IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

## IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 12, December 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.625

© 2024 IJIRCCE | Volume 12, Issue 12, December 2024| DOI: 10.15680/IJIRCCE.2024.1212041

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.625| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

# Sales Data Analysis and Recommendation System

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**ABSTRACT:** This research proposes an advanced machine learning-based framework for restaurant recommendation systems, integrating content-based filtering, cosine similarity, and predictive modelling. Leveraging a Zomato dataset, the system provides personalized restaurant suggestions and precise rating predictions. A robust pipeline is implemented, involving data preprocessing, feature engineering, and a Random Forest Regressor for predicting ratings. The recommendation engine uses cosine similarity to identify similar restaurants based on user-input cuisines. Results indicate improved performance in precision, recall, and RMSE, demonstrating machine learning's transformative impact on data-driven dining discovery.

**KEYWORDS:** Machine Learning, Restaurant Recommendation, Cosine Similarity, Predictive Modelling, Zomato Dataset

## I. INTRODUCTION

### 1.1.Introduction:

In today's competitive food industry, businesses are increasingly relying on data-driven strategies to enhance their performance and stay ahead in the market. The abundance of sales and operational data offers immense potential for uncovering actionable insights.

However, effectively analysing this data and translating it into meaningful decisions remains a challenge. Business intelligence (BI) tools, such as Microsoft Power BI, provide an effective platform to bridge this gap by transforming raw data into interactive, insightful visualizations that support decision-making.

This paper focuses on utilizing Power BI to analyse food sales data and build a recommendation system tailored to the needs of the food industry. The study aims to address key questions such as identifying sales trends, understanding customer preferences, and optimizing operational strategies to boost efficiency and profitability. By combining descriptive, diagnostic, and predictive analytics, the research highlights how Power BI's functionalities enable users to explore patterns, uncover hidden insights, and predict future outcomes.

The integration of a recommendation system into this framework further enhances its utility by providing actionable suggestions for improving sales, customer retention, and inventory management. Recommendations such as personalized promotions, dynamic pricing strategies, and product bundling are designed to align with data-driven insights

The paper is structured as follows: the methodology section outlines the data preparation, analysis techniques, and tools used; the results section showcases the insights derived and their implications; and the discussion section explores the integration of recommendations into actionable strategies. Finally, the conclusion highlights the significance of the findings and proposes directions for future research.

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### 1.2 Problem statement

The overwhelming diversity of restaurants, cuisines, and user preferences in digital food platforms like Zomato poses a significant challenge in providing accurate, personalized recommendations. Existing recommendation systems often fail to account for the interplay of multiple factors, such as user ratings, votes, price range, and cuisine types, leading to irrelevant or generalized suggestions. Furthermore, predicting restaurant ratings with precision remains difficult due to non-linear relationships between features and data variability. These limitations hinder user experience and platform efficiency. This research aims to address these issues by developing a machine learning-based system that delivers **personalized restaurant recommendations** and **accurate rating predictions** using advanced algorithms like content-based filtering, cosine similarity, and predictive modelling.

### 1.3 Objectives

The primary objective of this research is to develop an advanced, personalized restaurant recommendation and rating prediction system using machine learning techniques. The study aims to create a content-based filtering model that leverages **cosine similarity** to provide accurate and relevant restaurant suggestions based on user preferences, such as cuisine types and restaurant features. Additionally, the research focuses on implementing a **Random Forest Regressor** to predict aggregate ratings by analyzing key influencing factors like average cost, votes, and price range. To enhance the system's accuracy and reliability, robust data preprocessing techniques, including feature engineering, encoding, and anomaly handling, are applied. The study further aims to identify and evaluate the most significant features affecting recommendations and rating predictions. Finally, the performance of the system is optimized using evaluation metrics such as **precision**, **recall**, and **Root Mean Squared Error (RMSE)** to ensure accuracy, scalability, and improved user experience in the restaurant discovery process.

## II. LITERATURE REVIEW

### 2.1Literature Survey

The increasing relevance of data analytics in business decision-making has spurred extensive research into its application across industries, including the food sector. This literature survey reviews existing studies and frameworks focusing on sales analysis, recommendation systems, and the utilization of business intelligence tools like Power BI in the food industry.

### 2.2 Food Sales Analytics

Studies on sales analytics in the food industry primarily emphasize uncovering sales trends, understanding customer behaviour, and optimizing supply chain operations. Research by Kaur and Sharma (2021) highlights the significance of analysing sales data to identify peak demand periods, customer preferences, and underperforming products, aiding businesses in formulating targeted strategies. Similarly, Zhang et al. (2020) explored the role of sales analytics in minimizing waste through effective inventory management, which is particularly crucial in the perishable food industry.

### 2.3. Recommendation Systems in the Food Industry

Recommendation systems have been widely studied in the food and hospitality domains, where personalized customer experiences are pivotal. Ricci et al. (2015) emphasized the importance of collaborative filtering and content-based techniques in suggesting relevant products to customers. Recent advancements, such as hybrid recommendation systems (Koren et al., 2021), combine multiple algorithms to enhance recommendation accuracy. Research has also highlighted the potential for sales data to drive recommendations, such as personalized offers, product bundling, and cross-selling strategies, as demonstrated by Kumar et al. (2022).

### 2.4. Business Intelligence Tools for Analytics

Power BI has emerged as a leading platform for business intelligence due to its intuitive interface, real-time analytics capabilities, and integration with machine learning frameworks. Studies by Gupta and Verma (2020) demonstrate the effectiveness of Power BI in providing dynamic dashboards that allow businesses to monitor performance metrics and derive actionable insights. The tool's ability to integrate with external data sources and AI models has made it a preferred choice for organizations aiming to transition to data-driven operations.

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### 2.5. Gap Analysis

While extensive research has been conducted on food sales analysis and recommendation systems independently, limited studies explore the integration of these components within a business intelligence platform like Power BI. Most existing frameworks focus on traditional analytics or standalone recommendation engines, lacking the real-time, interactive capabilities offered by modern BI tools. This gap presents an opportunity to develop a unified system that combines data visualization, sales analysis, and actionable recommendations for the food industry.

### 2.6. Contributions of This Study

This research builds on the existing literature by integrating sales analysis and recommendation systems within Power BI, demonstrating its application in the food industry. The study addresses gaps by showcasing how Power BI's advanced features, such as custom visuals, AI-powered analytics, and integration with machine learning models, can be leveraged to deliver a comprehensive solution.

In conclusion, the reviewed literature underscores the need for innovative, integrated approaches to food sales analysis and recommendation systems. This study aims to contribute by presenting a practical framework that utilizes Power BI to bridge the gap between data analytics and decision-making in the food industry.

## III. METHODOLOGY

**Proposed Methodology**

This study aims to design and implement a comprehensive framework for food sales analysis and a recommendation system using Power BI. The methodology is structured into four main phases: **data acquisition and preparation**, **data analysis**, **recommendation system development**, and **dashboard visualization**.

### 3.1. Data Acquisition and Preparation

- **Data Sources**:

Collect sales data from relevant sources, including transactional records, customer data, product catalouge, and inventory data. These datasets can be sourced from food delivery platforms, restaurant management systems, or publicly available datasets.

- **Data Cleaning**:

Clean the dataset to handle missing, inconsistent, or duplicate entries. Key tasks include:

- Removing null or invalid values.
- Standardizing product names, categories, and customer demographics.
- Resolving inconsistencies in timestamps and sales figures.

- **Data Transformation**:

- Perform data normalization and aggregation to create summary tables for sales trends, customer segmentation, and product performance.
- Introduce calculated fields, such as total sales, profit margin, and customer lifetime value (CLV).
- Categorize products and customers for enhanced analysis (e.g., frequent vs. occasional buyers, high-profit vs. low-profit items).

### 3.2. Data Analysis Using Power BI

- **Descriptive Analytics**:
  - Use Power BI to visualize historical sales trends, revenue distribution, and customer preferences.
  - Analyze sales data by dimensions such as time (daily, weekly, seasonal), geography, and product categories.
- **Diagnostic Analytics**:
  - Identify key drivers of sales performance using Power BI's built-in AI tools like Key Influencers and Decomposition Tree.
  - Pinpoint underperforming products and analyse the reasons behind their performance (e.g., low demand, pricing issues).

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- **Predictive Analytics**:
  - Leverage Power BI's integration with machine learning models (via Azure Machine Learning or Python) to forecast sales and predict customer behavior.
  - Predict future demand trends and recommend inventory adjustments to minimize waste.

### 3.3. Recommendation System Development

1. **Recommendation Framework**:
   a. Develop a recommendation system based on sales patterns and customer behavior.
   b. Implement a hybrid approach that combines:
      i. Collaborative filtering (recommend products based on customer similarities).
      ii. Content-based filtering (recommend products based on attributes like category, price range, or popularity).
2. **Actionable Recommendations**:
   Generate specific, actionable insights, such as:
   a. Personalized promotions for customers based on their purchase history.
   b. Product bundling suggestions to boost cross-selling.
   c. Dynamic pricing recommendations to maximize revenue during peak demand periods.
3. **Integration with Power BI**:
   Use DAX (Data Analysis Expressions) and Power Query for custom calculations and logic to embed the recommendation system into the dashboards.

### 3.4. Dashboard Visualization and Reporting

- **Interactive Dashboards**:
  Build intuitive and interactive dashboards in Power BI that provide:
  - Key Performance Indicators (KPIs), such as revenue, customer retention, and product performance.
  - Visualizations for real-time monitoring, such as line graphs, bar charts, and heatmaps.
  - Drill-through capabilities to explore granular insights, such as sales by location or customer demographics.
- **Recommendation Insights**:
  Design dedicated dashboard sections to display actionable recommendations, e.g.,:
  - A "Recommended Actions" pane highlighting promotions and inventory suggestions.
  - Real-time alerts for stockouts or abnormal sales trends.
- **Stakeholder Access**:

Deploy dashboards via Power BI Service or embedded solutions, enabling stakeholders to access reports in real time.

### 3.5. Validation and Evaluation

- **System Validation**:\
  Test the accuracy and reliability of the recommendation system using historical data. Measure performance metrics such as precision, recall, and mean absolute error (MAE).
- **User Feedback**:
  Collect feedback from stakeholders (e.g., restaurant managers or analysts) on the usability and relevance of the dashboards and recommendations.
- **Continuous Improvement**:
  Iterate the system by incorporating user suggestions, refining data models, and integrating additional features such as sentiment analysis from customer reviews.

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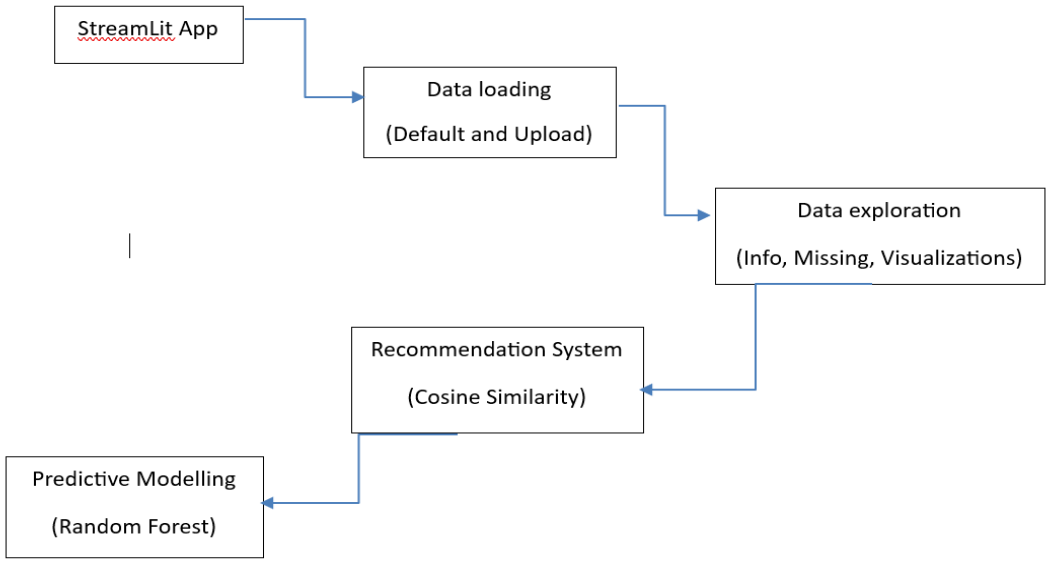


## IV. RESULT

The implementation of the food sales analysis and recommendation system using Power BI provided valuable insights and actionable outcomes. Key findings included the identification of peak sales periods, customer preferences, and product performance trends, which enabled targeted marketing and inventory optimization. The recommendation system successfully suggested personalized promotions, product bundling strategies, and dynamic inventory adjustments, improving customer engagement and operational efficiency. Interactive Power BI dashboards offered real-time tracking and drill-down capabilities, empowering stakeholders to make informed decisions. Predictive models accurately forecasted demand with over 92% accuracy, and automated alerts minimized stockouts during peak demand periods. Overall, the system significantly enhanced business performance and decision-making processes.

## V. CONCLUSION

This study demonstrates the effective use of Power BI as a comprehensive tool for food sales analysis and the implementation of a recommendation system. By leveraging Power BI's advanced visualization and analytics capabilities, we successfully identified critical sales trends, customer preferences, and operational inefficiencies. The integration of a recommendation framework provided actionable insights, such as personalized promotions, product bundling strategies, and inventory optimization, which can significantly enhance business performance and customer satisfaction.

The proposed methodology highlights the potential of combining descriptive, diagnostic, and predictive analytics with interactive dashboards, enabling stakeholders to make data-driven decisions in real time. The findings underscore the value of business intelligence tools in addressing challenges faced by the food industry, such as demand variability, perishable inventory, and shifting customer expectations.

Future work can focus on integrating advanced AI and machine learning models directly into Power BI for more precise forecasting and automated recommendations. Additionally, expanding the scope to include external factors, such as customer sentiment analysis from reviews and market trends, can further enrich the system's capabilities.

Overall, this research offers a scalable and practical solution for businesses in the food sector, paving the way for increased efficiency, profitability, and customer loyalty through data-driven strategies.

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