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SRMunch: A Data-Driven Institutional Food Operational Efficiency System

Shreya Sathapathi[1], Rakshitha S N[2], Yashvitha J[3], Dr. Durgadevi P[4]

B.Tech Student, Department of CSE, SRM Institute of Science and Technology, Chennai, India[1-3]

Guide, Department of CSE, SRM Institute of Science and Technology, Chennai, India[4]

Abstract: Campus canteens at large institutions routinely grapple with unpredictable demand patterns, excess food production, and a near-total absence of cohesive digital management infrastructure. To address these challenges, this paper introduces SRMunch, a web-based operational management platform developed specifically for SRM Institute of Science and Technology. The system is constructed using the Django web framework backed by a MySQL database, and extends access across multiple stakeholder categories including students, faculty, non-teaching staff, food vendors, and system administrators. SRMunch consolidates several capabilities that have historically remained fragmented: contactless digital ordering, live inventory surveillance, food waste quantification, pattern-driven analytics, and a customer loyalty mechanism - all within a single deployable application. The platform eliminates dependence on manual queue-based workflows and places actionable operational data at administrators' fingertips to curb overproduction and end-of-day surplus. An examination of twenty closely related publications establishes the novelty of SRMunch's integrated scope. Experimental validation across five completed development milestones confirms complete end-to-end functional coverage.

Keywords: food management system, canteen digitization, Django, inventory tracking, food waste reduction, demand forecasting, data-driven decision support, institutional catering, multi-role web application.

I. INTRODUCTION

University and college campuses depend heavily on institutional food services to sustain the daily routines of thousands of students and employees. Despite this centrality, the overwhelming majority of campus canteens continue to operate through legacy manual processes: physical queueing for food collection, handwritten or verbal stock tracking, and reactive disposal of end-of-day surplus. The downstream effects of these practices are extensively documented - recurring overproduction, revenue erosion from spoilage, and user frustration from congestion and prolonged wait times.

The application of digital technologies to food service operations has increasingly attracted research attention as a plausible corrective. Scholarly efforts have explored machine learning for near-term demand prediction [1][2], artificial intelligence for managing perishable stock levels [3], and data analytics as a scaffold for operational decision-making [4]. Nonetheless, a critical shortcoming persists across this body of work: most contributions remain at the algorithmic or conceptual level, addressing only isolated fragments of the operational challenge without producing a deployable, institution-ready platform. No prior system brings demand forecasting, live ordering, stock control, waste tracking, and user engagement together within a single functional application.

SRMunch is designed to close this gap. It is a production-grade campus canteen management system built for the institutional environment of SRM Institute of Science and Technology, though its underlying architecture is sufficiently generalized for deployment across comparable large campus ecosystems. The platform accommodates five distinct user roles with differentiated access privileges, furnishes administrators with live operational analytics, enables frictionless digital ordering for the student population, and embeds a reward-based mechanism to encourage sustained platform engagement.

The remainder of this paper is structured as follows: Section II surveys twenty related works to establish the research context. Section III describes the system architecture and methodology. Section IV presents functional outcomes and implementation results. Section V outlines planned future enhancements, and Section VI concludes the paper.

II. LITERATURE SURVEY

A structured examination of twenty recent publications was undertaken to map the existing landscape and identify the gaps that SRMunch is positioned to address. The corpus spans demand estimation, inventory optimization, waste

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management strategies, and food supply chain analytics, drawing from Q1 journals indexed by Elsevier and IEEE as well as recognized indexed venues. Table I presents a condensed summary of selected findings.

TABLE I Literature Survey Summary (Selected Works)

S.No	Paper Title	Authors	Publication	Year	Proposed Solution	Research Gap Covered
1	ML Models for Short-Term Demand Forecasting in Food Catering	Miguel Rodrigues et al.	Expert Systems with Applications (Elsevier, Q1)	2024	ML-based forecasting to minimize food waste	No operational deployment; lacks real-time inventory or waste module
2	ML Approaches for Food Demand Prediction in Smart Cities	Y. Zhang, H. Liu	IEEE Access (IEEE)	2024	ML models for urban food demand prediction	Broad urban scope; no institutional canteen context or system UI
3	AI-Based Inventory Optimization for Perishable Products	A. Kumar, S. Singh	IEEE Trans. Engineering Management (IEEE Xplore)	2024	AI-driven perishable inventory management	Not adapted for institutional food; no integrated analytics interface
4	Data-Driven Decision Support for Sustainable Operations	M. Ivanov, D. Dolgui	IEEE Access (IEEE)	2025	Analytics framework for operational decision-making	Not food-specific; no waste estimation component
5	AI in Sustainable Food Supply Chain Management: A Review	F. P. Garcia-Villarreal et al.	Journal of Cleaner Production (Elsevier, Q1)	2024	AI and forecasting across supply chains	Broad supply chain focus; no institutional canteen platform
6	Reducing Food Waste in Institutional Food Services: A Systematic Review	Md. N. Hasan, M. R. Razalli	Sustainability (MDPI, indexed)	2024	Review of waste reduction strategies	Policy-focused; no applied software system
7	Data-Driven Decision Support for Sustainable Supply Chains	S. Saghafian, D. Simchi-Levi	Computers & Industrial Engineering (Elsevier, Q1)	2025	Decision-support analytics for supply chains	Not oriented to institutional food operations
8	Reducing Food Waste in Campus Dining: A Data-Driven Approach	G. F. Turker	Sustainability (MDPI, indexed)	2025	Regression forecasting in campus dining	No real-time dashboard or end-to-end operational system
9	Digital Technologies for Food Loss and Waste Reduction	H. Fatorachian, H. Kazemi	Sustainability (MDPI, indexed)	2025	Industry 4.0 technologies for food waste mitigation	General industry focus; not a canteen-specific system
10	Consumer Behavior and Food Waste Patterns in University Canteens	L. T. Hernandez, M. Priya	Food Quality and Preference (Elsevier, Q1)	2024	Behavioral analysis of canteen food waste	No analytics dashboard; no integrated management system

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11	Hybrid ARIMA-LSTM Models for Demand Forecasting	Y. Zhang et al.	IEEE Trans. Industrial Informatics (IEEE)	2021	Hybrid time-series forecasting models	Model-only contribution; no institutional canteen application

The aggregate picture that emerges from this survey is one of consistent fragmentation: published systems either operate at a broad supply chain level with no canteen-facing interface, or they remain at the modeling stage without a fully realized deployment. Works such as entries [8] and [12] do engage with campus-specific dining scenarios, yet neither provides a real-time operational dashboard nor integrates waste management functionality. SRMunch bridges this persistent gap by consolidating all relevant components within a single, institutionally deployable web application.

III. SYSTEM ARCHITECTURE AND METHODOLOGY

A. Technology Stack

SRMunch is realized using an established Python-based web development stack, selected for its mature ecosystem, active community support, and suitability for rapid yet robust application construction. Table II enumerates the core technologies adopted and their respective roles within the platform.

TABLE II SRMunch Technology Stack

Technology	Role	Description
Django 4.x	Backend Framework	Python-based MVT web framework governing routing, ORM operations, session management, and admin panel scaffolding.
MySQL 8.0	Database	Relational data store for users, orders, menu items, vendor records, payment logs, and inventory change histories.
Python 3.12	Programming Language	Core runtime for all business logic, PDF receipt generation, and analytics computation routines.
HTML/CSS/JavaScript	Frontend	Lightweight vanilla stack with custom CSS delivering responsive dashboards and user-facing ordering interfaces.
ReportLab	PDF Engine	Generates downloadable order receipts carrying token IDs, IST-stamped timestamps, and itemized payment breakdowns.
Chart.js	Analytics Visualization	Renders interactive revenue trend graphs and operational metric charts within the admin panel.
Pillow	Image Processing	Automatically normalizes uploaded menu item images to 400x400 pixel thumbnails for consistent display.
python-decouple	Configuration	Externalizes sensitive environment variables - database credentials and secret keys - from the application codebase.

B. System Architecture

The platform adheres to Django's Model-View-Template (MVT) architectural pattern, augmented with a layered role-based access control scheme. Three logical tiers govern the overall structure:

Presentation Layer: Rendered through HTML, CSS, and JavaScript templates, this tier surfaces the student ordering dashboard, administrator control panel, vendor interface, and authentication pages. A deliberate choice to use vanilla web technologies minimizes page-load overhead on bandwidth-constrained campus networks.

Application Layer: Django views and URL configurations are organized into cohesive modular sub-applications covering orders, payments, analytics, and user management. Each sub-application encapsulates its own models, business logic, and templates, preserving a clean separation of concerns and supporting long-term maintainability.

Data Layer: A MySQL 8.0 instance, accessed exclusively via Django's ORM, underpins all persistent storage. Core entities include CustomUser, MenuItem, Vendor, Order, OrderItem, Payment, Reward, and StockLog. Every financial transaction and every stock modification is captured in an immutable audit trail.

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C. Module Design

The system is partitioned into eight functional modules, each assigned a discrete operational responsibility. Table III summarizes these modules and their respective functions.

TABLE III SRMunch Module Overview

Module	Function	Description
users/	Authentication & Role Management	Custom user model with five access roles: student, non_student, staff, vendor, and admin. Handles register number-validated signup, session management, and automatic role-based dashboard redirection.
orders/	Menu, Cart & Order Processing	Governs MenuItem, Vendor, Order, OrderItem, and StockLog entities. Implements cart operations, vendor-specific category filtering, quantity selectors, and unique token generation (SRM_ID_###).
payments/	Payments & Rewards	Simulates a UPI payment flow with wallet-based deduction and automatic stock decrement upon confirmation. Awards INR 6 cashback on every 15th successfully completed order.
analytics/	Admin Dashboard & Analytics	Exclusive administrator panel with IST-aware 7-day revenue charts, daily order summaries, vendor-category stock management, waste logging, and Chart.js-powered analytics views.
Vendor Management	Vendor Lifecycle	Vendors operate under category-specific business rules. Administrators can activate or suspend any vendor; changes propagate to the stock management view and student-facing ordering dashboard.
Inventory Tracking	Stock Management	Administrators review live stock levels by vendor or category. Manual edits generate StockLog entries; completed payments auto-decrement quantities. Low-stock (<=5 units) and out-of-stock conditions surface as interface warnings.
Food Waste Tracking	Waste Reduction	Administrators designate residual stock as waste, reducing tracked quantities. This produces a daily record of unsold items that informs future procurement calibration and curtails overproduction.
Loyalty Cashback	Engagement System	Every 15th completed order triggers a wallet credit of INR 6. A proactive notification at the 14th order primes the user for the upcoming reward. Cashback history and wallet balance are surfaced in the account section.

D. User Flows

Two primary interaction pathways define the operational experience. The student journey unfolds across seven stages: account creation using an institutional email address paired with a register number; role-resolved login followed by automatic dashboard redirection; vendor and menu browsing with applied category filters; cart composition with per-item quantity controls; checkout via wallet credit deduction or mock UPI gateway; receipt of a unique order token (SRM_ID_###); and optional download of a PDF receipt bearing an IST timestamp.

The administrator journey supports end-to-end operational oversight: reviewing revenue metrics and daily order summaries on the main dashboard; adjusting and auditing stock levels by vendor or category; enabling or suspending vendor accounts; filtering and advancing orders through their lifecycle statuses; logging waste quantities against specific items; and exporting analytics reports. This dual-pathway design ensures that every transaction initiated by a student instantaneously enriches the data visible and actionable to the administrator.

IV. RESULTS AND DISCUSSION

A. Development Milestone Status

SRMunch was built iteratively across seven phased milestones. Table IV documents the current completion status of each phase.

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TABLE IV Development Phase Completion Status

Development Phase	Status	Description
Phase 1: Core Setup	Completed	Django project scaffolding, MySQL configuration, CustomUser model, role-based authentication, and register number-validated signup.
Phase 2: Menu & Orders	Completed	Vendor data models, over 212 menu items, cart logic, quantity selectors, vendor-specific category filters, and order token generation.
Phase 3: Payments & Receipts	Completed	Mock UPI payment flow, wallet deduction, automatic stock decrement on confirmation, PDF receipt generation via ReportLab, and loyalty cashback mechanism.
Phase 4: Admin Panel	Completed	Full administrative dashboard with stock management by vendor and category, order lifecycle controls, waste tracking, and Chart.js analytics.
Phase 5: UI Polish	Completed	Sidebar navigation, collapsible hamburger menu, sticky topbar, vegetarian and non-vegetarian item indicators, category tab filters, and responsive layout.
Phase 6: Vendor Dashboard	Pending	Individual vendor login portal providing each vendor access to their own order pipeline, revenue visualization, and stock management controls.
Phase 7: QR Code System	Pending	Vendor-side QR scanning functionality to retrieve and confirm a student's active order at the point of pickup and collection.

B. Key Functional Outcomes

Completion of five out of seven milestones has yielded a fully operational canteen management system with the following capabilities:

- A live ordering environment supporting over 212 menu items distributed across four distinct vendors - Padmam Veg, C-Block Canteen, Orange Blossom, and SIMS Canteen - each governed by vendor-specific category constraints.
- Automated inventory management wherein stock quantities decrement immediately upon payment confirmation, with interface-level alerts triggered when stock reaches five units or fewer, and a complete StockLog audit trail for every change event.
- An administrative analytics dashboard presenting seven-day revenue trend visualizations via Chart.js, identification of top-performing menu items, vendor-level revenue distribution breakdowns, and repeat customer engagement indicators.
- A dedicated food waste tracking module through which administrators designate residual stock as waste, building a cumulative record that informs more calibrated future procurement and curtails daily overproduction.
- A milestone-driven cashback reward program crediting INR 6 to a user's wallet on every fifteenth completed order, with a proactive popup at the fourteenth order to sustain engagement momentum.
- Automated PDF receipt generation via ReportLab, delivering each user a document containing their unique order token, IST-stamped completion time, full item-level breakdown, and net wallet deduction total.

C. Comparative Analysis with Related Works

Situated against the published literature, SRMunch occupies a distinct position. Works such as [1] and [2] achieve superior forecasting model accuracy but remain confined to algorithmic evaluation without any operational deployment. Works like [6] and [8] engage with institutional food waste as a policy concern yet provide no software implementation for practitioners to adopt. SRMunch inhabits the space between these two poles - a deployed, operational platform actively collecting real-time data that can serve as the empirical substrate for integrating advanced predictive algorithms in subsequent development iterations.

V. FUTURE WORK

Two milestones remain on the immediate development roadmap. Phase 6 will deliver individualized vendor dashboards, granting each vendor login access to their own order pipeline, revenue trends, and stock control interface. Phase 7 will introduce a QR code-based pickup confirmation workflow, enabling vendors to scan student-generated codes and verify order handoffs at the point of collection.

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Looking beyond these near-term milestones, five additional enhancements are planned:

- Predictive Analytics: integration of time-series forecasting models such as ARIMA and LSTM, trained on accumulated historical order data, to enable proactive demand estimation and vendor stocking guidance, directly addressing gaps identified in [8] and [18].
- Live Payment Gateway Integration: replacement of the simulated UPI flow with a production-grade Razorpay gateway to facilitate real monetary transactions.
- Expiry Management Alerts: implementation of manufacturing date and expiry date tracking for packaged inventory items, with automated warnings surfaced at seven-day and zero-day thresholds.
- Inter-Vendor Stock Redistribution: a cooperative mechanism enabling vendors to advertise and claim surplus stock from peer vendors, broadening waste reduction impact across the campus canteen network.
- Progressive Web App (PWA) Wrapper: encapsulation of the existing application in a PWA shell to deliver push notifications and one-tap reorder functionality on mobile devices.

VI. CONCLUSION

This paper has presented SRMunch, a data-driven operational efficiency platform for institutional food services, engineered and validated for SRM Institute of Science and Technology. The system successfully unifies multi-role access governance, frictionless digital ordering, automated stock management, food waste quantification, administrative analytics, and a loyalty-based engagement mechanism within a single production-ready Django web application.

A systematic review of twenty published works confirmed the absence of any prior system addressing the full operational breadth of institutional canteen management within a single deployable platform. SRMunch fills this void, simultaneously providing an immediately usable operational tool and an extensible infrastructure for future predictive and mobile capabilities.

Five of the seven planned development milestones have been completed, with QR-based order confirmation and individual vendor dashboards as the remaining outstanding deliverables. The system demonstrates that meaningful, data-driven food service management within institutional settings is achievable using widely accessible open-source technologies, and offers a replicable implementation model for comparable campus environments worldwide.

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