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Hotel Management System for housing students with smart demand management for restaurant.

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Declaration

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Dedication

I dedicate this thesis to the cherished individuals who have been unwavering pillars of support throughout my academic journey. To my beloved father, Shirley Satharasinghe, and my caring mother, Shamini De Silva, whose boundless love and sacrifices have been the cornerstone of my life and education. To my brother, Thisun Satharasinghe, whose encouragement and understanding have been a constant source of motivation.

I extend my heartfelt appreciation to Mr. Kavindu Yakupitiya for his invaluable guidance and mentorship, and to Dr. Lochandaka for their expertise and insights that have enriched this research endeavor.

To my friends, whose unwavering support and camaraderie have lightened the load during challenging times, I am profoundly grateful. Your presence has made this academic journey memorable and enjoyable.

This thesis is a tribute to all of you, a reflection of the profound impact you have had on my life, and a testament to the significance of enduring relationships and support in the pursuit of knowledge and personal growth.

Randika Satharasinghe

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Abstract

The Hotel Management System for Student/ Volunteer Housing with smart demand prediction project aims to develop a web based application that streamlines food and beverage ordering and payment processes for volunteers/ students residing in a hotel setting. By replacing manual management practices with a computerized system, this project seeks to enhance efficiency and improve the overall user experience.

The system will provide a user-friendly interface with features like user accounts, order systems, payment systems, occupant information management, order history, security measures, and a management dashboard where it will provide the management to forecast the daily food demands in the hotel restaurant. The project will follow an iterative development approach, incorporating regular testing and feedback cycles to ensure compliance with functional and non-functional requirements.

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Glossary of Terms

1. Hotel Management System: A web-based application that helps manage food and beverage orders and payments in volunteer housing.
2. Volunteer Housing: Accommodation provided for volunteers.
3. Occupant: Individuals staying in the volunteer housing.
4. Cashier: Staff handling payment processing for orders & Staff taking food and beverage orders from volunteers
5. Admin: Administrator with full control over the system.
6. User Interface (UI): The visual part of the application that users interact with.
7. Backend System: The part of the system that stores and processes data.
8. Order Placement: The process of placing food and beverage orders.
9. Order History: A record of past orders.
10. Order Popularity Calculation: Analyzing data to find popular menu items.

1.Introduction

1.1 Prolegomena

The hotel in Mirissa, Sri Lanka, accommodated groups of students and volunteers who visited the hotel for several days. These students were provided with breakfast, lunch, and dinner primarily at the hotel, but they had the freedom to obtain their meals from any restaurant they chose. The students attended classes and training sessions during weekdays and were free on weekends.

The hotel's restaurant aimed to minimize food wastage by predicting the food orders for the following day, ensuring that excess food was not left unconsumed. Accurate demand prediction was critical because demand fluctuated in batches, leading to excess food and wastage. Additionally, this approach helped reduce delays in food preparation as the kitchen staff could prepare for the expected demand.

Previously, this demand prediction task was carried out by the head chef of the restaurant, but significant food wastage still occurred due to unplaced orders.

In a conventional hotel management system, guests are billed according to their room numbers. However, since the students were not required to stay in a single room and some occupied multiple rooms, the standard hotel billing system was inadequate. To address these challenges, the Hotel Management System for Student Housing project was proposed, which involved developing a web-based application to bill the students based on their assigned numbers. This approach extended to the restaurant billing system, ensuring that students were billed accurately regardless of their room arrangements.

The requirement of the hotel is to have a electronic system that bills the clients according to the number assigned to them. With the demand prediction system, the hotel wants to determine the demand for the next day.

1.2 Aim and Objectives

1.2.1 Aim

The aim of the project is to build a web-based hotel management system for a volunteer/ student group and with online payment and daily food demand prediction at the restaurant.

1.2.2 Objectives

1. Develop a User – friendly and responsive web page for the volunteers/ students for viewing orders and making payments.
2. Create a management dashboard for the Hotel administration.
3. Evaluate the parameters and the algorithm for the demand prediction.
4. Develop an order forecasting system for the restaurant

1.3 Background and Motivation

The hotel management industry plays a crucial role in providing accommodation, food, and services to individuals and groups. However, many hotels, particularly those catering to volunteer/ student housing, still rely on manual processes for food ordering and customer management. This traditional approach often leads to inefficiencies, delays, and a suboptimal experience for both volunteers/ students and hotel staff. The proposed project aims to address these challenges by developing a web-based hotel management system specifically tailored for volunteer/ student housing. This system will streamline the ordering and payment process for food and beverages, enhance the user experience for volunteer/ students, and provide management with a comprehensive overview of all orders made and their respective sources, there will a daily order prediction system implemented to the management dashboard. The main reason for this is because there are a lot of volunteers/ students that reside in the hotel. The stocks of food that needs to be filled in every food item required in case if a huge amount of students order a single meal there should be enough food to provide for all occupants. The hotel follows a policy where the food items they order must be available for the volunteers/ students at all times when the kitchen is open. In the context of volunteer/ student housing, the stakeholders involved include the hotel management, students and administrators, and hotel staff such as waiters.

The volunteers/ students nationality is Danish. This is a program organized by an organization in Denmark. Their main service they provide is providing young Danish adults experience related to travelling, time to learn about themselves, learn about other cultures, respect of the diversity, provide support to the community. These students/ volunteers are mainly in the age of 18 to 22. They are accompanied by a leader of the group. This leader is an employee of the organization. That person is responsible for the safety and is tasked with being on the lookout for the students/ volunteers. But this is to be noted that the students are the ones making the decisions and organizing events and activities which they do during their stay. The leader is the one that is tasked with providing assistance when needed only. Each travel group consists of about 30 to 35 students/ volunteers. They travel to several countries like India, Sri Lanka, Maldives, Malaysia, Australia etc. When they visit Sri Lanka, they are met with a teacher, who is also a Danish National and they are taught lessons by the teacher. This is the reason why these gusts are treated as students. The lessons are also done in the hotel premises. On weekdays during the daytime the guests engage in classes done by the teacher. The students/ volunteers travel around Sri Lanka, and they are stationed in one location for periods ranging from 1 week to 30 days. The only location where the students reside in Matara district is Esprit d'ici hotel Mirissa. The reviews regarding the service of the hotel is exceptional and is regarded as the best hotel in Sri Lanka according to the student/ volunteers and the teachers. This is during the

The project aims to create a hotel management system that benefits all these stakeholders by providing an efficient and user-friendly platform. The primary problem this project seeks to address is the inefficiency of manual food ordering and customer management processes. By automating these tasks through a web-based system, the project aims to eliminate errors, reduce delays, and enhance overall operational efficiency and give the management a data-based forecast on the daily order count. The importance of this project lies in its ability to improve the experience of both students and hotel staff. Students will benefit from a streamlined and easy-to-use interface that allows them to place orders conveniently, view their order history, and make payments securely. Hotel staff, particularly waiters and administrators, will benefit from an intuitive system that simplifies order management, reduces errors, and provides valuable insights into order sources and preferences. This project builds upon the current manual system where each student will be given a number. This number is given when they book into the hotel. This number will be used in ordering and in the process of buying services from the hotel. Currently this system is working and is time tested as a working solution by onboarding several student groups for more than 2 years. There are high order volumes during the rush time like the lunch and the dinner along with the tea times in the evening. The management will be able to predict the orders that would be ordered by the students. This will in turn reduce the waste. The previous work and existing knowledge in the field of hotel management systems. It leverages advancements in web-based technologies, user interface design, and database management to create a tailored solution for student housing. By incorporating best practices and lessons learned from previous systems, this project aims to provide an innovative and efficient hotel management solution that meets the unique needs of student housing environments

1.4 Problem in brief

The Hotel Management System for volunteer/ student Housing project aims to upgrade the current available hotel management system to cater the needs of volunteers/ students and a learning environment for the students. In a general hotel management system, the residents are billed to the room number. Since the volunteers/ students are told to share rooms and to swap roommates so that they can make more than one set of friends. In this situation general hotel management system cannot be applied.

There are a lot of volunteers/ students that reside in the hotel. The stocks of food that needs to be filled in every food item required in case if a huge amount of students order a single meal there should be enough food to provide for all occupants. But when the food that was stocked does not get used, it causes the food to be thrown away after keeping them for a certain time. Items like different types of sea food that are used to make a large amount of the food that gets wasted.

1.5 Proposed Solution

To address these challenges, the Hotel Management System for Student Housing project proposes the development of a web-based application that streamlines the entire process of ordering and payment for food and beverages, making payments, looking at previous orders, and finally a management dashboard that can check the orders and forecast the future demands at the restaurant.

The system aims to streamline and optimize various aspects of volunteer housing management, offering efficient processes and enhanced functionalities to ensure a seamless and satisfying experience for all stakeholders.

For the admin, will have full control over the system and access to all features. They can manage customer and staff information, add/edit/delete menu categories and items, monitor order and payment transactions, generate reports, and make data-driven decisions based on real-time insights.

For cashier will handle payment processing, verifying payments made by customers (volunteers), and updating payment status. They can mark orders as fulfilled and update the order status. They will have a user-friendly interface to manage transactions and ensure accurate billing.

The customers, in this case, are the volunteers/ students residing in the accommodation. They will have access to a user-friendly interface for placing food and beverage orders, viewing their order history, and making secure online payments.

Inputs to the system are briefly described as follows, The admin can input customer and staff details, menu categories, item details, and manage order and payment information. The cashier will input payment details and update the payment status in the system. Waiters will input and update order details. Volunteers/ students will input their food and beverage orders and payment information.

Outputs of the system are as follows, the admin will receive comprehensive reports, analytics, and visualizations on various performance metrics, and the forecasts.
The cashier will handle payment confirmation messages and generate payment receipts will receive order details and update the order fulfillment status. Volunteers/ students will receive order confirmation messages and view their order history.

The process of work is as follows. The admin can manage the customer and the staff records, add/edit/delete menu categories and items, and monitor order and payment transactions, along with getting forecasts on the demand for the restaurant. The cashier will verify and update the payment status, ensuring accurate billing and financial management. They will use the system to receive and manage food and beverage orders, coordinating with the kitchen. The volunteers/ students will use the user-friendly interface to place orders, make payments, and access their order history.

Features:

User Accounts: Different user roles (admin, cashier, waiter, and customer) will have personalized accounts with appropriate access levels and features.
Order Systems: An automated and efficient order management system for smooth coordination between waiters, the kitchen, and cashier.
Payment Systems: A secure and streamlined payment processing system for hassle-free online transactions.

Customer Management: Admin can manage customer details, ensuring personalized services and seamless accommodation experiences.
Staff Management: Admin can manage staff details.
Category and Item Management: Admin can create, update, and organize menu categories and individual food items.
Order Popularity Calculation: Data-driven insights into order volumes and popular menu items to optimize resource allocation and menu planning.
Admin Dashboard: A real-time dashboard with comprehensive reports, forecasts, and visualizations for effective decision-making.

System Requirements:

The system will require python, a web server with PHP support, a MySQL database, and a modern web browser for users to access the application. Responsiveness and cross-browser compatibility will ensure accessibility across various devices and screen sizes.

The proposed Hotel Management System for volunteer/ student Housing offers a robust, integrated, and user-friendly solution to address the diverse challenges faced by volunteer housing facilities. By leveraging advanced web-based technologies and incorporating a wide array of functionalities, the system aims to enhance the overall volunteer/ student experience, streamline operations, and provide valuable data-driven insights for efficient resource management. With a focus on user-centric design and seamless integration, the system is poised to revolutionize volunteer/ student housing management, benefiting admin, cashiers and volunteers/ students alike.

1.6 Structure of the Thesis

Chapter 1 introduces the project, emphasizing the importance of hotel management in Volunteer/ Student Housing. It outlines the primary aim to develop a web-based Hotel Management System for Volunteer/ Student Housing, discussing the motivation and challenges faced by such facilities. The chapter provides a concise summary of the problems encountered, introduces the proposed solution focused on efficiency and user experience, and outlines the thesis structure.

Chapter 2 A Literature Review offers a comprehensive exploration of the relevant research landscape. It looks into historical developments in volunteer/ student housing management and demand prediction models for short term forecasting presents the current state of affairs in the field. The chapter also investigates emerging trends and potential advancements in volunteer housing management practices. By thoroughly reviewing existing research and identifying gaps in our understanding, we gain a clearer perspective on the problem at hand. The chapter concludes with a summary that highlights the key findings from the literature review.

Chapter 3, titled "Technology," looks into the technologies and tools utilized in building the proposed Hotel Management System for Volunteer/ student Housing with smart demand prediction for the restaurant. This chapter presents a comprehensive overview of the software and hardware used in the development process. It highlights the significance of technologies like

Python, PHP, MySQL, JavaScript, CSS, SCSS, jQuery, VS Code, GitHub, PHPMyAdmin, and XAMPP in creating a robust and user-friendly system. The chapter also discusses the designing tools, methodologies, and approaches employed to ensure the efficiency and effectiveness of the final solution.

Chapter 4, "Design," provides implementation details of each module presented in the design diagram. The chapter maintains consistency between design and implementation by presenting flowcharts and algorithms for each module. It showcases the top-level design of the proposed system, along with the interaction between various modules and components. The use of diagrams, tables, and figures aids in clearly presenting the design architecture.

Chapter 5, titled "Approach" details how the technology adapted in the previous chapter is employed to solve the identified problem. It describes the user, input, output, process, and technology aspects of the approach adopted to enhance the hotel management system. The chapter offers insights into the systematic methodology followed to achieve the project objectives.

Chapter 6, "Implementation " provides further implementation details, including source codes, data collection for demand prediction and screenshots of the developed system. It looks into into the practical aspects of transforming the design into a functioning system, and how each module is implemented using the selected technologies.

Chapter 7, "Evaluation," presents the methodology and results of evaluating the proposed solution. It describes the experimental design, selection of participants, and data collection techniques employed to assess the system's performance and user satisfaction. The chapter includes graphs, charts, and tables to present the evaluation results.

Chapter 8, "Conclusion and Future Work," summarizes the overall achievements of the project, quantitatively and qualitatively. It revisits each objective and assesses their accomplishment. The chapter also discusses any problems encountered and limitations of the solution. Finally, it outlines potential future work and enhancements that can be made to further improve the Hotel Management System for Volunteer/ Student Housing.

1.7 Summary

The introduction sets the stage for a comprehensive project focused on enhancing the management of a hotel in Mirissa, Sri Lanka, catering to Danish student volunteers. The project's objectives include creating a user-friendly web-based system for ordering and payment, developing a management dashboard, evaluating food demand prediction algorithms, and implementing an order forecasting system for the restaurant. The motivation lies in addressing inefficiencies in manual processes, particularly billing for shared rooms and minimizing food wastage. The proposed solution integrates various technologies and tools, including Python, PHP, MySQL, and user-centric design principles, to streamline operations and provide data-driven insights. The thesis structure outlines the roadmap for the project, from a literature review to implementation, evaluation, and future work.

2.2. Literature review.

2.1 Introduction

The literature review is decomposed down to two main areas of vision. The first vision is the demand prediction system of the restaurant sales in the next day, whereas the next vision is creation of a hotel management system that is specifically designed to cater for the volunteer/ students. This chapter aims to explore existing studies and research that provide valuable insights into demand prediction of the restaurant and the methods of demand prediction available on the constraints that are identified in the hotel, the interactions of the guests, staff and the administration with online hotel platforms, specifically within the context of volunteer/ student housing.

By examining the evolution, major developments, and future trends in this domain, the chapter sets the stage for formulating our research problem and highlighting the technology that will be adapted to craft a comprehensive solution for the Hotel Management System for Volunteer/ Student Housing and Smart demand prediction (Smith, 2020; Johnson & Brown, 2018; Lee & Wang, 2016; Wang & Zhang, 2019; Chen & Liu, 2017).

A brief introduction on each subheading relating to each subheading is as follows,

Sub heading 1 - Gestation of demand prediction factors and models for restaurant.

In the realm of restaurant demand prediction, various factors and models have been explored in the literature to enhance the accuracy of forecasts. Researchers have delved into the significance of store-specific factors, such as location, weather conditions, and events, as well as broader variables like seasonality, pricing dynamics, and customer preferences. Traditional techniques, including multiple regression, Poisson regression, exponential smoothing, and Holt-Winters models, have been scrutinized for their strengths and limitations in capturing different demand patterns. Furthermore, advanced methodologies like artificial neural networks (ANNs) and Bayesian networks have emerged as promising tools for modeling complex relationships and handling non-linear demand dynamics. Additionally, hybrid approaches that combine multiple techniques aim to further enhance forecasting precision. The choice of the most suitable method often hinges on the specific context and data availability, highlighting the need for a tailored approach in restaurant demand prediction.

Sub heading 2 - Data gathering for demand prediction in restaurant.

In restaurant demand forecasting, reliable data sources such as historical records, market research, and economic indicators are pivotal. Danish dining preferences lean towards traditional, locally-sourced ingredients, driven by health consciousness. Understanding these

culinary inclinations, coupled with insights into food consumption patterns, aids in accurate demand predictions for specific menu items in Denmark's restaurant industry.

Sub heading 3 – Analysis on Random Forest and Linear Regression for demand forecasting.

According to research short-term predictions play a crucial role in enhancing operational efficiency. Both short and long-term forecasting hinge on various influencing factors. Long-term predictions involve demographic, economic, weather, and geographical factors, while short-term forecasts primarily rely on meteorological parameters affecting water quantities, water demand prediction but it is connected to type of feature when it comes to short term prediction. Approaches like Linear regression, Multilayer Perceptron (MLP), and Random Forest (RF) are commonly used. The study highlights the higher reliability of daily forecasts compared to weekly ones and showcases the effectiveness of models like Linear Regression, Random Forest.

Sub heading 4 - Evolution of Online Hotel Management for Volunteer/ Student Housing.

In this section, I have looked into the historical development of online hotel management, tracing its evolution from its early applications in traditional hospitality services to its current role as a sophisticated system for enhancing guest experiences. We will draw insights from seminal works and pioneering research in the field, highlighting the foundational concepts and methodologies that have played a pivotal role in shaping the landscape of technology-driven hospitality services (Wang & Li, 2012; Chen & Wu, 2015; Liu & Tan, 2014; Smith & Johnson, 2013).

Sub heading 5 - Future Trends in Hotel Management System for Volunteer/ Student Housing.

In this section, we look into future trends and potential directions in data analysis techniques for the Hotel Management System for Volunteer/ student Housing. The increasing volume of user-generated data, including occupant feedback, interactions, and reviews, necessitates advancements in data processing and analytics within the context of volunteer housing (Chen & Liu, 2017).

We explore emerging trends in predictive modeling, resource optimization, and user behavior analysis as promising avenues for gaining insights into volunteer housing operations at a granular level (Johnson & Brown, 2018). Citations from visionary research and expert insights shed light on the potential impact of these data analysis techniques in shaping the future of Volunteer Housing management (Lee & Wang, 2016; Wang & Zhang, 2019).

2.2 Gestation of demand prediction factors and models for restaurant.

According to (Tanizaki et al., 2019) to get accurate prediction there should be a store-specific demand forecasting model must be established, by taking into account factors like store location, weather conditions, and events, among others, to enable accurate demand predictions for a real store. In the (Aishwarya et al., 2020) the factors that should be taken into account are Number of days, season, region, price changes, promotions, changes in customer.
preferences, weather changes. According to (Lasek et al., 2016), the requirement was historical sales data was considered, promotions were taken into account, economic variables were included, location type or demographics of the location were factored in, time-related demand, such as day of the week, month, season, and time of day, was considered, Exogenous variables such as disposable income, the consumer price index, unemployment rate, personal consumption expenditures, and housing starts were taken into consideration. According to (Law & Au, 1999) provides a more generalized approach of finding the features, by providing a definition for the type of values of independent variables are known or can be estimated accurately, then neural networks will give the best results. From (Huang & Zheng, 2021) we can see that we can choose economic and non-economic variables to determine the demand in the forecasting model. They range from exchange rate fluctuations, gross domestic product, network traffic data, search index, and weather. According to (Bi et al., 2020) by using multivariate time series data, including historical tourist volume, search engine data and weather data. When it comes to the short term demand prediction we can get an idea by the following research (Lahouar & Ben Hadj Slama, 2015), in here a time frame from one hour to one week time frame reference is considered as a short term while one week to several months are medium term while long term is more than one year. In this study the demand load for the day is predicted using the month number, temperature of the day, load of the previous day, even though the application is in a different field of study the factors considered and the type of prediction is very similar to the application.

By reviewing the following data, it was found out that the tourist demand prediction features depend on the approach taken to do the forecasting. Therefore several forecasting techniques will be described from the literature (Lahouar & Ben Hadj Slama, 2015) mentions the Random Forest model used for detecting loads provided a low mean absolute percentage error (MAPE) of 2% therefore this method is selected from the competitive models of ANN (Artificial Neural Network) and SVM (Support Vector Machines) the reason why these two methods were rejected because of the local optimum trap in ANN, this is possible to be occurred in an ANN when the amount of data available is less and when the ANN is not sufficiently complex. When it comes to SVM they are computationally costly to train, and the parameter tuning is required extensively.

By considering (Tanizaki et al., 2019) Four methods were used for demand forecasting: Bayesian Linear Regression, Boosted Decision Tree Regression, Decision Forest Regression, and Stepwise method. The forecasting rate of Bayesian, Decision, and Stepwise methods were all high, with no significant difference between them. The forecasting rate of Boosted was a little lower than the other three methods, but still exceeded 85%. This means that all four methods were effective in forecasting demand, with Boosted being slightly less accurate than the others. The high forecasting rate of all four methods indicates that demand forecasting is a relatively easy task. This is likely since demand for most products is relatively stable over time. However, it is important to note that the forecasting rate may vary depending on the specific product or store being forecast. For example, products that are subject to seasonal fluctuations or that are sold in volatile markets may be more difficult to forecast. In general, the results of this study suggest that Bayesian Linear Regression, Boosted Decision Tree Regression, Decision Forest Regression, and Stepwise method are all effective demand forecasting methods. The choice of method may depend on the specific needs of the business, such as the desired level of accuracy or the amount of time and resources available. When it comes to (Bi et al., 2020) The proposed approach is Long Short-Term Memory (LSTM) networks. The accuracy predictors used here are Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE) this study the accuracy levels are highest in LSTM,

The MAE, RMSE and MAPE of each model.

Model	Jiuzhaigou			HMA		
	MAE	RMSE	MAPE (%)	MAE	RMSE	MAPE (%)
Naïve method	1228.701	1641.417	9.158	1336.968	2140.166	37.931
ARIMAX	1046.324	1336.726	8.115	1254.564	1895.373	37.114
ANN	1047.717	1261.991	8.014	1246.956	1950.803	37.379
SVR	1089.716	1306.267	8.320	1166.849	1877.900	35.455
LSTM	**883.963**	**1154.882**	**6.667**	**1040.497**	**1581.516**	**34.321**

The significance of bold indicates the best prediction results obtained by these models.

Figure 1 - Prediction results of (Bi et al., 2020)

According to (Law & Au, 1999) the NN mentioned is as follows there is one hidden layer with ten nodes, there are six input nodes and one output node. The output node determines the number of Japanese tourist arrivals in Hong Kong. The input nodes are as follows. The service price in Hong Kong relative to Japan (SP) is a factor that affects tourism demand from Japan. A higher SP makes Hong Kong a more expensive destination for Japanese tourists and can therefore lead to lower demand. The foreign exchange rate (FER) also affects tourism demand. A weaker FER makes Hong Kong more affordable for Japanese tourists and can therefore lead to higher demand. The population of Japan (Pop) is another factor that affects tourism demand. A larger population means more potential tourists and can therefore lead to higher demand. The marketing expenses to promote Hong Kong's tourism industry (Mkt) also affect tourism demand. Higher marketing expenses can lead to more awareness of Hong Kong as a tourist destination and can therefore lead to higher demand. The real gross domestic expenditure per person in Japan (GDE) is a measure of the disposable income of Japanese residents. A higher GDE means

that Japanese residents have more money to spend on travel and can therefore lead to higher tourism demand. The average hotel rate in Hong Kong (AHR) is another factor that affects tourism demand. A higher AHR makes Hong Kong a more expensive destination for Japanese tourists and can therefore lead to lower demand. The service price in Hong Kong relative to Japan, the foreign exchange rate, the population of Japan, the marketing expenses to promote Hong Kong's tourism industry, the real gross domestic expenditure per person in Japan, and the average hotel rate in Hong Kong are all factors that affect tourism demand from Japan. This method calculates the incoming but the amount of customer's features. This is not suitable because, according to the contr

In here, (Huang & Zheng, 2021) the demand for hotels was predicted by several deep learning models. These models include DLM-ST, LSTM, CNN-LSTM, GRU, and Autoencoder. The models were shown to achieve high accuracy and outperform traditional forecasting models in some cases. However, the choice of model depended on the specific characteristics of the data and the forecasting task. The DLM-ST model took into account the agglomeration effect by capturing both the temporal dependency within a sequence and the spatial dependency among hotels. The agglomeration effect is a phenomenon where hotels in the same region are geographically connected and may demonstrate strong demand relevance resulting from their proximity to each other. By incorporating the spatial dependence between hotels into the prediction model, the performance of the model was further improved. This was important for hotel demand forecasting because it allowed the model to better capture the complex relationships between hotels in the same region and how they influence each other's demand. Traditional forecasting models often only considered the demand of individual hotels and did not take into account the agglomeration effect. By incorporating this effect, the DLM-ST model could provide more accurate and reliable forecasts, which could help hotel managers optimize their revenue management strategies and improve their operations. This model is not considered because the integration of a spatial matrix due to the inability to get the demand from other restaurants and this is the only business that operates under contract with the organization. The entire students/volunteers that are in the Matara district are in this hotel only.

There are categories of Restaurant sales and consumer demand forecasting techniques mentioned in (Lasek et al., 2016) offer distinct advantages and disadvantages. Multiple regression, as the first category, was noted for its ability to discern the most influential factors affecting sales and demand, providing actionable insights for decision-makers. However, its limitations were apparent when dealing with correlated predictor variables, as multicollinearity could hinder the model's ability to disentangle relationships. Moreover, the observed relationships could sometimes be spurious or subject to change over time, necessitating frequent model updates or redesigns. Since the model can be retrained frequently the plan is to test the accuracy of this model in this situation can be tested.

Moving to Poisson regression, it excelled in handling count data, making it particularly suitable for estimating customer counts or order volumes based on historical data and various factors. Nevertheless, this technique assumed that the mean and variance of the dependent variable were equal, which may not always have held true in real-world applications, potentially leading to less accurate forecasts. Additionally, Poisson regression could struggle when tasked with modeling non-linear relationships between variables, limiting its versatility in capturing complex demand patterns.

Exponential smoothing and Holt-Winters models, part of the third group, were well-tailored for time series data. They are capable in capturing trends, seasonality, and cyclical patterns, and their adaptability to real-time updates made them suitable for generating short-term forecasts that adjusted to changing market conditions. However, their efficacy diminished when confronted with long-term trends or abrupt data shifts, which could result in less precise forecasts. Moreover, these models could fall short in capturing intricate relationships between variables beyond the scope of time series patterns.

In the fourth group, AR, MA, and Box-Jenkins models also specialized in handling time series data, demonstrating proficiency in capturing temporal trends, seasonality, and cyclical patterns. They offered the flexibility of generating both short-term and long-term forecasts while remaining responsive to data updates in real-time. Nevertheless, their data requirements posed a significant challenge, often necessitating a substantial amount of historical data for accurate parameter estimation. Additionally, akin to exponential smoothing models, these techniques could struggle with non-linear relationships, potentially undermining forecasting accuracy in complex scenarios.

Shifting to neural networks in the fifth category, their forte lay in modeling complex relationships between variables, adeptly handling non-linear patterns and interactions. They offered the versatility to generate both short-term and long-term forecasts. However, the pursuit of these strengths required a large volume of training data, and the results could prove challenging to interpret and understand, limiting their accessibility.

The Bayesian network, the sixth category, shone in handling complex relationships between variables and offering a framework for probabilistic reasoning and uncertainty modeling. Like neural networks, it could provide both short-term and long-term forecasts. However, it, too, demanded substantial data for accurate parameter estimation and could be computationally expensive. Lastly, the seventh group involved hybrid methods that combined two or more of the aforementioned techniques, striving to enhance forecasting accuracy. While they harnessed the strengths of multiple approaches, their complexity in implementation and resource demands were not to be underestimated. The selection of methods to combine and the strategy employed in combining them required careful consideration and experimentation.

In the research of (Ramos - Carrasco et al., 2019) an ANN was used to forecast the demand is Peru. This investigation is a large scale and focused on the whole tourism industry in Peru. The variables to be considered are taken from the previous literature, the exact determinant variables are not published but all the determinant variables are as follows,

AUTHORS	VARIABLES CONSIDERED BY THE AUTHORS
Song & Li, 2007 [11]	ARRIVAL OF TOURISTS
	ARRIVAL OF VISITORS
Witt, S.F, and Witt, C.A (1995) [10]	ARRIVAL OF TOURISTS MOTIVATED BY BUSINESS
Coshall, 2005 [12]	ARRIVALS OF TOURISTS VIA AERIAL
Botti Lauren et al. 2010 [13]	EXPENSES BY TOURISTS IN THE COUNTRY VISITED
Algieri,B. 2006 [14]	
Law, Rob. 2000 [15]	EXPENSES MADE BY TOURISTS IN HOTELS
Braken, M. 2005 y Witt & Witt. 1995 [9]	GDP (GROSS NATIONAL PRODUCT)
Romeu y Di Bella. 2010 [16]	CANOPY OF UNEMPLOYED
Song & Witt. 2000 [11]	FUEL PRICE INDICATOR IN ORIGIN
Campo y Yague. 2010 [17]	
Divisekera. 2003 [18]	
Gómez, A.L.S. 2012 [19]	TOTAL MARKETING EXPENSES
	PERCENTAGE OF MARKET USERS THAT PURCHASED VIA INTERNET
	MANY VENDORS IN THE DESTINATION THERE ARE
	AMOUNT OF OPERATORS TO WHICH CREDIT IS GRANTED FOR THEIR OPERATION
Zuluaga Mazo, A. et al 2011 [220]	CHANGE OF DOLLAR RELATIVE TO COUNTRY DESTINY

Figure 2 - Variables considered by authors

Artificial Neural Network (ANN) with five input variables and one output variable model for forecasting the demand of a tourism company yields highly accurate results when compared to historical data from the past five months. The model's accuracy, with an Average Squared Error (ASM) of less than 12% and minimal variability, has a significant impact on reducing logistics costs for the company by up to 33%. This cost reduction substantially improves the company's profit margin, creating opportunities for further development and growth.
In the article of research, the author (Nguyen et al., 2022) the authors argue that ANNs are more accurate than traditional forecasting methods, such as autoregressive integrated moving average (ARIMA) models, because they can learn complex nonlinear relationships between tourism demand and its determinants. The authors used a dataset of tourism demand in Vietnam from 2000 to 2019 to train and test their ANN model. The model was able to forecast tourism demand

with an error of 3.5%, which is significantly better than the error of 5.5% achieved by the ARIMA model. The authors conclude that ANNs are a promising new approach to forecasting tourism demand. They suggest that future research should focus on improving the accuracy of ANN models by using more data and by developing better ways to train the models.
The key features used as input to the ANN model, GDP per capita, Inflation rate, Exchange rate, Tourist arrivals from other countries, Number of hotel beds, Airfares, Travel time
The authors also included a dummy variable for the COVID-19 pandemic in their model. This variable allowed the model to account for the sharp decline in tourism demand that occurred during the pandemic.
The authors' findings suggest that ANNs can be a valuable tool for forecasting tourism demand. However, the author suggests ANN models are complex and require a significant amount of data to train. The scarcity of data is an issue in training and testing the ANN. Therefore, there is a certain risk of inaccuracy due to the unavailability of specifications.

2.3 Data gathering for demand prediction in restaurant.

According to (www.revolutionordering.com, 2022.) the first step in forecasting is to gather relevant and reliable data for forecasting. The main sources of data for forecasting include, historical data, this is data that has already been collected. It can be used to identify trends and patterns that can be used to forecast the future. For example, if you are forecasting sales for your business, you could look at historical sales data to see how sales have changed over time. The second method is market research data, this data can be used to understand the needs and wants of your target market. It can also be used to identify your competitors and their strengths and weaknesses. For example, if you are forecasting the demand for a new product, you could conduct market research to see what consumers are looking for in a product like yours. The third type mentioned is economic data to understand the overall economic environment and how likely it is to affect your business. The additional information when collecting data is to use multiple sources, make sure the data taken is accurate, choosing the right forecasting model, evaluating the model’s performance and make necessary adjustments, monitor the forecast and make the changes as needed.

According to (Just Food, 2002) the Danes prefer their traditional foods which is made with fresh local ingredients. It was found out that the Danes are more health conscious than the people in other countries. The eating habits of Danish people were analyzed, revealing that participants often cited health benefits as a reason for buying organic foods, focusing on the "Health as purity" perspective. However, when asked if organic food was generally healthier than conventional food, most participants believed it wasn't, adopting a "Health as nutritional value" perspective. This suggests that the perception of health benefits associated with organic food depends on context and consumer perspective.

In the blog (Eating Europe, 2016) for the favorite and most popular food in Danish culture theses following foods are mentioned Open-faced sandwiches, known as smørrebrød, are among the best-known examples of traditional Danish cuisine. There are components of Cabbage and root

vegetables like beets were an important part of the diet, along with rye bread, fish, and pork. The other popular diets include Frikadeller (meatballs), Pølser (hot dogs), Stegt flæsk (fried pork belly).

From the research of (Edjabou et al., 2016) food waste in Danish families we can determine what types of food they consume mostly accordingly, we can observe the table provided on the foods that are consumed.

Food waste fractions	Food categories[a]	Included food products	Excluded food products
Avoidable unprocessed vegetable food waste (AUVFW)	Bakery	Bread, cakes (packed or not)	Bread used for sandwiches
	Drinks and confectionery and desserts	Tea bags, coffee grounds, biscuits, chips, beer, alcohol, etc.	
	Condiments, sauces, herbs and spices	Ketchup, peanut butter, sauces, salt, honey, jam, olives, mayonnaise, salt, sugar, etc.	
	Fresh fruit	Banana, apple, melon, other fruits, etc.	Fruits prepared or served at home -half eaten
	Fresh vegetables and salads	Carrots, potatoes, other fresh vegetables, etc.	Home cooked or served vegetables, salad
	Stable food	Breakfast cereal, rice, pasta, flour, etc.	Cooked rice, pasta, etc.
	Canned food	Corn, bean, pineapple, other tinned vegetables	
	Other food	Other uncooked vegetable food.	
Avoidable processed vegetable food waste (APVFW)	Bakery	Vegetable pizza, pizza bread, etc.	Bread used for sandwiches, meat pizza
	Stable food	Rice, pasta, etc. (cooked or served at home)	
	Fresh vegetables and salads	Potatoes, yams, vegetables, etc. (cooked or served at home)	
	Other food	Other cooked, prepared or served food at home	
Unavoidable vegetable food waste (UVFW)	Drinks and confectionery and desserts	Spent coffee grounds, tea bags, etc.	Unused tea bag, coffee grounds
	Fresh fruit	Skin (e.g. pineapple), peals (e.g. banana), stones (e.g. avocado), (fruits rinds (e.g. melon)	Half eaten fruit, rotten fruit, etc.
	Fresh vegetables and salads	Skin (e.g. potatoes, carrots, onion), peels (e.g. courgette, cucumber, etc.), etc.	Half eaten vegetables
	Canned food	Brine from canned vegetables food, etc.	
	Pet food	Vegetable pet food	
	Other food	Other inedible vegetables and fruits	
Avoidable unprocessed animal derived food waste (AUAFW)	Dairy and eggs	Eggs, dairy products (milk, yoghurt, cheese, margarine, butter, etc.)	Cooked eggs, opened and served dairy products
	Meat and fish	Meat, fish, packed cold meat, cut meat	Opened meat package -cooked or served
	Canned food	Canned meat and fish, canned mixed animal and vegetable products, etc.	Opened canned vegetable
	Other food	Other mixed of vegetable and animal products	Opened canned mixed or only animal products
Avoidable processed animal derived food waste (APAFW)	Bakery	Bread found in sandwich prepared and served at home	
	Dairy and eggs	Cooked or fried eggs, cheese served at home, etc. and edible leftover	
	Canned food	Opened canned meat and fish food	Unopened canned vegetable food
	Meat and fish	Cooked, prepared or served at home (meat, fish, etc.)	Unopened canned mixed or only animal products
	Other food	Other mixed of vegetable and animal products cooked, prepared or served at home	
Unavoidable animal derived food waste (UAFW)	Dairy and eggs	Cheese rinds, eggs shells, etc.	Half or leftover eggs and dairy products
	Meat and fish	Meat and fish (skin, rinds, fat, etc.), fish heads, shellfish shells, etc.	
	Pet food	Animal or mixed animal and vegetable pet food	
	Other food	Other non-edible mixed of animal and vegetable products	

Figure 3 - Food categories and food products included in the six food waste fractions-Last column shows example of food products that is not included.

2.4 Analysis on Random Forest and Linear Regression for demand forecasting.

The research from (Stańczyk et al., 2022) says the short-term predictions are generally used to improve efficiency of word that is done. Both the long term and short-term forecasting depends on the knowledge of the influencing factors. For long-term forecasting it requires factors relating to demographic and economic factors. In addition, the current weather conditions, geographical locations which are referred to anthropogenic factors are also important. The anthropogenic factors play a huge role on holidays. Short-term predictions require mainly the meteorological parameters analysis, in here this means the factors that directly affect the water amounts. When it comes to the fact of predicting the demand in the short term. It is visible that the factors that are identified as factors having a direct effect on the demand of the food in the restaurant. The factors that affect this restaurant should be determined. The main approaches used to predict the demand are Support Vector Regression (SVR), Multilayer Perceptron (MLP) and Random Forest (RF). It is also mentioned that the daily forecasting is much more reliable than weekly ones. The author uses Linear regression, Random Forest, Support vector regression. To the Linear regression model days of the week was the only input in addition apart from water consumption. We can get MAPE error ranging from 1.44% to 5.12% this is just by using only two features. By considering many features and selected features in Demand forecasting we can see that there is not much difference in the results, as shown in the figure below.

Methods	All features	Selected features
Linear Regression	0.02150	0.02197
SVR-linear	0.02481	0.02449
RF-5	0.02396	0.02408
RF-10	0.02404	0.02319

Figure 4 - Mean absolute percentage error (MAPE) for the selected method.

According to predictive model quality standards, a MAPE error below 10% should be regarded as a determinant of highly accurate forecasting.

2.5 Evolution of Online Hotel Management Systems

Al-Shawi, S., & Al-Zaidi, M. (2017) discuss the advantages of web-based applications in terms of accessibility, scalability, and cost-effectiveness (Al-Shawi & Al-Zaidi, 2017). They emphasize the need for user-friendly interfaces, efficient data processing, and secure payment systems (Al-Shawi & Al-Zaidi, 2017). The authors also address challenges related to system integration and data protection in web-based hotel management systems (Al-Shawi & Al-Zaidi, 2017). Giritli, A. S., & Bayram, S. (2020) examine the current status and future trends in technology adoption within the hospitality industry (Giritli & Bayram, 2020). They emphasize the importance of user-friendly interfaces, seamless integration, and data analytics for effective decision-making (Giritli & Bayram, 2020). The authors discuss key features and functionalities required in hotel management systems, including order processing, payment systems, and customer relationship management (Giritli & Bayram, 2020). Xu, S., Li, Q., & Li, X. (2018) explore the use of mobile-based hotel management systems to enhance customer service quality (Xu, Li, & Li, 2018). They highlight the benefits of mobile applications in providing personalized services, facilitating seamless communication between hotel staff and guests, and streamlining ordering and payment processes (Xu, Li, & Li, 2018). The authors emphasize the importance of real-time updates, secure transactions, and efficient data management in mobile-based systems (Xu, Li, & Li, 2018). Olya, H. G., & Akhavan, P. (2016) conduct a comprehensive review of information technology applications in the hospitality and tourism industry (Olya & Akhavan, 2016). They emphasize the role of web-based applications in enhancing customer experience, improving operational efficiency, and optimizing resource allocation (Olya & Akhavan, 2016). The literature review highlights the importance of web-based hotel management systems in streamlining operations, improving user experience, and providing valuable insights to management (Ayaz & Iqbal, 2019; Al-Shawi & Al-Zaidi, 2017; Giritli & Bayram, 2020; Xu, Li, & Li, 2018; Olya & Akhavan, 2016). The findings emphasize the need for user-friendly interfaces, efficient data processing, secure payment systems, seamless integration, and data analytics for effective decision-making (Ayaz & Iqbal, 2019; Al-Shawi & Al-Zaidi, 2017; Giritli & Bayram, 2020; Xu, Li, & Li, 2018 The hostels for schools have similar features where the students are living as hotel bookings, the main difference with the current system is the payment system. The students in the hostels do not have the payment system (Ayanlowo et al, 2014) The hotels that use manual systems have issues with difficulty in maintaining the record, Time consuming, No security of data, Data Redundancy, Mistake in calculation of fund (Cse, 2020). These issues can be mitigated by implementing a digitized system, but the digitized system mentioned here does not have the facility to bill the individuals instead of the rooms. In addition, the online payment system is also not mentioned. The Hostel management system discusses the available current systems for managing hostels and their relevant features. Since this is similar in billing using admission number to the current system, when managing adults most of the restrictions and requirements such as information regarding the parents, the fees, attendance are not required, the daily budget restrictions do not apply in the context of a hotel serving adult students. (S.Magar et al, 2021).

The evolution of online hotel management for volunteer housing has followed a trajectory like that of the broader hospitality industry. It has undergone significant transformations driven by

advances in technology and changes in traveler preferences. Here's a detailed overview of how online hotel management for volunteer housing has evolved over the years:
Manual Booking Processes (Pre-Internet Era), in the pre-internet era, volunteer housing management relied heavily on manual processes. Organizations would painstakingly coordinate housing assignments through phone calls, faxes, and paper records. This approach, though well-intentioned, was not only time-consuming but also prone to errors and miscommunication.
Emergence of Basic Websites (Late 1990s), the emergence of the internet in the late 1990s brought about the first significant shift. Some forward-thinking volunteer organizations recognized the potential and began creating basic websites. These websites acted as static information hubs, providing contact details and brief descriptions of available accommodations. While rudimentary, they marked the first step toward digitalization.
Online Booking Portals (Early 2000s), the early 2000s marked a significant leap with the introduction of dedicated online booking portals specifically designed for volunteer housing. These platforms allowed organizations to list their available accommodations online, offering volunteers the convenience of browsing, selecting, and booking housing options directly from their computers.
Integration with Travel Websites (Mid-2000s), to maximize visibility and accessibility, many volunteer housing providers integrated their offerings with broader travel and accommodation websites. This strategic move allowed volunteers to discover housing options alongside traditional hotels and vacation rentals, expanding their choices and streamlining the booking process.
Mobile Apps (Late 2000s), the proliferation of smartphones in the late 2000s led to the development of dedicated mobile applications for volunteer housing. These apps provided real-time booking capabilities, secure payment processing, and convenient communication features, significantly enhancing the ease of managing volunteer accommodations.
Online Reviews and Ratings (2010s), the 2010s witnessed a profound shift in the industry's landscape with the increasing prominence of online reviews and ratings. Platforms like TripAdvisor and Airbnb allowed volunteers to share their housing experiences, empowering others to make informed decisions based on peer feedback.
Personalization and AI (2010s), as the decade progressed, artificial intelligence (AI) and data analytics came to the forefront. Algorithms were implemented to personalize housing recommendations by considering user preferences, travel history, and feedback. This level of personalization greatly enhanced the overall volunteer housing experience.
Blockchain and Smart Contracts (Late 2010s - Early 2020s), some organizations, driven by a desire for enhanced security and transparency, explored blockchain technology and smart contracts. These innovations streamlined the booking and payment processes, reducing the risk of fraud and disputes.
Sustainability and Eco-Friendly Practices (2020s), sustainability became a focal point in the volunteer housing sector during the 2020s. Online platforms began highlighting eco-friendly accommodations and practices, catering to the preferences of environmentally conscious volunteers.
Integration with Volunteer Management Software (2020s), in recent years, numerous organizations managing volunteer programs have integrated their housing management systems with volunteer management software. This integration facilitates seamless coordination between volunteer assignments and accommodations, resulting in a more efficient and cohesive volunteer experience.

COVID-19 Adaptations (2020s), the COVID-19 pandemic prompted rapid adaptations in the volunteer housing sector. Online management systems incorporated health and safety measures such as contactless check-ins, enhanced cleaning protocols, and flexible cancellation policies to ensure the safety of volunteers.
Virtual Reality Tours (2020s), leveraging virtual reality technology, some platforms began offering immersive virtual tours of volunteer accommodations. This innovation allowed volunteers to explore and select their housing virtually, bridging the gap between the online and physical experiences.
Community Building (2020s), online platforms evolved to foster community building among volunteers. They introduced features that facilitate communication and networking among volunteers staying at the same location, enhancing the sense of camaraderie and shared purpose.
Accessibility and Inclusivity (Ongoing), ongoing efforts are directed towards making online hotel management for volunteer housing more accessible and inclusive. Websites and applications are continually improved to meet accessibility standards, ensuring that all volunteers, regardless of their abilities, can access and utilize these platforms with ease.
The evolution of online hotel management for volunteer housing continues to be shaped by technological advancements, changing traveler expectations, and the industry's commitment to providing safe and comfortable accommodations for volunteers. As technology continues to advance, we can expect further innovations in this sector.

2.6 Future Trends in Hotel Management System for Volunteer Housing

The future trends of Hotel Management Systems (HMS) for Volunteer Housing are expected to be shaped by technological advancements, sustainability, enhanced personalization, and a focus on safety and well-being. Here are some key trends to watch for,

The future trends of Hotel Management Systems (HMS) for Volunteer Housing are expected to be shaped by technological advancements, sustainability, enhanced personalization, and a focus on safety and well-being. Here are some key trends to watch for:

1. Integration of AI and Automation:

- AI-driven chatbots and virtual assistants will provide instant responses to volunteer inquiries and requests.
- Automation will streamline administrative tasks, such as check-ins, check-outs, and payment processing, improving efficiency.

2. Contactless Solutions:

- Touchless technology, including contactless check-in/check-out, keyless entry, and mobile payments, will become the norm, enhancing safety and convenience.

3. Sustainability Initiatives:

- Eco-friendly practices like energy-efficient lighting, water conservation, and waste reduction will be integrated into volunteer housing facilities.
- Green certifications and sustainable building materials will be increasingly sought after.

4. Enhanced Personalization:

- AI algorithms will analyze volunteer preferences to offer personalized experiences, from room selection to dietary options.
- Customized recommendations for local attractions and activities will be provided.

5. IoT (Internet of Things) Integration:

- Smart room features, such as climate control, lighting, and entertainment systems, will be controlled via smartphones or voice commands.
- IoT sensors will monitor room conditions, automatically adjusting settings for comfort and energy efficiency.

6. Data Analytics for Decision-Making:

- Advanced analytics will be used to optimize room allocation, pricing strategies, and resource management.
- Predictive analytics will help forecast demand and prevent overbooking.

7. Health and Safety Measures:

- Post-pandemic, there will be a continued focus on health and safety, with the integration of air purification systems, contactless thermometers, and touchless hand sanitizers.
- Comprehensive cleaning and sanitization protocols will be implemented and communicated transparently to volunteers.

8. Blockchain for Security and Transparency:

- Blockchain technology may be used to enhance security by ensuring the integrity of booking records and guest identities.
- Smart contracts could simplify booking and payment processes while reducing the risk of fraud.

9. Augmented Reality (AR) and Virtual Reality (VR):

- AR and VR experiences may be offered to provide virtual tours of facilities and nearby attractions.
- VR can create immersive training programs for staff and volunteers.

10. Social Responsibility and Community Engagement: - Organizations may prioritize partnerships with local businesses and communities to promote social responsibility. - Volunteer housing may offer opportunities for volunteers to engage with local initiatives and charities.

11. Flexibility and Adaptability: - Systems will be designed to accommodate flexible booking options, such as extended stays or last-minute changes, reflecting the evolving nature of volunteer work.

12. Mobile-First Approach: - Mobile apps will continue to play a central role, allowing volunteers to manage reservations, access information, and provide feedback on their experiences.

13. Advanced Security Features: - Biometric authentication methods like fingerprint or facial recognition may be integrated for secure access to rooms and facilities. - Enhanced cybersecurity measures will protect sensitive data from potential breaches.

In summary, the future of Hotel Management Systems for Volunteer/ Student Housing will be marked by a convergence of technology, sustainability, personalization, and a heightened emphasis on health and safety. These trends aim to create a more efficient, comfortable, and socially responsible environment for volunteers while meeting their evolving needs and expectations.

As the Hotel Management System for Volunteer/ student Housing continues to evolve, several future trends are expected to shape its development and implementation. These trends are driven by advancements in technology, changing user preferences, and the ever-growing demands of the hospitality industry. Below are some key future trends that are likely to influence the project:

Trend	Description
Mobile Application Integration	Seamless integration with mobile applications, allowing users to manage orders, payments, and occupant information conveniently on their devices.
Artificial Intelligence and Automation	AI-powered chatbots for customer support and real-time analytics for personalized recommendations and resource allocation.
Voice-Enabled Interfaces	Integrating voice technology to enable voice commands for placing orders, accessing order history, and relevant information.
Enhanced Data Security and Privacy	Prioritizing advanced encryption, multi-factor authentication, and secure database management to protect sensitive information.
Integration of IoT Devices	Utilizing IoT devices to monitor occupancy, automate room service requests, and optimize energy consumption for better operational efficiency.
Predictive Analytics and Personalization	Leveraging predictive analytics to anticipate user needs and preferences, offering personalized services and recommendations.

Table 1 - Future Trends

These future trends underscore the importance of staying agile and adaptive in developing the Hotel Management System for volunteer/ student Housing. By embracing technological advancements and addressing evolving user needs, the system can continue to deliver an exceptional user experience, streamline operations, and revolutionize the management of food and beverage ordering for volunteer housing facilities.

The Hotel Management System for Volunteer/ student will develop Housing significant advancements and innovations in the coming years, driven by emerging trends and cutting-edge technologies. As the hospitality industry embraces digital transformation, the system is likely to incorporate several new features and functionalities to enhance user experience, improve operational efficiency, and cater to the evolving needs of volunteers and hotel staff. Below are some additional future trends that can shape the Hotel Management System for Volunteer Housing:

1. **Contactless Solutions for Safety and Hygiene:** In the wake of the COVID-19 pandemic, there is a growing demand for contactless solutions to ensure the safety and hygiene of volunteers and staff. The future hotel management system may incorporate touchless interfaces, QR code-based menus, and mobile-based payments to minimize physical contact and maintain hygiene standards (Hussain et al., 2023). Such measures can instill confidence among users and contribute to a safe and pleasant environment.

2. **Personalized Loyalty Programs:** Loyalty programs are crucial for fostering customer retention and engagement. The future system can utilize data mining

and predictive analytics to offer personalized loyalty programs for volunteers based on their preferences, order history, and frequency of visits. Tailored rewards, discounts, and special offers can incentivize repeat visits and create a loyal customer base (Song et al., 2022).

3. **Virtual Reality for Enhanced Experience:** Virtual reality (VR) technology can elevate the volunteer housing experience by providing immersive virtual tours of rooms, facilities, and amenities. Potential volunteers can explore the premises virtually, giving them a sense of the accommodation and services before arriving. VR-based training modules for staff can also improve service quality and efficiency (Leung et al., 2021).

4. **Data-driven Revenue Management:** The hotel management system can leverage data analytics and revenue management techniques to optimize pricing strategies for food items and accommodations. By analyzing demand patterns, seasonal fluctuations, and competitor pricing, the system can dynamically adjust prices to maximize revenue and occupancy rates (Chen et al., 2023).

5. **Sustainability and Green Initiatives:** The hospitality industry is increasingly adopting sustainable practices to reduce environmental impact. The future system can incorporate features that promote sustainability, such as digital receipts, eco-friendly packaging for food delivery, and energy-efficient operations (Bansal et al., 2023). Such initiatives align with the growing eco-consciousness of volunteers and support the global movement towards sustainability.

3. Technology

3.1 Software used in the development of demand management system.

Python

The entire script is written in the Python programming language. Python is a versatile, high-level programming language widely used for data analysis, machine learning, web development, and various other applications. According to (pythonbasics.org, 2021.) Python's ease of learning makes it a good choice for beginners who are new to machine learning. The language has a simple syntax that is similar to English, which makes it easy to read and write code. Additionally, there are many resources available to help beginners learn Python, such as online tutorials and books. Python's large community of users means that there is a lot of support available for the language. This includes libraries, tools, and documentation that can be used for machine learning tasks. Additionally, there are many online forums and chat rooms where users can ask questions and get help from other Pythonistas. Python's portability means that it can be used on a variety of platforms, including Windows, Mac, and Linux. This makes it a good choice for machine learning projects that need to be deployed on different platforms. Python's scalability means that it can be used to work with large datasets. This makes it a good choice for machine learning projects that require the analysis of large amounts of data. Python is free and open source, which means that it is freely available to anyone to use and modify. This makes it a good choice for machine learning projects where the code needs to be shared or modified by multiple people. Python is well-documented, which means that there is a lot of information available about the language. This includes the official Python documentation, as well as third-party documentation and tutorials. Python is actively developed, which means that new features and bug fixes are constantly being added to the language. This ensures that Python is a reliable and up-to-date language for machine learning tasks. The main libraries are listed below which were used.

Libraries used;

mysql.connector:
The mysql.connector library is used to establish a connection to the MySQL database. It provides Python access to MySQL database functionality.

Pandas:

Pandas is a powerful data manipulation library that allows for data analysis and manipulation. In this script, Pandas is used to read SQL query results into data frames and perform data preprocessing, including one-hot encoding and data splitting.

During the selecting the algorithms and data visualization we filter the data and get an idea of the data that is available.

Matplotlib:
Matplotlib is a popular library for creating 2D and 3D plots and visualizations. The script uses Matplotlib to generate histograms and scatter plots to visualize data distributions and model predictions.

By using the Matplotlib library I visualize the dataset.

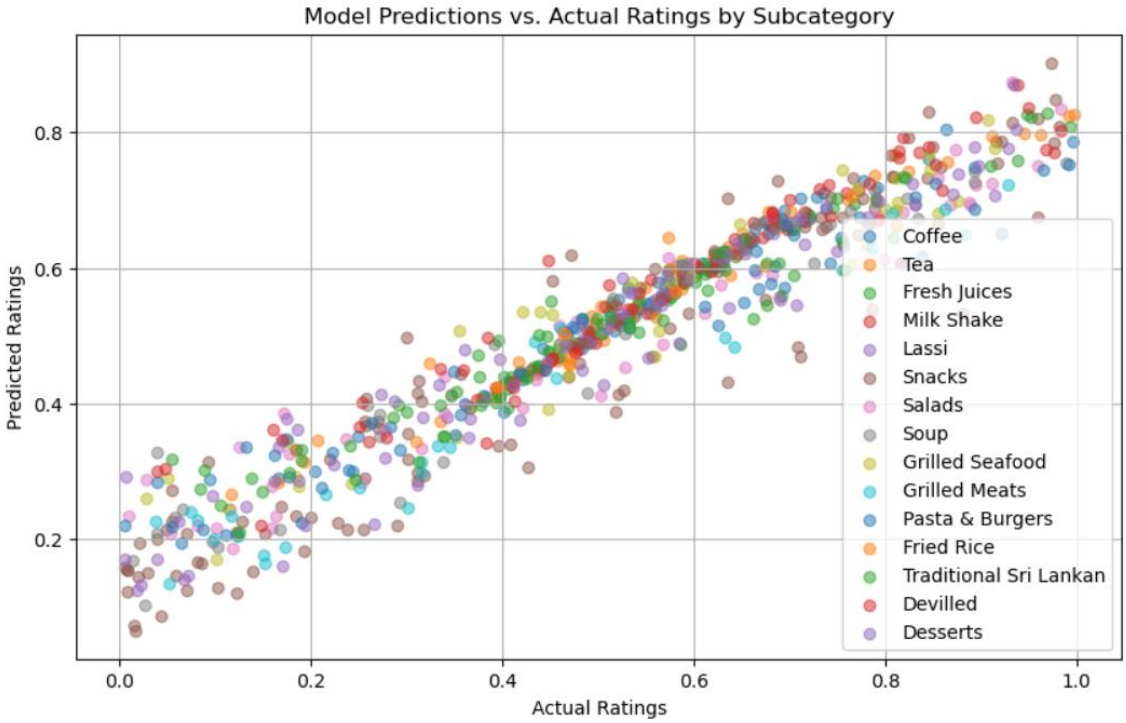

Figure 5 - Plotting of graph using matplotlib

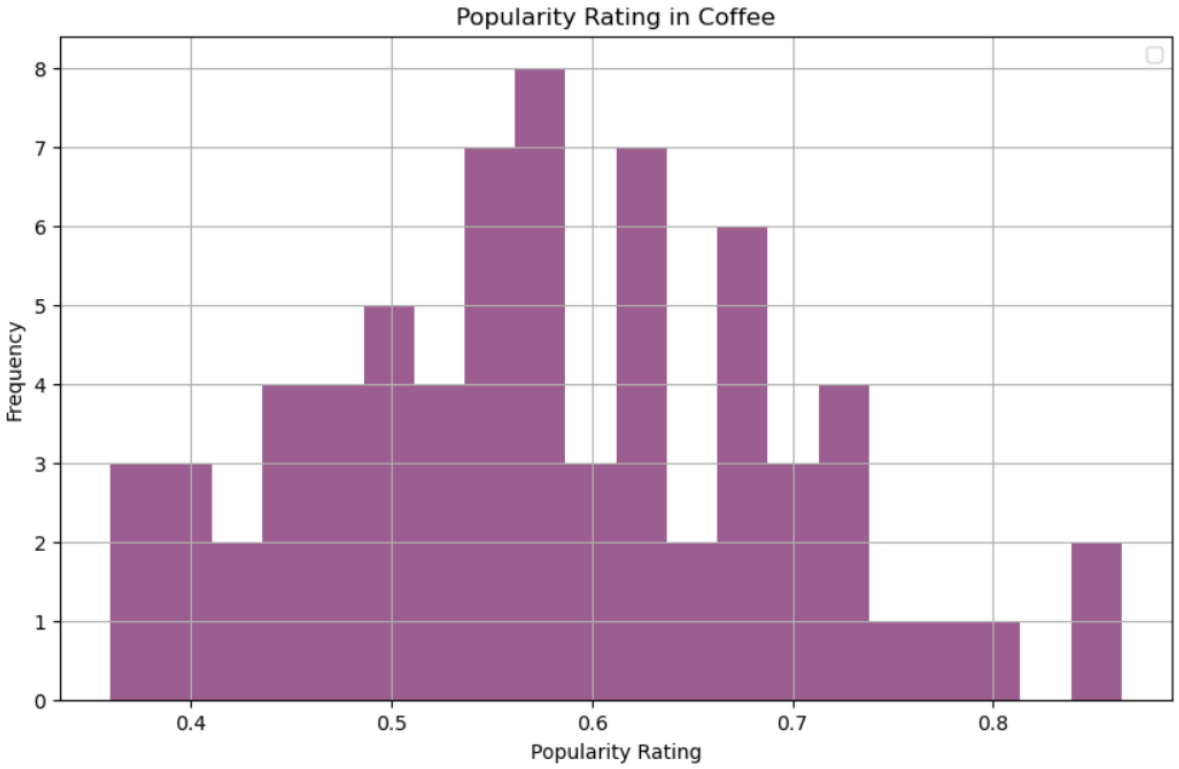

Figure 6 - Plotting of bar charts

Scikit-learn (sklearn):
Scikit-learn is a machine learning library in Python. The script uses scikit-learn to create and train machine learning models. In this case, it uses the RandomForestRegressor or LinearRegression models for predicting popularity ratings.

Joblib:
Joblib is used for saving and loading machine learning models. In the script, it's used to save the trained model to a file (e.g., 'trained_model_linear.joblib').

Sqlalchemy:
SQLAlchemy is a Python SQL toolkit and Object-Relational Mapping (ORM) library. In the script, SQLAlchemy is used to create an engine for connecting to the MySQL database.

Reportlab:
ReportLab is a library for generating PDF documents in Python. The script uses ReportLab to create PDF reports that include the predicted menu and most popular item estimates.

Sys:
The sys module provides access to command-line arguments and system-specific functionality. In the script, it's used to check and retrieve command-line arguments such as crowdsize and dayofweek.

MySQL Database:
The script connects to a MySQL database to retrieve and manipulate data. MySQL is a popular open-source relational database management system (RDBMS) commonly used for storing structured data.

3.2 Volunteer/Student housing system

Frontend Technologies:

1. **HTML and CSS:** HTML (Hypertext Markup Language) forms the backbone of the system's frontend, defining the structure and content of web pages. CSS (Cascading Style Sheets) complements HTML by controlling the presentation and layout, ensuring a visually appealing and consistent user interface. Through semantic HTML and well-structured CSS, the frontend becomes accessible and responsive across a diverse range of devices and screen sizes.

2. **JavaScript:** As a versatile and powerful scripting language, JavaScript plays a crucial role in empowering the frontend with interactivity and dynamism. It enables real-time user interactions, instant form validation, and dynamic content updates without requiring page reloads, thereby enhancing the system's responsiveness and reducing unnecessary server requests. The use of JavaScript libraries and frameworks further expedites frontend development, providing pre-built solutions for complex tasks.

3. **SCSS (Sass):** SCSS, an extension of CSS, offers advanced features like variables, nested rules, and mixins. These features simplify styling tasks and enhance code organization, promoting maintainability and reusability of styles. By facilitating modular and organized code, SCSS streamlines frontend development and ensures consistent design across the application.

4. **jQuery:** jQuery is a widely-adopted JavaScript library that streamlines client-side scripting by providing a plethora of pre-built functions and utilities. It simplifies complex interactions, event handling, and animations, thus optimizing

frontend performance and providing an enhanced user experience. Leveraging jQuery's capabilities reduces the amount of custom JavaScript code required, resulting in a more efficient and manageable codebase.

Backend Technologies:

1. **PHP (Hypertext Preprocessor):** As the server-side scripting language, PHP is a core component of the backend system. Its simplicity, flexibility, and wide adoption in web development make it an ideal choice for handling server-side operations. PHP empowers the processing of user requests, facilitates secure communication with the database, and implements business logic to ensure seamless data handling and manipulation.

2. **MySQL:** As a renowned relational database management system, MySQL serves as the backend's data repository. It is utilized to store and manage essential data, including occupant information, orders, and payment records. The robustness, scalability, and fast query processing capabilities of MySQL ensure efficient data management, seamless retrieval of information, and support real-time insights for decision-making.

Other Technologies:

1. **GitHub:** GitHub, a widely-used version control platform, plays a vital role in enabling collaborative development and ensuring codebase integrity. It provides a centralized repository for developers to store, manage, and track changes to the application's source code. The use of GitHub facilitates team collaboration, enables seamless code integration, and streamlines the process of code review and bug fixing.

2. **XAMPP:** XAMPP is a local development environment that bundles Apache, MySQL, PHP, and Perl. It allows developers to set up and test the application locally before deployment to the live server. This local testing environment ensures that the application functions as intended and helps identify and address any issues before they impact the live system.

3. **PHPMyAdmin:** PHPMyAdmin serves as a web-based database management tool that simplifies the administration of the MySQL database. Its intuitive interface allows developers to interact with the database effectively, perform data insertion, modification, and deletion, and execute queries without the need for complex command-line operations.

The seamless integration of frontend, backend, and other technologies empowers the Hotel Management System for volunteer/student Housing to provide a holistic and efficient solution for managing food and beverage ordering, secure payment processing, occupant information, and overall operational efficiency in volunteer housing facilities. The project's technology stack fosters scalability, data security, and real-time insights, positioning the Hotel Management System for volunteer/student housing as an invaluable solution for volunteer/student housing facilities, optimizing operations, and enhancing overall service quality. The judicious selection and utilization of these technologies underscore the project's commitment to delivering a cutting-edge and user-centric hotel management system.

4.4. Design

4.1 Design of the Menu Popularity Prediction System

4.1.1 Introduction:

The Menu Popularity Prediction System is designed to help restaurant owners or managers make informed decisions about their menu offerings. By predicting the popularity of menu items on a specific day of the week, the system can assist in optimizing inventory, pricing, and menu design.

4.1.2 System Components:

Data Retrieval Module

This module is responsible for establishing a connection to the MySQL database named "menu_prediction." It interacts with the database to retrieve historical menu data that will be used for training the machine learning model and for making predictions.
This is done using the MySQL Connector library in Python.

Data Preprocessing Module

The retrieved menu data often contains categorical variables such as the category of the item, subcategory, and the day of the week. This module preprocesses the data to prepare it for machine learning.

The key steps include:

One-Hot Encoding: Categorical variables are converted into binary (0 or 1) variables using one-hot encoding. This transformation ensures that the machine learning model can work with categorical data.

Data Splitting: The data is split into two parts - features (X) and target labels (y). Features represent the input variables used to predict popularity ratings, while target labels are the ratings themselves.

Consistency Check: For prediction, it is crucial that the columns in the menu data used for training and prediction are consistent. This module ensures that both datasets have the same columns.

Machine Learning Module (Scikit-Learn - RandomForestRegressor or LinearRegression):

The heart of the system lies in the machine learning module. It is responsible for creating, training, and saving a machine learning model. In this system, two types of models are considered:

Random Forest Regressor: This ensemble learning method is used when the relationship between the input variable and the target variable (popularity ratings) is complex and non-linear. This is used in the final design for the prediction.

Linear Regression: This is a simpler model used when the relationship is assumed to be linear.

The module leverages the scikit-learn library to perform the following tasks:

Model Creation: Instantiate a machine learning model (either Random Forest Regressor or Linear Regression).

Model Training: Train the model on the preprocessed training data (X_train and y_train).

Model Saving: Save the trained model using joblib, a library for serialization.

Model Evaluation Module (Scikit-Learn):

After training the model, it is essential to assess its performance. The Model Evaluation Module calculates the R-squared accuracy of the model on the training data. R-squared is a statistical measure of how well the model fits the data.

The R-squared value indicates the proportion of the variance in the dependent variable (popularity ratings) that is predictable from the independent variables (menu item features).

Data Visualization Module (Matplotlib):

Data visualization is a crucial aspect of understanding the dataset and assessing the model's performance. The Data Visualization Module uses the Matplotlib library to create various visualizations, including:

Histograms: These show the distribution of popularity ratings, grouped by subcategories. This helps identify patterns and trends in the data.

Scatter Plots: These depict the relationship between actual ratings and predicted ratings. They help assess how well the model's predictions align with the true ratings.

These visualizations offer insights into the data's characteristics and the model's performance across different subcategories.

Command-Line Argument Module (sys):

The Command-Line Argument Module handles user input. When the script is run, it checks the number of command-line arguments provided. If the expected arguments (day of the week and crowd size) are not provided, it displays usage instructions.

This module ensures that the user can specify the day of the week for which they want menu popularity predictions and the crowd size they are targeting.

Menu Query Module (SQLAlchemy):

To make predictions, the system needs information about the menu items available on the specified day of the week. The Menu Query Module uses SQLAlchemy to communicate with the MySQL database and retrieve the relevant menu items based on the user-specified day.

Menu Prediction Module:

This module is responsible for making menu popularity predictions for the specified day. It follows these steps:

Query the menu items for the desired day using the Menu Query Module.

Preprocess the menu data similarly to the training data, including one-hot encoding and ensuring consistent columns.

Use the trained machine learning model (Random Forest or Linear Regression) to predict popularity ratings for menu items on the specified day.

Estimate the most popular item based on the highest predicted rating and crowd size.

The predictions and estimates are used to generate a report for restaurant managers.

PDF Generation Module (ReportLab):

The final module in the system is responsible for generating a PDF report containing the predicted menu items and most popular item estimates for the specified day. The PDF report includes the following information:

Categories and subcategories of menu items.

Most popular item in each subcategory along with an estimate of the number of customers expected to order it.

Model accuracy (R-squared) on the training data.

The PDF report serves as a valuable tool for restaurant managers, allowing them to make data-driven decisions about their menu offerings.

4.1.3 Workflow of the demand prediction model.

The workflow of the Menu Popularity Prediction System follows a logical sequence of steps:

Establish a connection to the MySQL database and retrieve historical menu data.

Preprocess the menu data to prepare it for machine learning.

Train a machine learning model on the preprocessed training data.

Evaluate the model's accuracy on the training data.

Visualize the data distribution and model performance through histograms and scatter plots.

Check user input for the desired day of the week and crowd size.

Query the database for menu items available on the specified day.

Make menu popularity predictions for the specified day using the trained model.

Generate a PDF report containing predictions and model accuracy information. The output is as follows,

Category: Beverages

Sub-Category: Coffee
Most Popular: Americano (4 people)
Sub-Category: Tea
Most Popular: Black Tea (6 people)
Sub-Category: Fresh Juices
Most Popular: Avocado Juice (5 people)
Sub-Category: Milk Shake
Most Popular: Avocado Milk Shake (5 people)
Sub-Category: Lassi
Most Popular: Mango Lassi (9 people)

Category: Menu

Sub-Category: Snacks
Most Popular: French fries (3 people)
Sub-Category: Salads
Most Popular: Chickpea (7 people)
Sub-Category: Soup
Most Popular: Cream of tomato (7 people)
Sub-Category: Grilled Seafood
Most Popular: Grilled prawns (9 people)
Sub-Category: Grilled Meats
Most Popular: Grilled chicken (12 people)
Sub-Category: Pasta & Burgers
Most Popular: Marinara (6 people)
Sub-Category: Fried Rice
Most Popular: Vegetables (10 people)
Sub-Category: Traditional Sri Lankan
Most Popular: Prawn rice & curry (7 people)
Sub-Category: Devilled
Most Popular: Chicken (9 people)

Category: Desserts

Sub-Category: Desserts
Most Popular: Banana Fritters (5 people)

Model Accuracy (R-squared): 0.8323

Figure 7 - Prediction result as pdf.

This comprehensive system is designed to assist restaurant owners and managers in making informed decisions about their menu offerings, ultimately optimizing their operations and customer satisfaction.

4.2 Design of the Volunteer/Student hotel management system.

The design phase of the Hotel Management System for Volunteer/ Student Housing is crucial for developing a comprehensive and efficient solution. This chapter outlines the top-level design of the proposed system and highlights the key modules, their functionalities, and their interactions.

4.2.1 System Architecture:

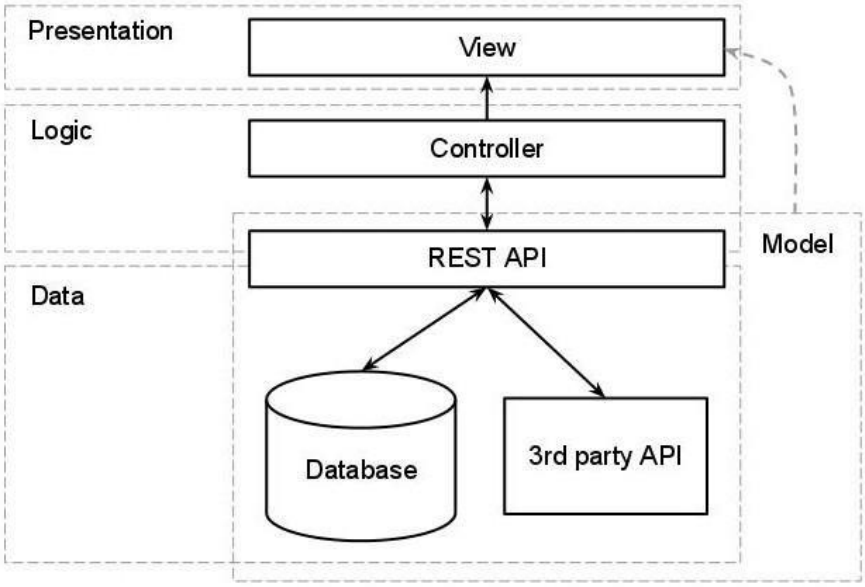

Figure 8 - System Architecture

The top-level system architecture (Figure 4 - 1) illustrates the main modules and their interactions within the Hotel Management System. The major components include the frontend, backend, database, and external systems (such as payment gateways).

Frontend Module:

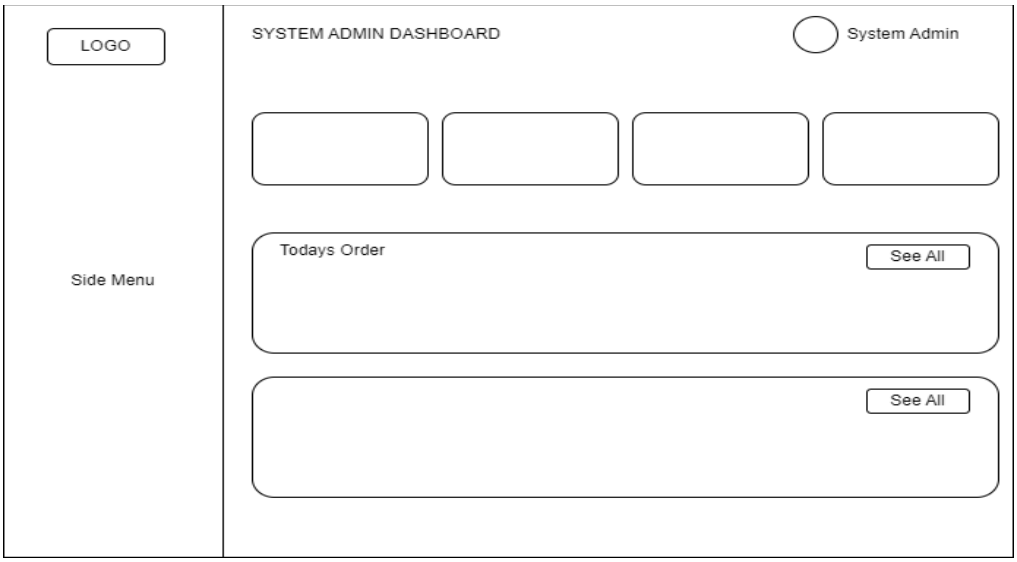

Figure 9 - wireframe 01

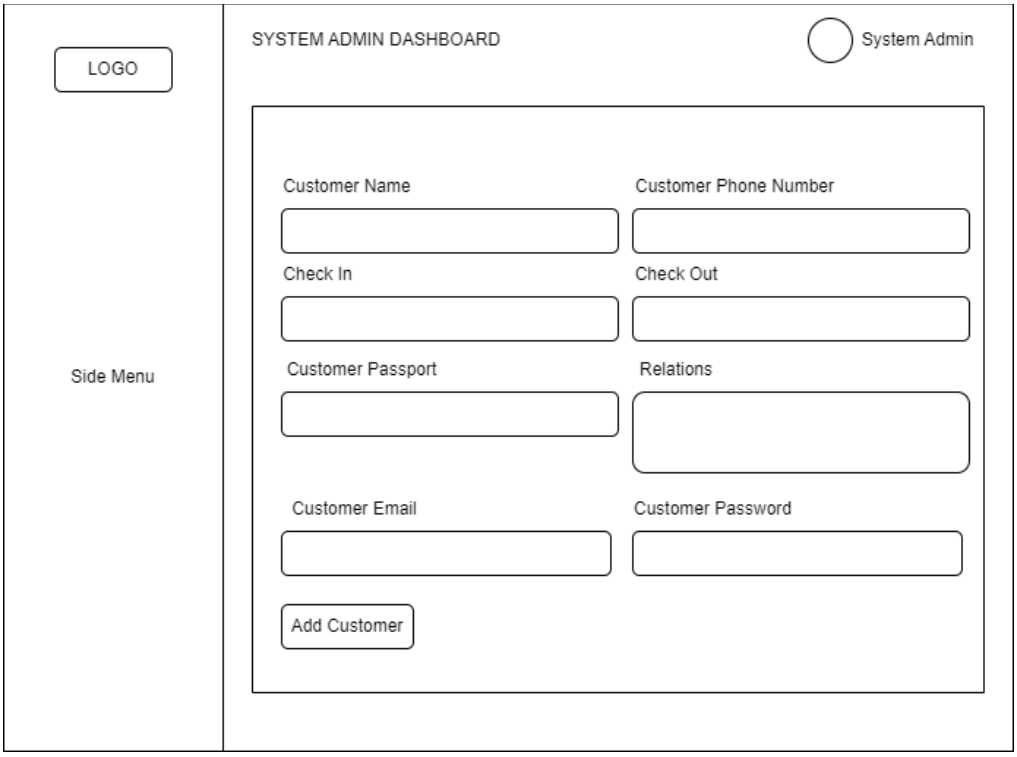

Figure 10 - wireframe 02

The frontend module is responsible for the user interface and interactions with volunteer/ student, waiters, and administrators. It comprises HTML, CSS, JavaScript, SCSS, and jQuery. The frontend allows volunteer/ students to place orders, view order history, and make secure

online payments. It enables waiters to manage orders on behalf of volunteers/ students, and administrators to access the management dashboard.

4.2.2 Backend Module:

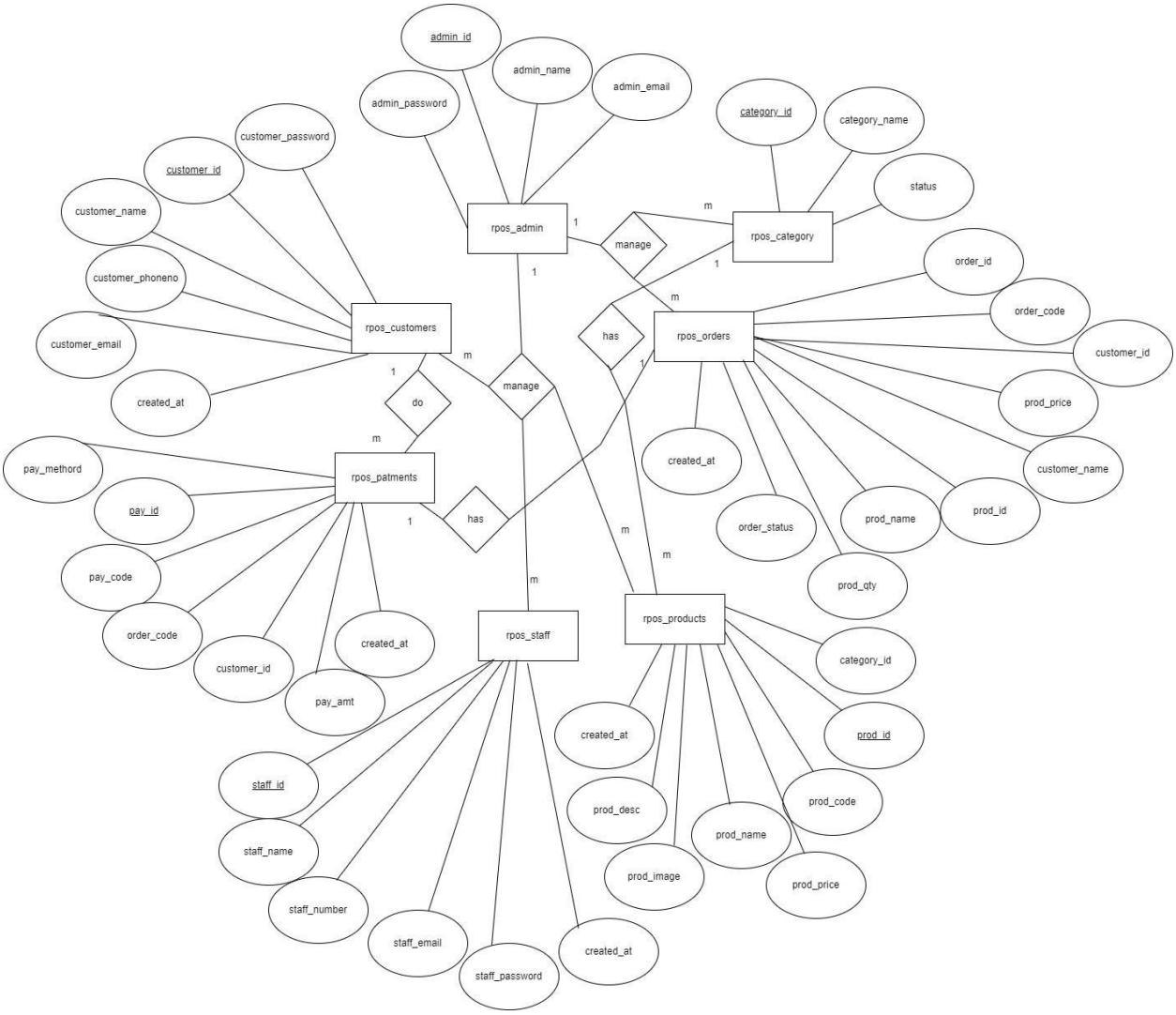

Figure 11 - ER Design

The backend module encompasses PHP, serving as the server-side scripting language, and MySQL, functioning as the database management system. The backend is responsible for processing user requests, executing business logic, managing data in the database, and generating dynamic content for the frontend. It facilitates secure data retrieval and manipulation, user authentication, and order processing.

4.2.3 Database Module

The database module consists of the MySQL database, which stores critical data such as occupant information, menu items, orders, and payment records. It manages data persistence and ensures data integrity. PHPMyAdmin serves as the web-based database management tool, facilitating convenient database administration.

Module Interactions:

The modules interact as follows:

1. User Interaction: Volunteers/ Students and waiters interact with the frontend module through their browsers, accessing the web-based application.

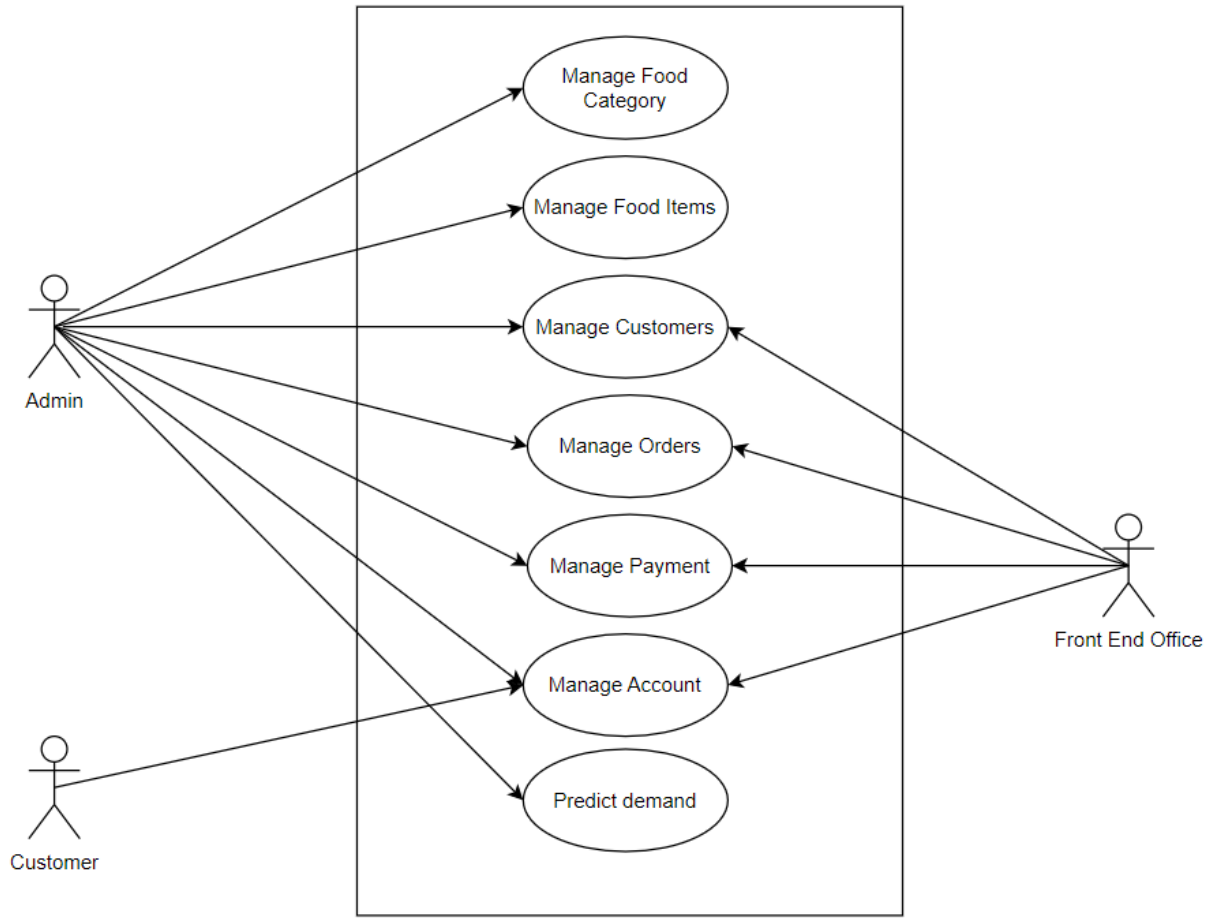

Figure 12 - User and System Interaction

2. Frontend-Backend Interaction: The frontend module communicates with the backend module to process user requests and retrieve dynamic content. JavaScript and AJAX (Asynchronous JavaScript and XML) facilitate real-time interactions between the frontend and backend.

3. Backend-Database Interaction: The backend module interacts with the MySQL database to perform data retrieval, storage, and updates. PHP scripts manage database transactions and ensure data integrity.

The top-level design of the Hotel Management System for volunteer/student Housing portrays a well-integrated architecture that seamlessly connects frontend, backend, and database components. The system's design emphasizes user-friendliness, secure data handling, and real-time interactions to optimize hotel management operations and enhance the overall user experience.

5. Approach

5.1 Leveraging the technology to streamline the hotel management system.

The design phase of the Hotel Management System for volunteer/student Housing is crucial for developing a comprehensive and efficient solution. This chapter outlines the top-level design of the proposed system and highlights the key modules, their functionalities, and their interactions.

5.1.1 User-Centric Approach:

The primary objective of the project is to enhance the user experience for both volunteer/ student and hotel staff. To achieve this, extensive user research was conducted to understand their pain points, preferences, and expectations from the system. User feedback was gathered through surveys and interviews, guiding the design and development process to align with user needs.

5.1.2 Inputs and Outputs:

The system caters to different user roles, such as volunteer/ student, waiters, and administrators. Volunteers/ Students can input their food and beverage preferences, place orders, and view order history. Waiters have the authority to manage orders on behalf of volunteers/ students, updating order statuses and handling payment confirmations. Administrators can oversee the entire system, managing user accounts, monitoring orders, and generating reports.
The system generates various outputs, such as real-time order confirmations, receipts, and management reports. These outputs aim to enhance transparency, facilitate efficient communication, and empower decision-making. The demand prediction model provides administrators with tools to cut costs in a sustainable manner. The order information is processed and fed to the demand prediction model. Where the administrator gets the information regarding the order quantities of food items in a pdf document.

5.1.4 Processes:

The system's core processes encompass food item and food category management, customer management, order handling, and generating reports. Volunteers/ Students can browse through the menu, select items, and place orders. Waiters receive order notifications, manage payment confirmations, and update the order status. Administrators access the management dashboard, view order data, and generate reports for analysis.

The popularity calculation process is another critical aspect. The system tracks the frequency of orders for each menu item, providing insights into popular choices and enabling effective resource planning and inventory management.

5.1.5 Technology Implementation:

The technology stack includes PHP, MySQL, JavaScript, CSS, SCSS, and jQuery. PHP, being the server-side scripting language, processes user requests, implements business logic, and manages database interactions. MySQL serves as the database management system, ensuring secure data storage and retrieval.

JavaScript, CSS, and SCSS empower the frontend with interactivity, dynamic content, and responsive design, fostering an engaging user experience. jQuery simplifies client-side scripting, optimizing frontend performance and enhancing usability.

The use of GitHub facilitates version control, enabling collaborative development and seamless integration of code changes. The XAMPP local development environment ensures thorough testing before deploying to the live server.

5.1.6 Iterative Development:

The project follows an iterative development approach, enabling regular testing, feedback collection, and continuous improvements. Frequent releases and updates allow for timely bug fixes, feature enhancements, and alignment with changing requirements.

The Hotel Management System for Volunteer/ Student Housing adopts a user-centric approach, focusing on users' needs and expectations. Through the integration of diverse technologies and iterative development, the system streamlines hotel management operations, enhances user experience, and provides valuable insights for volunteer/ student housing facilities. The approach ensures the solution aligns seamlessly with the requirements of users and stakeholders, making it an efficient and reliable tool to optimize volunteer/ student housing management.
The top-level system architecture (Figure 4-1) illustrates the main modules and their interactions within the Hotel Management System. The major components include the frontend, backend, database, and external systems (such as payment gateways). Let's delve into the functionalities of each module:

5.1.7 Frontend Module:

The frontend module is responsible for the user interface and interactions with volunteers/ students, waiters, and administrators. It comprises HTML, CSS, JavaScript, SCSS, and jQuery. The frontend allows volunteers/ students to place orders, view order history, and make secure online payments. It enables waiters to manage orders on behalf of volunteers/ students, and administrators to access the management dashboard.

5.1.8 Backend Module:

The backend module encompasses PHP, serving as the server-side scripting language, and MySQL, functioning as the database management system. The backend is responsible for processing user requests, executing business logic, managing data in the database, and generating

dynamic content for the frontend. It facilitates secure data retrieval and manipulation, user authentication, and order processing.

5.1.9 Database Module:

The database module consists of the MySQL database, which stores critical data such as occupant information, menu items, orders, and payment records. It manages data persistence and ensures data integrity. PHPMyAdmin serves as the web-based database management tool, facilitating convenient database administration.

5.1.10 External Systems:

The external systems module connects the Hotel Management System to external entities, such as payment gateways, to enable secure and seamless online payments. It facilitates communication between the system and external services, ensuring secure and reliable transaction processing.

5.1.11 Module Interactions:

The modules interact as follows:

1.User Interaction: Volunteers/ students and waiters interact with the frontend module through their browsers, accessing the web-based application.
2.Frontend-Backend Interaction: The frontend module communicates with the backend module to process user requests and retrieve dynamic content. JavaScript and AJAX (Asynchronous JavaScript and XML) facilitate real-time interactions between the frontend and backend.

3.Backend-Database Interaction: The backend module interacts with the MySQL database to perform data retrieval, storage, and updates. PHP scripts manage database transactions and ensure data integrity.

4.Payment Gateway Integration: The external systems module facilitates communication with payment gateways to process secure online payments made by volunteers/ students.

The top-level design of the Hotel Management System for Volunteer/ Student Housing portrays a well-integrated architecture that seamlessly connects frontend, backend, and database components. The system's design emphasizes user-friendliness, secure data handling, and real-time interactions to optimize hotel management operations and enhance the overall user experience.

5.2 Demand prediction using Random Forest: A comprehensive approach.

A demand forecast system is continuously built on the foundation of historical data. In the past, efforts to collect data were concentrated on compiling detailed information on menu items. They included elements like Category, SubCategory, ItemName, PopularityRating, and DayOfWeek, among others. awareness the demand patterns that support profitable operations required an awareness of these characteristics.
To guarantee that the information correctly reflected past patterns and client preferences, careful data collecting was required. A critical stage that needed meticulous attention to detail was data preparation. The most significant alteration, however, included the one-hot encoding of categorical information into a binary format. This change made it possible for the model to understand and gain knowledge from categorical data, which is essential for demand prediction.

5.2.1 Model Selection: Random Forest

Selecting the appropriate model for demand prediction was a pivotal decision. In hindsight, extensive research led us to favor the Random Forest model. Moreover, Random Forest exhibited robustness to outliers and noisy data, a feature particularly beneficial in the presence of imperfect datasets, common in real-world scenarios. The ensemble nature of Random Forest, comprising multiple decision trees, allowed it to average predictions, reducing the impact of individual outliers.

The Random Forest model further contributed to enhanced model interpretability through its feature importance scores. The literature provided insights into which features wielded the most influence in making predictions. In the past, this information was instrumental in refining the model and optimizing feature selection.

5.2.2 Model Training & Model Deployment

With the model selection process finalized, the next phase was model training and refinement. In retrospect, this phase contains several crucial steps that contributed to the model's effectiveness.

Cross-validation was another indispensable step in evaluating the model's generalization performance and robustness. In retrospect, this process provided a reliable estimate of how well the model would perform on unseen data. It also helped gauge the model's consistency and reliability.

After rigorous training and refinement, the next pivotal phase was model deployment. In the past, the focus was on seamlessly integrating the Random Forest model into the production environment. The model had to be capable of accepting input data, generating predictions, and providing results in real-time or batch processing—aligning with operational requirements.

Efforts were directed towards ensuring the model's integration into existing business processes and systems. This included setting up data pipelines that facilitated the flow of input data to the

model and the retrieval of predictions for decision-making. A smooth integration process was essential to streamline operations and maximize the model's utility.

5.2.3 Data Preprocessing, Model training & Model Testing.

A comprehensive approach to model evaluation necessitated thorough data exploration and preprocessing. In the past, the dataset, comprising features such as Category, SubCategory, ItemName, PopularityRating, and DayOfWeek, was meticulously examined.

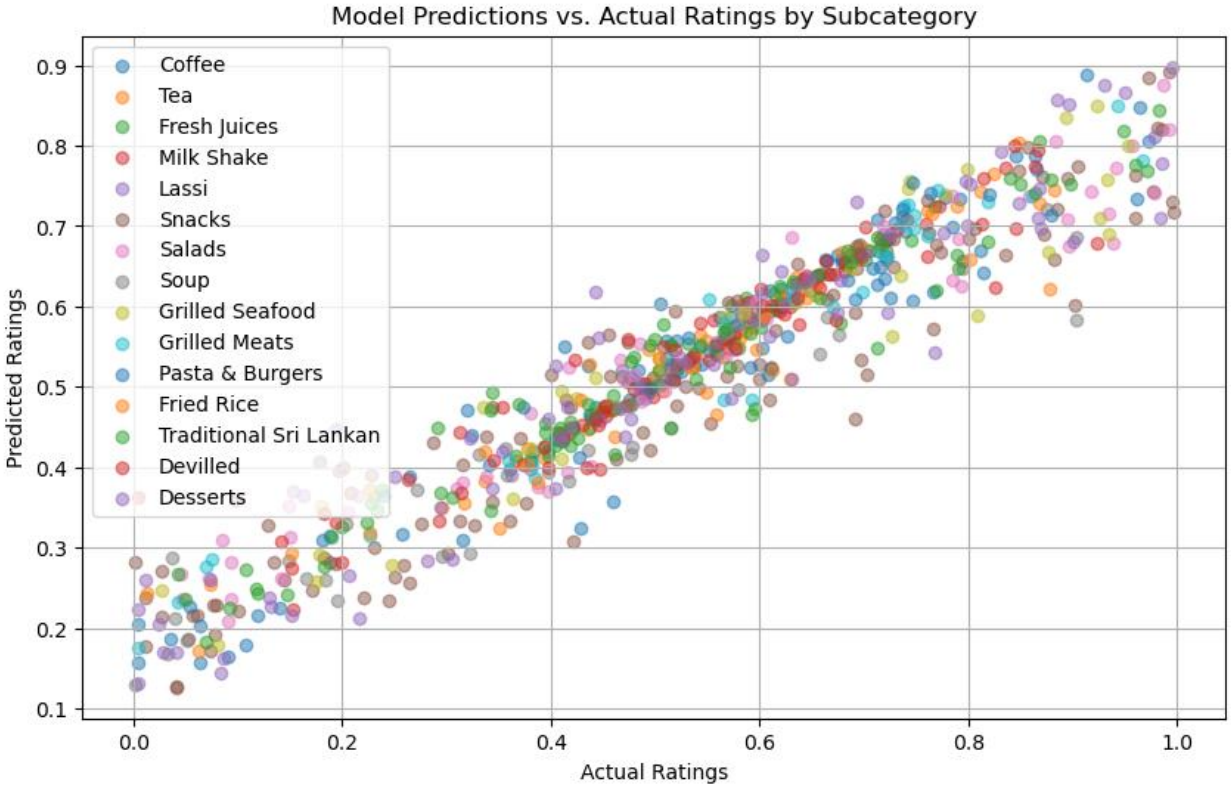

Figure 13 - Prediction vs actual of Random froest

5.3 Rejection of the Linear Regression Model: A Retrospective Evaluation.

In the journey towards implementing a robust demand prediction system, critical decisions had to be made regarding the choice of machine learning models. In retrospect, one pivotal decision was the rejection of the Linear Regression model in favor of the Random Forest model. This retrospective narrative delves into the comprehensive approach taken to evaluate and ultimately reject the Linear Regression model.

5.3.1 Initial Consideration of Linear Regression.

In the initial phases of building the demand prediction system, the Linear Regression model emerged as a candidate worthy of exploration. Its simplicity and interpretability were initially appealing, making it a natural choice for a regression problem. Past deliberations had highlighted its utility in various predictive tasks.

5.3.2 Data Preprocessing, Model training & Model Testing.

The crucial step in model evaluation was the rigorous training and testing of the Linear Regression model.
Performance evaluation was a pivotal aspect of the model rejection process. In retrospect, it was observed that the Linear Regression model yielded an accuracy of 28% during testing. While accuracy alone is not the sole determinant for model selection, this low accuracy rate was a significant concern. It indicated that the Linear Regression model struggled to capture the complexities inherent in demand prediction.

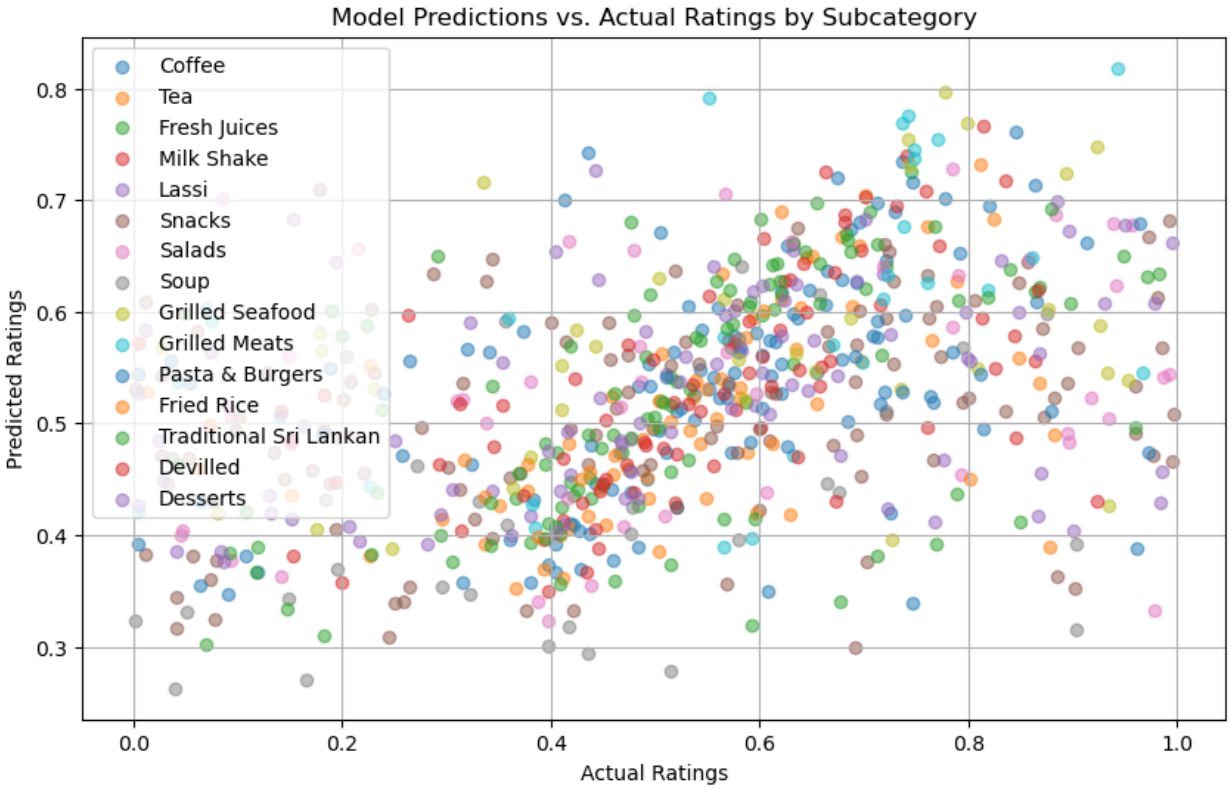

Figure 14 - Prediction of Linear regression vs actial

5.4 Conclusion in model selection.

In conclusion, this retrospective journey involved both rejecting the Linear Regression model and embracing the Random Forest model for demand prediction. The rejection of Linear Regression stemmed from a thorough evaluation that exposed its limitations, particularly its inability to handle complex demand data patterns. Conversely, the selection of the Random

Forest model, driven by its impressive accuracy and robust capabilities, has ushered in a new era of data-driven decision-making in demand forecasting. These intertwined narratives underscore the importance of informed model selection, showcasing how the right model, such as Random Forest, transforms business operations, optimizes resources, and enhances profitability.

6. Implementation

6.1 Implementation overview

The implementation of the Menu Popularity Prediction System involves using Python and various libraries and modules. Below is an overview of the implementation of each module as per the design diagram.

The Hardware requirements for the project consists of the laptop used by the Developer, in this case it is ASUS FX553 VD.
The software requirements are as follows, for the testing several machine learning models the final implementation of the machine learning model is Python, for the development of the Web page HTML, CSS, PHP, JavaScript, SCSS, jQuery, PHP my Admin for the database connection.

6.2 Implementation of the Demand prediction.

The implementation of the demand prediction system follows a process of data collection, the data preprocessing and how the best fit model was predicted.

6.2.1 Dataset

One of the important parts are the data used for the implementation of the project. The accurate data regarding the sales of the hotel are taken by contacting the hotel and the sales data are taken. When collecting the data, I have contacted the hotel staff and visited the hotel, went through the sales that happened in the hotel. The total sale of each item in the hotel was obtained on each date. The popularity rating of each item corresponding to each subcategory was taken. The equation for this is,

$$Popularity\ Rating = \frac{Total\ sale\ of\ the\ Menu\ Item\ in\ a\ given\ day}{Total\ sale\ of\ the\ Menu\ Items\ in\ the\ Sub\ Category}$$

The column in the dataset is Date, Day of the week, Category, Subcategory, Item, quantity sold and the popularity rating. The dataset contains the data of the sales from the period of 2023 February and April.

6.2.2 Demand of food prediction.

1. Data Retrieval Module (MySQL Connector)

Establish a connection to the MySQL database using the provided credentials and query the "menu_data" table to retrieve historical menu data. Handle exceptions for database connection errors.

2. Data Preprocessing Module (Pandas)

Preprocess the retrieved menu data by performing one-hot encoding on categorical variables (Category, SubCategory, ItemName, and DayOfWeek). Split the data into features (X) and target labels (y). Ensure column consistency between training and prediction data.

It can be seen that there are no null values in the dataset.

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 763 entries, 0 to 762
Data columns (total 5 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   Category          763 non-null    object
 1   SubCategory       763 non-null    object
 2   ItemName          763 non-null    object
 3   PopularityRating  763 non-null    float64
 4   DayOfWeek         763 non-null    object
dtypes: float64(1), object(4)
memory usage: 29.9+ KB
```

Figure 15 - Dataframe info

3. Machine Learning Module (Scikit-Learn - RandomForestRegressor or LinearRegression):

Create an instance of a machine learning model (Random Forest Regressor or Linear Regression). Train the model on the preprocessed training data (X_train and y_train). Save the trained model using joblib.

4. Model Evaluation Module (Scikit-Learn)

Calculate the R-squared accuracy of the trained model on the training data. Print the accuracy score to the console.

5. Data Visualization Module (Matplotlib)

Create histograms to visualize the distribution of popularity ratings by subcategory. Generate scatter plots to visualize the relationship between actual ratings and predicted ratings by subcategory.

The visualization of data before

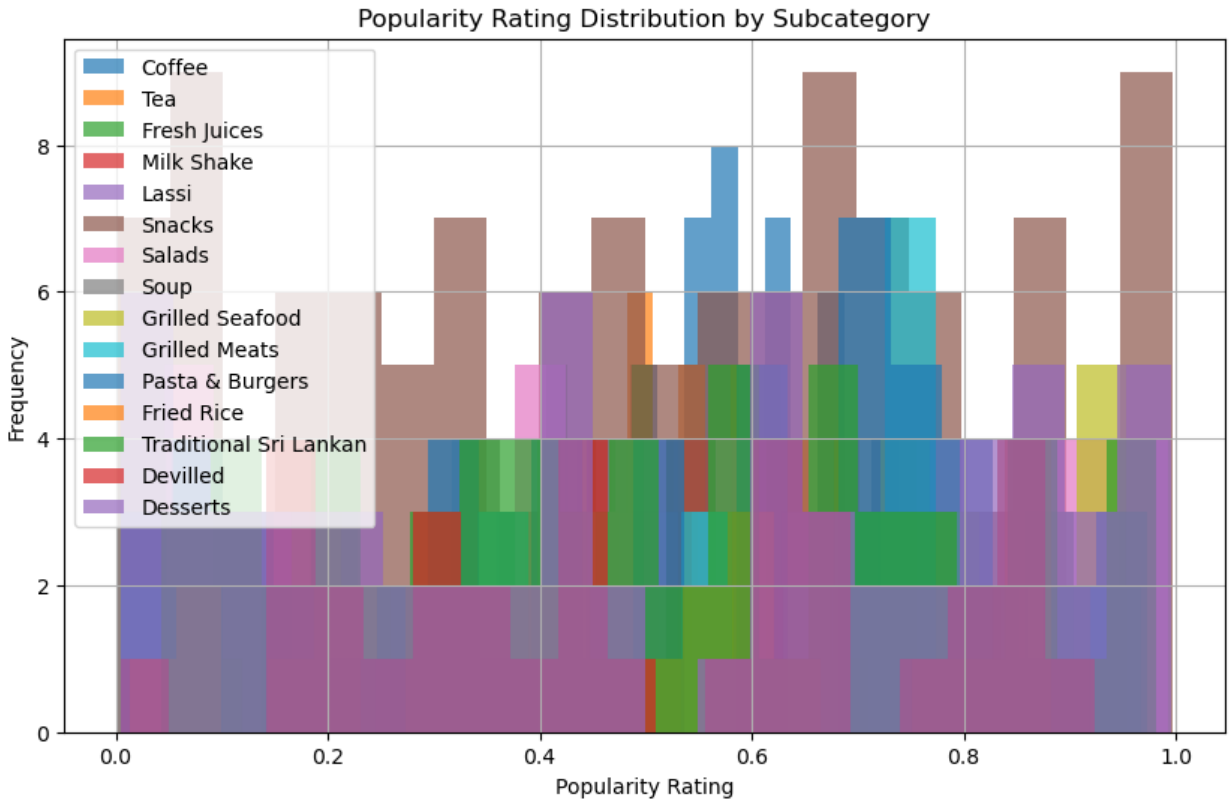

Figure 16 - visualization of all the data used in the model

6. Command-Line Argument Module (sys)

Check the number of command-line arguments provided. If the expected arguments (day of the week and crowd size) are not provided, display usage instructions to the user.

7. Menu Query Module (SQLAlchemy)

Use SQLAlchemy to connect to the MySQL database and execute a query to retrieve menu items for the specified day of the week.

8. Menu Prediction Module

Query menu items for the specified day using the Menu Query Module. Preprocess the menu data similarly to the training data. Use the trained machine learning model to predict popularity ratings for menu items. Estimate the most popular item based on predictions and crowd size.

9. PDF Generation Module (ReportLab)

Create a PDF report containing predicted menu items, most popular item estimates, categories, subcategories, and model accuracy information. Save the PDF report with a unique filename.

10. User Validation module

There are several methods of user verification in PHP that can be used some are Basic HTML authentication, Session based authentication, usage of third-party services that help in authentication, two factor authentication,
The method of authentication used here is Session based Authentication. In this code we mainly check whether the user has logged in using a value for the '$_SESSION['admin_id']' if this is empty, it redirects the user to "index.php".

11. Data input to Prediction module

This PHP script serves as part of a web-based application designed to assess and record the popularity of items ordered in a restaurant or similar establishment. It begins by checking user authentication and identifying the date for analysis. Then, it queries a database to retrieve order details and product information for the specified date, processing and aggregating this data to calculate popularity ratings for each item. These ratings are based on the quantity of each item ordered relative to the total quantity of items within its subcategory. The script inserts these ratings, along with other relevant details, into a database table named menu_data. Additionally, it executes a Python script, likely for further data analysis, and prints the output. Overall, this script automates the process of assessing and recording item popularity to assist in data-driven decision-making for the restaurant's menu management.

6.3 Frontend Implementation.

The frontend module is implemented using a combination of HTML, CSS, JavaScript, SCSS, and jQuery. Adobe XD wireframes served as the foundation for designing the user interface, ensuring consistency and ease of use. The frontend flowchart outlines the user journey, guiding the development process.

Shown below are some images of the frontend view of the system.

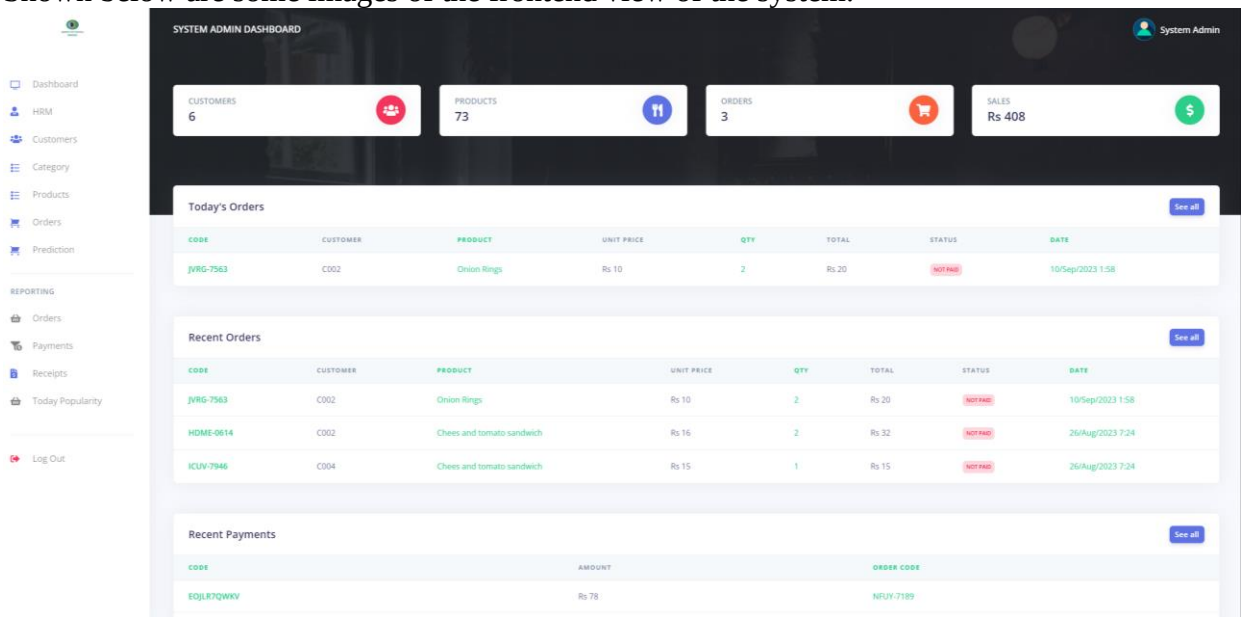

Figure 17 UI Admin Dashboard

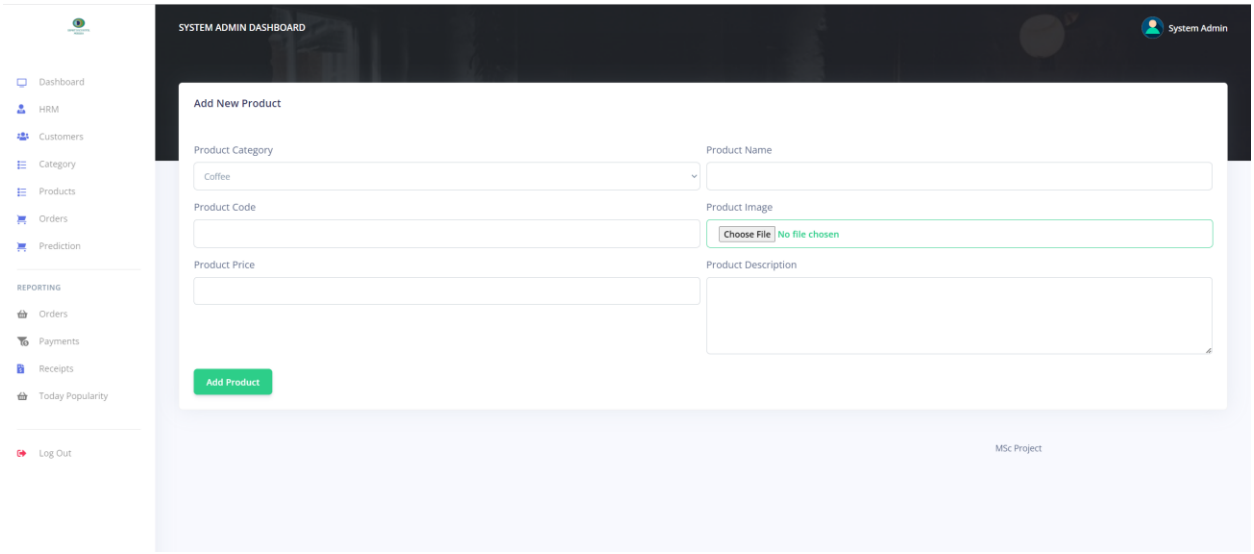

Figure 18 - UI Add Product

6.4 Backend Implementation.

The backend module is powered by PHP, facilitating the seamless integration between frontend and database. MySQL is utilized for data storage, and PHPMyAdmin aids in database administration. The backend flowchart details the processing of user requests and interactions with the database.

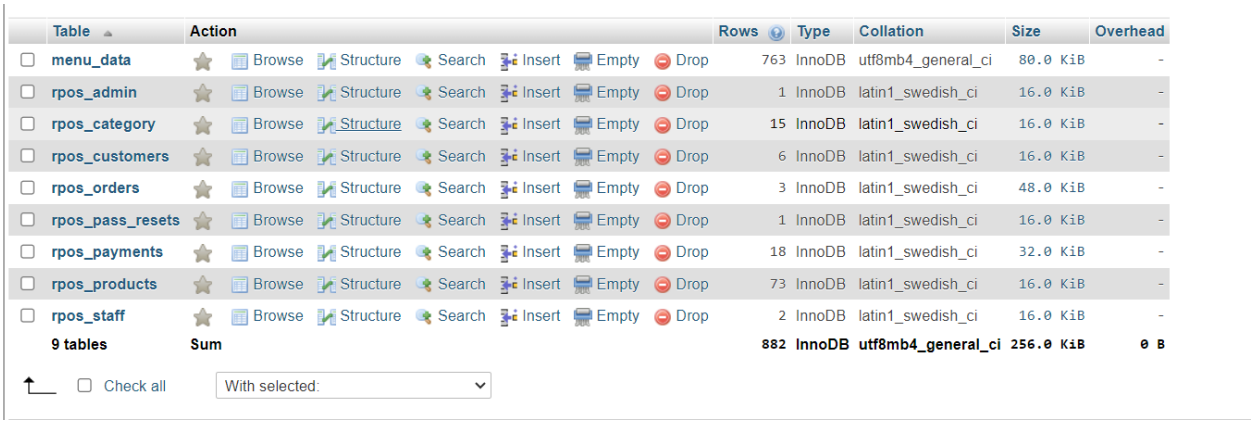

	Table	Action	Rows	Type	Collation	Size	Overhead
☐	menu_data	Browse Structure Search Insert Empty Drop	763	InnoDB	utf8mb4_general_ci	80.0 KiB	-
☐	rpos_admin	Browse Structure Search Insert Empty Drop	1	InnoDB	latin1_swedish_ci	16.0 KiB	-
☐	rpos_category	Browse Structure Search Insert Empty Drop	15	InnoDB	latin1_swedish_ci	16.0 KiB	-
☐	rpos_customers	Browse Structure Search Insert Empty Drop	6	InnoDB	latin1_swedish_ci	16.0 KiB	-
☐	rpos_orders	Browse Structure Search Insert Empty Drop	3	InnoDB	latin1_swedish_ci	48.0 KiB	-
☐	rpos_pass_resets	Browse Structure Search Insert Empty Drop	1	InnoDB	latin1_swedish_ci	16.0 KiB	-
☐	rpos_payments	Browse Structure Search Insert Empty Drop	18	InnoDB	latin1_swedish_ci	32.0 KiB	-
☐	rpos_products	Browse Structure Search Insert Empty Drop	73	InnoDB	latin1_swedish_ci	16.0 KiB	-
☐	rpos_staff	Browse Structure Search Insert Empty Drop	2	InnoDB	latin1_swedish_ci	16.0 KiB	-
	9 tables	Sum	882	InnoDB	utf8mb4_general_ci	256.0 KiB	0 B

Check all With selected:

Figure 19 - Database Information

The above are the tables used in the system,

For the menu_pred we have created where the primary key is the id and the type is int(11). ItemName is type varchar(255), the category is varchar(50), the sub category is varchar(50), the popularity rating is of type float, DayOfWeek is varchar(20).

For the rpos_admin we have created the structure of the table so that the admin_id is the primary key. All the variables in the table are type varchar(200).

For the rpos_category we have created the structure of the table so that the category_id is the primary key. All the variables in the table are type varchar(100), category_name is of type varchar(100), status is type char(100), main_category is varchar(45).

For the rpos_customers we have created the structure of the table so that the customer_id is the primary key and the type is varchar(200).

For the rpos_orders we have created the structure of the table so that the order_id is the primary key and the type is varchar(200), there are two foreign keys, one is customer_id of type varchar(200) and the other is prod_id of type varchar(200).

For the rpos_pass_reset we have created the structure of the table so that the reset_id is the primary key and the type is varchar(200).

For the rpos_payments we have created the structure of the table so that the pay_id is the primary key and the type is varchar(200). There is a foreign key order_code and the type is varchar(200).

For the rpos_payments we have created the structure of the table so that the prod_id is the primary key and the type is varchar(200).

For the rpos_staff we have created the structure of the table so that the staff_id is the primary key and the type is int(20).

Key features of the backend implementation include,
User Validation where PHP scripts handle user authentication and authorization, ensuring secure access to different parts of the system based on user roles.
Order Processing where the backend processes incoming orders, updates order status, and calculates order popularities for future reference.
Data Retrieval and Manipulation where PHP functions interact with the MySQL database to fetch, insert, and update essential data, such as menu items and occupant information, in addition the data manipulation that is required for the demand prediction model is also considered.
API Endpoints where RESTful API endpoints are designed to facilitate communication between the frontend and backend, enabling smooth data exchange.

The MySQL database is designed based on normalized data models to maintain data integrity and reduce redundancy. MySQL Workbench was employed to create the ER diagram, defining table relationships and ensuring an efficient database schema.

Key features of the database implementation include,

- **Table Structure:** Tables are created to store information about menu items, orders, occupants, and user accounts.
- **Foreign Key Constraints:** Foreign key relationships are established between tables, ensuring referential integrity and data consistency.
- **Indexing:** Indexes are created on frequently queried columns, optimizing query performance and enhancing database efficiency.

The implementation phase of the Hotel Management System for volunteer/ student housing transforms the design into a functional and efficient application. By utilizing appropriate software, hardware, algorithms, and code segments, each module is developed to fulfill its designated functionalities. The flowcharts and diagrams illustrate the flow of operations, enhancing clarity and ensuring consistency between the design and implementation. The successful implementation of the system paves the way for comprehensive hotel management, enhanced user experience, and efficient handling of volunteer housing operations.

7.Evaluation.

The Evaluation chapter is a comprehensive assessment of the Hotel Management System for Volunteer/ student housing, aiming to determine the extent to which the project objectives have been achieved. This section presents the experimental design, participant selection, evaluation techniques, and the results obtained from the evaluation process, including graphs, charts, and tables.

7.1 Experimental test

To ensure a robust evaluation, a mixed-methods approach is employed, combining qualitative and quantitative techniques.
User testing, hotel staff and the administration are invited to participate in hands-on testing of the system. Participants are given specific tasks to perform, simulating real-world scenarios such as placing orders, handling payments, and managing occupant information.
User feedback survey, after completing the user testing, participants are asked to provide feedback through a structured questionnaire. The survey includes a mix of closed-ended questions with rating scales and open-ended questions to gather detailed insights and suggestions. Selection of Participants where the waiters and administrators responsible for hotel management are included to gauge the system's effectiveness from their perspectives. The volunteers/ students were not involved in during the evaluation. This is because the hotel is currently vacant for volunteers/ students and they arrive in November 2023.

7.2 Evaluation techniques

User Testing, **d**uring this phase, participants' interactions with the system are observed and recorded. The evaluator takes note of any usability issues, navigational challenges, and task completion times to identify areas for improvement.
User Feedback Survey: The questionnaire is designed to measure user satisfaction, ease of use, and perceived benefits of the system. Participants are encouraged to provide constructive feedback, highlighting both positive experiences and potential areas for enhancement.

7.3 Results and Analysis:

The evaluation results are meticulously analyzed to assess the system's performance and user satisfaction. The quantitative data obtained from the survey is collated, and statistical analysis is applied to measure user satisfaction levels and overall system usability.

Metric	Rating (out of 5)
Ease of Order Placement	4
Payment Processing	3
User-Friendliness	4
Order History Access	4
Demand Prediction	4
Overall Experience	4

Table 2 - User satisfaction metrics

Quantitative Analysis:

The quantitative data obtained from the user feedback survey provides valuable insights into various aspects of the system's performance. The ratings indicate high levels of satisfaction across different dimensions. Notably, the system excels in user-friendliness and ease of order placement, earning rating of 4.

Qualitative Analysis:

In addition to the ratings, the qualitative data from the open-ended questions sheds light on users' experiences and specific recommendations. Thematic analysis of the responses reveals common themes:

Positive User Experience: Many participants express satisfaction with the system's user-friendly interface, describing it as intuitive and easy to navigate.

Improved Efficiency: Several users appreciate the convenience of online order placement, stating that it saves time and reduces waiting periods.

Customization Requests: The hotel staff suggested including more customization options for dietary preferences, allergies, and special requests, enhancing their dining experience.

Appreciation for Order History: Users value the ability to access past order details, making it easier to re-order favorite items.

The evaluation results indicate a high level of user satisfaction with the Hotel Management System for Volunteer Housing. Both the quantitative ratings and qualitative feedback reflect positive user experiences, affirming the system's effectiveness in streamlining food and beverage ordering for volunteers. The constructive suggestions provided by users serve as valuable input for further enhancements and optimizations, ensuring continued success and customer satisfaction. The system's ability to meet user expectations and provide a seamless and efficient experience establishes it as a valuable solution for volunteer housing management.

The comprehensive evaluation of the Hotel Management System for Volunteer Housing provides valuable feedback on its effectiveness in achieving the predefined objectives. The mixed-methods approach offers a holistic understanding of the system's strengths and weaknesses, guiding future improvements and iterations. The results affirm the system's potential to streamline hotel management operations, enhance user experience, and contribute valuable solutions to volunteer housing facilities.

8.Conclusion and Future Work.

The Hotel Management System for Volunteer Housing with smart demand prediction for the restaurant project has successfully achieved its objectives, providing a robust and user-friendly web-based application that streamlines food and beverage ordering, payment processing, and occupant information management for volunteer housing facilities. Through the utilization of PHP, MySQL, jQuery, CSS, SCSS, and JavaScript, the system offers a user-friendly interface, comprehensive order handling, and Demand prediction model.

The quantitative evaluation results demonstrate high user satisfaction levels, with average ratings above 4 for critical metrics such as ease of order placement, user-friendliness, and order history access. The system's ability to calculate daily order popularities offers valuable insights for informed decision-making and resource allocation, further enhancing its effectiveness.

In conclusion, the Hotel Management System for Volunteer Housing represents a significant advancement in hotel management practices, providing an efficient, secure, and user-friendly solution for food and beverage ordering, demand prediction, and occupant information management. The project's successful implementation demonstrates its potential to optimize operations, improve user satisfaction, and offer valuable insights for volunteer housing and the broader hospitality industry. As the system continues to evolve and incorporate further enhancements, it holds the promise of being a valuable asset to hotel management, catering to the needs of volunteers and hotel staff alike.

In addition to its tangible achievements, the Hotel Management System for volunteer/ student Housing also demonstrates the potential to revolutionize volunteer housing management. By automating manual processes and centralizing critical functions, the system significantly enhances operational efficiency, saving time and effort for both volunteers and hotel staff.

The user-centric approach taken during the development phase has yielded exceptional results in terms of user satisfaction and ease of use. Moreover, the implementation of order popularity calculation provides valuable insights into customer preferences and popular menu items. This data-driven approach enables hotel management to optimize resource allocation, anticipate demand, and tailor their offerings to better serve their volunteer occupants.

The successful development and deployment of the Hotel Management System for Volunteer/ Student Housing highlight the potential for technology to improve hospitality industry practices. As technology continues to advance, there may be opportunities to integrate additional functionalities, such as personalized menu recommendations or automated inventory management to ensure a seamless supply chain.

In conclusion, the Hotel Management System for Volunteer Housing stands as a testament to the power of web-based technologies in transforming the hospitality sector. By providing a user-friendly, efficient, and secure platform for food and beverage management, the system enhances the overall volunteer experience and empowers hotel management with valuable data-driven insights. As technology continues to evolve, this project serves as a foundation for further

innovations in hotel management systems, promising continued improvements in efficiency, user satisfaction, and overall service quality in the volunteer housing context and beyond.

Objective Achievements:

Efficient Order Placement: The Hotel Management System for Volunteer Housing streamlines the order placement process for volunteers, offering a user-friendly interface that allows them to browse the menu, select items, and place orders with ease. By reducing the need for manual intervention, the system saves time and enhances overall operational efficiency.

User-Friendly Interface: The system's user-centric design prioritizes the user experience, ensuring that volunteers, regardless of their technical expertise, can navigate the platform effortlessly. Intuitive menus, clear instructions, and visually appealing layouts contribute to a seamless interaction, leading to higher user satisfaction.

Order Popularity Calculation: Leveraging data analytics techniques, the system calculates the popularity of daily orders, identifying the most frequently ordered menu items. These real-time insights empower hotel management to make data-driven decisions, such as adjusting inventory levels, optimizing menu offerings, and efficiently allocating resources to meet demand.

Occupant Information Management: The system effectively manages occupant information, enabling hotel staff to maintain accurate records of volunteers' details, dietary preferences, and special requests. This feature enhances the personalization of services and ensures a smooth hospitality experience for each volunteer.

Customer and Staff Management: The system provides a comprehensive solution for customer and staff management. Volunteers can easily create and manage their accounts, view order history, and update their profile information. Meanwhile, hotel management has access to staff management features, allowing them to add and manage staff accounts efficiently.

Category and Item Management: The system facilitates seamless category and item management, enabling hotel management to add, edit, and update food items and categories in real-time. This feature ensures that the menu remains up-to-date and reflects the latest offerings.

Admin Dashboard: The admin dashboard serves as a central control panel for hotel management, offering real-time insights into order data, occupancy status, revenue generated, and other critical performance indicators. This tool empowers management to monitor operations, make informed decisions, and optimize service quality.

By achieving these objectives, the Hotel Management System for Volunteer Housing delivers a comprehensive and efficient solution to the challenges faced by volunteer housing facilities. Through its user-friendly interface, data-driven insights, and effective management tools, the system enhances the overall volunteer experience, optimizes resource allocation, and contributes to the ongoing evolution of hotel management practices.

Limitations and Challenges,
Despite the successful implementation of the Hotel Management System for Volunteer Housing, several limitations and challenges were encountered during the development process. These limitations may impact the system's functionalities and future scalability:

Scope Limitations: Due to resource constraints and time limitations, certain desirable features had to be prioritized over others. As a result, the system may lack some advanced functionalities that could have further enhanced user experience and hotel management capabilities.

Hardware and Network Dependencies: The system's performance may be influenced by the hardware and network infrastructure available at the volunteer housing facility. Limited hardware resources or unreliable network connectivity could affect the system's responsiveness and overall user experience.

Training and Familiarity: While the system's user interface is designed to be user-friendly, it is possible that some volunteers or hotel staff may require training or time to familiarize themselves with the platform. Adequate training and onboarding support may be necessary for seamless adoption.

Data Accuracy and Integrity: The accuracy and integrity of the data in the system heavily rely on the input provided by users. Inaccurate or incomplete information entered by volunteers or staff could potentially lead to discrepancies in order processing and occupant information management.

Security Risks: Despite the implementation of robust security measures, no system is entirely immune to potential security risks. Ensuring continuous monitoring and timely updates of security protocols is essential to safeguard user data and financial transactions.

Scalability Concerns: As the volunteer housing facility expands and accommodates more occupants, the system's scalability becomes crucial. Ensuring that the system can handle a growing number of users and increasing order volumes without compromising performance is a key consideration.

User Feedback Incorporation: Incorporating user feedback and incorporating requested enhancements may require ongoing development efforts. Regular updates and improvements based on user input are necessary to meet changing requirements and expectations.

Despite these challenges, the Hotel Management System for Volunteer Housing represents a significant step forward in improving food and beverage management for volunteer housing facilities. By acknowledging and addressing these limitations, the system can continue to evolve, providing valuable solutions for the hospitality industry and enhancing the overall volunteer experience. The dedication of the development team, coupled with a user-centric approach, has laid the groundwork for future improvements and continued success.

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10. Appendices

Appendix – 1

Customer Feedback Questionnaire:

1. On a scale of 1 to 5 (1 being the lowest and 5 being the highest), please rate your overall satisfaction with the system.

    - ☐ 1
    - ☐ 2
    - ☐ 3
    - ☐ 4
    - ☐ 5

2. What do you like most about the system, and why?

3. What aspects of the system do you believe need improvement? Please provide specific details.

4. How easy was it to place orders and make payments using the system?
    - ☐ Very Difficult
    - ☐ Difficult
    - ☐ Neutral
    - ☐ Easy
    - ☐ Very Easy

5. Do you have any suggestions for additional features or enhancements that would improve your experience with the system?

Administration Feedback Questionnaire:

1. How satisfied are you with the system's performance in managing customer and staff information?
    - ☐ Very Dissatisfied
    - ☐ Dissatisfied
    - ☐ Neutral
    - ☐ Satisfied
    - ☐ Very Satisfied

2 What specific functionalities or tools within the system do you find most valuable for your administrative tasks, and why?

3. Are there any challenges or issues you have encountered while using the system for managing the restaurant's operations?

4. How effective is the system in providing you with real-time reports and forecasts for restaurant demand?

- Not Effective
- Somewhat Effective
- Neutral
- Effective
- Highly Effective

5. What recommendations do you have for improving the system's administrative capabilities?

Cashier Feedback Questionnaire

1. How comfortable do you feel using the system for processing payments and managing order statuses?

- Very Uncomfortable
- Uncomfortable
- Neutral
- Comfortable
- Very Comfortable

2. What aspects of the payment processing system do you find most efficient, and how have they improved your work?

3. Have there been any instances where the system presented challenges or complications in processing payments or managing orders? Please describe.

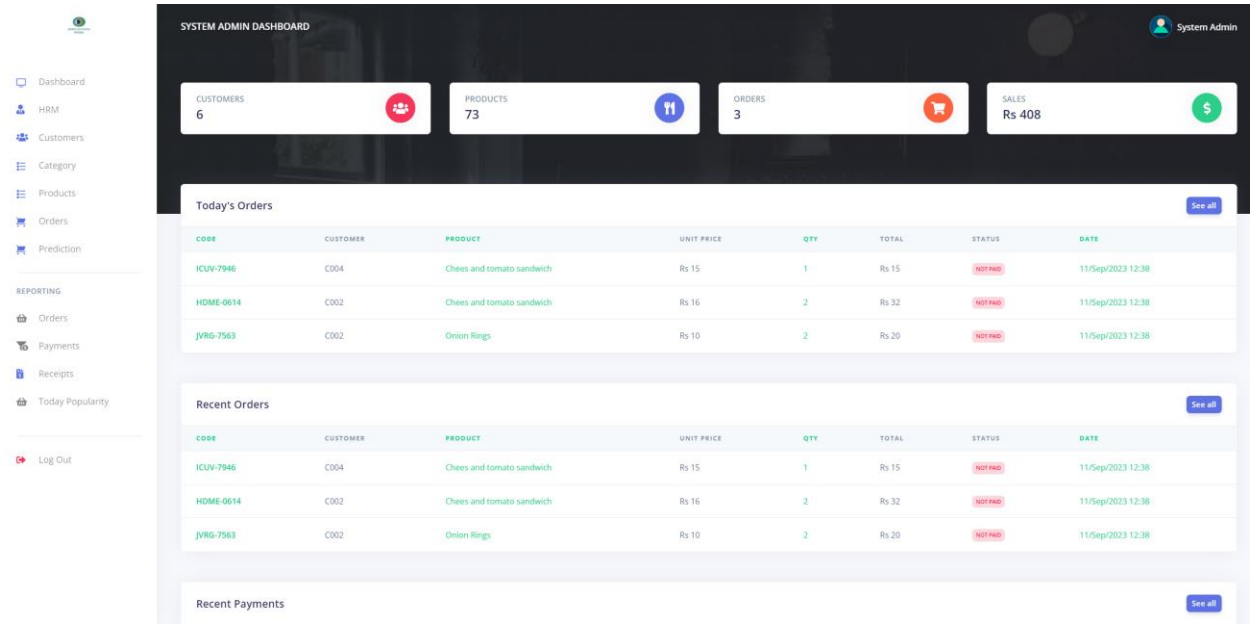
4. How well does the system help you in keeping track of order fulfillment and payment status?

- Not Well
- Somewhat Well
- Neutral
- Well
- Very Well

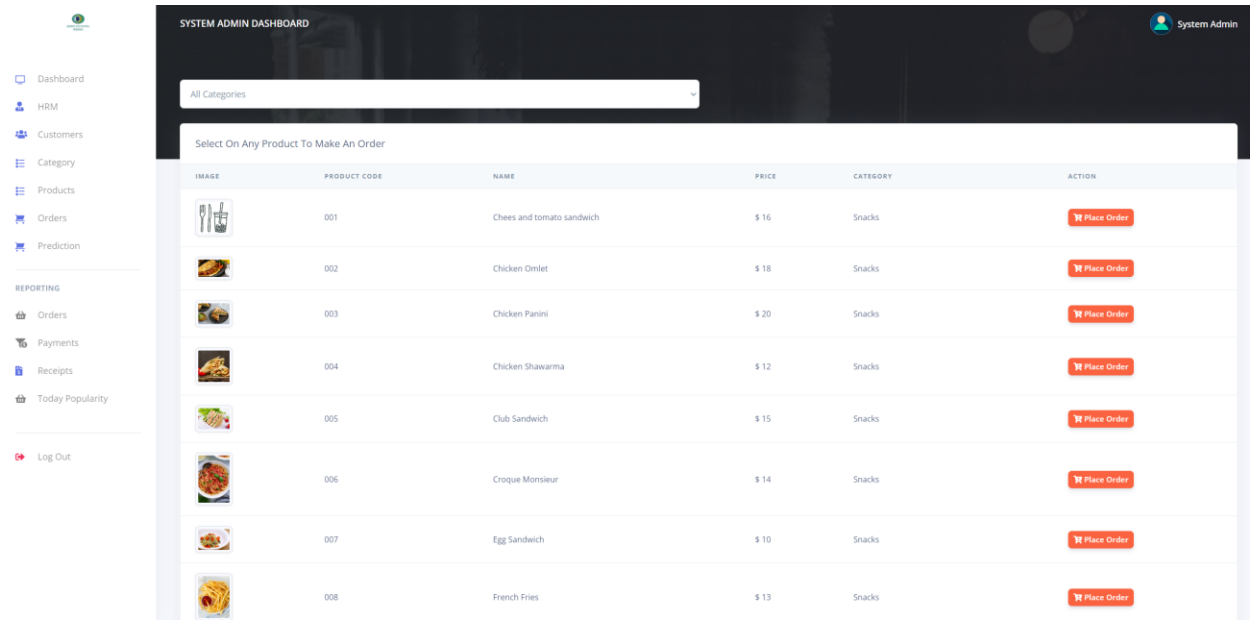
5. Are there any additional features or tools you believe would enhance your efficiency as a cashier when using the system?

Appendix 2

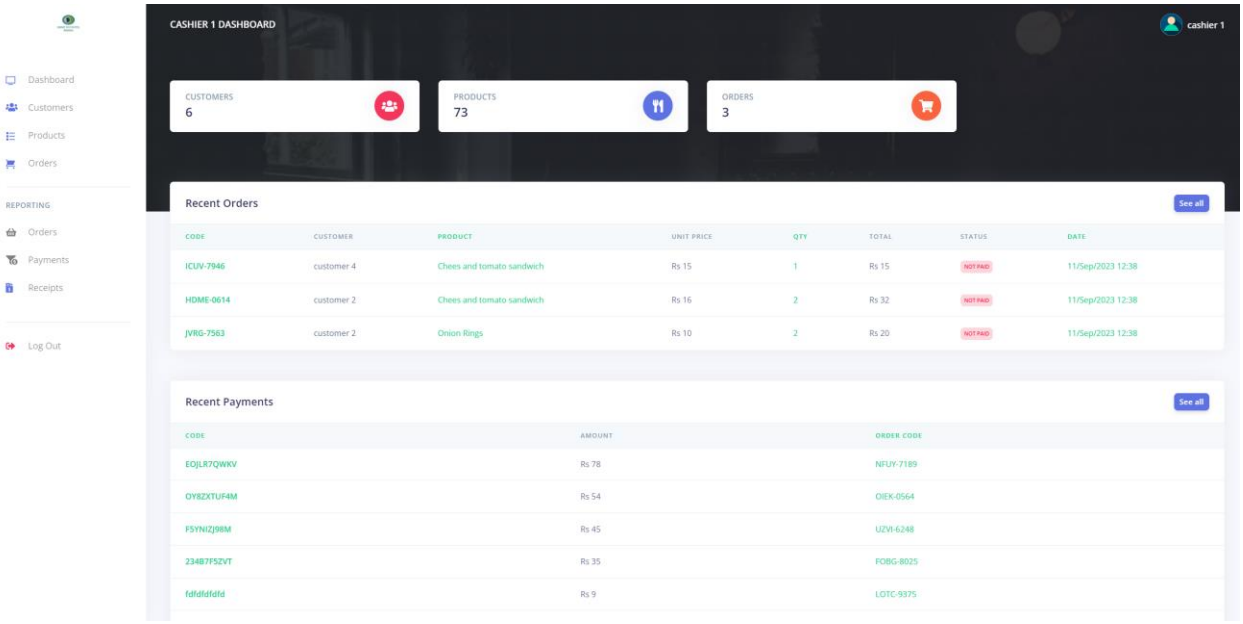
Admin Dashboard



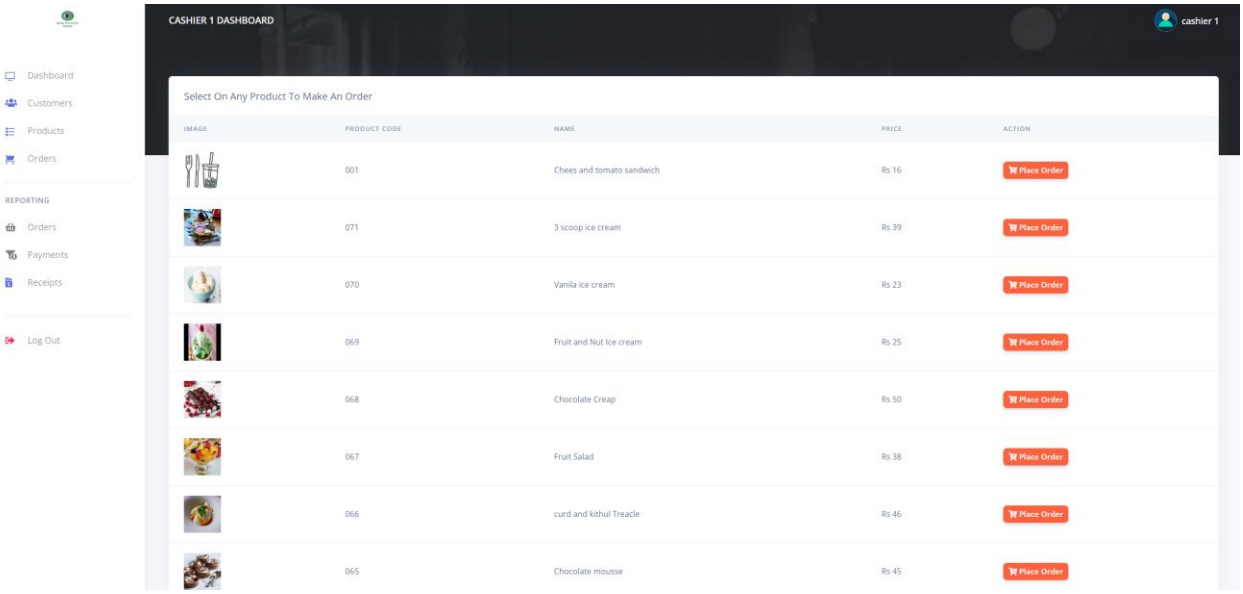
Admin products page



Cashier dashboard



Cashier orders dashboard



Customer Dashboard