# Leveraging Artificial Intelligence and Machine Learning for Sustainable Food Management and Enhanced Customer Satisfaction: A Study of Selected Restaurants in Hamirpur District, Himachal Pradesh

Yashveer Bhardwaj [1]*, Dr. Sanjay Singh [2]

[1]     *Research Scholar, Department of Hospitality Management, CT University, Ludhiana, India*
[2]     *Assistant Professor, Department of Hospitality Management, CT University, Ludhiana, India*

## ARTICLE INFO

## ABSTRACT

The hospitality industry is undergoing a paradigm shift driven by the integration of Artificial Intelligence (AI) and Machine Learning (ML), particularly in the realms of sustainability and customer-centric innovation. This study investigates the potential of AI and ML technologies in promoting sustainable food management and enhancing customer satisfaction within selected restaurants in Hamirpur district, Himachal Pradesh. As a region characterized by rising tourism and increasing environmental concerns, Hamirpur provides a unique context to explore the intersection of technology, sustainability, and service quality in food and beverage operations.

The research employs a mixed-methods approach, incorporating structured interviews with restaurant stakeholders, AI-driven data analysis of inventory and sales patterns, and customer feedback surveys. Specific focus areas include the implementation of ML algorithms for predictive demand forecasting, intelligent inventory optimization to reduce food waste, and AI-enabled personalization of menu offerings based on dietary preferences and consumption trends.

Through empirical analysis, the study aims to uncover how AI-supported systems contribute to both operational efficiency and improved customer satisfaction, while simultaneously aligning with sustainable development goals. The research also explores barriers to AI adoption in small and medium-sized food establishments and proposes a scalable model for integrating intelligent systems into resource-conscious hospitality practices. The outcomes are expected to offer valuable insights for policymakers, restaurateurs, and technology developers working towards a greener and more guest-focused future in the Indian hospitality sector.

## Introduction

In recent years, the global hospitality industry has been at the forefront of transformative change, catalyzed by technological advancements and shifting consumer behavior. With heightened awareness of climate change and resource conservation, sustainability has emerged as a central concern in hospitality operations. Simultaneously, the digital age has ushered in a new era of customer expectations centered on personalization, efficiency, and quality service. Against this backdrop, Artificial Intelligence (AI) and Machine Learning (ML) have surfaced as pivotal enablers of innovation, offering data-driven solutions to complex

challenges in food service management and guest experience enhancement.

The integration of AI and ML in hospitality is redefining how businesses operate, particularly in food and beverage sectors where the balance between sustainability and customer satisfaction is most delicate. From reducing food waste through predictive analytics to curating customized dining experiences based on guest preferences, these technologies provide a strategic advantage. AI applications can analyze vast amounts of data in real time—ranging from customer reviews and purchasing patterns to inventory levels and seasonal demand—enabling restaurants to make informed decisions that align with environmental and economic goals.

The significance of this technological evolution is especially pronounced in regions like Hamirpur district in Himachal Pradesh. Known for its natural beauty, cultural richness, and increasing tourist influx, Hamirpur represents a unique microcosm where traditional culinary practices meet modern service demands. The hospitality industry in this district, particularly small and medium-sized restaurants, faces a dual imperative: to preserve the authenticity of local cuisine while adapting to the efficiency-driven dynamics of a competitive marketplace. This study places a spotlight on Hamirpur, examining how AI and ML tools can help these establishments not only survive but thrive by implementing sustainable and customer-focused practices.

Hamirpur's geographic and socio-economic context makes it a fertile ground for such research. The district has witnessed notable growth in tourism over the past decade, driven by domestic travelers seeking offbeat destinations and a growing awareness of environmental stewardship. However, with increased footfall comes increased pressure on local food systems, waste management practices, and service capabilities. Traditional restaurant operations often struggle with resource allocation inefficiencies, overproduction of perishable goods, and limited capacity for nuanced customer engagement. This creates a compelling case for exploring AI- and ML-based interventions that can offer intelligent solutions tailored to the region's needs.

Moreover, the government's emphasis on digital transformation under initiatives such as Digital India and the growing accessibility of AI-driven platforms further amplify the relevance of this study. For restaurant owners and operators in

Hamirpur, embracing these technologies could translate into improved sustainability metrics, optimized inventory control, and elevated guest experiences—ultimately contributing to long-term business viability and environmental stewardship.

This research aims to bridge the gap between emerging technology and traditional hospitality practices by analyzing the adoption and impact of AI and ML in selected restaurants within the Hamirpur district. Through a comprehensive investigation that includes stakeholder interviews, customer feedback surveys, and data-driven performance analysis, the study seeks to provide actionable insights and a replicable model for technology-enabled sustainable food management. In doing so, it aspires to contribute not only to academic discourse but also to practical strategies that support the Indian hospitality industry's transition towards a more sustainable, efficient, and customer-centric future.

## Theoretical Framework/Literature Review

The theoretical underpinning of this study draws from a combination of innovation diffusion theory (Rogers, 2003), sustainability frameworks, and service quality models such as SERVQUAL.

Together, these perspectives help explain how and why restaurant operators in semi-urban settings like Hamirpur adopt or resist AI and ML technologies.

Recent literature (post-2021) has expanded significantly on the role of AI and ML in hospitality and food service management:

**Wamba-Taguimdje et al. (2021)** highlighted how AI-powered analytics enhance operational efficiency and sustainability, with applications ranging from real-time supply chain management to customer behavior prediction.

**Tussyadiah (2022)** emphasized the transformative power of machine learning in providing hyper-personalized guest experiences through recommender systems and chatbots, which significantly influence customer loyalty and satisfaction.

**Li et al. (2022)** demonstrated the use of AI in menu engineering, linking consumer behavior data with dynamic pricing and nutritional optimization to align menu offerings with health and sustainability goals.

**Gursoy & Chi (2023)** examined customer perceptions of AI technologies in food service, revealing that while younger demographics are more receptive to AI-enabled services, transparency and

perceived usefulness are key mediators of trust and acceptance.

**Wang et al. (2023)** investigated how AI tools are being used in small hospitality businesses to minimize food waste and energy consumption. Their study found that algorithm-driven inventory management systems reduced resource use by 18–27%.

**Kim & Lee (2022)** explored the integration of AI in improving food traceability and safety in small food enterprises, contributing to higher consumer confidence.

**Singh & Verma (2023)** studied AI-driven sustainability reporting in Indian hospitality businesses, linking AI analytics with SDG performance monitoring.

**Zhang et al. (2022)** focused on AI-enabled emotion detection in customer service interactions, highlighting its impact on service recovery and satisfaction.

**Joshi & Sharma (2023)** evaluated digital transformation readiness in rural Indian hospitality settings, providing insight into infrastructural and cultural challenges to AI adoption.

**Fernandez & Kapoor (2023)** discussed the role of machine learning in forecasting food trends and aligning local restaurant offerings with market demand.

## Research Methodology

### Research Design

A convergent parallel mixed-method approach was utilized, wherein both qualitative and quantitative data were collected simultaneously but analyzed separately. The findings were then merged to provide a holistic understanding of the research problem.

### Sampling Method and Population

The target population for this study included restaurant owners, managers, chefs, and customers in the Hamirpur district. A purposive sampling technique was used to select 10 small to medium-sized restaurants that have adopted or shown interest in AI or ML-based solutions. For the customer survey, a convenience sampling method was employed, involving 100 diners across these establishments.

### Data Collection Methods

- **Primary Data**:
  - **Structured Interviews**: Conducted with restaurant stakeholders to understand operational practices, AI

adoption levels, challenges, and perceived benefits.

- o **Customer Surveys**: Designed to assess customer satisfaction, perceptions of AI-enabled services (e.g., personalized menus), and sustainability awareness.
- o **Observational Analysis**: Documented staff behavior and customer interaction with AI-supported features (e.g., digital menus, feedback kiosks).
- **Secondary Data**:
  - o Academic journals, trade publications, market research reports, and government documents were reviewed to gather contextual and comparative information.

## Gaps in Existing Research

While there is ample literature on AI in urban hospitality sectors, very few studies examine its role in semi-urban or rural contexts. Additionally, research on how AI supports sustainability in smaller restaurants is underdeveloped. This study aims to bridge this gap by focusing on

practical implementation and localized challenges in the Hamirpur district.

## Analytical Tools and Techniques

- **Quantitative Data**: Customer responses from surveys were analyzed using SPSS. Descriptive statistics (mean, frequency, percentage) and inferential statistics (Chi-square tests, ANOVA) were employed to interpret customer satisfaction trends.
- **Qualitative Data**: Thematic analysis was applied to interview transcripts to identify common themes, challenges, and perceptions among restaurant stakeholders.
- **AI & ML Integration Assessment**: Real-time inventory and sales data from three participating restaurants using AI-enabled POS systems were analyzed for patterns in food waste reduction, inventory turnover rates, and sales optimization.

This multi-pronged methodology ensured triangulation and reliability of the results, enabling the study to draw meaningful conclusions about the impact and scalability of AI and ML technologies in the regional hospitality landscape.

## Results and Discussion

The results derived from the mixed-methods research indicate notable outcomes regarding the integration of AI and ML technologies in restaurant operations within the Hamirpur district.

**Response Rate** Out of 100 customer surveys distributed, 91 were completed and returned, resulting in a 91% response rate. Structured interviews were successfully conducted with 10 restaurant stakeholders.

**Customer Survey Analysis** The data collected from customers revealed a positive inclination towards AI-driven personalization and service efficiency. The following table summarizes key findings from customer feedback:

| Survey Parameter | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Personalized recommendations improved experience | 52% | 30% | 12% | 4% | 2% |
| AI-based ordering reduced wait time | 47% | 35% | 10% | 6% | 2% |
| AI menus enhanced food selection satisfaction | 55% | 28% | 9% | 5% | 3% |
| Awareness of sustainable practices improved | 43% | 36% | 14% | 5% | 2% |

**Stakeholder Interview Themes** Interview analysis revealed the following recurring themes:

- **Operational Efficiency**: AI-based inventory systems reduced food spoilage by up to 25%.
- **Customer Retention**: Personalized experiences led to higher revisit intent.
- **Barriers to Adoption**: Cost of implementation and lack of technical skills.

- **Perceived Benefits**: Improved decision-making, cost savings, better resource allocation.

**Observational Insights** Restaurants using AI for sales forecasting showed more balanced inventory usage and minimal food wastage during peak periods. AI-integrated digital menus and feedback systems also enhanced customer interaction.

**Comparative Inventory and Waste Analysis** Below is a comparative analysis of three restaurants using AI systems versus those without:

| Parameter | AI-Enabled Restaurants (Avg.) | Non-AI Restaurants (Avg.) |
|---|---|---|
| Monthly Food Waste (kg) | 18 | 32 |
| Inventory Turnover Ratio | 6.5 | 3.9 |
| Average Daily Sales (INR) | 18,000 | 13,500 |
| Customer Satisfaction Score | 4.3 / 5 | 3.6 / 5 |

**Discussion**

The results affirm that AI and ML integration significantly enhance both sustainability and service quality in the hospitality context. Personalized recommendations and intelligent inventory systems were widely appreciated by customers and operators alike. While initial investment remains a challenge for small businesses, the long-term benefits—such as reduced waste, improved sales forecasting, and higher customer satisfaction—are compelling. This emphasizes the potential for AI-driven innovations to reshape semi-urban hospitality practices sustainably.

**Conclusions**

This study has established that Artificial Intelligence (AI) and Machine Learning (ML) are not just futuristic concepts but practical tools that can significantly contribute to sustainable food management and elevated customer satisfaction in semi-urban hospitality settings. The findings from selected restaurants in the Hamirpur district of Himachal Pradesh illustrate that even small and medium-sized enterprises can benefit from the adoption of intelligent systems, despite the challenges posed by limited resources and technological expertise.

The research revealed several critical insights. Firstly, AI-driven tools such as

predictive analytics, personalized digital menus, and automated inventory systems enable more efficient resource management. The reduction of food waste by up to 25% in AI-enabled restaurants demonstrates the tangible environmental benefits these technologies can deliver. Improved inventory turnover and increased daily sales figures further point to the economic viability of these systems.

Secondly, the role of AI in enhancing customer satisfaction was evident through high satisfaction ratings and positive feedback regarding personalized services and faster, more accurate order processing. The customer survey highlighted that a significant majority appreciated AI-enabled recommendations and services, which positively influenced their overall dining experience.

In conclusion, the integration of AI and ML technologies represents a promising pathway toward sustainable hospitality practices that are environmentally conscious and customer-focused. By leveraging data and intelligent systems, restaurants in regions like Hamirpur can not only enhance their operational performance but also contribute meaningfully to broader sustainable development goals. This research advocates for a structured and inclusive

roadmap to facilitate the digital transformation of India's hospitality industry—one that ensures equitable access to innovation and technology for all segments of the market.

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