

Web-based Online Reservation Utilizing Reinforcement Learning Algorithm

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The growing demand for hotels and resorts has created significant opportunities for the adoption and expansion of technology (Somera & Petrova, 2024; Amirulloh et al., 2024; Zahidi et al., 2024). One notable development is the rise of online booking systems in the hospitality industry, including hotels, resorts, airlines, and other service-oriented businesses. In line with this trend, hotels and resorts require an efficient system to streamline and enhance its booking and reservation processes. To meet customer needs, the resort's system must be both user-friendly and tailored to its specific operational requirements.

Implementing a web-based reservation system alleviates the complexity of traditional booking procedures, reducing the need for manual processing and minimizing errors (Park et al., 2018; Sahara et al., 2025). Such systems can estimate total reservation costs and significantly reduce the time required for staff to complete bookings. As technology continues to advance, customers increasingly expect faster and more efficient services. A well-designed online reservation system allows customers to select and reserve their preferred rooms quickly, enhancing overall

satisfaction.

This paper seeks to address these needs. The system features two main components: a back-end dashboard for administrative use and a customer-facing front end. The back-end allows resort staff to manage, monitor, and verify bookings efficiently, consolidating all user data in one location and reducing reliance on multiple spreadsheets. The customer-facing interface is intuitive, enabling seamless booking and payment. First-time users will provide their information through a registration form, while subsequent bookings will be faster due to stored data.

A key feature of the system is the Reinforcement Learning Algorithm (RLA). RLA enables the system to learn optimal decision-making strategies by evaluating the correctness of user commands, rewarding accurate actions, and providing consequences for incorrect ones (Gao et al., 2025; Taherdoost, 2023). This algorithm is critical for optimizing system processes and ensuring efficient, step-by-step decision flows based on user interactions.

In the hotel and resort industry, booking systems are central to operational efficiency and business success. Resorts must manage room availability, amenities, and customer inquiries effectively. Without a dedicated booking system, they rely on personal phone calls or social media messages, which is time-consuming and prone to errors. Implementing an online booking system will streamline operations, enhance customer service, and support marketing efforts by providing visual advertisements and detailed information online, thereby attracting more guests.

The use of management information systems (MIS) within the resort supports effective inventory and reservation management. The inventory system, a crucial component of MIS, tracks available resources and updates in real-time whenever a booking occurs. This allows the resort to anticipate

demand, prepare accommodations, and maintain necessary supplies, ensuring seamless guest experiences. MIS also helps identify booking trends, guiding decisions on purchasing and maintaining inventory (Ali, 2019; Hamdat et al., 2024).

Reinforcement learning is designed to maximize rewards through trial-and-error learning. Unlike traditional machine learning methods, it does not provide explicit instructions for each action (Sutton & Barto, 2015). The agent observes the current state, selects actions based on exploration and exploitation strategies (Terven, 2025), and receives a reward (r_{t+1}), updating its knowledge of the environment for future decisions. Q-learning, a model-free reinforcement learning technique, divides operations into discrete episodes, updating Q-values based on actions taken and rewards received (Premakumari et al., 2025; Alavizadeh et al., 2022)). This approach allows the system to learn optimal policies, balancing short-term and long-term rewards.

An online booking system replaces manual spreadsheets and data entry, automating processes such as payment, scheduling, availability tracking, and notifications. It enables 24/7 bookings, accommodating customer preferences such as partial or full payments. Automated features also support reporting and resource management, benefiting both customers and resort staff. Hence, this system ensures that customers can make bookings at any time without being constrained by operating hours. It enhances accessibility, convenience, and overall customer satisfaction. Additionally, the system safeguards personal information through a dedicated data privacy interface, preventing fraud, identity theft, and other security risks associated with online reservations.

Theoretical Framework

Technological Innovations in Booking Systems

In today's competitive hospitality industry, technological innovations play a central role in shaping how resorts and hotels manage their reservations and deliver services to guests. The introduction of online booking platforms transformed the traditional process by eliminating the reliance on manual spreadsheets and phone inquiries. This shift allowed businesses to accommodate bookings 24/7, giving customers the convenience of securing reservations at any time, regardless of business hours. More advanced systems now integrate artificial intelligence (AI) and machine learning techniques to further optimize booking efficiency (Sousa et al., 2024; Grieco et al., 2025; López-Naranjo et al., 2025).

One notable innovation is the RLA, which equips booking systems with the ability to learn and adapt based on user interactions. Unlike rule-based systems, RLA applies a trial-and-error approach to determine the most effective response to user commands. When customers input correct information, the system confirms and processes the request. Incorrect inputs, on the other hand, are met with programmed feedback or corrective actions, allowing the system to guide users toward successful bookings. This creates a dynamic feedback loop where the system continuously improves its performance over time.

The implication of this technology is significant: it reduces human intervention in repetitive tasks, minimizes booking errors, and enhances the responsiveness of the system to different customer behaviors. By integrating RLA, resorts can offer a more personalized booking experience, where the system “learns” preferences and provides tailored suggestions (Chen et al., 2022; Leka et al., 2025). This not only boosts efficiency but

also increases customer satisfaction, as users perceive the system as intuitive and user-friendly. Ultimately, these innovations highlight how automation and AI-driven systems are becoming indispensable tools for modern resorts and hotels.

Role of MIS and Inventory Management

While booking systems focus on the customer-facing aspect of reservations, MIS provide the backbone for internal operations. MIS refers to the computer-based systems that collect, store, and analyze data to support decision-making in an organization. In the context of resorts and hotels, MIS plays a critical role in managing inventory, resource allocation, and scheduling, ensuring that the business operates smoothly behind the scenes.

The inventory subsystem of MIS is particularly vital. Each time a reservation is made, the system automatically updates the records of available rooms, amenities, and consumable resources. This ensures that managers and staff have real-time insights into the current status of accommodations, dining facilities, pools, and other entertainment areas. Such real-time monitoring reduces the risk of overbooking, which is a common challenge in manual systems. It also allows management to prepare accommodations and services ahead of guest arrivals, contributing to a seamless experience.

Moreover, MIS enables data-driven decision-making by identifying patterns and trends in customer reservations (Chen et al., 2012). For example, managers can analyze seasonal peaks, determine which facilities are in high demand, and forecast supply needs. This helps the resort plan purchases, schedule staff, and maintain facilities proactively. In addition, MIS supports long-term strategic decisions, such as expanding certain

amenities or launching targeted promotions, based on historical booking data.

By combining operational efficiency with strategic foresight, MIS and its inventory component provide resorts and hotels with a competitive advantage. They not only support daily operations but also ensure that the business is adaptable to fluctuations in demand and capable of delivering consistent service quality.

Existing Studies on Reservation Systems in Resorts and Hotels

A number of studies and system designs highlight the growing reliance on computerization in the hospitality industry. These works serve as evidence that both small-scale resorts and large hotels benefit significantly from adopting automated reservation systems.

Lagman (2018) introduced a LAN-Based Reservation with Billing System for Hacienda Gracia Resort and Hotel, designed to improve reservation management and billing accuracy. The system minimized manual errors, reduced delays, and streamlined the handling of customer bookings. Importantly, the study demonstrated how computerization could bridge the gap between guest expectations and operational limitations, particularly in resorts that previously relied on face-to-face or social media-based bookings.

Similarly, Adegboye and Akingbade (2023) designed a website for Atican beach resort for booking and reservation using HTML, PHP and MySQL. This system provided instant booking confirmations and allowed customers to modify their arrangements with minimal hassle. By maximizing the resort's online presence, the system also improved visibility, attracted more potential customers, and offered competitive rates. The study highlighted how direct online booking systems not only reduce

reliance on third-party platforms but also strengthen customer relations through convenience and transparency.

Together, these studies reflect a broader trend: the hospitality industry is steadily moving toward automation and digitalization to remain competitive. Resorts and hotels that adapt to technological innovations in reservations position themselves to achieve higher efficiency, increase customer satisfaction, and expand their market reach. These findings emphasize that computerization is not merely a luxury but a necessity in ensuring business sustainability in a fast-evolving industry.

Research Framework

Data

This study gathered data from the survey results from 20 respondents. The sample size was determined using Slovin's formula, and a random sampling method was employed to distribute the questionnaires. The questionnaire was designed based on ISO/IEC 25010 standards, covering the following aspects: functionality and performance efficiency, maintainability, usability, accessibility and compatibility, and security. The four-point Likert scale was used to evaluate each criterion. Respondents selected from the following categories: strongly agree, agree, disagree, and strongly disagree. Each response category corresponds to a mean range, which determines the interpretation of the evaluation results. To analyze the responses, the weighted mean formula was applied.

Experimental Design

Figure 1 illustrates the experimental design of the study. The process begins with the admin, who manages the system, logging in with a valid

username and password. Upon successful login, the admin accesses the dashboard, which displays the services offered by the resort and provides tools to manage reservations efficiently.

Figure 1

Experimental design of the study



The system will process client information throughout its operations, from input to output. Data will be collected directly from the forms completed by customers during the booking process on the website. This information will then be stored, processed, and used to manage reservations efficiently.

Ethical Considerations

Online reservation systems can raise several ethical concerns that must be addressed to ensure responsible and equitable use. Key considerations include:

Privacy: Online reservation systems collect and store users' personal information. It is essential to ensure that this data is kept secure and used solely for the purposes for which it was collected.

Accessibility: The system should be accessible to all users, including individuals with disabilities. This requires designing the website or application to comply with accessibility standards and ensuring that information is easy to access for everyone.

Fairness: The system must provide equal access to all users. This includes implementing anti-discrimination policies and ensuring that the system does not favor certain users over others.

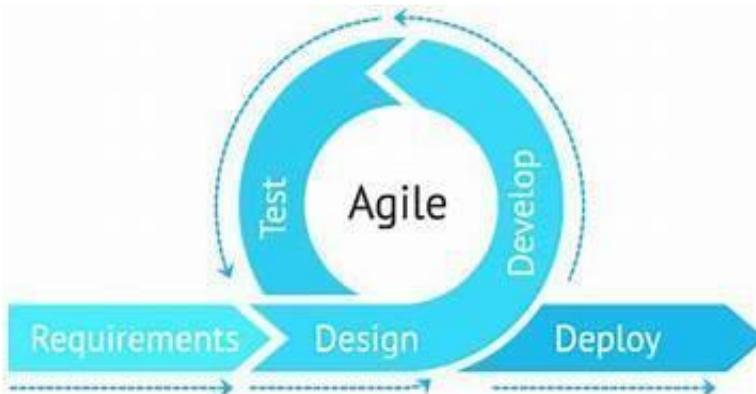
Transparency: The reservation system should operate transparently, allowing users to understand how decisions are made. This includes disclosing any algorithms or biases that may influence recommendations or other system outputs.

Responsibility: The system’s owners and operators are accountable for maintaining system security, protecting users’ data, and ensuring ethical use. They must take appropriate measures to prevent and address any unethical or harmful practices associated with the system.

Agile Software Development and Client Interaction

Figure 2

Agile methodology model



Agile software development emphasizes flexibility and encourages modifications from clients and other stakeholders throughout the project lifecycle. The development team actively seeks feedback by creating joint releases and iterating the software in successive cycles. Changes in

customer requirements are not considered challenges; rather, they are integral to the development process. Incorporating client feedback and interaction is critical to Agile methodologies, as it ensures the software product aligns with the evolving needs of the users.

Procedures of the Different Phases

Scientific applications and experimental facilities generate massive datasets, which often need to be transferred to remote sites for collaboration, processing, and long-term storage. To support increasingly data-intensive research, Software-Defined Networks (SDNs) are used to facilitate high-speed and reliable data transfer between participating institutions. Next-generation research networks leverage SDN technologies to provide high-bandwidth, on-demand access. In this context, the system for online data scheduling coordinates bandwidth reservations and data transfer nodes to ensure that approved jobs are completed within user-specified time windows, improving upon existing systems by enabling more advanced and efficient data handling.

For the operational phase of the online booking system, the process follows these steps:

Search for an online booking app or website. Customers begin by searching online for resorts and tour locations that meet their preferences. The internet serves as the platform for identifying legitimate and suitable options.

Search for resort information. While browsing, customers gather detailed information about the resort, including itineraries and available services. This allows them to assess the resort's offerings and suitability for their needs.

Check availability and initiate booking. Once satisfied with the

information, customers begin the booking process. They may reserve a room or an entertainment area through the website, depending on their requirements.

Fill out required details and documents. Customers complete the online booking form, providing all necessary personal and reservation information. They can review their submitted data to ensure accuracy.

G-Cash payment. To prevent scams and ghost bookings, the resort requires a half-payment per reservation. This policy protects against revenue loss and ensures that resources are properly allocated.

Booking confirmation via SMS verification. After payment, customers receive a confirmation notification on the website. They are advised to save a screenshot of the receipt. Additionally, an SMS verification is sent to the customer's phone to confirm the booking, providing an added layer of security.

Technical Framework

Materials

The materials used in developing the system include both software and hardware requirements.

Software

The system was developed using a variety of software tools and platforms essential for design, implementation, and coordination of the project. These technologies were selected to support the development, deployment, and maintenance of the online reservation system, ensuring that all components function efficiently and integrate seamlessly.

Table 1*Software specifications and software platforms*

System Type	x64-based PC
Operating System	WINDOWS
System Directory	Cloud Server, Render, Vercel, PostgreSQL
Designing	Angular and FastAPI
Text Editor	VS CODE
Languages	Typescript and Python

The following outlines the software specifications and platforms used in developing the system, including system type, operating system, development environment, text editors, and programming languages.

Visual Studio Code (VS Code). Visual Studio Code is a free, open-source text editor developed by Microsoft. It is supported on Linux, macOS, and Windows. Despite its lightweight design, VS Code offers robust functionality and has become one of the most widely used development environment tools.

PostgreSQL (Postgres). PostgreSQL is a free, open-source relational database management system (RDBMS) that emphasizes extensibility and SQL compliance, making it suitable for handling complex data operations.

Cloud Server. Cloud servers function similarly to physical servers, providing data storage, running applications, and supporting system operations.

Render Hosting. Render is a unified cloud platform for building and running applications and websites. It provides free TLS certificates, a global CDN, DDoS protection, private networks, and auto deployments from Git.

Vercel Hosting. Vercel is a platform designed for front-end developers, offering speed, reliability, and seamless deployment to enable

rapid application and website development.

Angular. Angular is a TypeScript-based, open-source framework for building single-page web applications (SPA). It is maintained by Google and a community of developers.

FastAPI. FastAPI is a modern, high-performance Python web framework for building APIs, utilizing standard type hints for improved development efficiency.

TypeScript. TypeScript is a free, open-source, high-level programming language developed by Microsoft that extends JavaScript by adding static typing with optional type annotations.

Python. Python is a high-level, general-purpose programming language known for its simplicity, readability, and wide range of applications in web development, data analysis, and automation.

Hardware

Table 2

Hardware resources

Device Name:	DESKTOP-TAPTENL
Processor:	Intel(R) Core(TM) i5-4210H CPU @ 2.90GHz 2.90 GHz
Installed RAM:	8.00 GB
System Type:	64-bit operating system, x64-based processor
Edition:	Windows 10 Pro

These specifications ensure that the system runs efficiently and supports all development and operational processes.

Modeling

System modeling is a method used to organize and represent the structure and flow of data within a system, as well as the logic, procedures,

and rules that govern its processes. This study illustrates the logical design of the system using a Data Flow Diagram (DFD) context, providing a visual representation of how data moves through the system and how processes interact.

Figure 3

The system's developed context data flow diagram

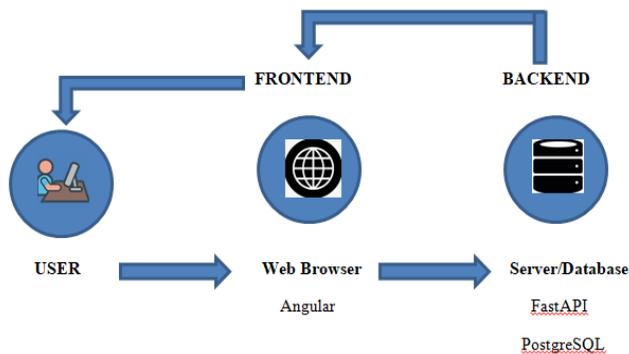


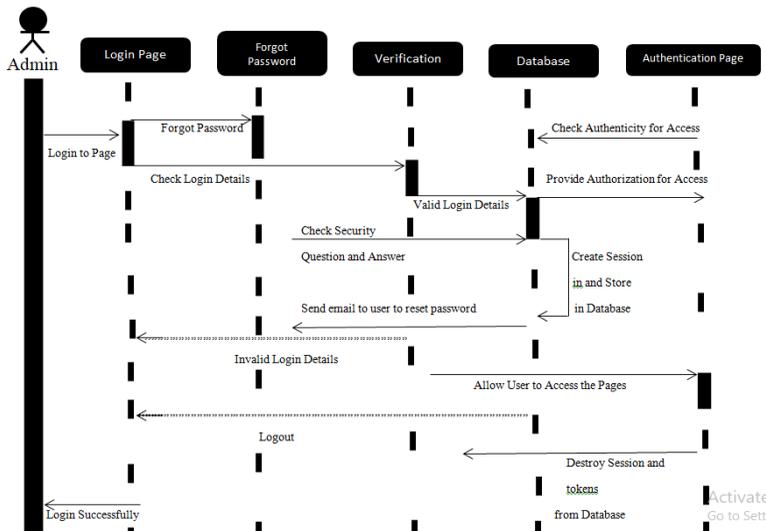
Figure 3 illustrates the context-level DFD of the developed system. A context DFD provides a high-level view of the system, highlighting its boundaries and scope. At the center of the diagram is the resort online reservation system, while the two external agents are Administration and Guests. This diagram visually represents the interactions between users and the system, emphasizing data exchanges and system functionality at a conceptual level.

System Design

Figure 4 illustrates the UML sequence diagram of the system, showing the overall design and workflow for processing online reservations at the resort. The system is designed so that only the admin and staff can log in, ensuring controlled access to sensitive operations.

Figure 4

UML sequence design of system



The protection of sensitive client data, such as login credentials, credit card information, reservation records, and financial reports, is critical. Loss or compromise of such data can have severe legal and reputational consequences. The following best practices were implemented to safeguard client information:

Limiting access to sensitive information. Critical client data should only be accessible to authorized personnel. Restricting access reduces the risk of accidental or malicious data leaks, thereby enhancing system security and minimizing potential human errors.

Intelligent password security measures. Strong, complex passwords are required to prevent unauthorized access. Additionally, multi-factor authentication (MFA) is implemented, notifying users if login attempts are made from unknown devices. This provides an added layer of protection against unauthorized access.

Use of dedicated servers. While shared servers may reduce costs,

they pose security risks because multiple websites share the same infrastructure. Dedicated servers, though more expensive, provide enhanced security for both the business and its customers.

Firewall and antivirus protection. Firewalls block unauthorized access, while antivirus software detects, prevents, and removes malware. These measures protect the system from external threats and reduce vulnerabilities that could compromise client data.

Regular security updates. Security patches and updates are critical for preventing exploitation of known vulnerabilities. For example, attacks like the WannaCry ransomware exploited unpatched systems. Regular updates ensure the system remains protected against emerging threats.

Maintaining client data security is a top priority. The system is designed to safeguard sensitive information through access control, strong authentication, dedicated servers, protective software, and continuous monitoring. Regular security assessments and updates, combined with contingency planning, ensure the system remains robust and secure against potential threats.

USE Case

Figure 5 illustrates the use case diagram for customers, depicting how customers interact with the online reservation system at the resort. The diagram highlights the steps involved in making a reservation online, from accessing the system to completing the booking process. This visual representation clarifies the customer workflow and the interactions required to successfully reserve accommodations or services at the resort.

Figure 5

Use case diagram for customer

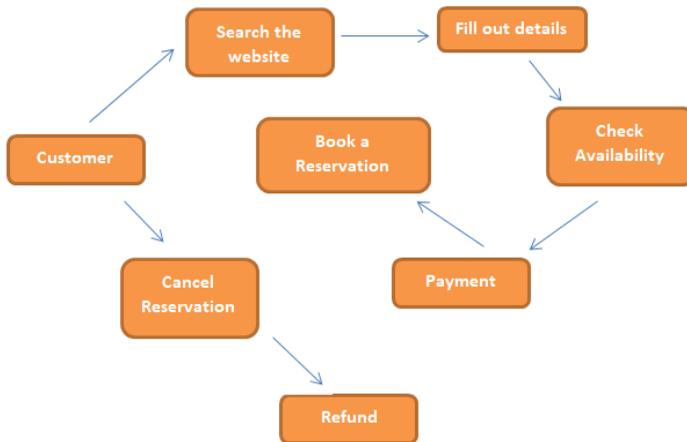


Figure 6

Use case diagram for admin

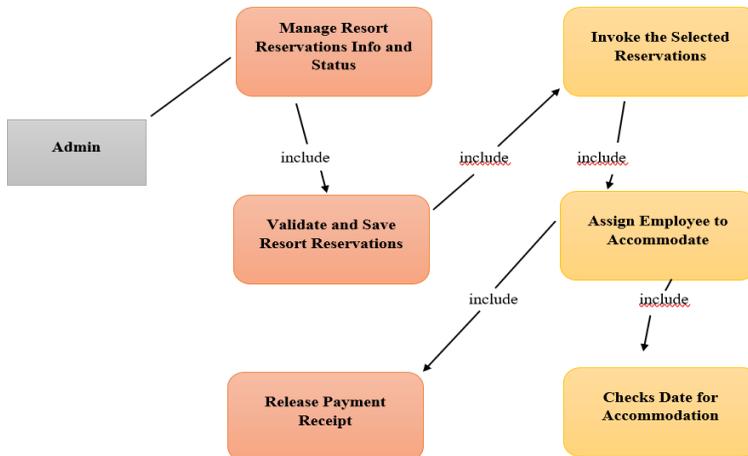


Figure 6 illustrates the use case diagram for the admin, showing how the admin manages resort reservations within the system. The admin can validate and save reservations, invoke selected bookings, assign employees to handle specific reservations, and issue payment receipts. This diagram provides a clear overview of the administrative responsibilities and

interactions necessary to efficiently manage the resort's online reservation system.

Figure 7

Data flow diagram

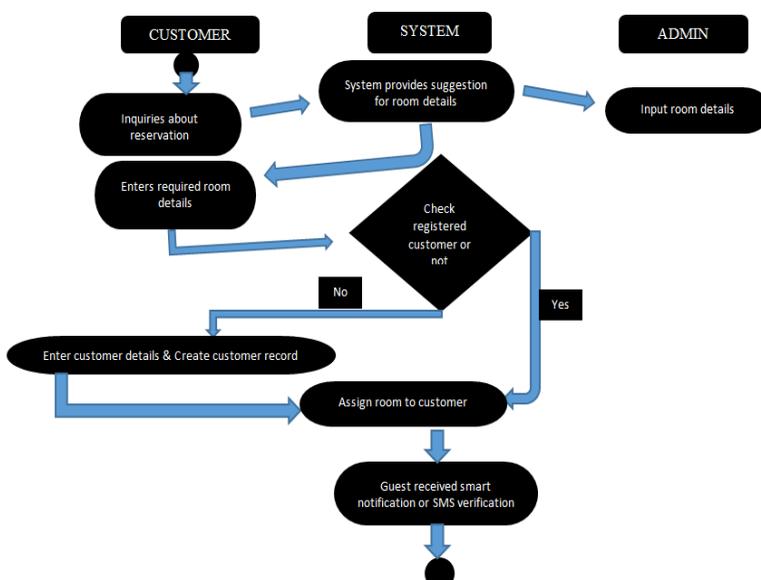


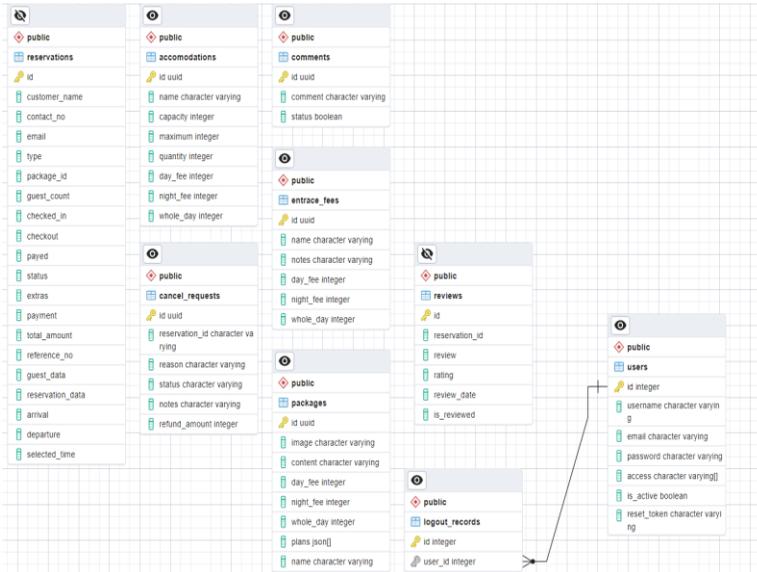
Figure 7 presents the DFD illustrating the interactions among the customer, the system, and the admin. The process begins when the customer inquires about a reservation. The system provides suggestions for available room details, while the admin inputs room information into the system. Next, the customer enters the required reservation details, and the system verifies whether the customer is registered. If the customer is confirmed as registered, the system assigns a room and sends a notification to the customer, confirming the reservation. This DFD clearly represents the flow of data and the interactions between users and the system during the reservation process.

Figure 8 illustrates the database schema / Entity-Relationship (ER) diagram of the developed system. It demonstrates the relationships between

different entities within the database and how they are conceptually linked to support system operations. This schema ensures data integrity and proper organization of information within the online reservation system.

Figure 8

Database schema / ER diagram of the system



During the development phase, the programmers utilized multiple programming languages, including TypeScript and Python, to build a robust and efficient system tailored to the client’s requirements. The development process also incorporated various technologies and tools, such as Visual Studio Code, the CodeIgniter framework, Bootstrap, Angular, FastAPI, Cloud Server, and PostgreSQL Database, along with appropriate styling formats. These technologies collectively ensure the system is functional, scalable, and user-friendly.

System Evaluation

The system was evaluated using a survey conducted with 20

respondents. The questionnaire was developed based on ISO 25010 standards, covering the following aspects: functionality and performance, efficiency, maintainability, usability, accessibility and compatibility, and security. Data were analyzed using the weighted mean formula, and responses were recorded using a four-point Likert scale.

Table 4

Weighted mean distribution of the criteria for the developed system

Criteria	Weighted Mean	Remarks
Functionality and Performance Efficiency	3.46	Strongly Agree
Maintainability	3.53	Strongly Agree
Usability	3.59	Strongly Agree
Accessibility and Compatibility	3.47	Strongly Agree
Security	3.48	Strongly Agree
Average	3.51	Strongly Agree

Table 4 presents the overall weighted mean and remarks from the researchers' survey evaluating the system. The total average weighted mean of the system is 3.51, with a remark of Strongly Agree, indicating that the system successfully meets the specified requirements and is well-received by respondents.

Functionality and Performance Efficiency: The system is easy to access from any location and performs efficiently. The average weighted mean is 3.46, with a remark of Strongly Agree, demonstrating that respondents are satisfied with its performance.

Maintainability: The system is easy to maintain and incurs low operational costs. The average weighted mean for maintainability is 3.53, with a remark of Strongly Agree.

Usability: The system is user-friendly and easy to navigate. Even

respondents with limited computer experience were able to learn the system's controls within minutes. The average weighted mean for usability is 3.59, with a remark of Strongly Agree.

Accessibility and Compatibility: The system is compatible with all major web browsers and accessible to a wide range of users. The average weighted mean is 3.47, with a remark of Strongly Agree.

Security: The system ensures secure usage for all users. The average weighted mean for security is 3.48, with a remark of Strongly Agree.

These results indicate that the developed system is highly effective, user-friendly, secure, and reliable, meeting both user and operational requirements.

Conclusion

The primary objective of this project was successfully achieved through the development of a system capable of pre-emptively detecting booking conflicts and verifying whether a reservation already exists for a specific date. In addition, the system provides comprehensive management tools for handling accommodations, packages, and entrance fees, which can be easily updated if the business modifies its offerings. The system also includes automated email notifications to inform customers about the status of their reservations, ensuring clear and timely communication.

Following testing and evaluation, the system met the ISO/IEC 25010 standard for system evaluation, excelling in functionality and performance efficiency, maintainability, usability, accessibility and compatibility, and security. These results indicate that the developed system is reliable, user-friendly, and well-suited for the long-term operational needs.

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