the platform.

Reports Management	Generates and displays detailed reports on user activity, product listings, sales transactions, revenue, and platform usage to support data-driven decision-making.
Review and Rating System	Allows users to rate transactions and provide feedback for transparency.
Activity and Transaction Logs	Tracks user actions and stores order history for monitoring and record-keeping.

The product listing and management function enables sellers to effectively upload, modify, and manage surplus food products, guaranteeing precise and current product details. Secure user registration and authentication safeguard accounts and allow smooth access to the platform. Role-based access control allocates suitable permissions to administrators, merchants, and customers, ensuring system integrity and appropriate access to features. The module for order and payment processing guarantees seamless and secure transactions, from order placement to payment confirmation. The integrated messaging feature promotes direct interaction between buyers and sellers, improving coordination and customer support. A feedback and rating system enhances transparency and trust by enabling users to provide reviews and assess transactions. Finally, activity and transaction logs offer an extensive digital record of user behaviors and order histories, aiding in efficient oversight and responsibility. These functional specifications collaborate to establish a safe, efficient, and sustainable platform for surplus food redistribution.

Non-Functional Requirements

The non-functional requirements of SurplusHub guarantee that the platform provides reliable, safe, and efficient service to every user. Performance efficiency ensures quick system reactions while browsing products, placing orders, and other essential

interactions, enhancing a seamless user experience. Table 4 presents the non-functional requirements for the SurplusHub.

Table 4: Non-Functional Requirements

NON-FUNCTIONAL REQUIREMENT	DESCRIPTION
Performance Efficiency	Ensures fast response times for product listings, searches, and transactions, even under high user traffic.
Scalability	Supports an increasing number of users, products, and transactions without performance degradation.
Security and Data Protection	Implements encryption, authentication, and secure payment processing to protect user data and transactions.
Usability and Accessibility	Provides a user-friendly interface with intuitive navigation and accessibility features for different user needs.
Reliability and Availability	Ensures the system operates with minimal downtime and remains available for users 24/7.
Maintainability	Allows easy updates, bug fixes, and feature enhancements with minimal system disruption.
Compliance	Adheres to data protection laws, online transaction regulations, and e-commerce security standards.

Scalability guarantees that the system can handle increasing numbers of users, transactions, and listings without affecting performance. Encryption, authentication, and secure payment processing are prioritized for security and data protection, ensuring the safety of sensitive information. Usability and accessibility focus on creating an intuitive interface that is simple to navigate for all user categories, including individuals with different degrees of technical skill. Dependability and accessibility guarantee that the system stays functional and reactive, even during intense use, reducing downtime and

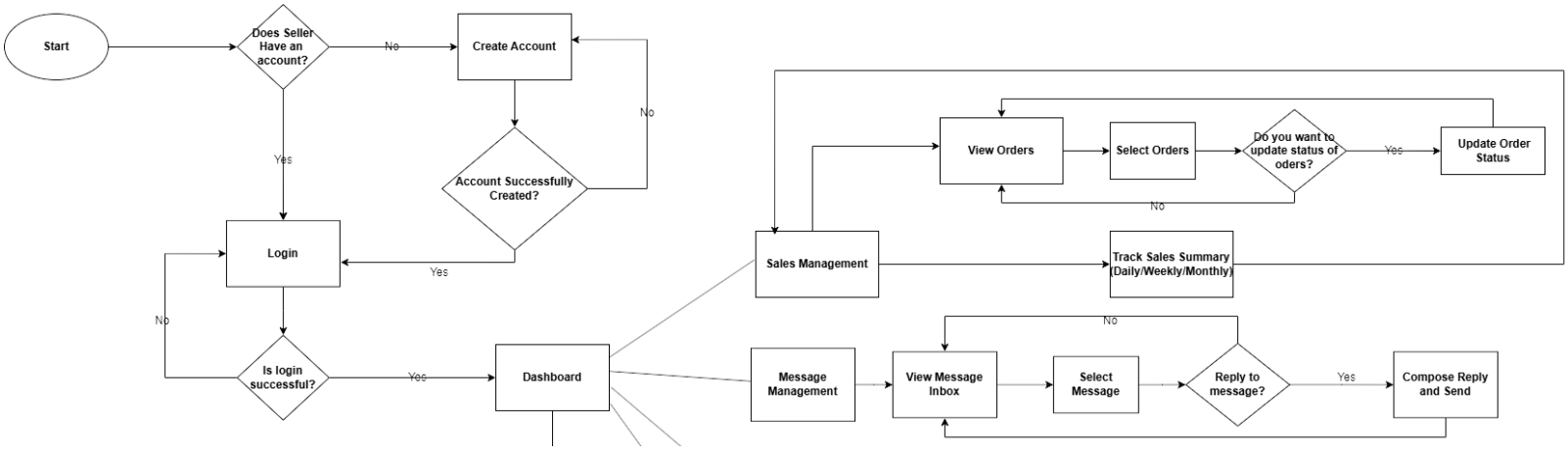
interruptions in service. Maintainability ensures that the system can receive updates and improvements without compromising overall stability. Finally, adhering to legal and industry standards enhances user trust and promotes responsible digital behavior. These non-functional specifications, backed by thorough unit, load, and security assessments, establish the basis for a reliable and user-focused platform for surplus food trading.

System Flowchart

The system flowchart visually represents key processes in a business system, showing interactions between users, sellers, and administrators. It helps understand system operations, ensuring efficient task performance and identifying potential bottlenecks for improvement. The user flow covers account creation to order fulfillment, including browsing products and tracking orders. The seller flow focuses on product management and order processing, while the admin flow involves overseeing user and seller accounts and managing accounts. Decision points guide the flow based on specific conditions.

Figure 1 provides a clear visualization of the seller workflow in SurplusHub, enhancing communication among stakeholders and ensuring an efficient, organized system that supports a smooth and productive seller experience.

Figure 1. Seller System Flowchart (Web)



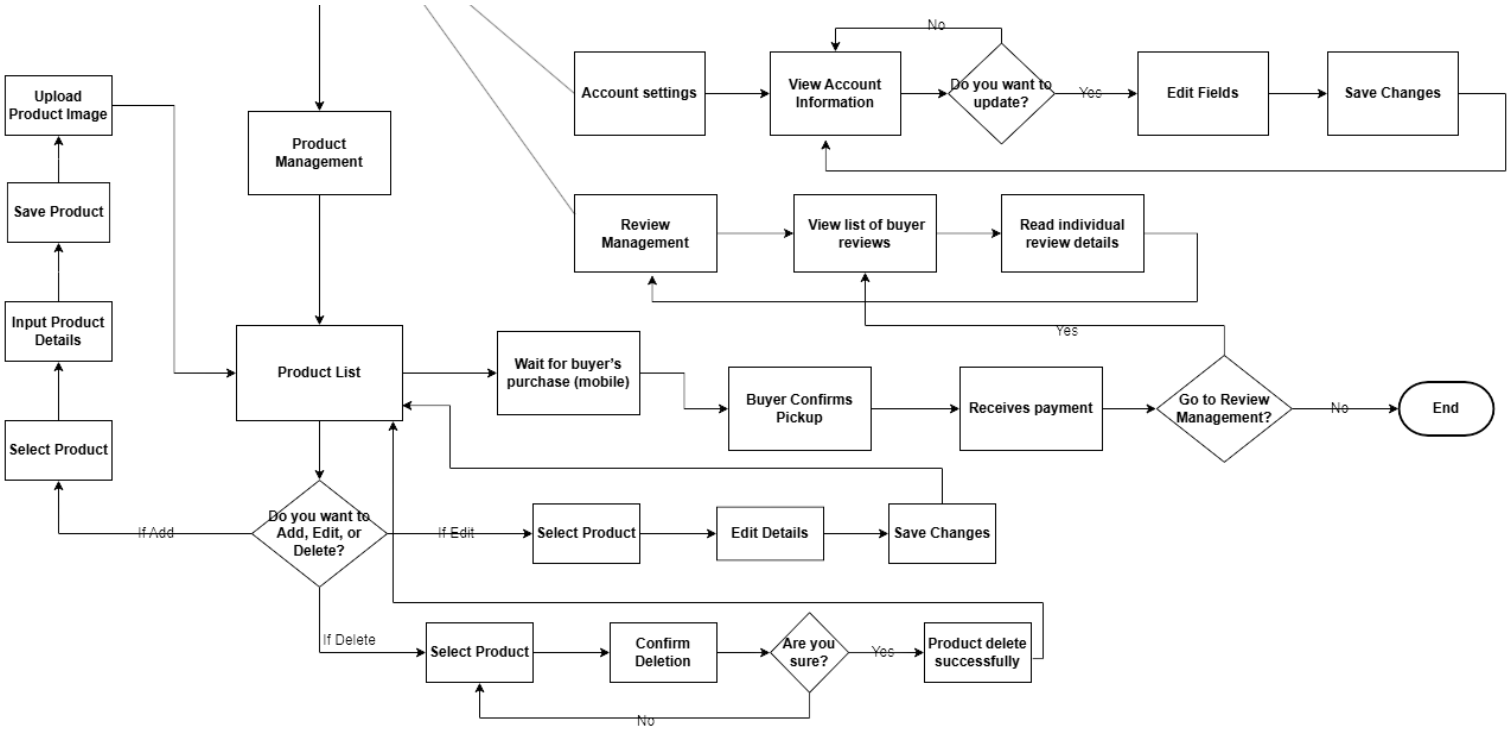


Figure 1. Seller System Flowchart

Figure 1 presents a comprehensive visualization of the seller flow within the SurplusHub platform. The process begins with the seller being prompted to either log in or create an account, depending on whether they are a new or returning user. If the seller does not yet have an account, they proceed to the account creation stage. Upon successfully creating an account, they are allowed to log in. This step ensures that only registered and verified sellers can access the platform, reinforcing platform security and trust.

Once the login is successful, the seller is directed to their dashboard, which acts as the central hub for all seller-related activities. From here, one of the key responsibilities is product management. Sellers can add, update, or remove product listings as needed. This functionality ensures that buyers have access to accurate and up-to-date product information, which is essential for making informed purchasing decisions.

In addition to product management, sellers also engage in sales monitoring. Through the sales management section, they can view ongoing transactions, check the status of orders, and track their overall sales performance. This allows sellers to maintain control over the order fulfillment process and ensure that deliveries are processed efficiently.

Following the listing of products, sellers enter a waiting phase, where they monitor buyer engagement and await purchases—represented by the "Wait for buyer's purchase" step. Once a buyer completes a purchase, the seller receives payment, signaling the successful completion of the transaction. This marks a crucial milestone in the seller's operational flow, as it reflects revenue generation and confirms that the system supports secure, reliable financial transactions.

Post-transaction, sellers can access the review management section, where they are able to view feedback left by buyers. This not only helps sellers understand customer satisfaction but also gives them an opportunity to improve future service and engagement. Sellers can communicate directly with buyers or platform support through the message management feature, promoting transparency and smooth coordination. The flow allows sellers to manage their account settings, enabling them to update personal or business information, preferences, and other customizable options. This ensures that sellers can maintain a tailored and efficient workspace within the platform.

Figure 2 illustrates the Buyer Flow for SurplusHub, providing a clear visualization of the steps involved in browsing, purchasing, and reviewing surplus products. This flowchart enhances communication and alignment among stakeholders by mapping the buyer's journey from viewing products to completing a transaction and optionally leaving

a review. It supports efficient operations and a seamless user experience by ensuring that each interaction is well-organized and user-centric.

Figure 2. Buyer System Flowchart (App)

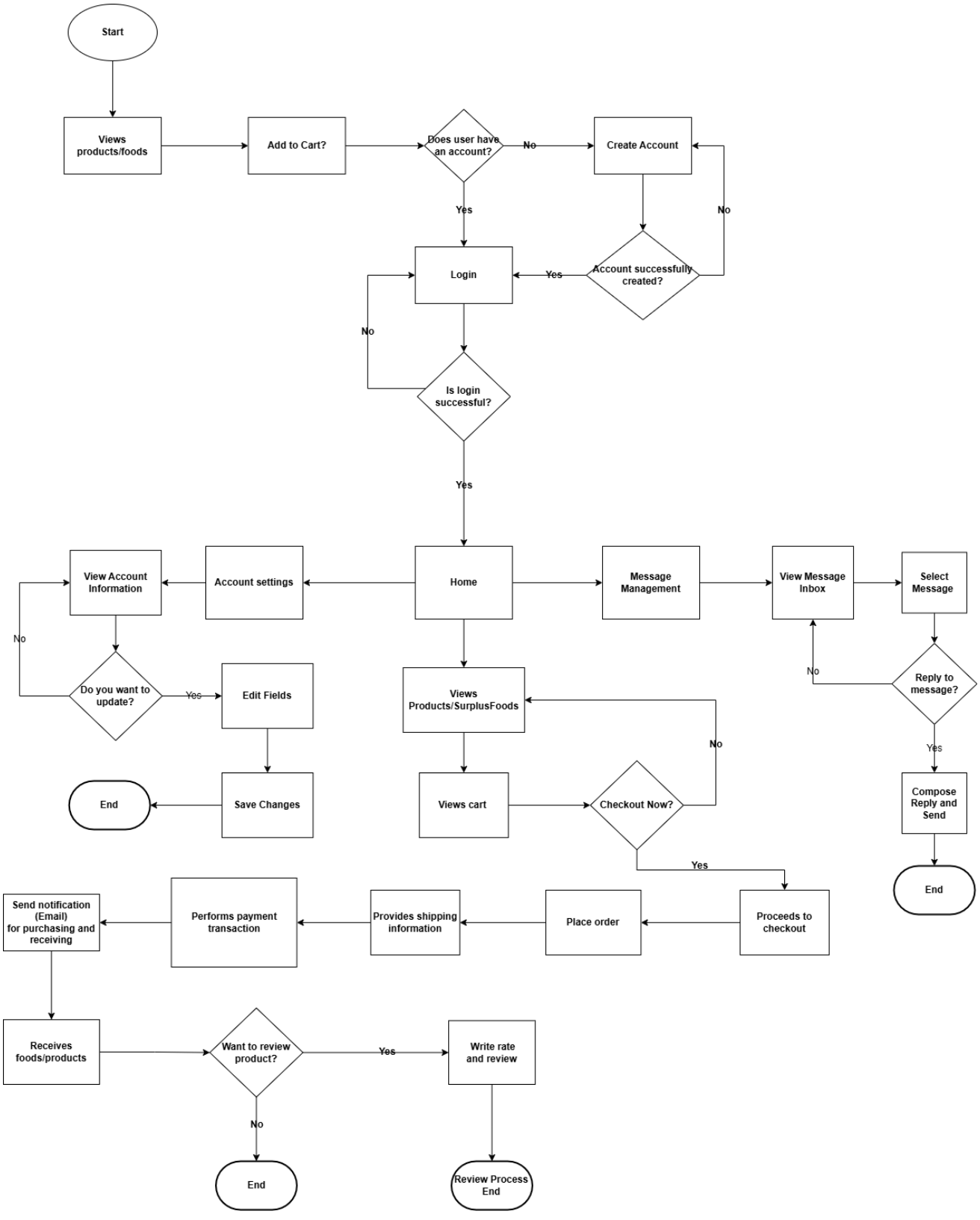


Figure 2. Buyer System Flowchart

Figure 2 illustrates the Buyer System Flowchart, detailing the end-to-end journey of a buyer within the platform. The process begins with account verification, where the system checks if the user already has an existing account. If not, the user proceeds to create an account by providing the necessary details. Upon successful registration, the user is directed to the login process. Once login credentials are authenticated, the user gains access to the system dashboard, marking the beginning of the actual user interaction with the platform.

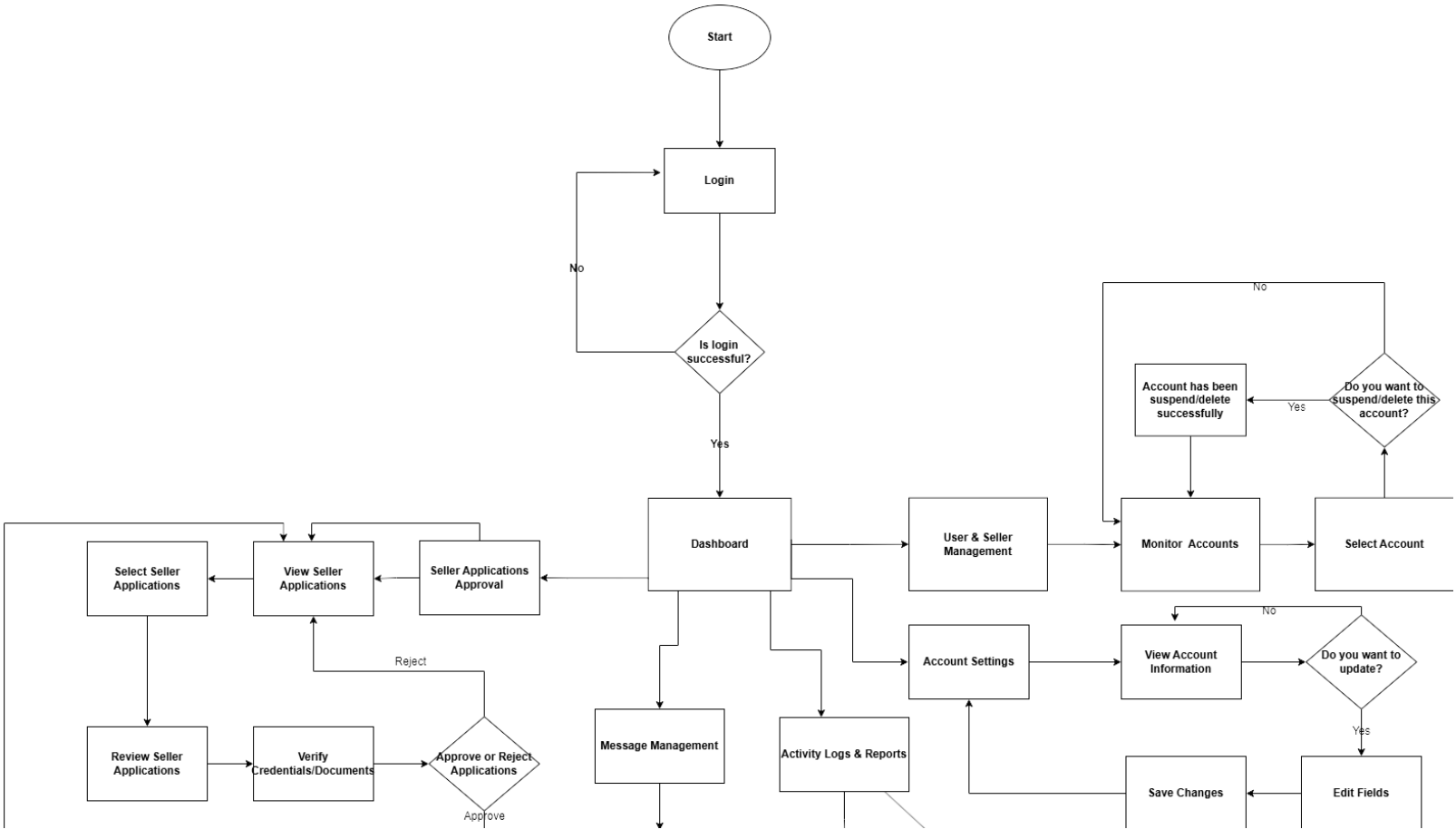
After logging in, buyers can view available products or surplus foods. This browsing process allows users to explore the marketplace freely. When a buyer finds an item of interest, they have the option to add it to their cart. If they choose not to, they may continue browsing. Once items are added, users can access their cart to review selected products. At this point, the system asks whether the buyer would like to proceed to checkout. If yes, the buyer initiates the checkout process, beginning with entering shipping details, followed by choosing a payment method and performing the payment transaction. Once the payment is successfully processed, the buyer places the order.

In addition to browsing and purchasing, users can manage their profiles through the Account Settings section. This feature allows users to view and edit their account information as needed. After editing, they can save changes and continue using the system. The platform also includes Message Management, which enables users to access their message inbox, view messages from sellers or system notifications, and reply to any inquiries. This enhances communication and transparency between buyers and sellers. After the buyer receives the product, the system will ask them if they want to leave a

review. If the buyer chooses to give a review, they can write their feedback and give a rating about the product. This helps other customers know what to expect and helps improve the quality of products on the platform. Whether the buyer writes a review or decides to skip it, that's the final step in the buying process.

Figure 3 illustrates the Admin Flow of SurplusHub, outlining the core administrative processes including user, seller management, seller approval, and message oversight. This visual representation enhances clarity and coordination among stakeholders by mapping the admin's journey from login to system oversight. It supports structured and efficient platform management, contributing to a smooth and secure user experience for both buyers and sellers.

Figure 3. Admin System Flowchart (Web)



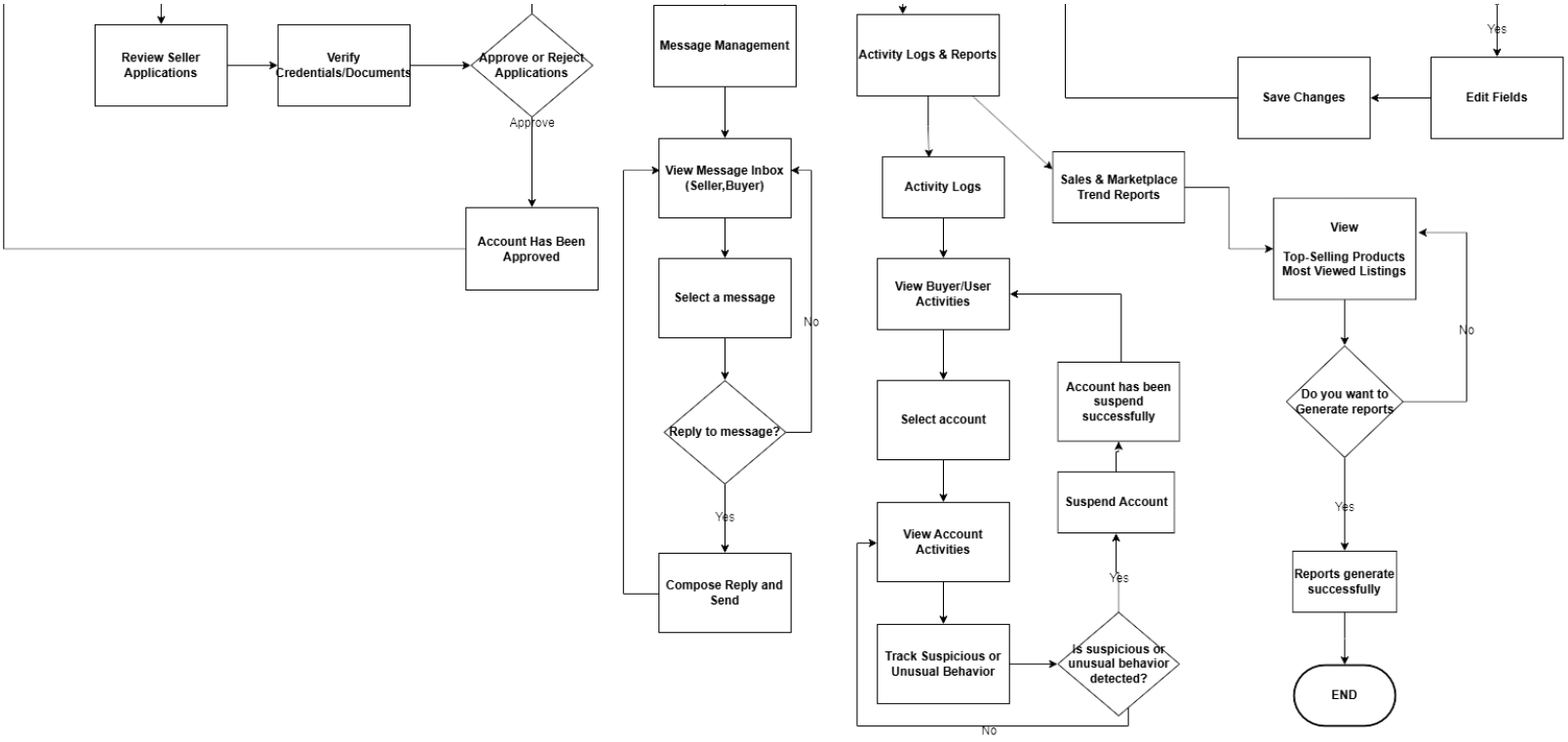


Figure 3. Admin System Flowchart

Figure 3 presents the Admin System Flowchart, outlining the key responsibilities and activities carried out by the administrator within the platform. The flow begins with the login process, where the administrator inputs their credentials to access the system. A decision point determines whether the login is successful. If the login fails, the process terminates; otherwise, the administrator proceeds to the dashboard.

Once logged in, the administrator accesses the main dashboard, which serves as the central control panel for managing various components of the system. From here, the administrator can navigate to several distinct processes starting with User & Seller Management. In this section, the administrator has the ability to suspend or delete accounts that violate platform policies. Admins can also track user and seller activities through activity logs and detect suspicious or unusual behavior. Closely related to this is the Seller

Applications Approval process, where the admin selects applications submitted by each application. Approved accounts are activated, while rejected ones are terminated from further processing.

The flowchart also includes Message Management, where the administrator can view communication between buyers and sellers, select specific messages, and compose replies when necessary. This helps resolve disputes and maintain professional interactions on the platform. Another function available to the admin is Account Settings, which allows the administrator to update their own account details, such as login credentials or preferences. If no update is needed, the process simply ends. Additionally, through the Activity Logs & Reports section, the administrator can view buyer and seller activities, track behavioral patterns, and generate reports related to marketplace performance, such as top-selling products or most-viewed listings

Architecture Diagram

The architecture diagram of SurplusHub shows a visual overview of the system's overall architecture, demonstrating how different components work together to enable smooth transactions for buying and selling surplus foods. The illustration emphasizes the essential parts, comprising the frontend interfaces, backend services, database systems, and external services like payment gateways and delivery systems.

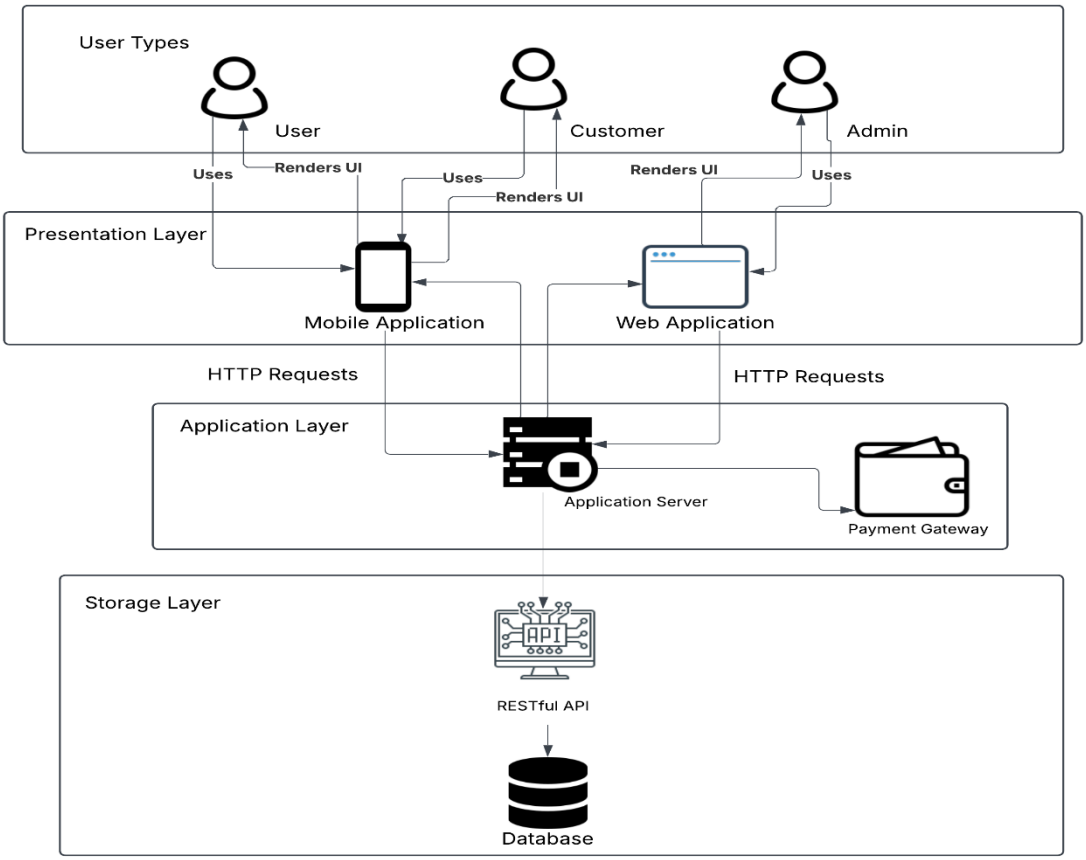


Figure 4: Architecture Diagram

The architecture diagram for SurplusHub illustrates an extensive three-tier system created for a surplus food marketplace. It includes separate client elements: a Bootstrap/CodeIgniter web application for sellers and administrators, along with a React Native mobile app for users. These clients interact via a central RESTful API layer developed with CodeIgniter, which standardizes data transfer and enforces uniform business rules. The server layer consists of three main elements: a PHP application server that manages business logic, a MySQL database that keeps structured data (such as user profiles, products, and orders), and an independent file storage system designed for media assets like product images. This distinction between database and file storage improves

efficiency, scalability, and cost-effectiveness. The architecture allows separate scaling of elements, supports various user roles with fitting interfaces, and preserves a clear division of responsibilities, which will facilitate future expansion and new feature integration. Communication proceeds systematically from users through their individual interfaces, through the API layer, to the application server that oversees interactions with both the database and file storage.

3.2.3 Programming Environment

The programming environment includes the tools, libraries, and frameworks that support the development and maintenance of the system. This section covers the integrated development environment (IDE), version control systems, and other key utilities that streamline the development process.

Front End

The front-end of SurplusHub is designed to provide a smooth and engaging user experience. It leverages modern web technologies to develop an intuitive interface, allowing for seamless navigation and enhanced accessibility. Below are the tools used in front-end development.

HTML. Hypertext Markup Language is a markup language that employs tags to encode web pages and document components, including text and images. It still fulfills the fundamental requirement it was designed for over 30 years ago: guiding web browsers on rendering digital content for anyone with internet access [15].

CSS. Cascading Style Sheets is a stylesheet language and a web technology employed to define the visual representation of a website or web application. In general,

styles set by CSS are used in HTML documents while a web browser handles the rendering [11].

Back End

The back-end of SurplusHub is the backbone of the platform, handling everything behind the scenes to keep things running smoothly. It manages data, processes transactions, and ensures secure and efficient communication between the front-end and the database. With a focus on reliability and performance, the back-end is built using powerful technologies to deliver a seamless experience for users. Here are the tools used in its development.

JavaScript. It is a dynamic programming language used for a variety of purposes, including creating games, web apps, and websites. It enables you to add dynamic elements to webpages that are not possible with just HTML and CSS [13]. In SurplusHub, JavaScript plays a key role in creating a smooth and engaging experience, allowing users to navigate easily, receive instant updates, and interact with different features seamlessly.

PHP. Hypertext Preprocessor is a server-side scripting language that is open-source and widely utilized by developers for web development. It is also a versatile language that you can utilize to create various projects, including Graphical User Interfaces (GUIs) [5].

MySQL. It is a database management system that is open-source. MySQL is capable of creating and managing databases and their contents, ranging from the smallest to the largest, and delivering information to its users [18].

Codeigniter. It is a PHP framework created by EllisLab. It requires no additional configuration. There is no requirement to utilize the command line. It is very lightweight.

It offers a comprehensive array of libraries for frequently required tasks, along with an easy-to-use interface and organized structure to utilize these libraries [12].

React Native. It is a well-known framework created by Meta Platofrms since it enables developers to use JavaScript, a commonly utilized programming language, to create mobile applications. This implies that you can shift from web development to mobile development without having to master an entirely new language [4]. In SurplusHub, React Native will be used to develop the mobile application, ensuring a seamless and responsive user experience across different devices while maintaining a single codebase for both platforms.

XAMPP. It is an abbreviation representing Cross-Platform, Apache, MySQL, PHP, and Perl, where the Ps signify PHP and Perl, respectively [10]. This tool will be used for the localhosting of the system.

3.3 Testing Plan

This section outlines the strategies and methodologies used to evaluate the functionality, security, and performance of SurplusHub. It includes various testing phases such as unit testing, security testing, and load testing to ensure the system meets its requirements and operates as intended. Figure 1 shows the testing plan for this research.

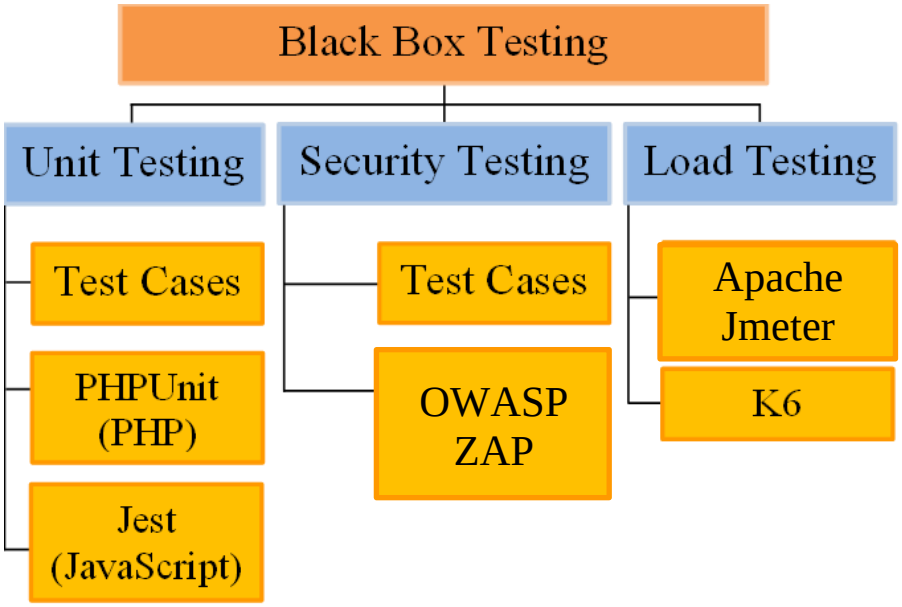


Figure 5. Testing Plan

Figure 1 presents a Black Box Testing strategy that incorporates Unit Testing, Security Testing, and Load Testing to ensure software reliability and performance. Unit Testing focuses on verifying individual components using test cases and tools like JUnit (Java) and Jest (JavaScript) for efficient validation. Security Testing identifies vulnerabilities to prevent fraud and cyber threats, utilizing test cases and tools like OWASP ZAP to identify security weaknesses. Lastly, Load Testing assesses system performance under varying conditions, employing Apache JMeter and K6 to measure stability and responsiveness.

3.3.1 Types of Testing

Software testing employs various approaches to ensure system reliability, functionality, and performance. Testing types like unit testing, security testing, and load testing help detect defects and enhance software quality at different stages of development.

Functional Testing. It is a category of software testing that verifies the software system conforms to the functional requirements/specifications. The aim of Functional tests is to evaluate every function of the software application by supplying suitable input and checking the output against the Functional requirements [8]. For example, in SurplusHub, a functional test may verify that the product listing module accurately fetches and shows available surplus items from the database as expected. An additional test case could verify that the user registration function accurately logs user details and blocks the formation of duplicate accounts. The test cases for functional testing of these features is present in Appendix A.

Security Testing. This testing involves assessing your software to detect vulnerabilities or weaknesses that could be targeted by hackers or attackers. The significance of security testing is immense, as it ensures that software is safe and capable of safeguarding sensitive data and information from unauthorized access or exploitation [14]. OWASP ZAP tool generally used to perform automated and manual security testing helping to defend and mitigate against the cyber threats. The security test scenarios for SurplusHub will focus on safeguarding against common vulnerabilities. This will involve confirming that unauthorized individuals cannot circumvent authentication, checking for SQL injection in input fields, and blocking cross-site scripting (XSS) via appropriate content sanitization. Session management will be evaluated for the secure processing and expiration of user sessions, whereas access control assessments will confirm that users do not surpass their designated permissions. Furthermore, encryption assessments will be performed to ensure the safe transfer and storage of confidential information. The complete set of security test cases can be found in Appendix B.

Load Testing. This testing method that assesses how a system behaves and performs under anticipated and maximum workload scenarios. It includes exposing the system to imitated user demands, network traffic and data amounts to assess its response time, throughput, resource usage, and stability. It seeks to uncover performance bottlenecks, scalability challenges, and any other possible issues that could arise when the system faces large numbers of simultaneous users or heavy activity [7]. Apache JMeter and K6 tools enable load testing by analyzing response times, system behavior, and potential bottlenecks. Organizations can enhance their applications to maintain stable performance even during peak usage conditions by conducting load tests. For SurplusHub, load testing will involve simulating hundreds or thousands of simultaneous users exploring product listings, placing items in their carts, and completing the checkout process. Test cases will also include putting pressure on the database with large product uploads from sellers and frequent search queries from buyers to assess indexing and retrieval performance. Moreover, load tests will evaluate the platform's performance during simultaneous user logins, payment processing, and order confirmations to detect any delays or failures. These test scenarios will aid in confirming that SurplusHub stays responsive and stable during peak traffic events such as sales promotions or seasonal demand surges. These scenarios are covered in detail in the load testing test cases provided in Appendix C.

3.3.2 Testing Tools and Framework

Testing tools and frameworks play a crucial role in automating, managing, and executing test cases effectively. They help ensure software quality by providing a structured approach to validation, maintaining accuracy, consistency, and scalability

throughout the development process. By streamlining testing, these tools contribute to a more reliable and efficient system.

Test Cases. It is a set of standards or factors that will be employed to assess if an application, software system, or any of its functionalities is operating as expected In SurplusHub, test cases are crucial for assessing the platform's features, such as user authentication, product listings, transactions, and notifications. By adhering to organized test cases, developers can detect and fix problems, guaranteeing a fluid and effortless experience for both buyers and sellers.

PHPUnit. It is a testing framework designed for programmers using PHP. PHPUnit is a representation of the xUnit design for frameworks used in unit testing. Installing it and getting started is quite simple [1]. In SurplusHub, PHPUnit will be utilized to verify that the back-end logic, database interactions, and API functions operate properly, assisting developers in detecting and correcting errors prior to deployment.

Jest. It is a JavaScript testing framework created to verify the accuracy of any JavaScript codebase. It enables you to create tests using an easy-to-understand, well-known, and comprehensive API that provides results swiftly. It collaborates with projects involving: Babel, TypeScript, Node, React, Angular, Vue, and another technologies [26]. At SurplusHub, Jest is set to test front-end components, verifying that the user interface operates as intended, interactive features work correctly, and real-time updates occur smoothly.

OWASP ZAP. Zed Attack Proxy (ZAP) is a free and open-source tool for penetration testing that assists AppSec experts in accurately identifying both known and unknown cyber threats. It is primarily utilized for web applications and offers a broad range

of features to ensure various cyber threats are detected promptly [2]. In SurplusHub, OWASP ZAP will be employed to examine the system for possible vulnerabilities, like SQL injection and cross-site scripting (XSS), guaranteeing that user information and transactions stay safe.

Apache JMeter. It is a free software used for load testing applications and assessing their performance. Load tests mimic user actions that nearly reach the maximum capabilities of an application's specifications. Testers can utilize Apache JMeter to mimic different or intense loads on one or more servers, networks, or entities to evaluate a system's robustness [6]. At SurplusHub, JMeter will be utilized to replicate heavy user traffic and evaluate system performance under varying loads, ensuring that the platform can effectively manage numerous users and transactions.

K6. Grafana K6 is a load testing tool that is open-source and crafted specifically for developers. In contrast to conventional load testing tools that necessitate specialized skills or intricate configurations, K6 adopts a code-first methodology utilizing JavaScript, which makes it user-friendly for developers who are accustomed to contemporary programming standards [9]. At SurplusHub, K6 will be utilized to evaluate the platform's scalability and stability, confirming its capacity to accommodate increasing user demands while sustaining peak performance without interruptions.

APPENDIX A

Functional Testing

TEST ID	TEST CASE DESCRIPTION	EXPECTED RESULT	TEST PROCESS	RESULT (0/1)
LOGIN MODULE				
FTLOGIN-01	Test login with correct credentials	User is logged in.	Input correct email/password → Log in → Redirect to dashboard	
FTLOGIN - 02	Test login with incorrect credentials	Login fails with error	Enter invalid credentials → Log in → Verify "Invalid credentials" message and blocked access	
FTLOGIN - 03	Test OTP resend during login/registration	New OTP is sent successfully.	Start registration → Wait for OTP → Click "Resend OTP" → Verify new OTP is received via email	
FTLOGIN - 04	Test session timeout during login	User asked to re-login	Log in → Stay idle past session timeout → Attempt to click → Prompted to re-login	
FTLOGIN - 05	Test redirection after login based on role	User redirected to correct dashboard	Log in with different roles → Check redirected dashboard	
USER MANAGEMENT MODULE				
FTUSER-01	Test user registration with valid data.	User account is created.	Fill registration form → Submit → Enter OTP → Account created	
FTUSER -02	Test registration fails for existing email	Error "Email already in use." appears	Register using existing email → Submit → Check for error	
FTUSER -03	Test profile update by user.	Updated info is saved.	Log in → Go to profile → Edit info → Save → Check updates	
FTUSER -04	Test role-based access control enforcement	Access allowed/denied based on role	Try accessing seller/admin pages with wrong role account → Confirm access blocked	
FTUSER -05	Test user deactivation and reactivation	User access revoked/restored appropriately	Admin disables user → Try logging in → Reactivate → Log in again	

TEST ID	TEST CASE DESCRIPTION	EXPECTED RESULT	TEST PROCESS	RESULT (0/1)
PRODUCT MANAGEMENT MODULE				
FTPROD-01	Seller adds product with valid data	Product listed successfully.	Log in as seller → Add product → Fill fields → Submit → View listing	
FTPROD -02	Upload blocked if required fields are missing.	Error shown on missing fields	Leave fields blank → Submit → Validation errors shown	
FTPROD - 03	Seller updates product info	Info updated and saved	Edit product → Change values → Save → Confirm updated info	
FTPROD - 04	Seller removes a product	Product no longer listed	Delete product → Check marketplace for removal	
FTPROD - 05	Product stock updates after order	Quantity adjusted	Buyer places order → Seller views product → Quantity updated	
SEARCH AND DISCOVERY MODULE				
FTSEARCH -01	Search product by keyword	Matching results shown	Enter search term → Results display matching products	
FTSEARCH -02	Filter results by category	Filtered results displayed	Choose category filter → Only relevant items shown	
FTSEARCH -03	Sort products (e.g. by price)	Products sorted correctly	Apply sorting → Confirm correct order	
FTSEARCH -04	View full product details	All details are visible	Click a product → View name, image, price, stock	
FTSEARCH -05	Handle no search results	“No results” message displayed	Search random text → Confirm empty state or feedback	

TEST ID	TEST CASE DESCRIPTION	EXPECTED RESULT	TEST PROCESS	RESULT (0/1)
MESSAGING MODULE				
FTMESSAGE -01	Buyer sends message to seller	Message appears in inbox	Buyer → Open product → Click message → Type and send	
FTMESSAGE -02	Seller replies to buyer	Message added to thread	Seller opens inbox → Replies to thread → Buyer sees reply	
FTMESSAGE -03	Show timestamps and sender name	Sender/time shown in message thread	Open chat → Verify metadata on each message	
FTMESSAGE -04	Notify user of new message	Notification badge/popup appears	Receive new message → Notification shown	
FTMESSAGE -05	Restrict messaging to eligible users	Message option hidden	User hasn't bought product → Open page → No "Message Seller" option	
TRANSACTION MODULE				
FTTRANS - 01	Buyer places an order	Order processed and seen by seller	Buyer → Add item → Checkout → Seller sees order	
FTTRANS - 02	Enforce minimum order quantity	Order processed and seen by seller	Try less than min quantity → Proceed → Validation alert	
FTTRANS - 03	Cancel order before seller accepts	Order Canceled	Buyer → Pending order → Cancel → Confirm	
FTTRANS - 04	Show correct order summary	Accurate summary shown	Buyer → Checkout → View summary screen → Confirm product, price, qty	
FTTRANS - 05	Log transactions in user history	Records stored and visible	Buyer → Check history → Verify order details	

TEST ID	TEST CASE DESCRIPTION	EXPECTED RESULT	TEST PROCESS	
REPORTS MANAGEMENT MODULE				
FTREPORT-01	Seller views sales reports	Review saved and shown	Log in as buyer → Complete an order → Go to "My Orders" → Select order → Leave a review → Verify it appears on product page	
FTREPORT-02	Admin views platform-wide statistics	Review shown on product page	Log in as seller → Go to seller dashboard → Select a product → View customer reviews	
FTREPORT-03	Filter reports by date	Review option not shown	Log in as buyer → Open a product you haven't purchased → Check for absence of review input section	
FTREPORT-04	View most sold products	List of top-selling items appears	Open reports → Select "Top Products" → Confirm ranked product list is shown	
FTREPORT-05	Load revenue visualizations	Graph loads with accurate values	Open revenue analytics → Chart shows revenue bars or pie	
COMMUNITY ENGAGEMENT MODULE				
FTCOMM-01	Buyer submits review after purchase	Review saved and shown	Buyer places order → Buyer checks transaction history → Confirm order with amount, date, and status is recorded	
FTCOMM-02	Seller views product reviews	Reviews visible	Seller → Dashboard → Product → View reviews	
FTCOMM-03	Only buyers can leave review	Review input hidden	User hasn't bought product → No review section	
FTCOMM-04	Show average star rating	Average stars visible on product	Open product page → Star count matches reviews	
FTCOMM-05	Display total number of reviews	Review count shown on product	Open product page → Confirm total number of submitted reviews is displayed	

APPENDIX B

LOAD TESTING

TEST ID	TEST CASE DESCRIPTION	EXPECTED RESULT	TEST PROCESS	
LT-01	Simulate 50 users browsing product listings simultaneously	Pages load within 1–2s, no crashes	Use JMeter to simulate GET requests on product listing endpoint	
LT -02	30 users adding items to cart at the same time	Cart updates correctly, no delays or duplicate entries	Simulate POST requests on the cart API using K6 or JMeter	
LT -03	20 users checking out and completing payment simultaneously	Transactions succeed without timeouts, no server overload	Use scripts to simulate checkout and Payment Gateways integration	
LT -04	50 users logging in within 2 minutes	Login completes under 1.5s per user, no auth errors	Use JMeter to simulate login requests	
LT -05	100 rapid search queries within 1 minute	Results return within 1s; system remains responsive	Simulate multiple GET requests to search endpoint	

APPENDIX C

SECURITY TESTING

TEST ID	TEST CASE DESCRIPTION	EXPECTED RESULT	TEST PROCESS	
ST-01	Test session expiration after inactivity	User is logged out after timeout	Log in → Stay idle beyond session timeout → Attempt action → Verify login prompt	
ST -02	Test password reset with invalid token	Reset fails, error shown	Use expired token → Attempt password reset → Verify error	
ST -03	Test successful password reset with valid token	Password is updated; user can log in with new credentials	Click “Forgot Password” → Enter registered email → Receive reset link → Click link (valid token) → Enter new password → Submit → Log in with new password → Verify login success	
ST - 04	Test SQL injection on login input	Input is sanitized; login fails	Enter SQL payload in email/password field (e.g., ' OR '1'='1) → Submit → Verify no unauthorized access	
ST - 05	Test access control to restricted admin pages	Access denied for non-admin users	Log in as regular user → Try to access /admin URL → Verify redirection or error	

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