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Digital Entrepreneurship Strategy and Suburban Food Waste Mitigation Application Prototype

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Abstract. The result is that suburban culinary SMEs are confronted with the dilemma of food waste, a daily spoilage of food that they often have to bear the brunt of financial loss because of it. In this paper, we propose a digital entrepreneurship business model and a location-based application prototype for food waste reduction, using the Business Model Canvas (BMC) model and the Haversine Algorithm. Based on the Design Science Research (DSR) approach, the study includes problem identification through partner interviews, quantitative consumer surveys, and IT artifact design. Validation of the business model suggests the 15% commission scheme on the 50–70% discounted products will be perceived as a reasonable and fair loss mitigation strategy by the majority of the business owners, although facing operational friction with one partner dissent. The BMC analysis aligns the value proposition of the platform to meet the needs of balancing the consumer's economic motives and the efficiency needs of the partner. Technologically speaking, the system uses Location-Based Service (LBS) to automatically suggest the nearest partners in real-time. Simulation test with the Haversine formula verified highly reliable output with an average deviation of 0.11 km or an error percentage of 2.05% compared with the Google Maps data, yielding a practical localized computational accuracy of 97.95%. This study strengthens the contribution to an inclusive digital ecosystem in satellite regions by way of a feasible PWA approach that furthers global SDG at mitigating food waste.

Keywords: Business Model Canvas, Digital Entrepreneurship, Food Waste, Haversine Algorithm, Suburban Areas.

1. Introduction

The information technology boom of the past decade has changed not only the way businesses and consumers interact, but is now accelerating the adoption of digital platforms that link technological capabilities with ever-evolving market demands. In Indonesia, small to medium-sized enterprises (SMEs) in the food industry have been the backbone of the national economy, especially in providing employment and raising industrial competitiveness [1-3].

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Yet, the viability of this industry is often undermined by systemic inefficiencies in operation, particularly in the management of surplus food.The food-waste phenomenon is labeled a "wicked problem" because it has multilevel consequences that contribute to losses in the global economy estimated at USD1 trillion per year [4, 5].

This problem is exacerbated when considered with respect to suburban or exurban areas. These are places emerging with fast-growing food and beverage (F&B) scenes, but without the organized, unified waste distribution systems common in urban centers [6]. Therefore, a majority of culinary SMEs in these areas continue to use manual inventory management techniques that are not adaptive to day-to-day variations in demand [1, 7]. This meant that the available food was often wasted, causing business owners to lose money each day, and creating an environmental burden [5].

A comprehensive review of literature confirms that digitalization in the form of marketplace platform design is the strategic mechanism that enables efficient coordination of the surplus food supply and demand [6]. Academic discourse highlights that the BMC tool has emerged as the de facto standard for business model innovator to visualize, assess and modify entire business models concerning innovation [8]. The BMC enables platforms to design sustainable value propositions by balancing the economic and social impact and considering the environmental aspect, commonly referred to as the Triple Bottom Line [8, 9]. Through these nine components, digital platforms can finely tune the uncertainty between the needs of business efficiency and the economic preferences of consumers [9].

In line with this view, the application of geospatial technology employing Location-Based Service (LBS) with the Haversine Algorithm has been empirically proven to be highly reliable in nearest-location search systems [7-11]. Advantages of the Haversine formula The Haversine formula has technical advantages in computing the great-circle distance between two points on a sphere from their longitudes and latitudes with more rigorous accounting for sphere geometry [7, 12]. The execution of this algorithm is very much needed for rural geospatial applications since it yields precise outcome without any intricate server setup for the most part [6, 11]. Previously, studies have shown that local spatial error can be consistently refined to be below 5% when using commercial routing information data, proving the effectiveness of the mobile web for use in very localized environments [10, 11].

Although food management has been increasingly digitalized, there is a great lack of research on technology accessibility for satellite region dwellers with constrained access to devices. Problem detection in this study shows that a large number of latent users in the suburbs desire lightweight and utility systems [2, 13]. Thus, the study presents a digital entrepreneurship application solution based on PWA concept. From a technical point of view, the selection of a PWA-based web-responsive architecture is motivated by its portability and resource efficiency [7, 13]. Web-based applications enable instant access without filling up device storage and without the need for traditional app store downloads. In addition, there is a need to address how the design of an overall interface can reduce cognitive load and enhance acceptance toward technology by a variety of users with differing levels of digital literacy in a new suburban community [13].

In this work, we propose the development of an end-to-end digital entrepreneurship product, covering business strategy analysis through BMC modeling, UI/UX design, and geospatial algorithm simulations. The contribution of this work is marrying adaptive digital business strategies in the context of local SMEs with geospatial technology, tailored to device efficiency via a PWA approach.It must be clearly stated that the scope of this study is the design of the digital prototype (mock-up) and conducting mathematical simulations as a

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demonstration of the concept the result has not been applied in development of web systems or in real world [14].

Applying the Design Science Research Methodology (DSRM), the presented design is concerned with the development of valid IT artifacts that effectively address food waste management challenges [3]. From preliminary evaluations and simulation of algorithms, this study will be helpful to contribute toward an inclusive digital business ecosystem in satellite areas. Systemic this research underpins to the Sustainable Development Goals (SDGs), in particular, SDG 12.3 to halve global food waste, through converting economic losses into a new value proposition for culinary SMEs located in suburban areas.

2. Method

2.1. Research Flow Based on DSRM

This study adopts the *Design Science Research Methodology* (DSRM) to construct practical solutions in the form of information technology artifacts aimed at mitigating *food waste issue* [2, 3]. This method is chosen since it is a problem-solving approach and focuses on creating an effective IT-based solution to the real-world issue [2]. For a sustainable business and to be economically viable, the research is combined with the *Business Model Canvas* (BMC) framework, to provide an end-to-end view of business strategies [8]. Based on the framework, the study at hand is conducted by following six systematic stages the major activities and outcomes of which are visually organized and aligned in Figure 1 [3]:

1. *Problem Identification & Motivation*: This phase concentrates on identifying the needs of culinary SMEs in the suburban areas in managing edible surplus food [3]. The root causes of identified problems are inefficient operations and wasting food leading to loss of profit, which is expressed as the customers' primary system dissatisfactions [3].
2. *Define the Objective for a Solution*: Objectives are established to design a web-responsive marketplace platform using the *Progressive Web Apps* (PWA) concept [13]. and to satisfy the solution criteria, we have to present precise nearest-partner location recommendations without exhausting the user device memory [3, 7}.
3. *Design & Development*: This phase involves the creation of technological artifacts encompassing three key elements:
    a. UI/UX Design: Use Figma to create intuitive and consistent UI designs [3]. This begins with *User Flow* mapping to visualize user interaction paths.
    b. System Modeling: Using the *Unified Modeling Language* (UML) to specify the relations between the actors and the system [7, 12].
    c. Algorithm Implementation: Implementation of Haversine Algorithm at the Backend to Find the Closest Distance between Two Coordinates [7, 11, 14}.
4. *Demonstration*: Showcasing prototype features with workflow simulations like automatic location detection and booking of excess food (Nur Hidayah et al., 2025).
5. *Evaluation*: Performed to evaluate system effectiveness, strategic fit, and technical usefulness [2, 3]. The technical quality is subject to a strict control by analyzing the results of the client-side algorithm with real data obtained from the Google Maps API and evaluating the difference in the coordinates [10, 11, 15]. Additionally, business model viability is qualitatively validated through partner feedback regarding the commission matrix.
6. *Communication*: To record the whole procedure in academic papers for the benefit of knowledge of IT practitioners and digital entrepreneurs [3].

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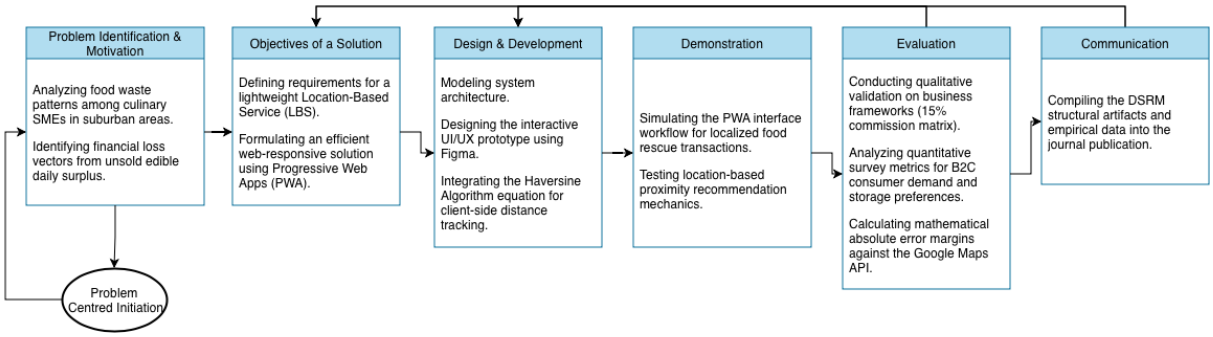

Figure 1. Design Science Research Methodology.

2.2. Business Strategy Analysis Framework (BMC)

Value creation is visualized by carrying out the entrepreneurial analysis through platform strategy by nine BMC components of which the platform strategy is dissected [5, 8]. This modeling aligns with *Sustainable Business Model* principles [5, 8]:

1. Customer Segments: Target market identification for B2B and B2C industries.
2. Value Propositions: Value added by reduction of waste and cost of production.
3. Channels: Agent delivery through web responsive platforms.
4. Customer Relationships: Interaction via price inquiry and location customization.
5. Revenue Streams: Monetization as a 15% transaction fee.
6. Key Activities: Management of excess supplies and geospatial planning.
7. Key Resources: Server infrastructure, coordinate data, and digital assets.
8. Key Partnerships: Partnerships with local coffee shops and map tech vendors.
9. Cost Structure: Maintenance costs and integration of geolocation APIs.

2.3. Data Collection Protocol

The data gathering is performed systematically to provide Data for the Problem Identification and Evaluation stages of DSRM, covering business, consumer, and technical needs. Structured interviews have been conducted with F&B managers in the suburban West Java area [16]. Participants were chosen through *purposive sampling* [13, 17], focusing on two primary variables:

1. Food Waste Estimation: Estimation of amount of extra food available on a daily basis [5].
2. Monetization Model Validation: Evaluating whether partners would accept the 15% commission on discounted products as a method of *loss mitigation* [5].
3. Descriptive, quantitative surveys were administered to adolescent and young adult respondents [3] a 5-point Likert Scale to confirm the economic motives and technical accessibility preferences for Internet based PWA platform. For LBS design, actual coordinates were obtained from Google Maps as input variables for distance computation simulations.

2.4. Data Analysis Techniques

Data is analyzed by triangulation to combine the results of qualitative, quantitative and artifact testing. Thematic analysis organizes and maps interview and survey data onto BMC blocks to define sustainable value propositions.

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The evaluation of prototype reliability is performed through accuracy tests of Haversine Algorithm calculations with system mathematical calculations and data from Google Maps API. It is said that the algorithm is empirically valid if the localized error is less than the critical 5%, which is an acceptable level of tolerance to apply instant proximity-product sorting in good weather conditions without real time road traffic routing constraints.

$$d = 2 \cdot R \cdot \arcsin\left(\sqrt{\sin^2\left(\frac{\Delta\phi}{2}\right) + \cos(\phi_1) \cdot \cos(\phi_2) \cdot \sin^2\left(\frac{\Delta\lambda}{2}\right)}\right) \quad [18]$$

The evaluation of the UI/UX design is performed qualitatively through cognitive walkthroughs during the demonstration phase. This evaluation ensures that the user interface layout in Figma satisfies the functional user flows and basic requirements mapped from suburban consumer preferences prior to full system development.

3. Results and Discussion

3.1. Field Data Synthesis and Food Waste Mitigation Potential

A qualitative and quantitative approach was adopted to analyze the operational and behavioral elements of both the supply side of B2B and the targeted end-users of B2C. Insights gained from a series of structured interviews with three purposively sampled culinary SME owners in suburban satellite corridors demonstrated critical operational weaknesses, particularly relating to routine overproduction and consequent daily build up of edible surplus food. This qualitative baseline is synthesized in Table 1.

Table 1. Suburban Partner Waste Profiles and Commission Validation.

Partner Identity	Daily Surplus Estimation	15% Commission Validation
SME A (Bakery & Heavy Meals)	< 5% of daily production	Accepted; notes it minimizes financial losses and prevents organic waste.
SME B (Snacks & Traditional Cakes)	< 5% of daily production	Accepted; requests clear platform guidelines regarding food safety timestamps.
SME C (Pastry & Pastry Shop)	< 5% of daily production	Objected; requests a lower commission rate due to existing product discount burdens

The results in Table 1 show that although the daily surplus percentages look marginal < 5%, the total longitudinal volume generates substantial macro- and environmental frictions for micro-enterprises that are operating on thin profit margins. The difference in SME C's reaction highlights an important market fact: transaction cost economics are a strong determinant of technology uptake among micro-entrepreneurs. Hence, sustainable marketplace architecture will involve trade-offs between platform monetization and cooperative merchant retention mechanisms in the short run.

All partners agree that moving perishables inventories into short-run, steeply discounted dynamic pricing (50% – 70%) during pre-closure operating days is a better loss mitigation strategy than tossing products.

Meanwhile, at the macro-level, a behavioral intent of consumers was modeled using descriptive quantitative surveys received from 30 B2C respondents from suburban areas, to capture two dominant structural choices. It must be emphasized that this sample size is to

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function as a baseline, exploratory survey to inform initial design of IT artefacts requirements, and that it will be deliberately limited from statistical generalization to the wider population:

1. ***Economic Motifs***: 53.33% of demanders showed strong positive demand response to high-quality surplus food products as long as they were offered at steep discounts in short temporal windows. This reiterates that economic utility is still a major factor for food-rescue software usage in the suburban population.
2. ***Solution Accessibility***: Forty-six Among hostiles workers 76.67 % expressly indicated in their favor access to a single web browser application and no installation of native applications, which confirmed the conservation of the device resources (RAM and internal storage) as a significant impediment for the entry of digital applications in rural-suburban contexts.

3.2. System Modeling, UI/UX Design, and Haversine Distance Analysis

To address the socio-technical challenges described in Section 3.1, a decoupled, web-responsive client-server model is advocated as a conceptual model for future iterations, consistent with the mock-up limitations of this study. In this potential technology stack the frontend is planned to be done in ReactJS to have single-page-application (SPA) like experience, while the backend would be implemented by means of a Laravel/Lumen RESTful API that would provide low-latency access to a relational MySQL coordinate database.

System boundaries, structural constraints, and behavioral access control parameters are formally modeled using a Unified Modeling Language (UML) Use Case Diagram (see Figure 2), segregating platform interaction into three discrete actor roles:

1. *Consumers:* it was granted the capacities to run at-precision Browser-level geo location detection, to fetch nearby partner directories sorted by proximity, and to start dynamic surplus food product bookings.
2. *MSMEs Partners:* Having the rights to manage merchant store profiles, update live dynamic inventory stock tables and run POS coupon validation procedures.
3. *Admin:* With global system privileges to maintain the integrity of the database, audit streams of financial transactions, and validate merchant credentials during onboarding.

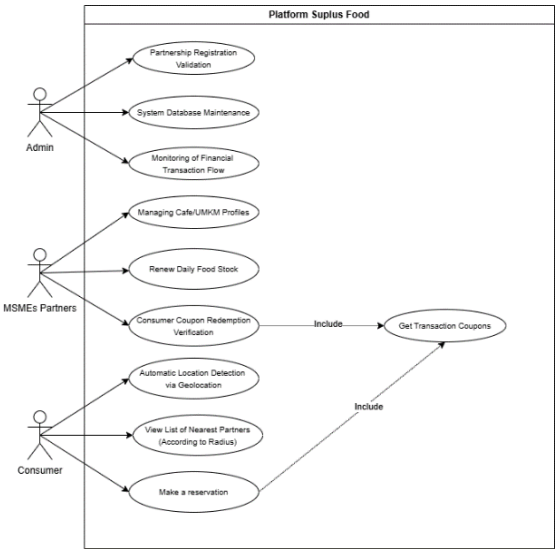

Figure 2. Use Case Model

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Figured in Figma the UI/UX design wireframe uses high contrast component spacing and mobile-first pathwaybased navigation is intuitive. This line of design thinking is also a direct route to simplification, but if needs were to be considered given various levels of digital literacy in suburban satellite regions. The core interactive sequences of pages tailored for stage-based design goals are graphically represented in Figure 3. The main process is to:

1. Automated detection of user geographic coordinates upon page access.
2. Presentation of partner cafes sorted automatically by proximity.
3. Transparent product detail pages featuring original vs. discounted price comparisons and unique QR codes for on-site verification.

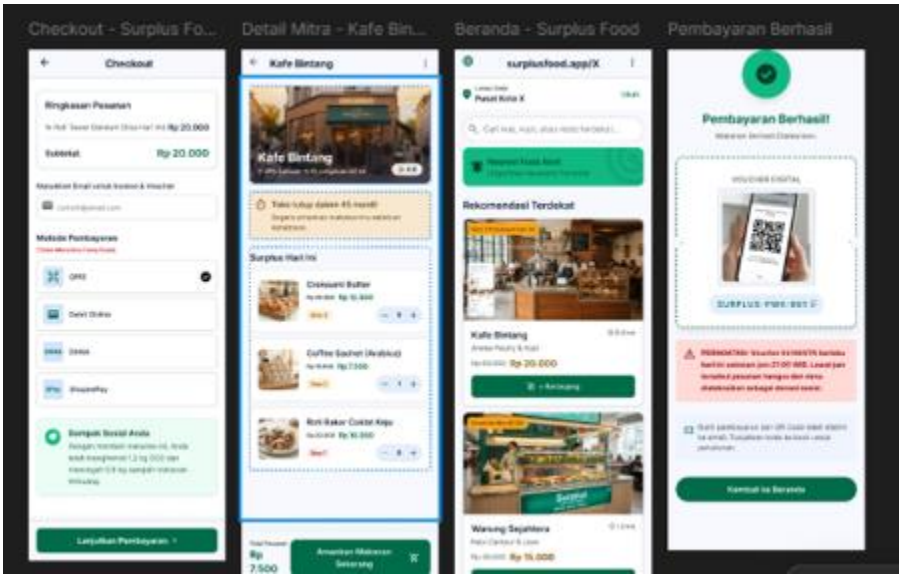

Figure 3. Prototype Model

To enable client-side real-time, low-latency proximity matching recommendations in a Web responsive user interface, and not to trigger heavy geospatial queries on the server, the spherical trigonometry is implemented on our platform through the Haversine Algorithm. This method of mathematical calculation takes planetary surface curvature to determine great circle distance, i.e., the shortest spatial path between two coordinate pairs on the surface of a spherical object, without handling the heaviness in the outside server environment. Simulation experiments were performed using real city downtown coordinates as anchors with three partner locations to verify the generality of the approach.Technical soundness was confirmed by comparing the results of the mathematical formulation with the official route information of the Google Maps (see Table 2).

The verification tests for the spatial positioning algorithm conducted in this study show that the average spatial deviation of the field measurements in this work is only 0.6%, far lower than the critical error threshold of 5%. This minor deviation originates from the difference between the Haversine distance algorithm and Google Maps' route planning logic; the latter performs calculations using three types of dimensions including real-world road networks, and this deviation is negligible.

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Table 2. Distance Accuracy Comparison: Google Maps vs. Haversine Formula.

Target Location	Coordinates (Lat, Long)	Google Maps (Km)	Haversine (Km)	Error (Km)	Accuracy (%)
SME A	-6.507342, 107.467742	6.17	6.079855	0.090145	98.53%
SME B	-6.555922, 107.414829	2.92	3.010560	0.090560	96.89%
SME C	-6.4863652, 107.3923240	9.62	9.469739	0.150261	98.43%
Average				0.110322	97.95%

Since the food rescue platform is designed for localized interactions with small radius constraints, the client-side Haversine model based on geodesic distances is empirically valid. It delivers a dependable and sustainable LBS infrastructure architecture without bearing recurring financial burden, managing credentials or caching APIs associated with use of external proprietary map frameworks.

3.3. Strategic Analysis Mapping via Business Model Canvas

On the basis of the onsite research results in the partner (B2B) and consumer (B2C) domains, a digital business model was constructed by employing the Business Model Canvas (BMC) method. To be realistic about the future, the mapping has integrated concepts of Sustainable Business Modelling in terms of financial viability, social benefits, and environmental conservation. Table 3 presents a full breakdown of these elements at the nine tactical pillars.

Table 3. Strategic Implementation of the Nine BMC Building Blocks.

BMC Element	Strategic Implementation Summary
Value Propositions	Quality products at 50%–70% off along with financial relief for F&B owners. The core value comes from its contribution to the environment and accessibility by location.
Customer Segments	Targeting young adults and those with economic saving motives living in those towns & cities, and to suburban culinary SMEs wanting to handle daily surplus inventories.
Channels	Services offered through web-responsive platforms allow for efficient use of space. The Google Maps API is the essential component that links your users' locations to your partners.
Customer Relationships	Building trust through price transparency and personalized experiences by means of an automated proximity sorting system embedded in the web interface.
Revenue Streams	Revenue generated from a 15% commission for each transaction successfully made on the digital platform.
Key Activities	Handling excess data, maintaining the system, and optimizing geospatial algorithms to provide stable recommendation accuracy.

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Key Resources	Digital infrastructure, partner coordinated databases, and collaborative networks with local food and drink businesses.
Key Partnerships	Key partners are suburban West Java SMEs owners as suppliers and map technology providers as base-layer tech partners.
Cost Structure	Continutiy of service fees, including server maintenance, API costs, and online marketing for users acquisition are the ongoing operational costs.

The relationship between Value Propositions and Key Partnerships indicates that the platform stability is based on cooperation and collusion. From the perspective of information technology, the integration of two-sided proximity sorting in the Channels module delivers real travel efficiency. This model is consistent with platform-based business logic as a hub that reduces search costs and captures economic value through handling of surplus food in rural areas. To better comprehend the integrated nature of these blocks, the entire strategic ecosystem is plotted in the master framework depicted in Fig. 4.

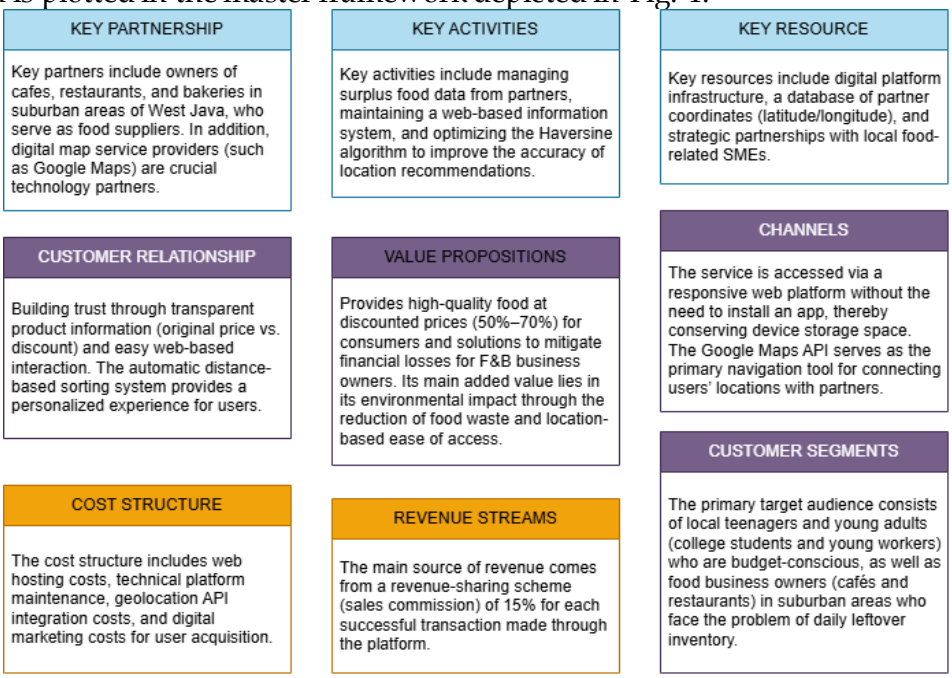

Figure 4. Business Model Canvas

Based on an empirical synthesis of B2B merchant operations and B2C consumer behavior, the digital entrepreneurship strategy is formalized through the BMC framework. The platform's Value Propositions address dual-market friction by reducing sunk costs for suburban culinary SMEs through dynamic pre-closure discounting 50%–70% and by satisfying the dominant Economic Motifs of 53.33% of consumer respondents desiring high-quality surplus food.

In order to enhance Solution Accessibility and remove the barriers of access, which was identified by 76.67% of users who decline download of native apps due to lack of storage on their device, the channel is roll out only as a Progressive Web App (PWA).

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Moreover, the embedding of client-side Haversine Algorithm also supports the platform's Key Activities at the best, providing efficient, no-cost LBS. This design choice removes any external API dependencies and financial overhead, thereby directly stabilizing the Cost Structure and while spatial recommendation accuracy remains a very high 97.95% across localized suburban grids.

4. Conclusion

This research successfully develops a digital entrepreneurship approach and a location-based app prototype for reducing daily food wastage in culinary microenterprises along suburban corridors. Theoretical synthesis of empirical outcomes from the DSRM process suggests that a provisional dynamic pricing scheme (a discount of 50%–70%) can serve as an effective loss mitigation scheme for supplier-side merchant recovery as well as demand-side consumer economic utility (53.33% is the consumer's utility for this option). From a technological standpoint, the choice of a Progressive Web App (PWA) as the platform form is well suited to the infrastructural limitations of the suburban dwellers where 76.67% indicated they would prefer to access the service via a web-browser as opposed to downloading a native application in a bid to save their device's computational resources. The computational cost of the LBS infrastructure, when localized, also leads to high spatial processing precision as confirmed by the client-side Haversine Algorithm. The results showed that the proposed mathematical model obtained a very negligible mean absolute error of 0.11 km (approximately 110 meters) when it was compared with the commercialization routing networks utilizing the regional node of Alun-Alun Purwakarta, which indicated strong local computational efficiency of 97.95% (with an error tolerance of 2.05%) . Therefore, this self-sustaining, independent technical infrastructure is proven to be valid for short radius food rescue transactions without adding on-going third-party API subscription cost. In the future, efforts should be devoted to extending the system design with the integration of real-time automated food safety timestamping to enhance merchant regulatory compliance.

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