Q-Fitness Gym System: An Integrated Web Application for Smart Gym Operations and Member Engagement

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ABSTRACT

The Q-Fitness Gym System (QFGS) is a web-based management platform developed to enhance the operational efficiency of fitness centres through automation and integration. The system centralizes key functionalities, including member registration, class scheduling, staff and instructor management, and secure payment processing. Designed using the Agile methodology, QFGS ensures iterative development, adaptability, and continuous improvement based on user feedback. The system architecture follows a three-tier design, emphasizing scalability and data security through a MySQL relational database. Comprehensive testing, including unit, integration, and user acceptance tests, verified the functionality, usability, and reliability of the system. The implementation of QFGS demonstrates significant improvements in administrative productivity, resource utilization, and member satisfaction by reducing manual tasks and providing an intuitive digital experience. Overall, QFGS offers an innovative solution for modern gym management, bridging the gap between traditional operations and smart digital transformation.

Keywords: Fitness management system, web-based application, digital transformation, user experience

INTRODUCTION

The fitness industry has been rapidly transformed by digital technologies that change how services are delivered, how consumers interact with providers, and how facilities manage operations. Platform-based and web-enabled fitness services which including online class delivery, membership portals, and in-app payments have expanded the reach and monetization models of fitness providers and changed consumer expectations for convenience and personalization [1], [2]. Recent empirical research shows that well-designed digital fitness platforms increase user satisfaction and the likelihood of online payments by improving perceived usefulness and ease of use, particularly when platforms support engagement and enjoyable experiences [2]. At the same time, market studies document a broader structural shift: many gyms and fitness clubs are adopting hybrid business models that combine in-club services with online course platforms and third-party coaches to sustain revenue and expand audiences [4].

From a technical perspective, modern fitness management systems integrate several components: membership and billing modules, scheduling and class management, trainer/staff portals, and analytics which often using web-based architectures and cloud databases to scale and secure data. Research on fitness management infrastructures highlights the value of Internet-of-Things (IoT) data [11], real-time processing and secure data sharing (including approaches that combine IoT and blockchain for provenance and privacy) to support richer service features and trustworthy record-keeping [1], [5]. Similarly, system-level optimization work demonstrates how modular, three-tier or microservice architectures with relational databases and RESTful interfaces support maintainability and extensibility in fitness and health information systems [1].

The choice of development methodology influences whether such systems meet user needs in practice. Contemporary empirical studies of Agile adoption report that iterative development with frequent customer involvement improves the alignment of software products with stakeholder requirements, reduces late rework,

and increases project success rates — provided teams have sufficient capability and user engagement during development [3], [13]. Given the evolving requirements of gym operators (scheduling complexity, payment workflows, multi-role access) and the need to incorporate user feedback (members, trainers, administrators), an Agile approach supports incremental delivery and early validation of critical features.

Despite the availability of commercial gym management packages, many small and medium fitness centres still rely on manual or fragmented processes for member records, class scheduling, and payments. These gaps produce administrative overhead, errors in billing and registration, and suboptimal member experience. The Q-Fitness Gym System (QFGS) was developed to address these operational challenges by providing an integrated web-based platform that centralizes membership management, class scheduling, staff/trainer management, and payment processing. This paper documents the design, implementation, and evaluation of QFGS, showing how an Agile, three-tier web application with a MySQL backend can streamline gym operations and improve administrative efficiency and member engagement.

Related Work

Zhao, Wang, and Zhu [6] presented a practical web-based gym management system using a browser/server (B/S) architecture with a MySQL backend to handle membership, booking, and data storage; their conference paper describes module decomposition, database schema choices and implementation considerations for small-scale gym deployments, demonstrating how a unified web system can reduce administrative overhead. Building on system-level perspectives, Tchórzewski, Nabiałek, and Księżopolski [7] analysed a gym management web application through the lens of control and systems theory, modelling subsystems and data flows to evaluate stability and responsiveness; their approach highlights the value of formal modelling and measurement when designing management software for complex service organisations.

User engagement and the behavioural effects of fitness apps have also been widely studied. Valcarce-Torrente et al. [8] performed a randomized field experiment to examine how fitness applications influence exercise habits, customer satisfaction and retention intentions among fitness centre users. Their results indicate that mere availability of an app does not automatically improve habits or loyalty—successful digital interventions must combine usability, motivational features and sustained use—an insight that guides the QFGS's emphasis on intuitive member portals and engagement features. Finally, Zhou and colleagues [9], Bhanushali and colleagues [15] explored IoT-enabled gym management, proposing an unmanned gym system that uses cloud services and mobile clients to monitor training items and physiological data in real time; this work demonstrates the potential for future enhancement of administrative platforms with sensor data and real-time analytics, even though many current gym management solutions (including Q-Fitness) prioritize scheduling, billing and member administration first.

Taken together, these studies contribute three key lessons for gym management system design: (1) unify administrative functions via web architectures and well-designed databases to reduce manual work [6]; (2) model and measure system behaviour to ensure stability and predictable performance [7]; and (3) prioritise user engagement and sustained interaction rather than treating apps as standalone features [8]. The QFGS builds on these foundations by delivering a modular, three-tier web application that centralizes membership, scheduling, billing and role-based access while preserving extensibility for future IoT or analytics integrations [9][15]. A summary of related work is highlighted in Table I.

Table I. Summary of related work

Ref	Objective / Focus	Methodology / Approach	Key Findings
[6]	To design and implement a web-based gym management system using B/S architecture and MySQL database.	Developed and tested a modular web system managing membership, booking, and data storage.	Demonstrated that centralized web architectures improve efficiency and data accessibility in gym operations.
[7]	To analyse a gym management application using control and systems theory.	Modelled subsystems, data flows, and control stability using system theory.	Identified design factors improving system reliability and responsiveness.

[8]	To investigate the effect of fitness apps on user habits, satisfaction, and retention.	Experimental study with gym users assessing digital engagement outcomes.	Found that engagement and motivation, not just technology adoption—drive satisfaction and retention.
[9], [15]	To design an IoT-based unmanned gym management system with cloud and mobile integration.	Developed an intelligent IoT system for real-time monitoring of training data and attendance.	Demonstrated automation potential in gym management via IoT and cloud computing.

METHODOLOGY

The development of the QFGS adopted an Agile software development approach, designed to ensure iterative delivery, frequent stakeholder feedback, and adaptability to changing gym operations requirements. Agile methodologies are widely acknowledged in web-based system development for their flexibility, which is especially useful when aligning software features with user needs [10]. The development process of QFGS comprised five key phases: requirements gathering, system design, implementation, testing & validation and deployment.

Requirements Gathering

The requirements-gathering phase of the QFGS focused on identifying user needs and specifying both functional and non-functional requirements that would guide the development of a reliable, user-friendly, and secure web-based gym management solution. This stage described the system requirements for each primary user group: administrators, staff, and customers and defined the system behaviours necessary to support daily operations [13], [16]. The analysis process began with understanding the shortcomings of the existing manual approach, particularly in managing member information, class scheduling, trainer coordination, and payment tracking. Through observation and discussions with stakeholders, the development team determined the essential capabilities required to automate and simplify these workflows.

The functional requirements outlined the main services that QFGS must deliver. For staff users, the system must allow registration of new customers and viewing of available classes. Administrators require broader control, including the ability to manage class information, customer profiles, and staff or trainer records. Customers, on the other hand, should be able to subscribe to available fitness classes and view their class schedules through a personalized interface. These requirements ensure that all user roles can perform their respective tasks efficiently within a unified system environment, thereby improving coordination and minimizing administrative workload [14].

In addition to functional needs, several non-functional requirements were established to guarantee system quality and reliability. Performance requirements state that the system must remain dependable and provide appropriate error messages whenever invalid input data is encountered. Security requirements specify that user access should be authorized through a unique email and password combination, with passwords stored in encrypted form to protect sensitive information. Usability requirements emphasize that the system must feature a friendly and intuitive interface, guiding users clearly through each process with simple navigation controls. Reliability is also essential; therefore, all calculations and transactions must produce correct results. Collectively, these non-functional criteria ensure that QFGS operates consistently, protects user data, and delivers a smooth user experience. The requirements of QFGS are shown in Table II.

Table II. Requirements of QFGS

Category	**Details / Examples**
Functional Requirements	• Administrator – Manage member and staff accounts, update class information, monitor payments, and generate reports. • Staff – Register new members, update customer details, and view available classes. • Customer – Register and log in, subscribe to fitness classes, and view personal class schedules.
Non-Functional Requirements	• Performance – System must operate dependably and provide appropriate error messages for invalid inputs.

	• Security – Access controlled by email and password authentication; passwords stored in encrypted form. • Usability – Interface must be user-friendly and easy to navigate. • Reliability – All operations and calculations must produce correct, consistent results.

System Design

The system design phase of the QFGS translated the collected requirements into a structured technical framework that defined how the system components would interact and operate. The design focused on creating a web-based platform capable of managing gym operations efficiently while ensuring scalability, usability, and security. To achieve these objectives, the system adopted a three-tier architecture consisting of the presentation layer, application layer, and data layer (Fig 1). This layered approach promotes modularity and simplifies maintenance by separating user interface elements, business logic, and database management [12].

The presentation layer serves as the front-end interface that enables interaction between users and the system. It was developed using HTML, CSS, JavaScript, and Bootstrap to ensure responsiveness and user-friendly navigation. This layer provides interfaces for different users: administrators, staff, and members which allowing them to perform their designated tasks according to their access privileges. The application layer, implemented using PHP, functions as the system's core logic controller, processing user requests and communicating with the database. It handles data validation, business rules, and transaction control to ensure that each operation produces accurate and reliable results. The data layer uses a MySQL relational database to store and manage all system information, including user credentials, class schedules, payments, and reports. The use of a relational model enables data consistency, referential integrity, and efficient querying.

The system design also incorporated various modules to represent the main functional components of the gym's operations. These include the registration module, which handles member account creation and authentication; the class management module, which allows administrators and staff to add, update, or remove classes and trainers; and the payment module, which records and tracks member payments while generating corresponding reports. Each module interacts seamlessly with others through a centralized database, ensuring real-time synchronization of information across all system users.

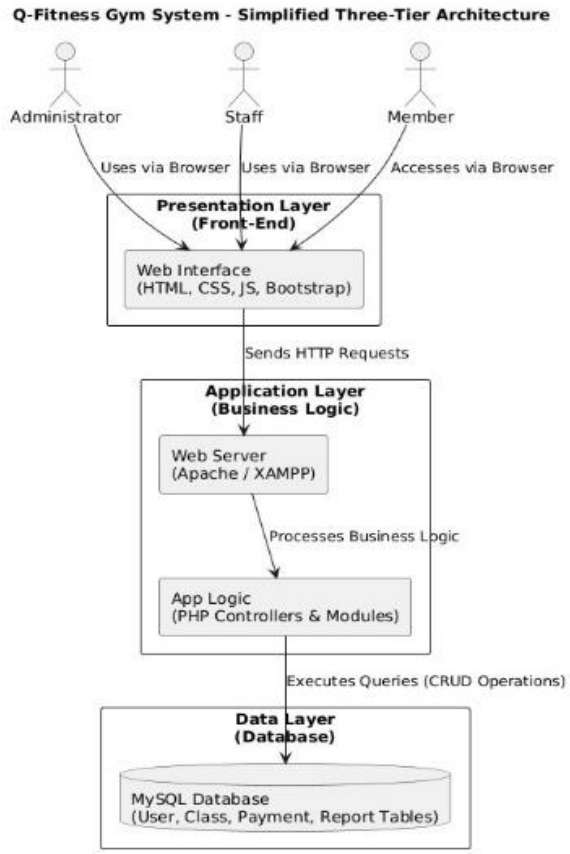

Fig1. Architecture diagram QFGS

Implementation

The implementation phase focused on converting the approved design of the QFGS into a fully functional web-based platform. Development was carried out in the XAMPP environment, which integrates Apache, PHP, and MySQL, providing an efficient local server for coding and testing. Using Visual Studio Code as the main IDE, the development team implemented system logic in PHP and created a responsive interface using HTML, CSS and JavaScript to enhance usability across devices.

The system modules were implemented incrementally to ensure stability and ease of integration. The main components included the registration and login module for user authentication, the class management module for updating schedules, and the payment module for recording transactions and generating reports. Each module was connected through shared database queries and PHP controllers, enabling consistent and real-time data exchange between users and the database.

Security and data validation were emphasized throughout the development process. Passwords were encrypted before storage, and user access was restricted based on roles to protect sensitive information. Input validation checks were included to prevent errors and ensure accurate data entry. Upon completion of coding, the system was deployed on a local server for testing, confirming that all modules functioned correctly and data flowed seamlessly. The successful integration of these components marked the completion of the implementation phase and readiness for final evaluation.

Testing and Validation

The testing and validation of the QFGS were carried out using the black-box testing technique to verify that each module functioned according to the specified requirements. In this approach, the internal program logic was not examined; instead, the system was tested solely based on its inputs and the corresponding outputs. Black-box testing was chosen because it effectively assesses the correctness of system behaviour from a user's perspective, ensuring that all functional requirements are met without needing access to the source code.

Each core module, such as registration, login, class management, and payment processing was tested by providing various input combinations and observing the resulting system outputs. For instance, valid registration data were expected to create new user accounts successfully, while invalid or incomplete entries generated appropriate error messages. Similarly, during login testing, valid credentials granted access to the respective user dashboard, whereas incorrect credentials produced an error notification. The class and payment modules were also tested to confirm that updates and transactions were accurately processed and reflected in the database.

Sample results of the black-box testing are shown in Table III; QFGS handled all valid and invalid inputs correctly, displaying accurate outputs and maintaining data consistency. All modules performed as expected under normal and boundary conditions, demonstrating that the QFGS met its intended functional requirements. The successful execution of black-box testing confirmed the overall stability and reliability of the system, validating its readiness for deployment in a real gym management environment.

Table III . Black-Box Testing Results of QFGS

Test Case	Input Condition	Expected Output	Actual Output	Result
TC01	Valid name, email, password, and contact number entered.	Account created successfully and stored in the database.	Account created and data saved successfully.	Pass
TC02	Missing or invalid input (e.g., blank field or invalid email).	Display error message prompting user to correct the input.	Error message displayed correctly.	Pass
TC03	Valid email and password entered.	System authenticates and redirects to correct user dashboard.	Successful login and correct dashboard displayed.	Pass
TC04	Invalid credentials entered.	Display "Invalid Email or Password" message and deny access.	Error message displayed; access denied.	Pass

TC05	Administrator adds or updates class details.	Class information saved or updated successfully.	Data updated correctly and retrievable.	Pass
TC06	Incomplete class details submitted.	Display validation error message and reject submission.	Error message displayed; submission rejected.	Pass
TC07	Valid member ID and payment details entered.	Payment recorded successfully and confirmation shown.	Payment stored and confirmation displayed.	Pass
TC08	Incomplete or invalid payment details entered.	Display error message and prevent data insertion.	Error message displayed; data not inserted.	Pass
TC09	Administrator requests transaction report.	Accurate report generated and displayed.	Report generated accurately.	Pass
TC10	User clicks dashboard menu or links.	Redirect to correct page without error.	All links function properly.	Pass

Deployment

The deployment phase involved installing and configuring the QFGS on a local server using the XAMPP platform, which integrates Apache, PHP, and MySQL. The system database was imported, and connections between the application and database were established to enable smooth operation within the gym's internal network. Once configuration was completed, the system became accessible through a web browser for authorized users.

User accounts were created for administrators, staff, and members to verify access control and role-specific functionality. Proper file permissions and security settings were configured to protect sensitive data and prevent unauthorized access. The system was tested in the live environment to ensure full functionality after deployment.

RESULT

The Q-Fitness Gym System (QFGS) was successfully developed and implemented as a fully functional web-based platform. The system's user interfaces, designed for four distinct user roles: Customers, Instructors, Staff, and Administrators are presented and described below. These interfaces demonstrate the successful translation of the system's design specifications into a working application that meets its core objectives.

Customer Portal Interfaces

The system features an engaging and responsive home page (Fig 2) that serves as the main landing interface. It provides clear navigation to key sections such as class listings, BMI calculation, and user profile, facilitating easy access to the system's primary functions.

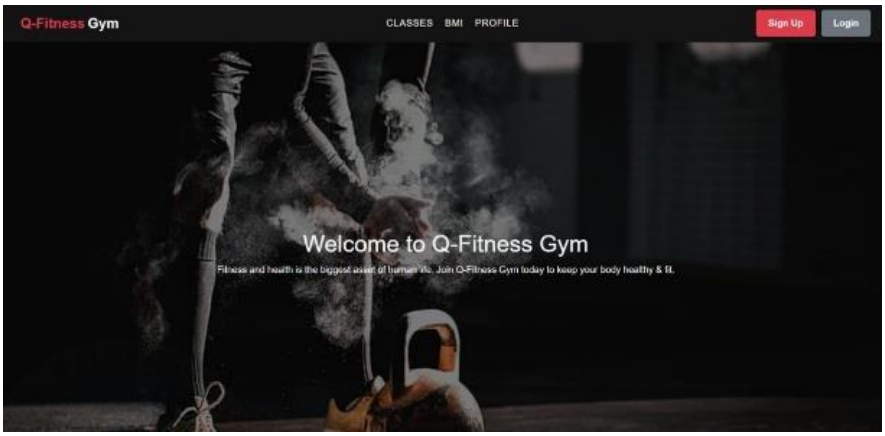

Fig 2 Home page

This page (Fig 3) displays all available fitness classes in an organized schedule, allowing customers to browse sessions, view details like time and instructor, and proceed to subscription—directly addressing the problem of disorganized class scheduling.

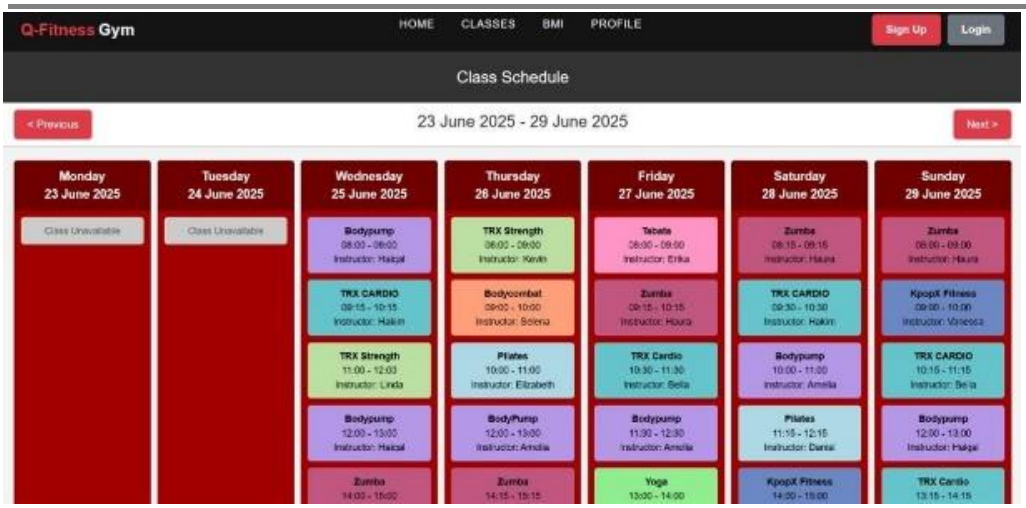

Fig 3. Class schedule page

The subscription workflow is streamlined. Customers select classes (Fig 4) and are presented with a confirmation page (Fig 5) to review their selections before finalizing the booking, ensuring accuracy and user confidence.

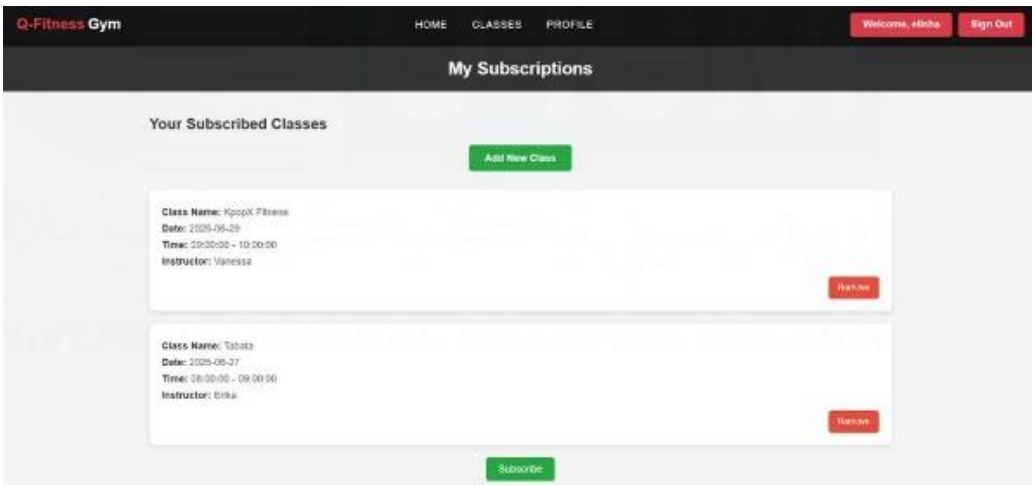

Fig 4. Subscription page

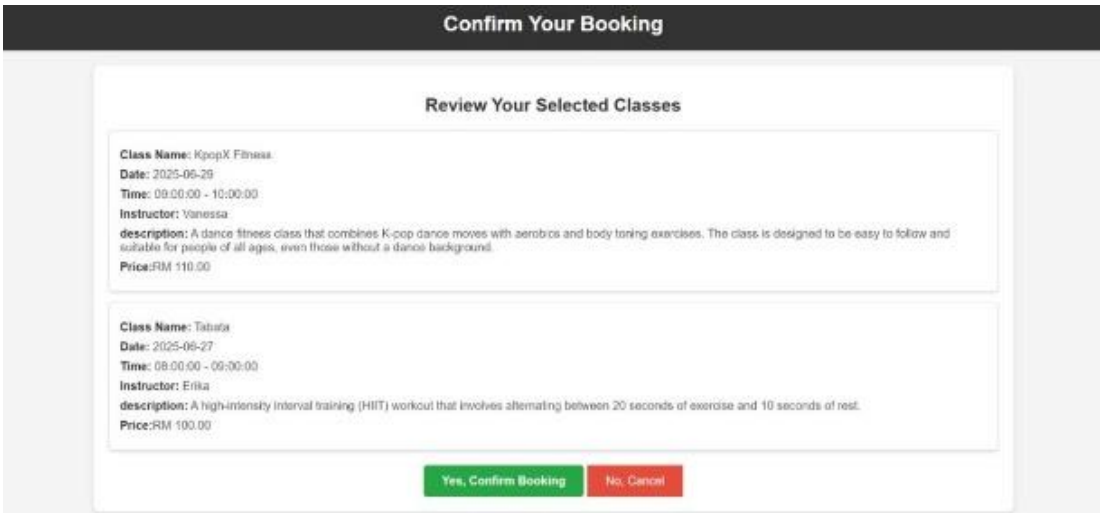

Fig 5. Booking page

An integrated payment module (Fig 6) allows for secure online transactions. A dedicated success page provides immediate confirmation, enhancing the user experience and automating the billing process.

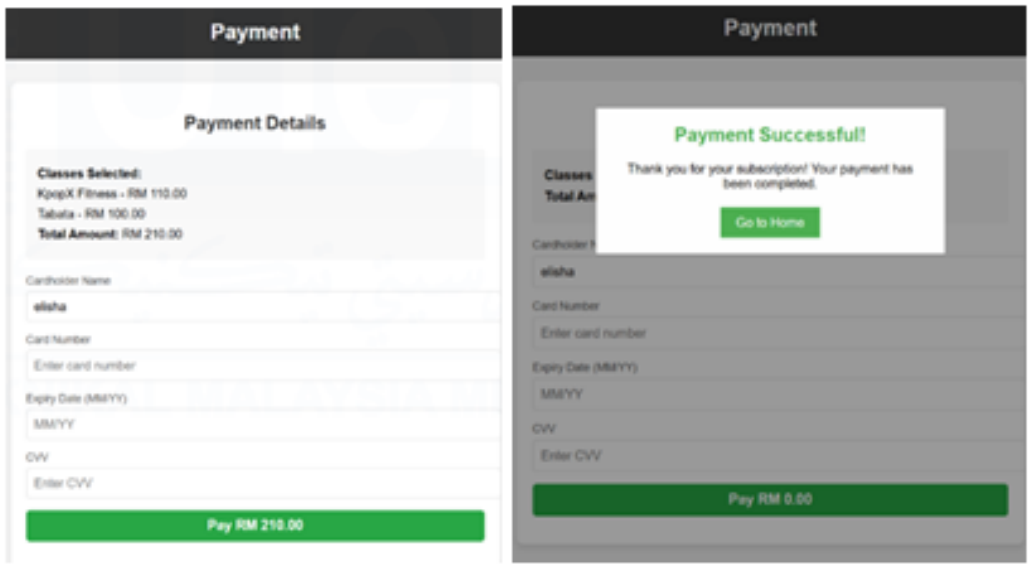

Fig 6. Payment page

The customer profile page (Fig 7) centralizes user information, subscribed classes, and payment status. A detailed view (Fig 8) allows members to manage their class bookings, supporting the objective of easy account management.

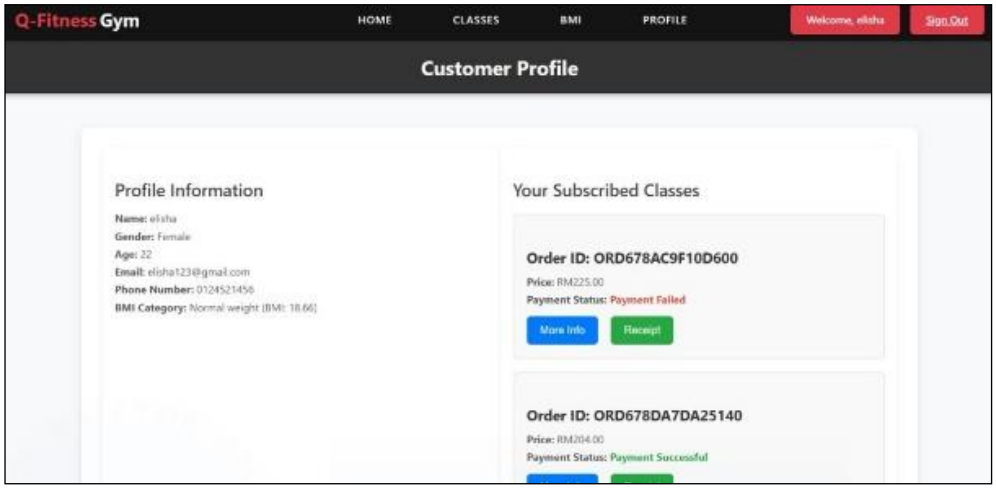

Fig 7. Customer profile page

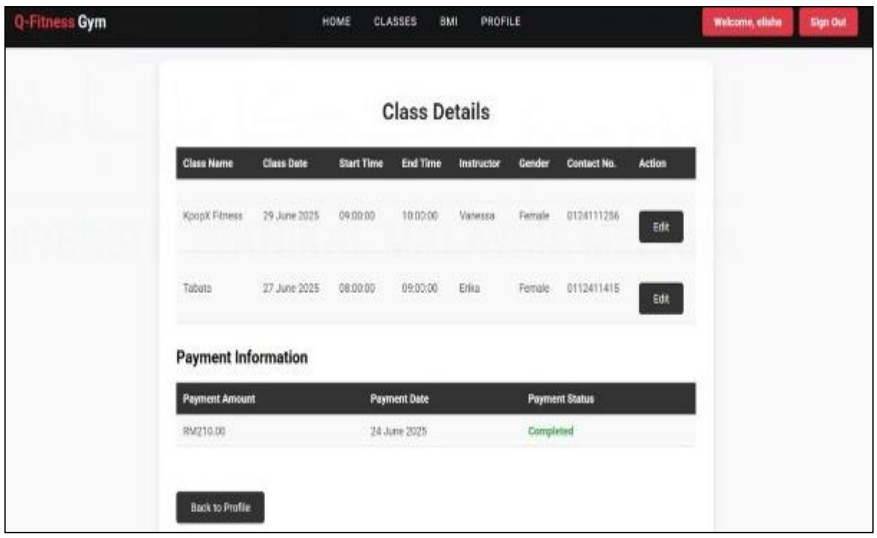

Fig 8. Class details page

The system includes a health-tracking feature where users can calculate their Body Mass Index (BMI) (Fig 9). A comprehensive history log allows members to monitor their progress over time, adding value beyond basic scheduling.

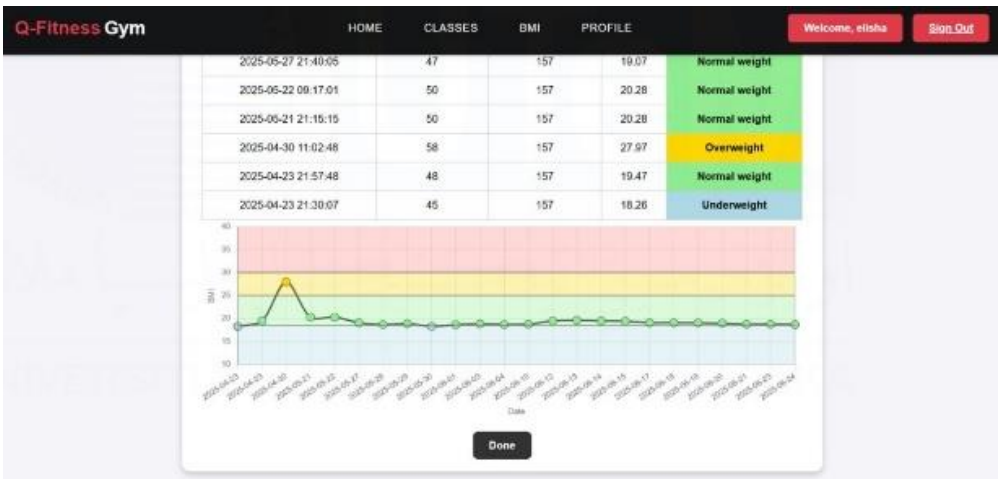

Fig 9. BMI page

Instructor Dashboard

Instructors are provided with a dedicated dashboard (Fig 10) displaying their assigned classes, schedule, and the number of registered customers per session, enabling them to manage their workload effectively.

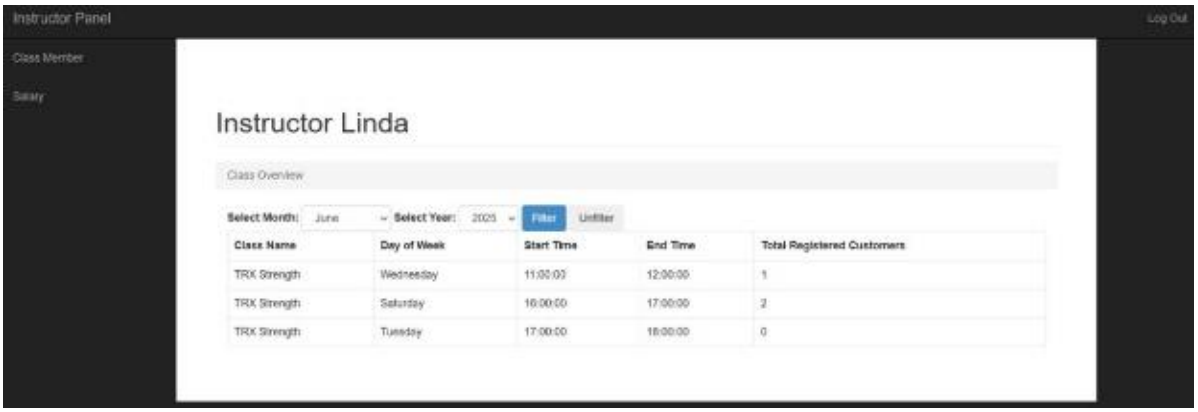

Fig 10. Instructor dashboard page

This interface (Fig 11) automatically calculates an instructor's salary based on predefined rates, class occurrences, and total hours worked, providing transparency and automating the payroll process.

Fig 11. Instructor salary page

Staff Management Interface

To support front-desk operations, a dedicated interface (Fig 12) allows staff to register walk-in customers directly, ensuring all member data is captured consistently within the system.

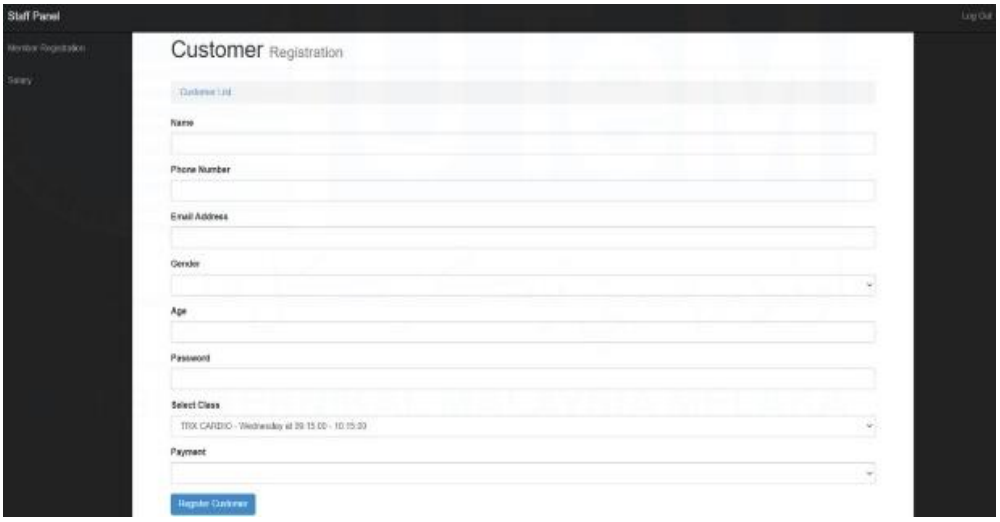

Fig 12. Customer registration page

Admin Dashboard

Admins have full CRUD (Create, Read, Update, Delete) capabilities for managing both instructors (Fig 13) and staff (Fig 14), centralizing user account control.

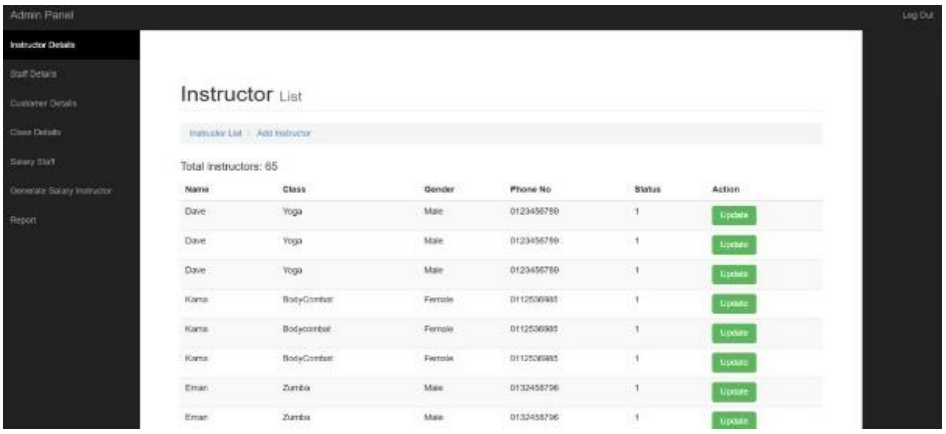

Fig 13. Instructor management page

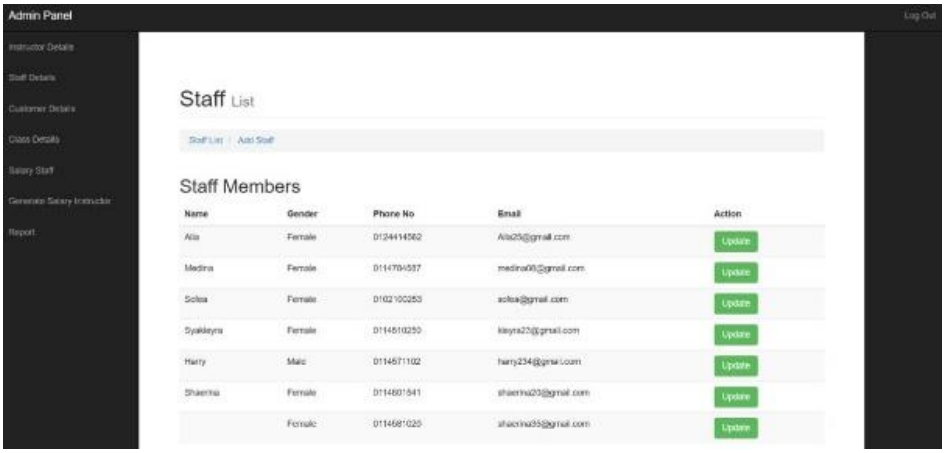

Fig 14. Staff management page

The system allows administrators to add new classes (Fig 15) and edit existing ones, including the ability to upload instructional videos (Fig 16), thus enriching the digital class offering.

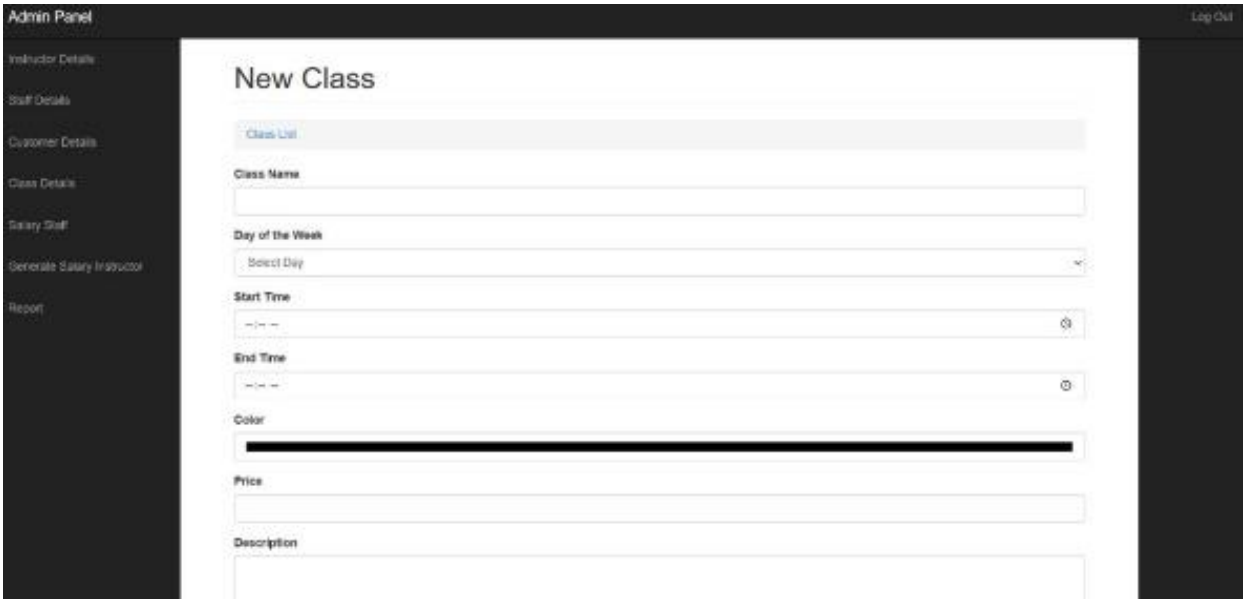

Fig 15. Class management page

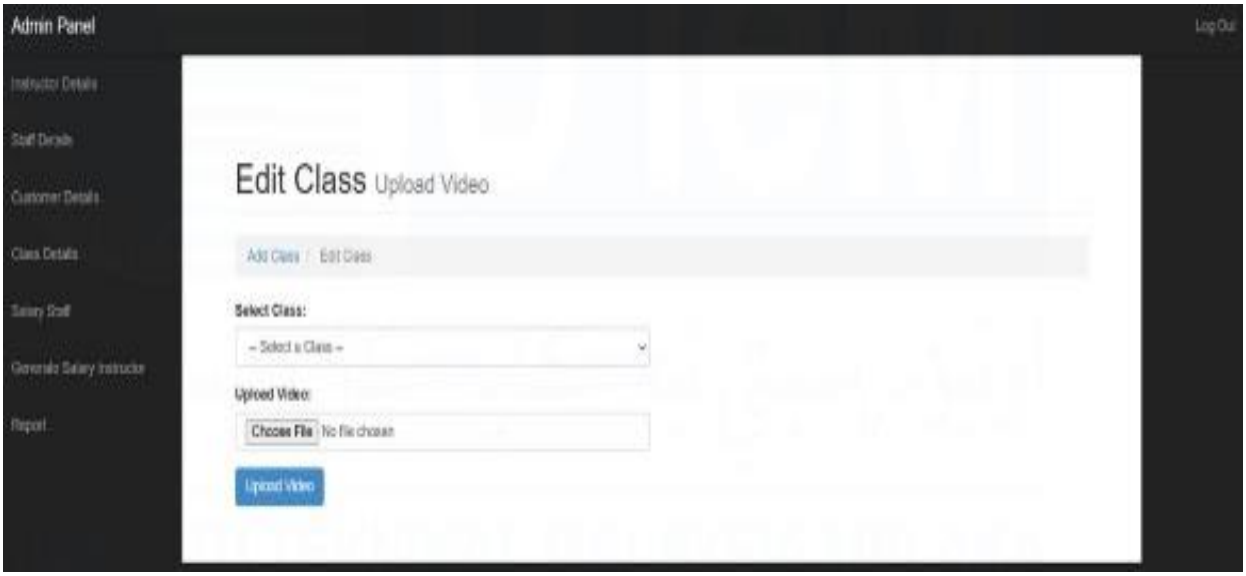

Fig 16. Class video upload page

A key administrative feature is the ability to automatically generate salary reports for instructors for a selected month and year (Fig 17), significantly reducing manual calculation effort.

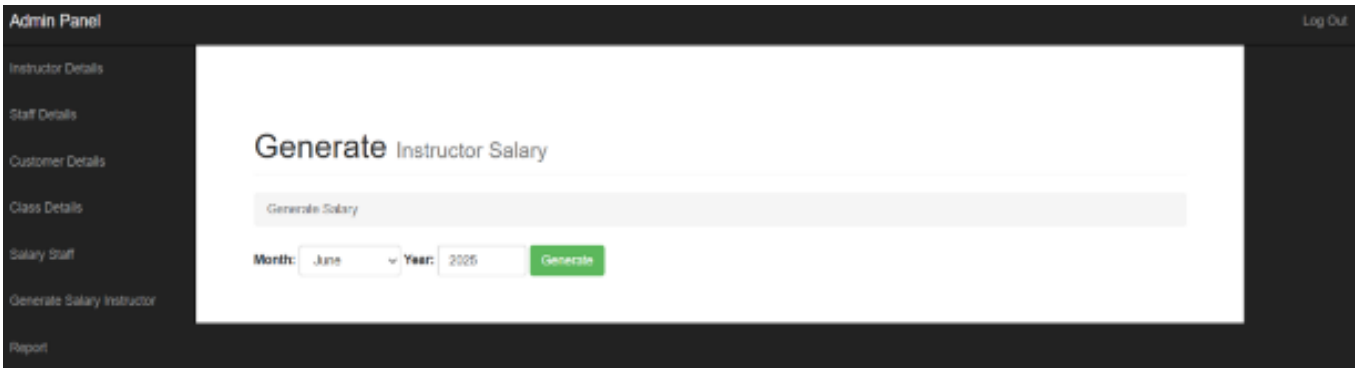

Fig 17. Salary generator page

The reporting module (Fig 18) provides critical business intelligence. It includes visual and numerical summaries of class subscription breakdowns, financial summaries, and member demographics, empowering data-driven decision-making for gym management.

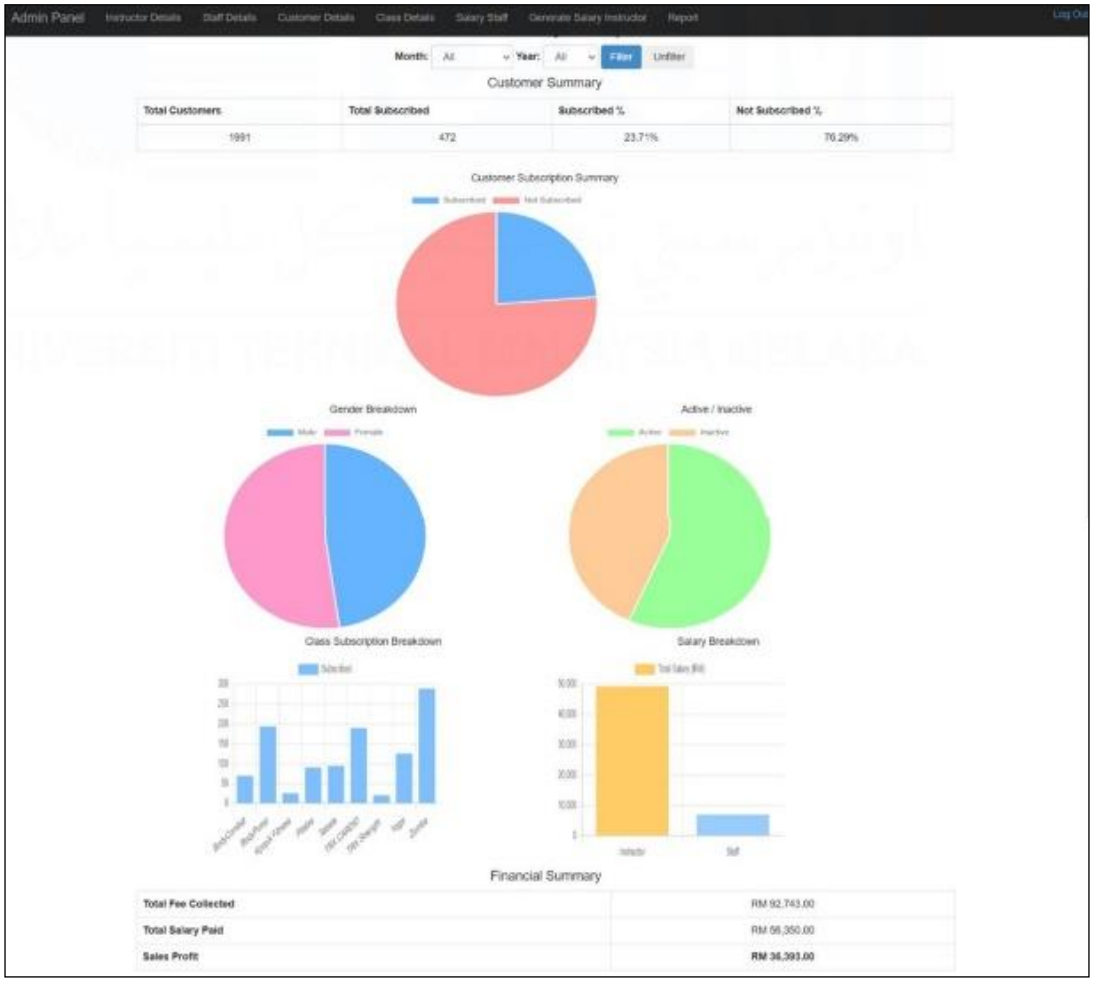

Fig 18. Report page

User Acceptance Testing

To assess the practical effectiveness and user acceptance, the system underwent User Acceptance Testing (UAT) involving a sample of selected systems users.

The UAT consist of three sections – Section A: Perceived Ease of Use, Section B: Perceived Usefulness, and Section C: Overall Satisfaction. The survey used a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) to measure user responses. Table IV shows the questions and the results of the survey.

The mean score of 4.77/5.0 for Perceived Ease of Use confirms the system's intuitive interface and streamlined navigation, allowing quick task completion (e.g., staff registering members, member booking classes).

Table IV. QFGS User Acceptance Testing Results

A: Perceived Ease of Use		**4.77**	
ID	**Statement**	**Focus**	
A1	The system is easy to use and navigate.	Usability	4.93
A2	I could complete my tasks quickly using the system (e.g., registration, class subscription).	Efficiency	4.74
A3	The interface is intuitive and guides me clearly through each process.	User- friendliness	4.89
A4	It was easy to recover from any errors I encountered.	Error Recovery	4.52

B: Perceived Usefulness		**4.83**	
ID	**Statement**	**Focus**	
B1	Using QFGS improves my productivity in managing gym operations/my membership.	Productivity	4.93
B2	QFGS is effective for centralizing membership and class management.	Centralization	4.78
B3	The system helps me make better decisions (e.g., viewing reports, monitoring progress).	Information Quality	4.78
B4	I believe QFGS is a valuable tool for modern gym management.	Overall Value	4.85
C: Overall Satisfaction		**4.76**	
ID	**Statement**	**Focus**	
C1	I am satisfied with the performance and responsiveness of the system.	Speed/ Performance	4.89
C2	I feel confident that the system produces correct and reliable results (e.g., payments, scheduling).	Reliability	4.70
C3	The system's security features (e.g., password protection) make me feel safe about the data.	Security	4.63
C4	Overall, I am satisfied with the QFGS.	Overall Satisfaction	4.81

The mean score of 4.83/5.0 for Perceived Usefulness affirms the system's capability in reducing administrative workload and increasing productivity through automation of tasks such as scheduling and billing.

The mean score of 4.76/5.0 for Overall Satisfaction reflects user confidence in QFGS's delivery as a dependable digital experience for both gym operators and members.

CONCLUSION

The Q-Fitness Gym System (QFGS) successfully integrates key gym management functions into a centralized, web-based platform, improving operational efficiency, user satisfaction, and administrative workflows. Its Agile development and three-tier architecture ensure scalability and adaptability for evolving fitness centre needs. User testing confirms strong acceptance and reliability across all roles. By bridging traditional gym operations with digital transformation, QFGS offers a robust foundation for future enhancements like mobile access, Internet of Things (IoT) integration, and advanced analytics, positioning it well for wider adoption and ongoing innovation in fitness management [15].

Future Work

Although the QFGS has effectively integrated core modules such as membership management, class scheduling, billing, and reporting, there remain multiple opportunities to extend its capabilities. One promising direction is the development of a mobile-friendly application that synchronizes with the web platform, allowing users to conveniently manage memberships, track their progress, and make real-time payments through their smartphones. Mobile integration would significantly improve accessibility and engagement, especially for members with dynamic schedules.

Another potential enhancement involves incorporating IoT and wearable device connectivity to enable automated data collection on members' workouts and health performance. Integrating IoT sensors and wearable fitness trackers could support real-time fitness monitoring, personalized workout recommendations, and performance analytics, providing users with a data-driven fitness experience [11]. In addition, adopting cloud computing infrastructure could strengthen data storage scalability, remote access, and multi-branch synchronization, making the system suitable for larger gym chains.

By looking at data in smarter ways, machine learning and predictive analytics can really boost how businesses understand their members. For example, artificial intelligence (AI) can help predict which members might stop attending based on their past attendance and payment habits. This lets staff reach out with personalized support to keep them engaged. Additionally, using these tools, businesses can anticipate how many people will join upcoming classes and balance the instructors' schedules more effectively by spotting trends in membership renewals and class sign-ups.

Lastly, future iterations of QFGS should emphasize data privacy, cybersecurity, and compliance with international standards such as the General Data Protection Regulation (GDPR). As more user data are stored and transmitted online, ensuring secure authentication, encryption, and ethical data use will be vital. Continuous feedback collection from gym staff and users should also guide system evolution, ensuring the platform remains adaptive to emerging fitness technologies and industry needs.

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