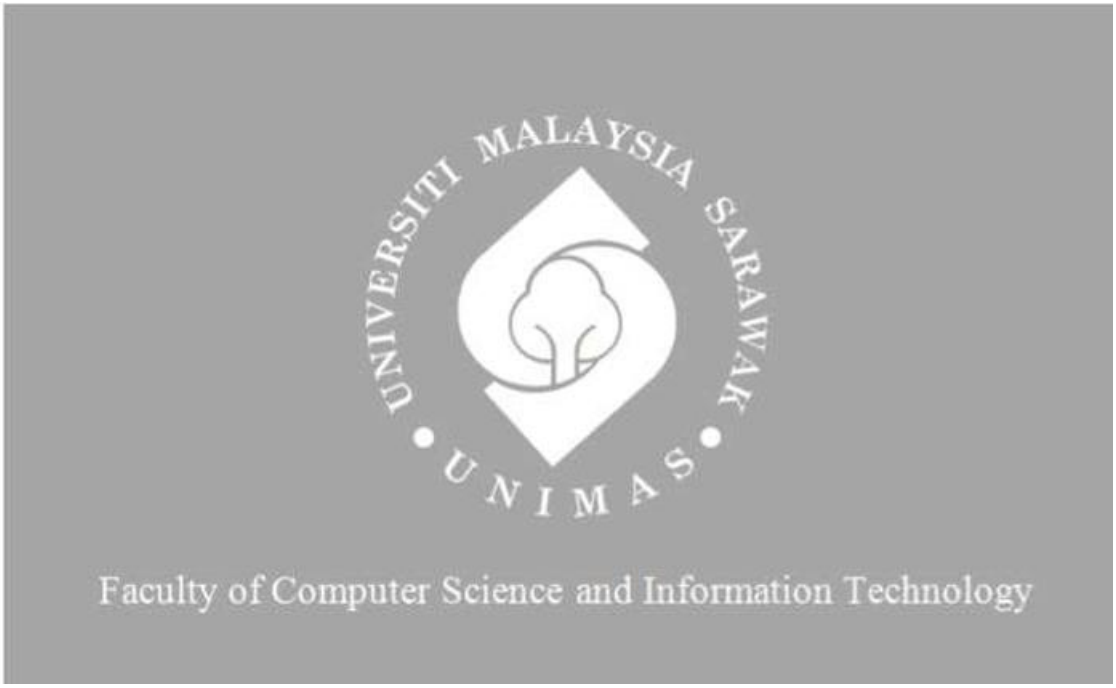

Web-Based Online Task Management System for UNIMAS Student

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2024/2025

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Chapter 1: Introduction

1.1 Introduction

In today's fast-paced digital environment, efficient task management is essential for both small teams and larger organizations. Collaborative projects require precise work distribution, progress tracking, and timely communication to ensure that all team members are aligned and working towards common goals (Kerzner, 2017). However, many existing task management tools often fall short in meeting the specific needs of smaller teams or individual users. These tools can be overly complex, expensive, or simply lack the necessary features that facilitate effective collaboration (Katz & Kahn, 1978).

This project aims to develop a modern web application, a Web-Based Online Task Management System, utilizing a microservices architecture with Java and Spring Boot for the backend and React.js for the frontend. The system will emphasize usability and real-time collaboration, with REST APIs facilitating seamless communication between the frontend and backend. It will provide a user-friendly interface designed to allow users to manage tasks effectively without requiring advanced technical skills. This project specifically targets UNIMAS students who frequently juggle multiple assignments and projects throughout their academic careers. By streamlining task management processes, the proposed system will help students stay organized and focused on their academic responsibilities. Furthermore, the application will facilitate better communication among team members and promote accountability through its interactive features, ultimately enhancing the overall productivity of student groups.

1.2 Problem Statement

Task management using traditional techniques such as spreadsheets or email threads becomes increasingly ineffective as teams and projects expand (Schmidt et al., 2019). For students managing group assignments or collaborative projects, missed deadlines and misunderstandings may arise from these approaches' inability to offer real-time updates, or a clear picture of work priorities (Davis & Houghton, 2018). Specifically for UNIMAS students, challenges include the difficulty in tracking task progress across different courses and the lack of integrated tools that support real-time collaboration within student group projects. Many current solutions may be too expensive or complicated for students who often seek straightforward tools that can help them manage their workload efficiently.

The lack of an integrated system that allows for easy task assignment, progress tracking, and communication can lead to frustration among team members. This often results in decreased motivation and productivity during critical academic periods. By creating a feature-rich, easily navigable, and reasonably priced task management system specifically designed for UNIMAS students, our project aims to address these problems effectively. The proposed system will not only simplify task management but also foster collaboration among students working on group projects.

1.3 Aims and Objectives

The main aim of this project is to develop a user-friendly task management application that enables efficient task tracking, collaboration, and real-time notifications tailored specifically for UNIMAS student users. The objectives of the project are as follows:

- To design a secure task management system with user-centered access control for students and project managers.
- To develop features for task creation, assignment, and real-time notifications using WebSockets.
- To evaluate the system's usability and effectiveness in addressing task management challenges faced by UNIMAS students.

1.4 Methodology

The project will adopt the Agile methodology, which is particularly well-suited for projects requiring flexibility and iterative development. This approach allows for continuous feedback from users specifically students and enables adjustments based on their needs throughout the development process.

Figure 1-1 Agile Methodology

The project will be developed in several phases:

1. **Requirement Analysis**

   Identify key features required for task management and gather requirements to create a feature list.

2. **System Design**

   Design the architecture using Spring Boot for the backend with MySQL for data storage.

3. **Development**

   Implement core features in iterations:

   - Backend: Set up the Spring Boot application and integrate Spring Security for user authentication. Develop REST APIs using Spring Boot for communication.
   - Frontend: Develop the user interface using React.js and Node.js for the development environment, utilizing npm for package management.
   - Notifications: Integrate WebSockets for real-time updates on task status.
   - File Storage: Configure local storage for file uploads.
   - Version Control: Utilize Git for source code management.

4. **Testing and Debugging**

   Conduct unit testing, integration testing, and user acceptance testing to ensure functionality and usability from a student perspective.

5. **Deployment and Presentation**

   Prepare for final presentation by ensuring the system runs smoothly in a local or cloud environment.

By following this Agile methodology, the project aims to remain adaptable to changes based on feedback from student users while ensuring that all essential functionalities are delivered effectively.

1.5 Scope

The goal of this project is to create a web-based task management system that can be accessed via a browser and is constructed with Java and Spring Boot. The system will include essential features such as user authentication, task creation and assignment, progress tracking, file attachments, comments, and real-time update notifications. These functionalities are particularly important for students who need to collaborate effectively on group projects (Baker et al., 2020).

The system will utilize local file storage to manage connected files securely while employing Spring Security for user authentication and MySQL as the relational database for data persistence. The full technology stack includes:

- Frontend: React.js, Material-UI
- Backend: Spring Boot, Java
- Database: MySQL
- Authentication: JWT-based
- Real-time Features: WebSocket
- Version Control: Git

REST APIs will be used for data communication between the frontend and backend. However, this project will not cover advanced analytics or integration with other third-party applications; it will focus primarily on the core functionalities necessary for effective task management among students. By concentrating on these essential features, the project aims to provide a practical tool that enhances students' collaborative efforts while addressing their unique challenges in managing academic workloads.

1.6 Significance of Project

This project offers a practical solution to the challenges faced by small teams and individual project managers especially students in handling tasks efficiently. Many widely available task management tools come with high costs or complex feature sets that may not be necessary or accessible for smaller-scale projects typically encountered in academic settings (Baker et al., 2020). By developing a streamlined web-based task management system tailored specifically for student needs, this project aims to bridge this gap by providing a tool that is both cost-effective and easy to use.

The addition of real-time notifications significantly enhances the collaborative aspect of this system by addressing common issues related to communication delays in traditional methods (Schmidt et al., 2019). Implementing WebSockets for live updates allows project managers and team members particularly students working on group assignments to receive timely alerts regarding changes in task status or deadlines. This capability is crucial in academic environments where maintaining coordination among peers is essential for accountability.

Furthermore, allowing users to add comments and attachments within tasks fosters an enriched collaborative environment that enables contextual communication directly related to specific work items. This feature enhances clarity among team members about expectations and responsibilities associated with each task they undertake together.

From an educational perspective, this project serves as an invaluable learning opportunity for those interested in web application design and development. Utilizing technologies such as Spring Boot with MySQL provides hands-on experience with fundamental frameworks essential for building robust applications that can benefit students in their future careers (Davis & Houghton, 2018). Additionally, incorporating real-time data processing using WebSockets equips developers with crucial skills relevant in today’s interactive web development landscape.

The implementation of role-based access control adds complexity to the project while demonstrating proficiency in creating secure applications—an essential skill set in professional settings where data security is paramount (Kerzner, 2017). Overall, this project not only addresses practical needs but also enhances the learning experience of students involved in its development.

1.7 Project Schedule

The project schedule shown in Table 1.1 outlines the timeline and tasks required to ensure the system is developed systematically and efficiently. This project starts from 29th September 2024 and ends on 18th July 2025, spanning a total of 293 days.

Table 1-1 Project Schedule

Task	Start Date	End Date	Duration (days)
Phase1: Initiation Phase	29/09/2024	04/11/2024	36
Establish project goals and scope	29/09/2024	05/10/2024	6
Develop project charter	05/10/2024	12/10/2024	7
Draft and initial proposal	12/10/2024	22/10/2024	10
Complete and finalize the proposal	22/10/2024	04/11/2024	13
Phase 2: Planning Phase	04/11/2024	02/12/2024	28
Develop a thorough project plan	04/11/2024	10/11/2024	6
Research and requirement gathering	10/11/2024	17/11/2024	7
Analyse existing systems	17/11/2024	24/11/2024	7
Prepare initial system requirements	24/11/2024	02/12/2024	8
Phase 3: Design Phase	02/12/2024	14/02/2025	74
Design UI layout and workflow	02/12/2024	11/12/2024	9
Wireframing and prototyping	11/12/2024	22/12/2024	11
High-fidelity UI design	22/12/2024	04/01/2025	13
Feedback and refinement of designs	04/01/2025	14/02/2025	41
Phase 4: Development Phase	25/01/2025	31/05/2025	127
Set up development environment	25/01/2025	31/01/2025	6
Develop core features	01/02/2025	18/04/2025	76
- User registration	01/02/2025	12/02/2025	11
- Login system	12/02/2025	25/02/2025	13
- Task creation and assignment	25/02/2025	20/03/2025	23

- Notifications	20/03/2025	10/04/2025	21
- Role-based access control	10/04/2025	18/04/2025	8
Test and debug system	18/04/2025	08/05/2025	20
System integration	08/05/2025	31/05/2025	23
Phase 5: Optimization and Feedback	01/06/2025	14/07/2025	49
Complete FYP2 report and documentation	01/06/2025	19/06/2025	18
Prepare for presentation	19/06/2025	26/06/2025	7
Showcase the system	26/06/2025	27/06/2025	1
Gather feedback	27/06/2025	04/07/2025	7
Implement required changes	04/07/2025	14/07/2025	10
Phase 6: Project Closure	14/07/2025	18/07/2025	4
Document outcomes and lessons learned	14/07/2025	16/07/2025	2
Conduct final project review and evaluation	16/07/2025	18/07/2025	2

Expected Outcome

The project aims to deliver a fully functional and user-friendly web-based task management system tailored specifically for UNIMAS students managing academic projects or small teams handling collaborative tasks. The system will enable project managers, especially students, to create, assign, and track tasks effectively, while team members can update their progress in real time. This ensures transparency and accountability within the team.

A secure login system with role-based access control will protect user data and ensure that tasks and responsibilities are assigned appropriately. The inclusion of real-time notifications will keep users informed about task updates, deadlines, and changes, fostering seamless communication and collaboration among users.

Additionally, the system will feature an intuitive dashboard that allows users to view tasks based on priority, status, or deadlines, providing a clear overview of progress and ensuring tasks are organized efficiently. The system will also support file attachments using local file storage, allowing team members to share resources and documents directly within the platform.

The proposed system is designed to be lightweight and adaptable, making it accessible for users with minimal technical expertise. By addressing the specific needs of students and small teams, this tool will bridge the gap between overly complex enterprise solutions and simpler individual task management tools. Ultimately, the system aims to enhance productivity, improve task coordination, and provide a reliable solution for effective task management.

Chapter 2: Literature Review

2.1 Introduction

Effective task management is critical for individuals and teams to streamline workflows, track progress, and achieve goals efficiently. Various tools and systems have been developed to address these needs, but existing solutions often fail to meet the specific requirements of smaller teams or student projects. This chapter explores the current state of task management systems, highlighting their strengths and weaknesses. A review of three popular systems Asana, Trello, and ClickUp is conducted to identify key features and limitations that will inform the development of the proposed Web-Based Online Task Management System. Finally, this chapter compares the proposed system with existing tools to establish its significance and value.

2.2 Background Study

Task management systems have evolved significantly over the years, transitioning from manual techniques such as handwritten task lists to advanced digital platforms. These systems provide functionalities like task creation, tracking, and collaboration, which have become essential for enhancing productivity and ensuring accountability in various contexts (Schmidt et al., 2019). With the rise of technology and the increased demand for efficient workflows, task management systems have become indispensable tools for individuals and teams alike.

Modern task management systems leverage user-friendly interfaces and advanced features, such as real-time notifications and user-centered access control, to facilitate collaboration and coordination (Baker et al., 2020). However, despite these advancements, many systems are designed for corporate environments, making them less suitable for specific use cases, such as student academic projects. For example, tools tailored for enterprises often come with features that are unnecessary for small teams and can be overwhelming for users with minimal technical expertise.

The development of contemporary task management systems heavily relies on modern web technologies. Frontend frameworks like React.js, Angular, and Vue.js have revolutionized user interface development by enabling the creation of dynamic, single-page applications. React.js, for instance, is favoured for its component-based architecture, virtual DOM, and strong community support, which contribute to efficient and scalable UI development (React.js Documentation, n.d.). Backend development often utilizes robust frameworks such as Spring Boot (for Java), Node.js (with Express.js), or Django (for Python), which provide powerful tools for building RESTful APIs and handling business logic (Spring Boot Documentation, n.d.). Microservices architecture, where an application is built as a collection of small, independent services, has also gained prominence for its scalability and flexibility (Newman, 2015).

Additionally, as noted by Davis and Houghton (2018), the success of any task management system depends on its ability to address user-specific needs. Students, for instance, require a platform that simplifies task tracking and fosters collaboration without imposing significant learning curves. This need for simplicity and functionality forms the basis for developing a web-based task management system tailored specifically for students.

The proposed system focuses on integrating essential features, such as task assignment, progress tracking, and real-time notifications, while maintaining ease of use. By utilizing technologies like Spring Boot, MySQL, React.js, and local file storage, the system aims to offer a streamlined solution that bridges the gap between complex enterprise tools and the simpler requirements of student users. This approach ensures that the proposed system not only enhances productivity but also addresses the unique challenges faced by UNIMAS students in managing their academic responsibilities.

2.3 Review on Existing System

Task management systems have gained widespread adoption in various industries, providing tools to organize, track, and execute tasks effectively. Among the many available systems, Asana, Trello, and ClickUp are three widely recognized platforms known for their innovative features and diverse use cases. This section reviews these systems to identify their strengths, limitations, and applicability to academic settings. The insights

gained from these reviews will serve as references for designing and implementing the proposed Web-Based Online Task Management System.

2.3.1 Asana

Asana is a robust task management platform designed to help teams plan, organize, and execute projects. Its intuitive interface allows users to create tasks, assign them to team members, set deadlines, and track progress through multiple project views, such as list, board, and calendar formats. Figure 2.1 illustrates the Asana dashboard, which provides an overview of tasks and projects. Figure 2.2 highlights the detailed task management feature, showing how users can assign tasks and set deadlines. Figure 2.3 showcases the calendar view, which helps users track deadlines visually. Figure 2.4 shows customization of project create; users can choose how to customize their project and choose what they want to view for when creating the project.

From a technical perspective, Asana is known to employ a sophisticated architecture, likely a combination of Ruby on Rails for its backend and a JavaScript framework (possibly React or a custom framework) for its rich frontend user interface. Its real-time notification system is robust, likely leveraging WebSockets or similar technologies to provide instant updates across various user interfaces. Asana's architecture supports high scalability, catering to large enterprises, which implies a distributed system design and advanced database management. However, this complexity often translates to a steeper learning curve and higher resource consumption, making it less suitable for simpler academic use cases.

Despite its extensive capabilities, Asana is not without limitations. The free version restricts access to advanced features, such as timeline views and task dependencies, which can be crucial for effective project management. Moreover, new users may find the interface overwhelming due to the abundance of options and settings. While Asana excels in facilitating collaboration for medium to large teams, its complexity and cost make it less ideal for smaller groups or individual users, such as students.

Asana’s emphasis on scalability and customization makes it a popular choice for corporate environments. However, for academic use, its features may be excessive and not entirely relevant. A simpler, more focused system that prioritizes essential functionalities is better suited for student needs.

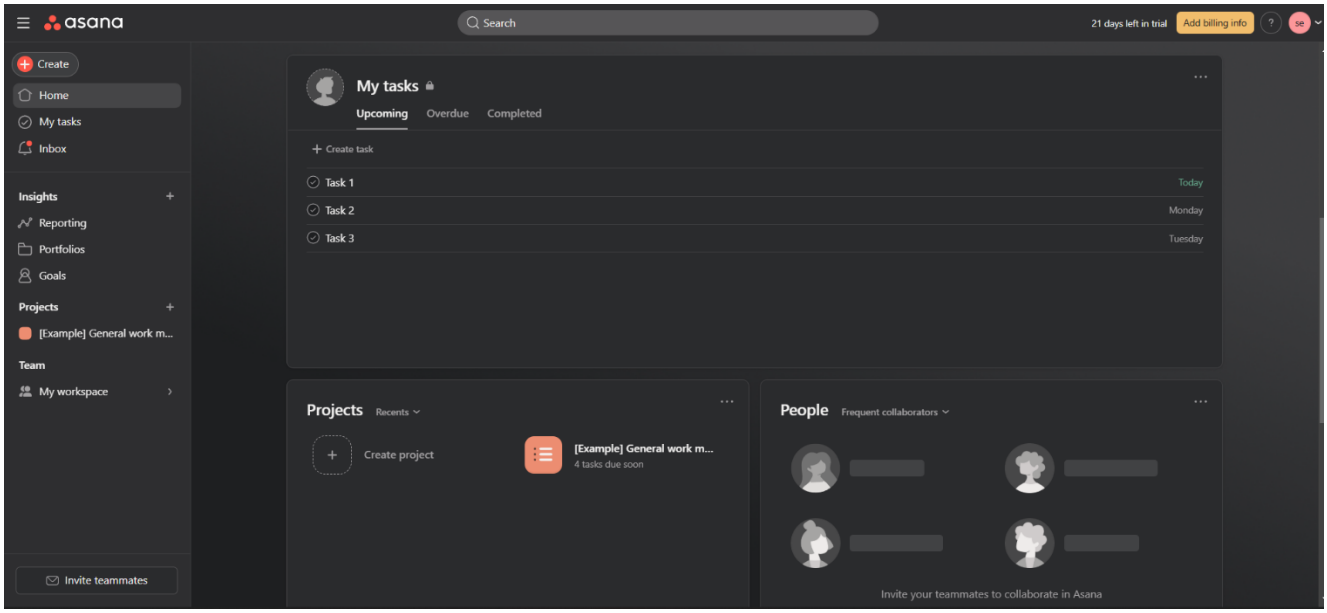

Figure 2-1 Dashboard in Asana

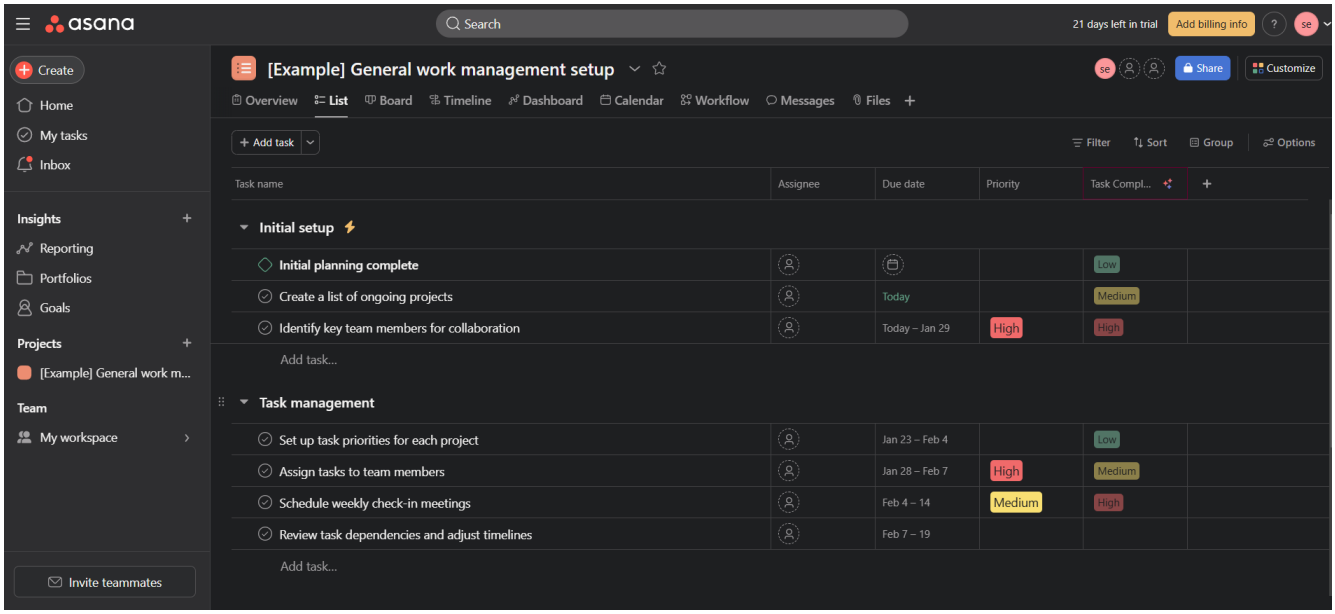

Figure 2-2 Detailed Task Management Feature in Asana

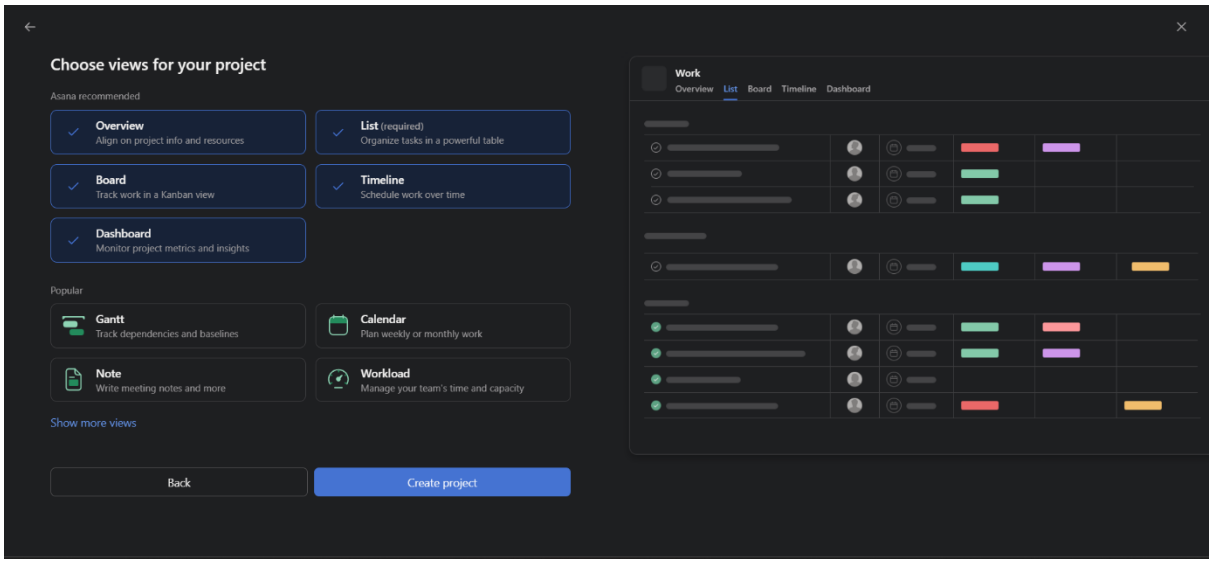

Figure 2-3 Project Creation in Asana

Project Creation in Asana

2.3.2 Trello

Trello is a highly visual task management tool that organizes projects using a Kanban-style board system. Users can create cards to represent tasks, assign team members, set due dates, and add labels for categorization. Figure 2.5 displays a typical Trello board, showing how tasks are organized into columns. Figure 2.6 provides a closer look at a Trello card, illustrating how users can add labels, checklists, and attachments to tasks. Figure 2.7 demonstrates Trello's integration capabilities, such as linking tasks with Google Drive or Slack.

Technically, Trello is built on Node.js for its backend, utilizing MongoDB as its primary database, which aligns well with its flexible, document-oriented data structure (Trello Engineering Blog, n.d.). Its frontend is likely built with a modern JavaScript framework, possibly React or Angular, to support its highly interactive drag-and-drop interface. Trello's real-time updates, crucial for its Kanban board functionality, are implemented using WebSockets, allowing immediate synchronization of changes across all users. While its technology stack is modern and efficient for its specific use case, its simplicity in architecture means it might lack the deep customization and reporting capabilities found in more enterprise-focused tools.

Trello’s drag-and-drop functionality makes it user-friendly, particularly for those new to task management systems. Its integration with third-party tools like Slack and Google Drive further enhances its versatility. However, Trello’s simplicity comes at the cost of advanced features. For instance, the free version lacks detailed reporting, analytics, and comprehensive user-centered access control, which are essential for more structured project management. Additionally, as projects grow in complexity, the Kanban board can become cluttered, making it difficult to maintain clarity and organization.

Trello’s strengths lie in its ease of use and adaptability, making it an excellent choice for small teams or individuals managing straightforward tasks. Nevertheless, its limitations in handling complex workflows highlight the need for a more comprehensive system that balances simplicity with functionality, particularly in academic settings.

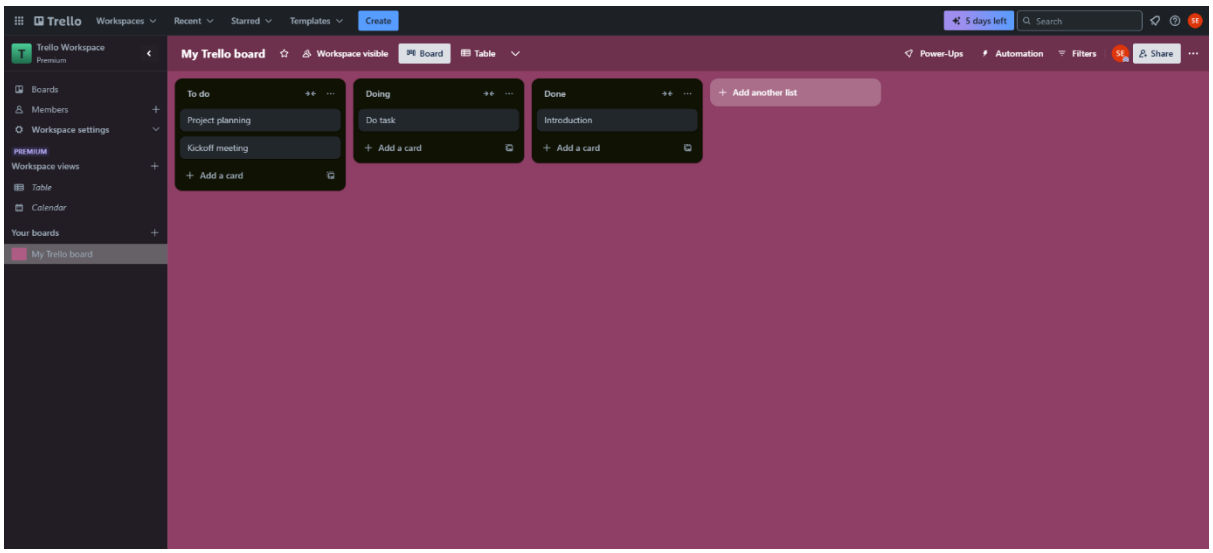

Figure 2-4 Trello Board in Trello

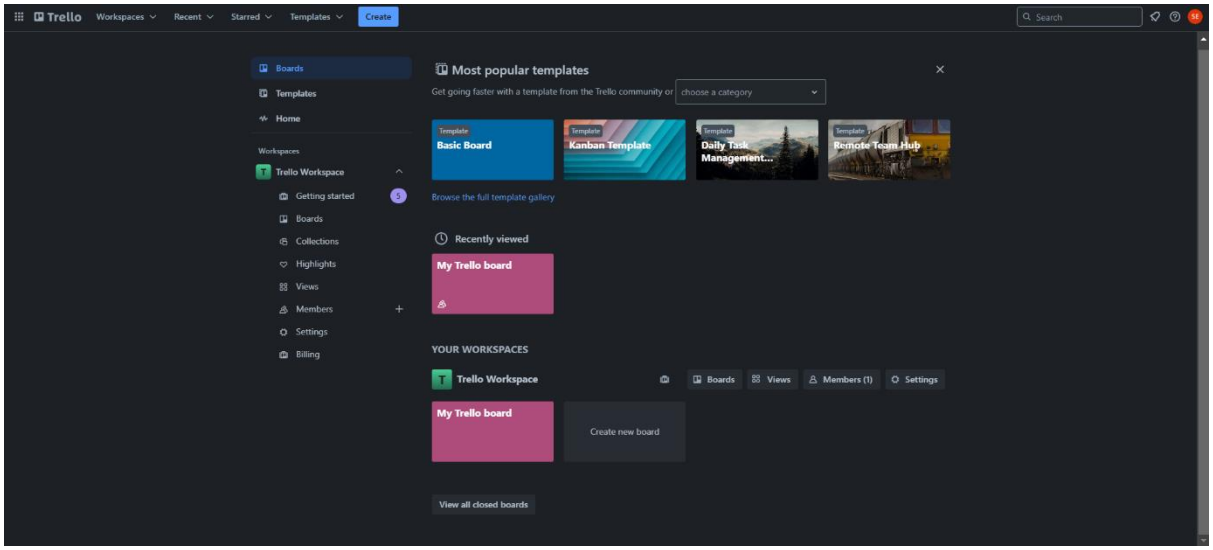

Figure 2-5 Board Creation in Trello

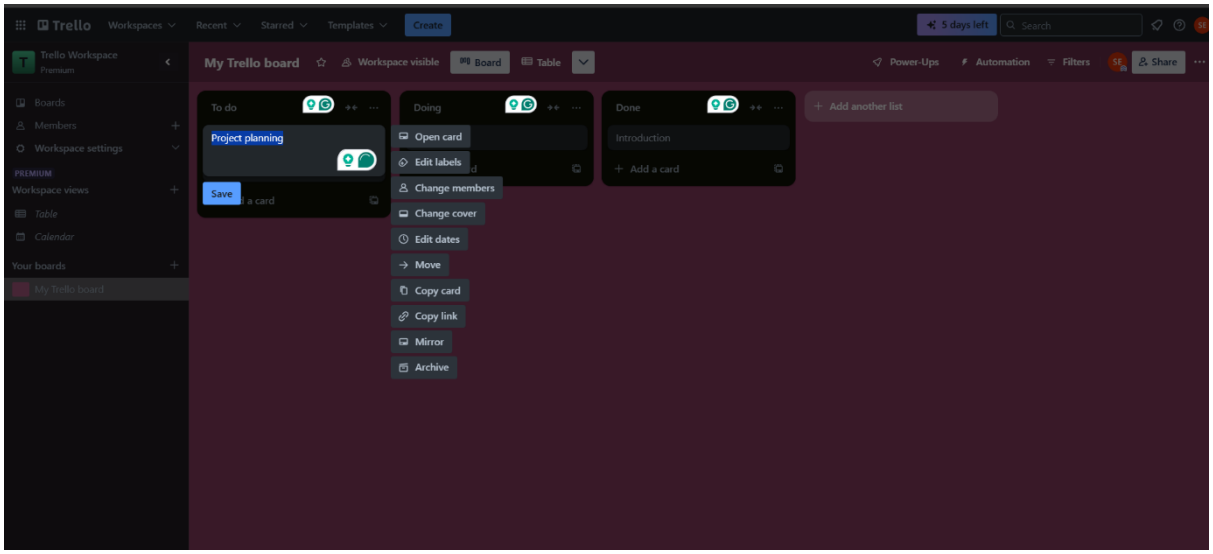

Figure 2-6 Trello Card Edit in Trello

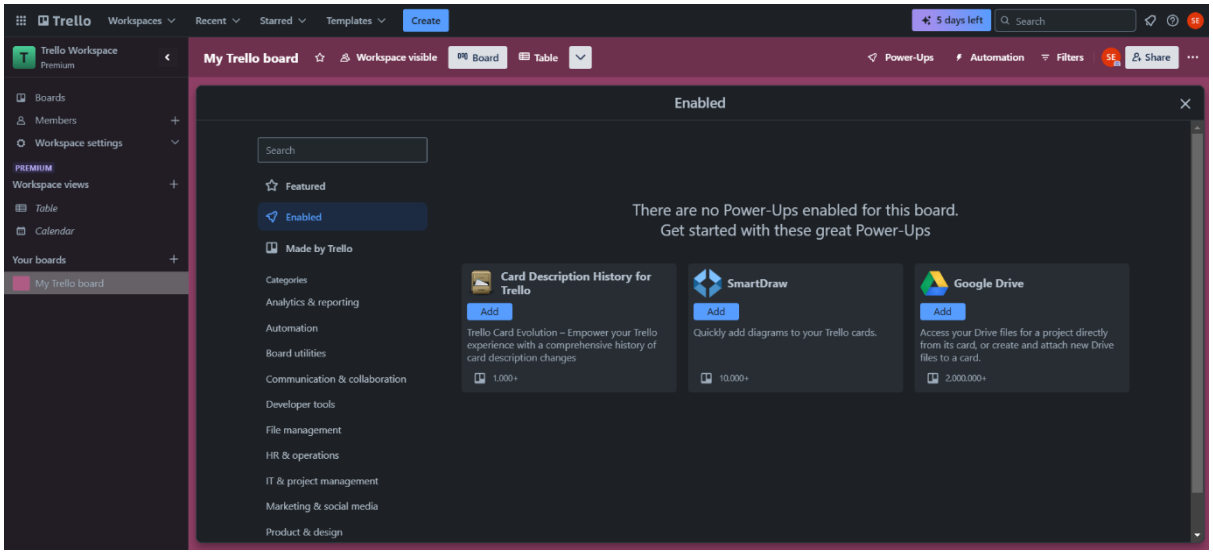

Figure 2-7Integration in Trello

2.3.3 Clickup

ClickUp is an all-in-one task management platform that aims to replace multiple productivity tools by offering a wide range of features. Users can create and manage tasks, set priorities, define dependencies, and track time spent on activities. Figure 2.8 showcases ClickUp's task management interface, which allows users to manage tasks in a list, board, or calendar view. Figure 2.9 illustrates ClickUp's reporting capabilities, showing detailed analytics and progress tracking. Figure 2.10 highlights the customizable workflow feature, which enables users to tailor the system to their specific needs.

From a technical standpoint, ClickUp employs a diverse technology stack, often including Node.js, React, and various database solutions (e.g., PostgreSQL, Redis) to support its extensive feature set and high customizability. Its architecture is likely microservices-based to handle the complexity and scale of its offerings. ClickUp's real-time notification system is highly integrated, providing granular control over alerts, suggesting a sophisticated WebSocket implementation. The platform's ability to offer deep customization views and integrations points to a highly modular and extensible codebase. However, this extensive feature set and underlying complexity can lead to a steep learning curve for new users and potentially higher system resource demands.

ClickUp's robust reporting and analytics capabilities make it a powerful tool for monitoring progress and identifying bottlenecks. Despite its versatility, ClickUp's extensive feature set can be a double-edged sword. The platform's complexity and steep learning curve may deter new users, particularly those with limited technical expertise. Additionally, while ClickUp offers a free plan, many advanced features, such as time tracking and detailed analytics, are locked behind paid tiers.

ClickUp is well-suited for teams that require a high degree of customization and control over their workflows. However, the platform's feature-heavy nature may be overwhelming for students managing academic projects. A simpler system that focuses on core functionalities, such as task assignment and real-time updates, would better address the needs of this user group.

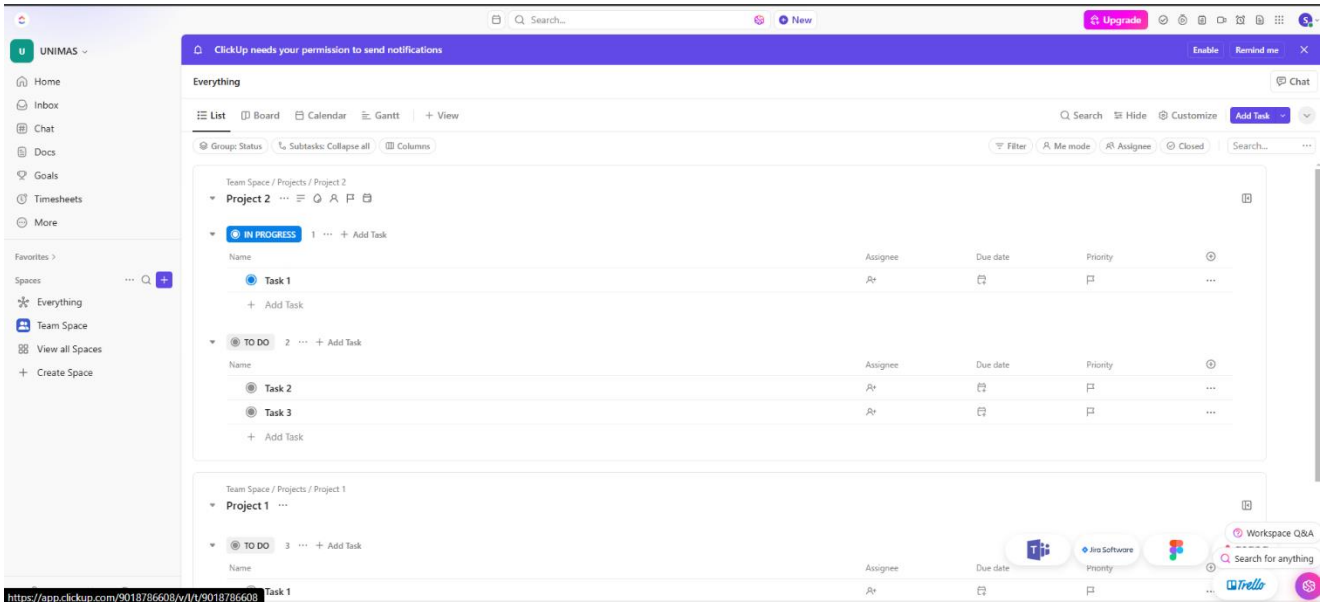

Figure 2-8 Task Management Interface for Clickup

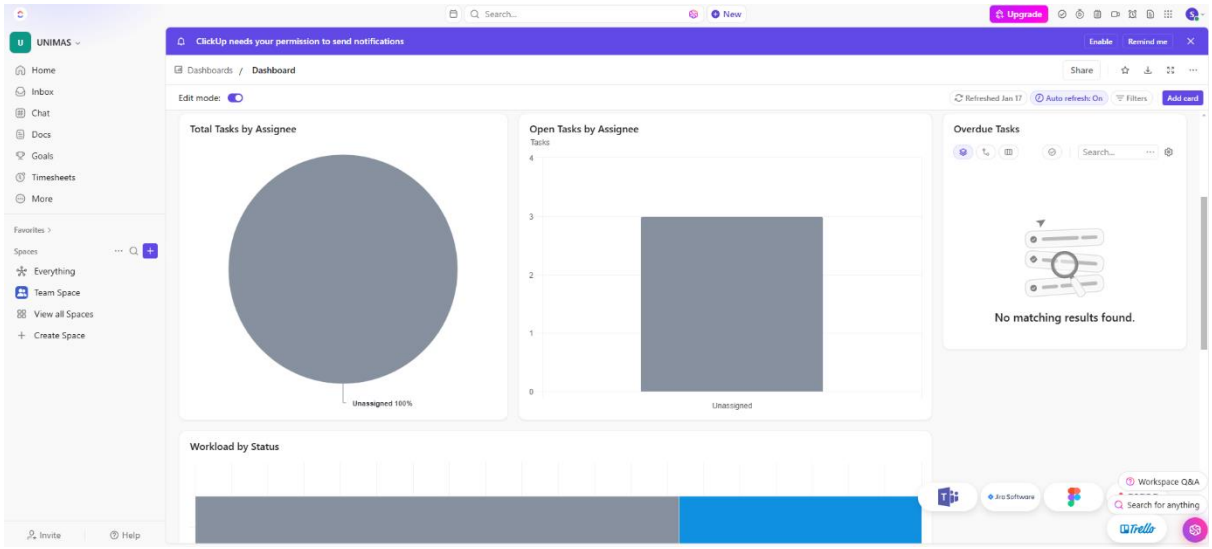

Figure 2-9 Task Reporting in Clickup

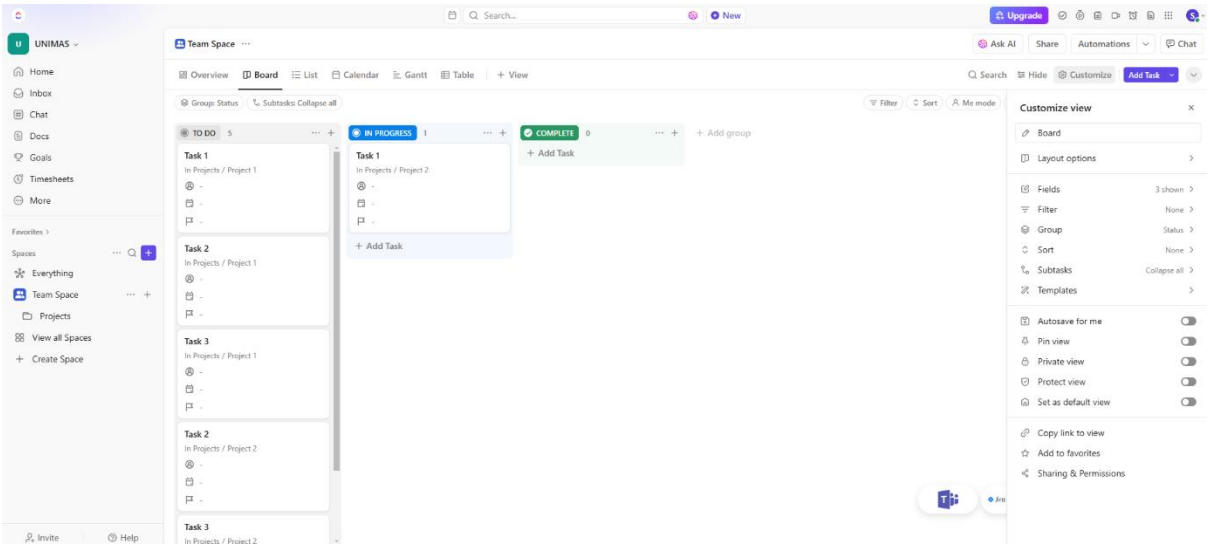

Figure 2-10 Customization View Feature in Clickup

In conclusion, the review of Asana, Trello, and ClickUp reveals several limitations that informed the design of the proposed system. While these tools offer robust features for task management, they are primarily designed for corporate or general-purpose use, making them less suitable for academic contexts. The proposed system addresses these gaps by focusing on the specific needs of students, such as simplified workflows, cost-effective implementation, and features like local file storage and real-time notifications. By learning from the strengths and limitations of these existing systems, the proposed system ensures a tailored and efficient solution for student task management.

2.4 Comparison Between Existing System and Proposed System and Objectives

The following table summarizes the comparison between Asana, Trello, ClickUp, and the proposed Web-Based Online Task Management System:

Table 2-1Comparison Existing System and Proposed System

System / Features	Existing System			Proposed System
	Asana	Trello	Clickup	Online Task Management System
Task Creation and Assignment	✓	✓	✓	✓
Real-Time Notification	✓	✓	✓	✓ (via websockets)
Role-Based Access Control	✓ (Limited)	✓ (Paid)	✓	✓ (collaborate task)

File Attachments	✓	✓	✓	✓ (Local Storage)
Customizable Workflow	✓	✓ (Limited)	✓	✓
Offline File Management	x	x	x	✓
Simplified User Interface	x	✓	x	✓
Task Prioritization	✓	✓	✓	✓
Targeted for Student	x	x	x	✓
Cost-Effective for Small Teams	x	x	x	✓
Frontend Framework	(Proprietary/JS)	(React/Angular)	(React)	React.js
Backend Technology	(Ruby on Rails)	(Node.js)	(Node.js)	Spring Boot (Java)
Database System	(PostgreSQL/MySQL)	(MongoDB)	(PostgreSQL/Redis)	MySQL
Authentication Method	(Session/OAuth)	(Session/OAuth)	(Session/OAuth)	JWT-based
API Architecture	(Monolithic/Hybrid)	(Monolithic/Hybrid)	(Microservices)	REST APIs (Microservices)
Real-time Capabilities	(WebSockets)	(WebSockets)	(WebSockets)	(WebSockets)

The comparison table highlights key features across Asana, Trello, ClickUp, and the proposed system, emphasizing their differences and how the proposed system is tailored to meet the specific needs of students. All the systems support task creation and assignment, enabling users to organize their projects efficiently by breaking them into smaller, manageable tasks. However, while Asana, Trello, and ClickUp cater to broader audiences, the proposed system simplifies this process for students, ensuring usability for those with minimal technical expertise. Real-time notifications are a common feature in all systems, but the proposed system distinguishes itself by utilizing WebSockets for instant updates, ensuring seamless communication without the restrictions often found in free versions of Trello or advanced features locked behind premium tiers in ClickUp.

User-centered access control is another critical feature where the proposed system stands out. While Asana and ClickUp offer this functionality to some extent, it is either limited or available only in paid plans for Trello. The proposed system provides a robust and clear user-centered access control mechanism tailored for academic use, ensuring that responsibilities are delegated effectively within a group project. In terms of file attachments, all existing systems rely on third-party cloud storage, which may present privacy concerns. The proposed system, however, integrates local file storage, offering a secure and centralized solution that is particularly advantageous for students managing sensitive project files.

Customizable workflows are available in varying degrees across the existing systems, with Asana and ClickUp offering advanced customization, while Trello provides basic Kanban-style boards. The proposed system incorporates customizable workflows but focuses on simplicity, allowing students to organize tasks in categories like “To Do,” “In Progress,” and “Completed” without overwhelming them with options. Additionally, the proposed system introduces offline file management, a feature absents in the other platforms. This ensures students have uninterrupted access to their resources, even in areas with unreliable internet connectivity.

When it comes to the user interface, Trello is recognized for its simplicity, while Asana and ClickUp often present a steeper learning curve due to their feature-rich designs. The proposed system bridges this gap by offering a straightforward, user-friendly interface, making it ideal for students. All systems support task prioritization, but the proposed system ensures this feature remains intuitive and easy to use, enabling students to manage their workload efficiently. Furthermore, unlike Asana, Trello, and ClickUp, which target a broad audience, the proposed system is explicitly designed for students, addressing their unique needs such as task delegation, progress tracking, and group collaboration.

Finally, the proposed system stands out for its cost-effectiveness. While the existing systems offer free versions with limited features and require premium subscriptions for advanced functionalities, the proposed system provides essential features without any additional costs. This affordability, combined with its targeted design, ensures that the proposed system is both practical and accessible, making it the ideal task management tool for students managing academic projects.

2.5 Significance of Features in the Proposed System

The proposed system is designed to address the limitations of existing task management tools while specifically catering to the needs of students managing academic projects. A key feature of the system is real-time notifications using WebSockets, which ensures that users are promptly informed of task updates or changes, fostering better communication and collaboration. This feature is particularly valuable for students who often work under tight deadlines and need to stay informed about task progress without unnecessary delays.

The choice of React.js for the frontend is significant due to its component-based architecture, which promotes reusability and maintainability, allowing for a highly interactive and responsive user interface. Its virtual DOM enhances performance by minimizing direct manipulation of the actual DOM, leading to faster updates and a smoother user experience. Spring Boot was selected for the backend due to its rapid development capabilities, convention-over-configuration approach, and robust ecosystem for building RESTful APIs. Its strong support for dependency injection and embedded servers simplifies deployment and scaling. MySQL is chosen as the database for its reliability, widespread adoption, and strong support for relational data, ensuring data integrity and efficient querying.

Another important feature is user-centered access control, which provides a secure and organized framework for managing responsibilities within a team. By defining roles such as "Project Manager" and "Team Member," the system ensures that tasks are delegated appropriately, enhancing accountability and reducing confusion. This level of control is often unavailable or limited in free versions of existing tools, making it a standout feature in the proposed system

WebSocket technology is crucial for implementing real-time features, enabling bidirectional communication between the client and server. This ensures instant updates for notifications, task status changes, and collaborative activities, which is vital for dynamic academic project environments. For authentication, JSON Web Tokens (JWT) are employed. JWTs provide a secure and stateless mechanism for user authentication, allowing the backend to verify user identity without needing to store session information on the server, which is beneficial for scalability in a microservices architecture..

Additionally, the system incorporates local file storage to simplify the process of attaching and retrieving files related to tasks. This reduces reliance on third-party storage services, offering a more secure and efficient method for managing project-related documents. For academic use, where privacy and data security are important, this feature provides significant advantages.

The system’s simple and intuitive interface further distinguishes it from other tools. By focusing on usability, the system ensures that even users with minimal technical expertise can navigate and utilize its features effectively. Unlike other platforms that may overwhelm users with excessive options and settings, the proposed system is designed to be straightforward and accessible, making it ideal for small teams and academic environments.

Finally, the proposed system’s unique focus on student-specific needs sets it apart from existing solutions. By addressing common challenges faced in academic projects, such as task prioritization, progress tracking, and effective collaboration, the system enhances productivity and ensures that teams can meet their goals efficiently. This combination of features aligns with the project’s overarching aim to provide a cost-effective, user-friendly solution tailored to students' requirements.

2.6 Conclusion

In this chapter, a comprehensive review of existing task management systems, including Asana, Trello, and ClickUp, has been conducted. The strengths and limitations of these systems were analysed, and their applicability to academic settings was evaluated. While these tools offer various features, they often fall short in addressing the specific needs of students managing group projects.

The proposed Web-Based Online Task Management System aims to bridge this gap by offering features such as real-time notifications, user-centered access control, and local file storage, all tailored to enhance collaboration and task tracking in academic contexts. Unlike existing systems, the proposed solution is designed to be user-friendly, accessible, and focused on the unique requirements of small teams and students.

This literature review highlights the importance of developing a system that not only meets functional requirements but also addresses the usability and practicality challenges faced by its target users. The findings from this chapter will guide the design and implementation of the proposed system, ensuring that it effectively serves its intended purpose while providing a valuable learning experience for its developers.

Chapter 3: Requirement Analysis and Design

3.1 Introduction

This chapter focuses on the requirement analysis and design of the Web-Based Online Task Management System, providing a foundation for its development. The Agile methodology, specifically the Scrum framework, has been selected as the guiding approach for this project due to its adaptability, iterative structure, and focus on continuous improvement. Scrum's emphasis on collaboration and incremental progress ensures that the system can effectively address the limitations identified in Chapter 2 while meeting the objectives set in Chapter 1. This chapter outlines how Scrum is applied in this project, detailing the methodology, requirements elicitation process, and design tools used. Use case diagrams, sequence diagrams, and activity diagrams are incorporated to illustrate the system's behaviour and interactions, offering a comprehensive understanding of how the proposed system operates and fulfils its intended purpose.

3.2 Brief Description of Methodology

The Agile methodology, specifically the Scrum framework, has been chosen for the development of this Web-Based Online Task Management System. Scrum is a structured yet flexible approach to software development, designed to handle projects where requirements evolve over time. Its iterative nature and focus on collaboration and feedback make it an ideal methodology for this project, ensuring that the system aligns with user needs while addressing the gaps identified in Chapter 2.

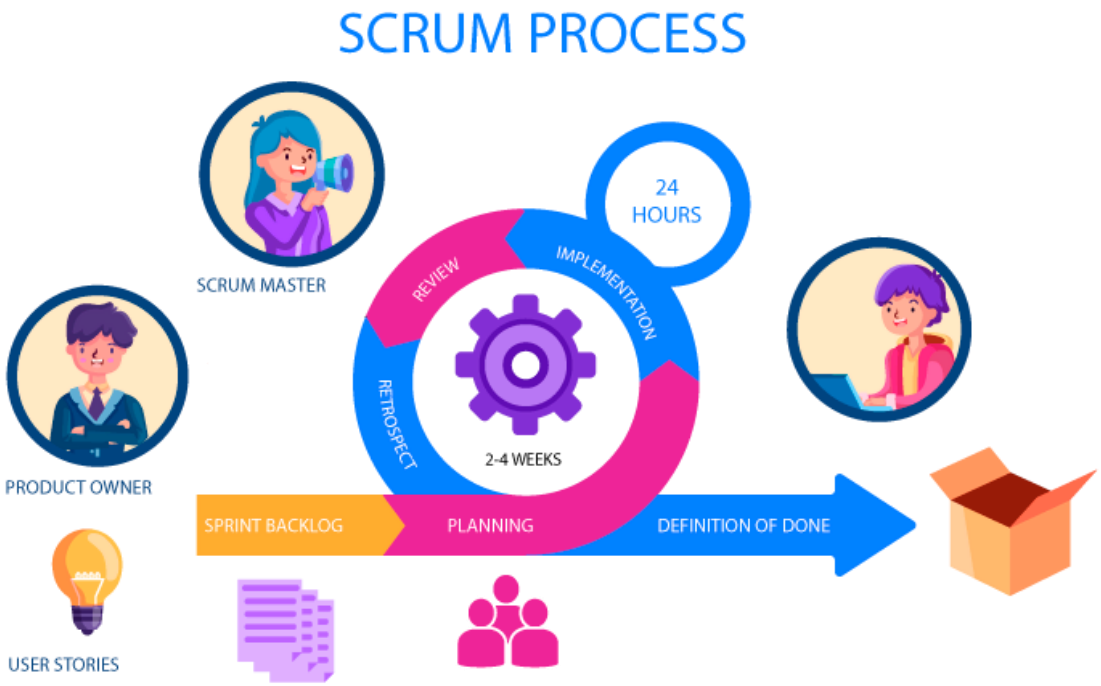

Figure 3-1 Scrum Process

Roles in Scrum

In a traditional Scrum setup, there are three primary roles: Scrum Master, Product Owner, and Scrum Team. However, as this is a personal Final Year Project, all these roles are undertaken by the developer, as detailed below:

a. **Scrum Master:**

   The developer acts as the Scrum Master, overseeing the entire development process. This includes ensuring adherence to Scrum principles, identifying and removing obstacles, and guiding the project toward its goals.

b. **Product Owner:**

   As the Product Owner, the developer defines the system's requirements, prioritizes features in the product backlog, and ensures that the project focuses on delivering value to its intended users—students and small academic teams.

c. **Scrum Team:**

   The developer also assumes the role of the Scrum Team, responsible for the technical tasks such as system design, implementation, testing, and debugging.

By taking on these roles, the developer ensures that all aspects of the project are managed effectively, maintaining consistency and focus throughout the development process.

Artifacts in Scrum

Scrum relies on three key artifacts to manage and document progress:

a. **Product Backlog:**

   This is a prioritized list of all the features and functionalities required for the system, based on the limitations of existing tools as identified in Chapter 2. For this project, the product backlog includes features such as user authentication, task creation, real-time notifications, user-centered access control, and local file storage. The product backlog acts as a roadmap, guiding the development process.

b. **Sprint Backlog:**

   From the product backlog, a subset of tasks is selected to be worked on during a specific sprint. This selection, called the sprint backlog, includes achievable goals that the developer commits to completing within the sprint's time frame. The sprint backlog ensures focused and incremental progress.

c. **Increment:**

   At the end of each sprint, the completed work constitutes an increment, representing a functional part of the system. Each increment adds value and moves the project closer to its final goal. For example, the completion of the user authentication module or the task creation functionality would be considered an increment.

Events in Scrum

The Scrum framework incorporates five key events to structure and guide the development process:

a. Sprint:

A sprint is a timeboxed development phase, typically lasting one to two weeks, during which the developer works on tasks identified in the sprint backlog. Each sprint results in an increment that contributes to the overall system.

b. Sprint Planning:

This event marks the beginning of each sprint. The developer selects tasks from the product backlog to include in the sprint backlog, prioritizing items based on importance and feasibility. This step ensures clear goals for the sprint and a realistic plan for achieving them. Tools used in this phase include Jira/Trello for backlog management.

c. Daily Scrum:

The Daily Scrum is a short meeting conducted every day during the sprint. In this project, the developer uses this time to evaluate progress, identify obstacles, and plan tasks for the next day. While traditionally a team event, this step is adapted for solo development to ensure continuous reflection and progress tracking.

d. Sprint Review:

At the end of each sprint, the increment is reviewed to ensure it meets the required standards and functionalities. For this project, the developer presents the increment to the Final Year Project supervisor to receive feedback and guidance. This feedback is incorporated into the subsequent sprint to refine the system.

e. Sprint Retrospective:

After the sprint review, the developer conducts a retrospective to reflect on what went well, what could be improved, and how to make the next sprint more effective. This event fosters continuous improvement in both the system and the development process.

Application of Scrum to the Proposed System

Since this project is a solo Final Year Project (FYP) with no external client, the Scrum framework is adapted to suit the unique needs of an individual developer working independently. This adaptation ensures that the principles of Scrum are followed while simplifying roles and processes to fit the context of the project.

In this adaptation, the developer assumes all three primary roles of Scrum—Scrum Master, Product Owner, and Scrum Team. As the Scrum Master, the developer manages the overall project timeline, monitors progress, resolves obstacles, and ensures adherence to Scrum principles. The Product Owner responsibilities are also undertaken by the developer, focusing on creating and prioritizing the Product Backlog. This involves defining user stories and features based on the requirements identified in Chapter 2 and ensuring that high-priority tasks are completed first. Acting as the Scrum Team, the developer is responsible for the technical implementation, testing, and refinement of the system throughout the development process. Specific tools used during the development phase include Git for version control, JUnit for backend unit testing, and React Testing Library for frontend testing. For potential future deployment, considerations for Docker/Kubernetes are noted for containerization and orchestration.

The Scrum artefacts and events are also tailored for this project. The Product Backlog contains all the features derived from the system requirements, categorized into tasks that can be completed within specific sprints. Each sprint is planned and executed with a subset of these tasks, referred to as the Sprint Backlog. The concept of an Increment remains integral, as the system evolves iteratively, with a functional version being delivered at the end of each sprint.

Although traditional Scrum involves collaboration within a team, this project replaces team interactions with self-assessment and feedback from the FYP supervisor, Dr. Muhammad Asyraf Bin Khairuddin. The Daily Scrum is adapted as a daily self-review session where the developer tracks progress, identifies challenges, and plans the next steps. The Sprint Review involves presenting the completed increment to the supervisor for constructive feedback. This feedback is critical to ensure the project aligns with academic and functional expectations. Additionally, a Sprint Retrospective is conducted after each sprint, allowing the developer to reflect on the process, identify areas for improvement, and apply these lessons in subsequent sprints.

The iterative nature of Scrum, combined with its emphasis on feedback and adaptability, makes it a suitable methodology for this project. This adaptation ensures that the proposed Web-Based Online Task Management System progresses in an organized and efficient manner, meeting both technical requirements and academic standards. By applying Scrum in this customized way, the developer is able to maintain a structured development process while continuously improving and addressing challenges throughout the project's lifecycle.

3.3 Requirement Analysis

Requirement analysis is a critical phase in software development that involves understanding and documenting the needs and expectations of users and stakeholders for the system being developed. For this project, the objective is to design and implement a Web-Based Online Task Management System tailored to the requirements of potential users, including students, professionals, and academic staff. The primary aim of the requirement analysis is to ensure that the system incorporates features that address user challenges and preferences effectively, making it user-friendly, efficient, and suitable for diverse environments.

To gather relevant data for this analysis, a combination of techniques such as surveys, interviews, and existing system studies is utilized. This ensures a comprehensive understanding of the needs, habits, and expectations of the target users. By doing so, the system can be designed to fulfil the users' requirements, while addressing the shortcomings of current task management tools. The information collected through these techniques forms the foundation for identifying functional and non-functional requirements, ensuring that the proposed system aligns with the end-users' expectations and delivers value effectively.

The questionnaire-based survey conducted for this project provides valuable insights into user preferences, the importance of specific system features, and potential improvements over existing tools. It also highlights the pain points experienced by users with current solutions, offering an opportunity to design a system that stands out in terms of usability, functionality, and efficiency. The following section elaborates on the results obtained from the survey and provides detailed analyses of the responses.

3.3.1 Requirement Elicitation from Questionnaire

To gather insights into the necessary features and functionality for the Web-Based Online Task Management System, a survey was conducted using a Google Form. The form was distributed to a total of 33 respondents, primarily consisting of students, along with a few working professionals, lecturers, and freelancers. The survey focused on understanding users' demographics, preferences, and challenges in using task management systems. The key findings and analysis of the responses are as follows:

Demographic Information

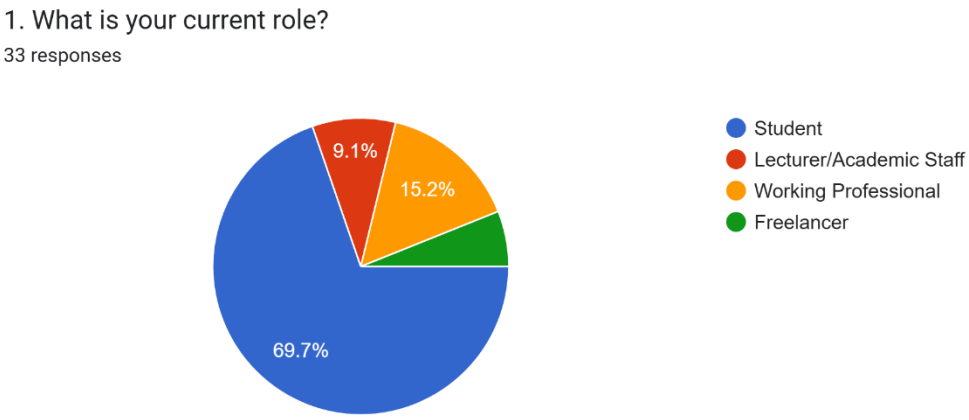

Figure 3-2Demographic Question 1

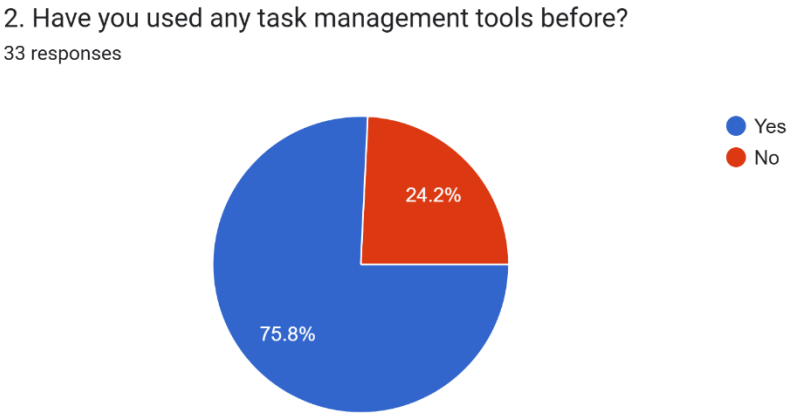

Figure 3-3 Demographic Question 2

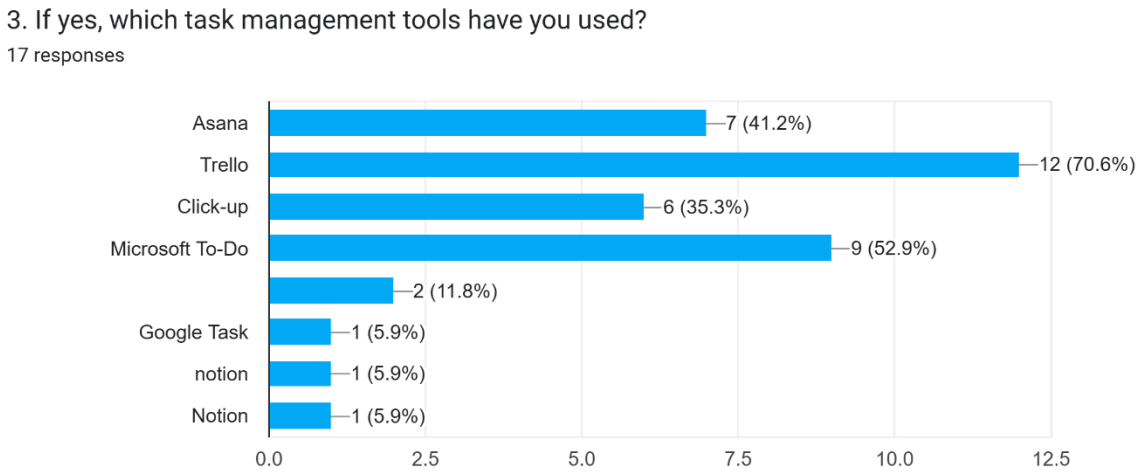

Figure 3-4 Demographic Question 3

Figure 3-5 Demographic Question 4

The respondents were categorized based on their current roles. The majority (approximately 70%) were students, aligning well with the primary target users of the system. The remaining respondents included working professionals (15%), lecturers/academic staff (10%), and freelancers (5%). This demographic distribution provided a balanced perspective, with an emphasis on students, who are expected to be the primary users of the task management system.

When asked about prior experience with task management tools, around 75% of the respondents confirmed they had used such tools, while 25% indicated no prior experience. Among those who had used task management tools, the most commonly mentioned platforms were Trello and Microsoft To-Do, followed by Asana and ClickUp. Some respondents also mentioned other tools like Notion and Google Tasks in the "Others" section. The frequency of usage varied, with 40% using task management tools daily, 30% weekly, 20% monthly, and 10% rarely. This

indicates that a significant proportion of users are frequent users of task management systems, emphasizing the need for a reliable and user-friendly solution.

System Features

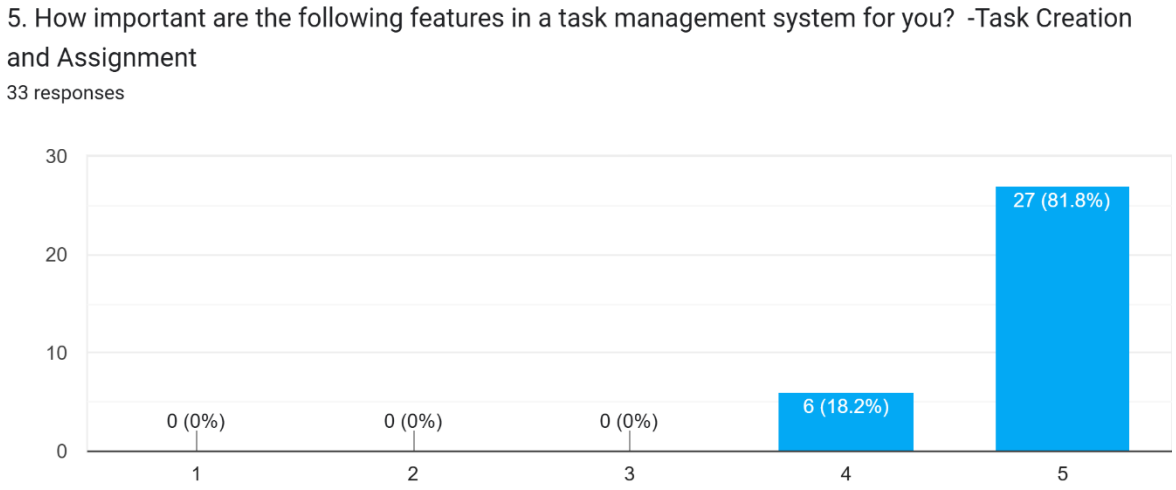

Figure 3-6 System Features Question 5.1

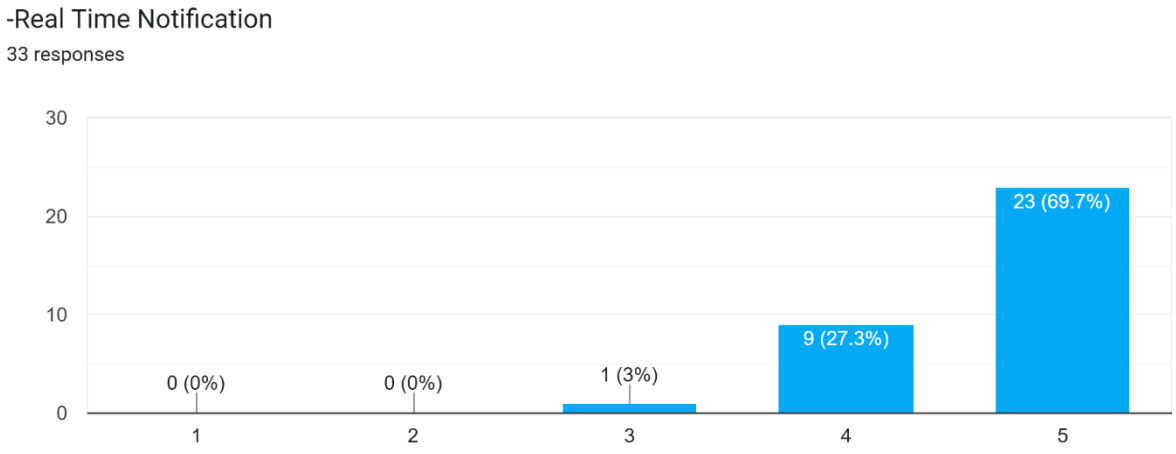

Figure 3-7 System Features Question 5.2

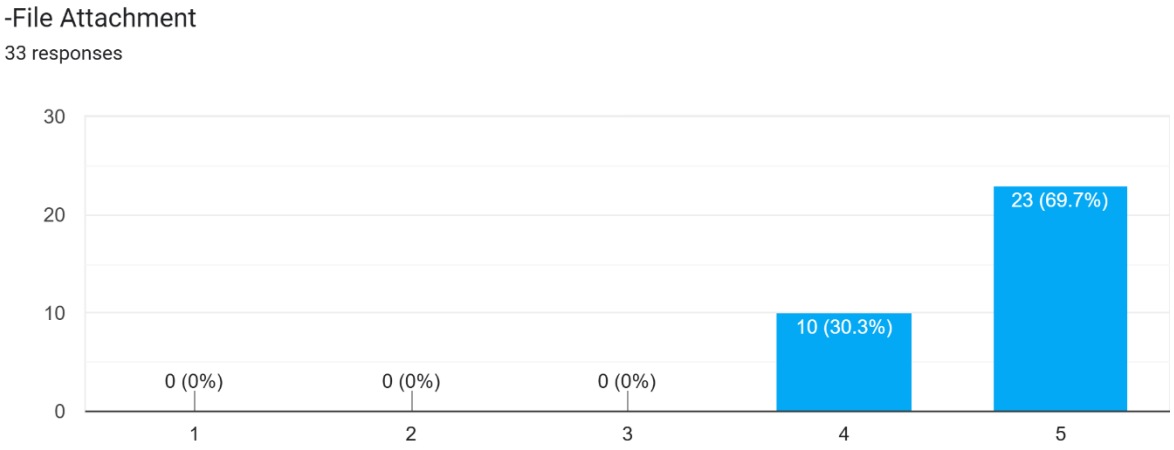

Figure 3-8 System Features Question 5.3

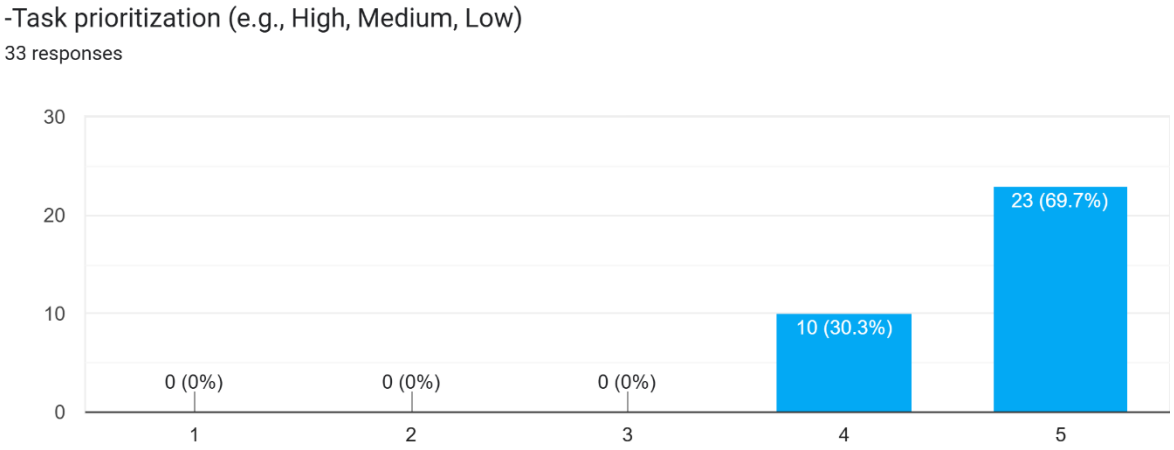

Figure 3-9 System Features Question 5.4

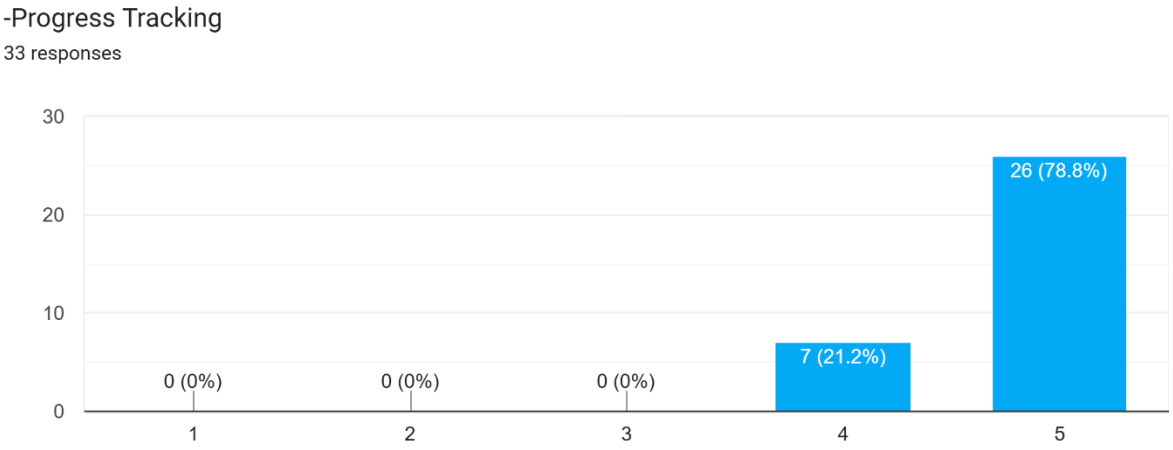

Figure 3-10 System Features Question 5.5

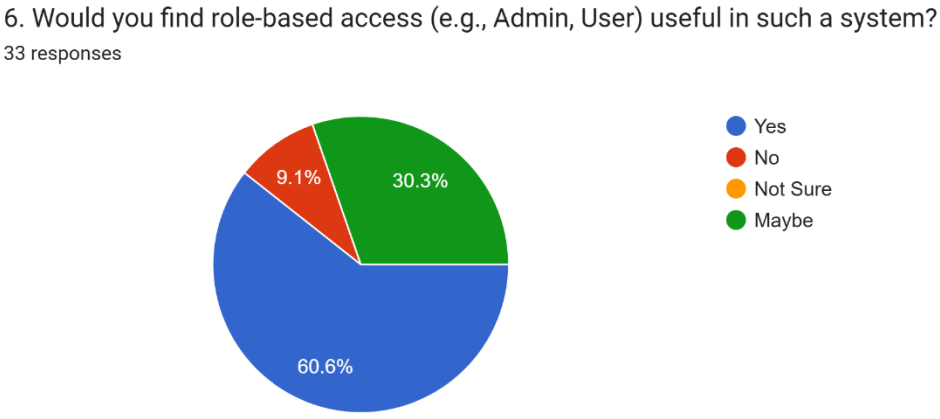

Figure 3-11 System Features Question 6

7. What type of notifications would you prefer for task updates?

33 responses

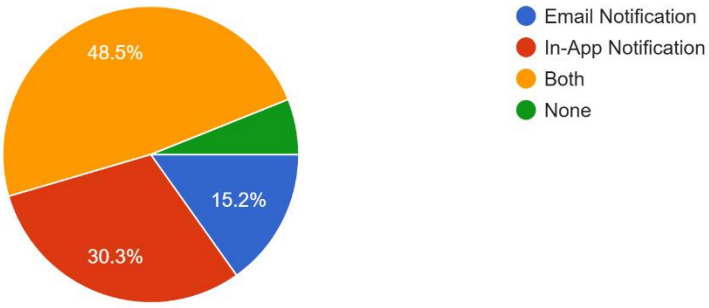

Figure 3-12 System Features Question 7

8. What device would you primarily use to access the system?

33 responses

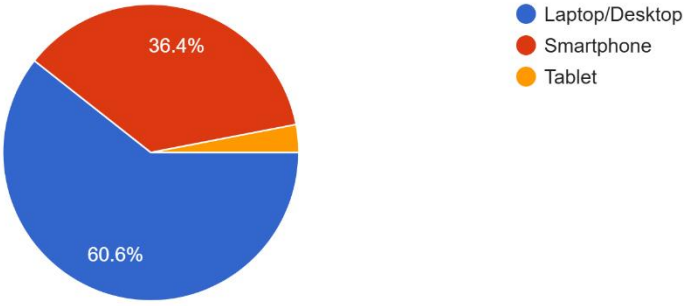

Figure 3-13 System Features Question 8

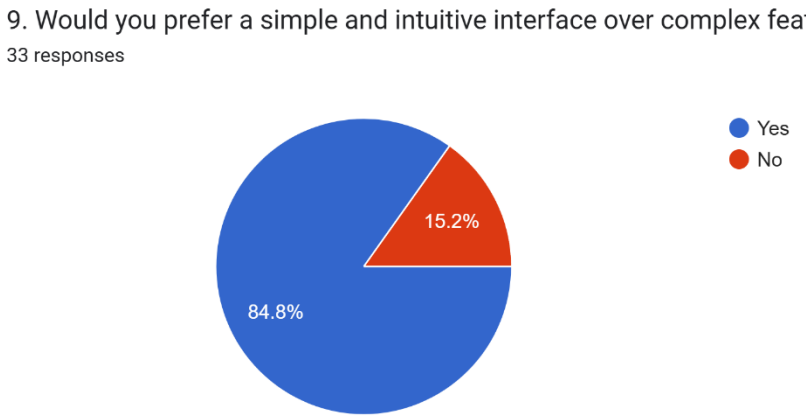

Figure 3-14 System Features Question 9

The survey provided critical insights into the key features that respondents deemed essential for a task management system. Participants were asked to rate the importance of various system features on a linear scale ranging from 1 (Not Important) to 5 (Very Important). The results offer a comprehensive understanding of user priorities, enabling the design of a system that aligns with user preferences. Below is an expanded analysis of the results:

- **Task Creation and Assignment**

  Task creation and assignment received the highest average score of 4.82, indicating that this is the most critical feature for the majority of respondents. Users require the ability to easily create tasks and assign them to team members or themselves, emphasizing the need for an intuitive interface for task creation. This feature forms the foundation of any task management system, as it ensures that users can quickly organize their workload and delegate responsibilities efficiently. The high rating highlights the demand for a straightforward and efficient mechanism for managing tasks.

- **Progress Tracking**

  Progress tracking was rated as the second most important feature with an average score of 4.79. Respondents indicated that they value the ability to monitor the status of tasks in real-time. This feature allows users to stay updated on the progress of their projects, providing transparency and accountability. Progress tracking is particularly beneficial for collaborative environments, as it enables team members to track milestones and ensure timely completion of tasks. The feedback underscores the importance of integrating clear progress indicators, such as visual dashboards or progress bars, into the system.

- **Task Prioritization**

  Task prioritization received an average score of 4.7, highlighting its significance in helping users manage their workload effectively. Respondents expressed a need for categorizing tasks based on priority levels (e.g., high, medium, low) to ensure that critical tasks are completed on time. This feature is essential for individuals managing multiple responsibilities, as it enables them to focus on the most urgent tasks first. The results emphasize the importance of providing users with flexibility and customization options for task prioritization.

- **File Attachments**

File attachment functionality also scored an average of 4.7, reflecting its relevance for respondents who rely on sharing and accessing files within their task management workflows. Users highlighted the need to attach files, such as documents, spreadsheets, or images, directly to tasks for better organization and collaboration. This feature is especially important for teams working on projects that require frequent document sharing. The data suggests that a streamlined file attachment process would enhance the usability and productivity of the system.

- **Real-Time Notifications**

  Real-time notifications were rated 4.67 on average, demonstrating the value of instant updates for task-related activities. Respondents indicated that they prefer receiving notifications to stay informed about task changes, deadlines, or assignments. Notifications play a crucial role in maintaining effective communication and ensuring that users remain engaged with the system. The slightly lower score compared to other features suggests that while notifications are important, users may prefer them to be non-intrusive and customizable to avoid notification fatigue.

Overall, the responses indicate that all five features are highly valued by users and should be prioritized during system development. Task creation and assignment, progress tracking, task prioritization, file attachments, and real-time notifications collectively form the core functionality of the system. These features will significantly enhance the usability and efficiency of the task management system, meeting the needs of both individual users and collaborative teams. By addressing these requirements, the proposed system can establish itself as a comprehensive and user-friendly solution for task management.

Regarding user-centered access, 60% of the respondents found it useful, 30% were unsure, and 10% did not consider it necessary. This highlights the potential demand for role differentiation, especially in collaborative or organizational contexts. For notifications, the majority (50%) preferred both email and in-app notifications, while 30% opted for in-app notifications alone and 15% for email notifications. This preference indicates the need for a dual notification system to cater to varying user requirements. The most preferred device for accessing the system was laptops/desktops (60%), followed by smartphones (35%) and tablets (5%). This reflects the importance of designing a responsive interface compatible with both desktop and mobile devices. Additionally, 85% of respondents expressed a strong preference for a simple and intuitive interface over complex features, underscoring the importance of user-friendly design.

Preferences and Challenges

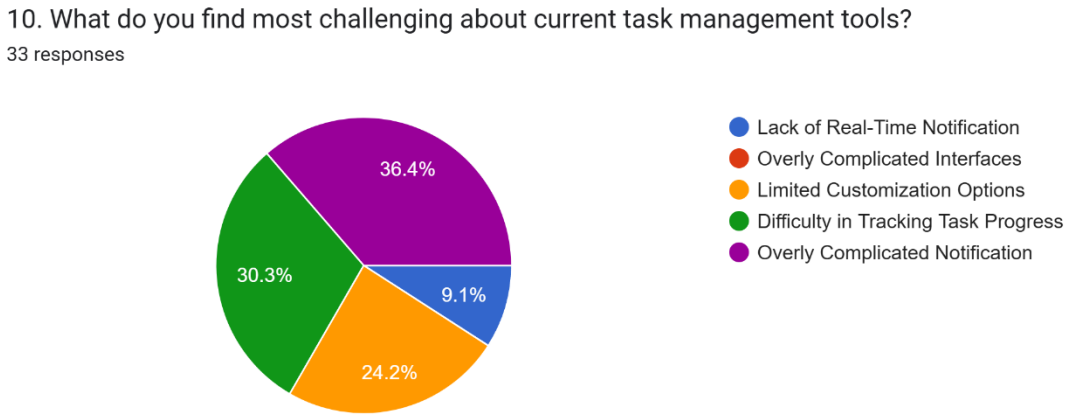

Figure 3-15 Preferences and Challenges Question 10

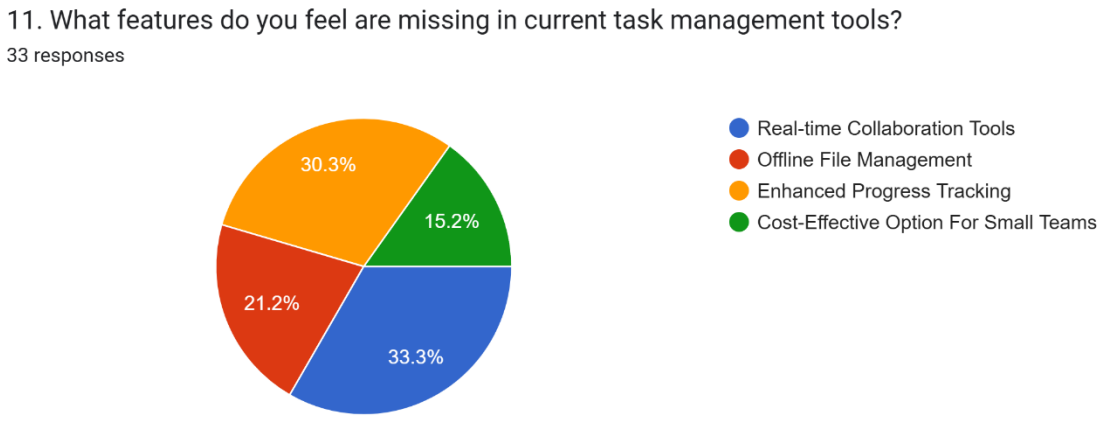

Figure 3-16 Preferences and Challenges Question 11

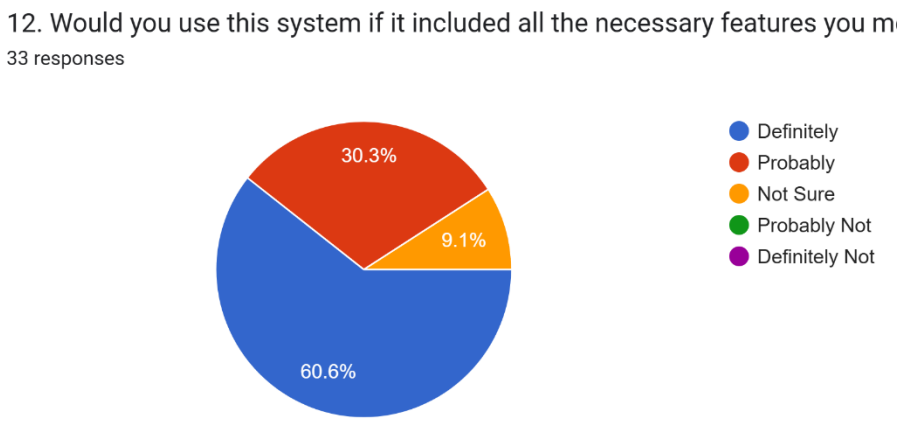

Figure 3-17 Preferences and Challenges Question 12

The survey delved into the challenges users face with current task management tools. The most common issues identified were overly complicated interfaces (36%) and difficulty in tracking task progress (30%). Other challenges included limited customization options (24%) and a lack of real-time notifications (10%). These responses indicate the need to focus on creating a streamlined, customizable, and easy-to-navigate system that simplifies progress tracking and ensures timely notifications.

Respondents were also asked about missing features in current tools. Real-time collaboration tools (35%) and enhanced task progress tracking (30%) emerged as the most desired features, followed by offline file management (20%) and cost-effective options for small teams (15%). This feedback emphasizes the importance of incorporating collaborative features and robust progress tracking mechanisms while keeping the system affordable for smaller user groups.

When asked about their likelihood of using the proposed system if it included the necessary features, 60% of respondents indicated they would "Definitely" use it, while 30% chose "Probably." Only 10% were unsure or unlikely to use the system, reflecting a high level of interest and potential adoption among the target audience.

Final Feedback

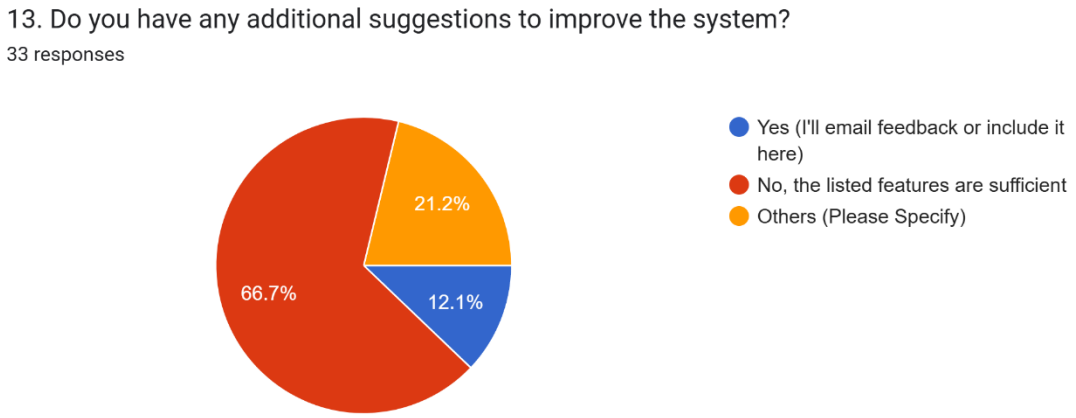

Figure 3-18 Final Feedback Question

In the final section, respondents were invited to share additional suggestions for improving the system. While 67% stated that the listed features were sufficient, 21% provided suggestions such as integrating calendar synchronization, enabling offline access, and ensuring data security. The remaining 12% preferred to email their feedback later. These suggestions provide valuable insights for refining the system further to meet user needs comprehensively.

In conclusion, the survey results highlighted the critical requirements for the Web-Based Online Task Management System. By addressing users' challenges and preferences, such as simplifying the interface, enhancing task tracking, and including real-time collaboration tools, the system can effectively cater to its target audience and achieve widespread adoption.

3.4 Software Requirements

The development of the Web-Based Online Task Management System necessitates the use of several software tools and platforms that streamline the development, testing, and deployment processes. These software tools are selected based on compatibility, ease of use, and integration capabilities with the selected programming language, frameworks, and database.

Key Requirements:

- **Operating System:**

  The project will be developed on Windows 10 as it is stable, widely supported, and compatible with all necessary development tools.

- **Frontend Development**:

  Node.js (version 16.x or later)
  npm (version 8.x or later)
  React.js (version 18.x)
  Material-UI

VS Code with relevant extensions (e.g., ESLint, Prettier, React Developer Tools)

- **Backend Development:**

  JDK 19
  Spring Boot 3.5.3
  Maven (for dependency management and build automation)
  Spring Tool Suite (STS) or IntelliJ IDEA (for efficient development and debugging)

- **Database Management System:**

  MySQL is selected for data storage due to its reliability, scalability, and ease of integration with Java-based applications.
  MySQL 8.0
  MySQL Workbench (for database management and querying)

- **Version Control System:**

  Git and GitHub are employed for source code management, versioning, and collaboration.

- **API Testing:**

  Postman (for testing REST API endpoint)
  Swagger UI (for API documentation and interactive testing)

- **Browser Compatibility Testing:**

  Google Chrome and Mozilla Firefox are used to test the interface and responsiveness of the application

Table 3-1 Software Requirement

Software Requirement	Details
Operating System	Window 10 or later
Frontend Development	Node.js (16.x+), npm (8.x+), React.js (18.x), Material-UI, VS Code
Backend Development	JDK 19, Spring Boot 3.5.3, Maven, Spring Tool Suite/IntelliJ IDEA
Database	MySQL 8.0, MySQL Workbench
API Testing	Postman, Swagger UI
Version Control	Git and Github
Browser	Google Chrome, Mozilla Firefox

3.5 Hardware Requirements

The hardware requirements for this project ensure smooth execution of development tools, efficient data processing, and a responsive testing environment. The specifications listed below are designed to support development, testing, and deployment activities effectively.

Key Requirements:

- **Processor:**

  A multi-core processor such as AMD Ryzen 7 (4800H) is required to handle simultaneous tasks, including IDE execution, database queries, and web rendering.

- **RAM:**

  At least 16 GB of RAM is needed to run multiple tools and services concurrently without performance degradation.

- **Storage:**

  A 1 TB SSD provides fast data access and sufficient space for storing project resources and files.

- **Display:**

  A Full HD monitor (1920 x 1080) ensures clear visualization of the user interface during testing and debugging.

- **Internet Connectivity:**

  A stable internet connection is essential for accessing cloud repositories, documentation, and performing real-time testing.

Table 3-2 Hardware Requirement

Hardware	Requirement
Processor	AMD Ryzen 7 (4800H) or equivalent)
RAM	16 GB or higher
Storage	1 TB SSD
Display	Full HD Monitor (1920 x 1080)
Peripheral Devices	Keyboard, Mouse
Network	Stable Internet Connection

3.6 Use Case Diagram

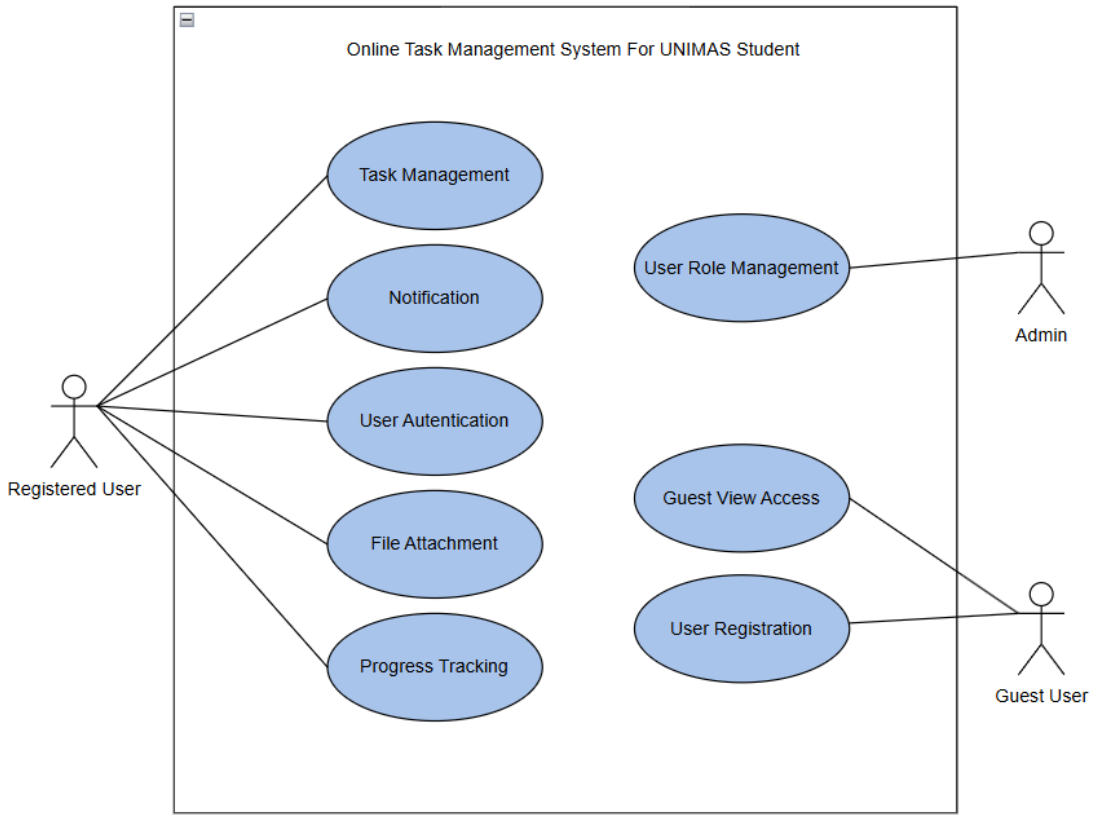

Figure 3-19 Use Case Diagram for Task Management System

3.6.1 Use Case Description

The use case description details the interactions and steps for achieving specific functionalities within the system for students and administrators, as shown in Table 3.3 – Table 3.7.

Table 3-3 User Registration Description

Use Case Name	User Registration
Actor	Guest User
Description	Allows guest users to register and create an account to access system features.
Precondition	Guest users must have access to the registration page.
Postcondition	A new user account is created and stored in the database.
Normal Flow	1. Guest navigates to the registration page. 2. Guest fills out required fields (username, password, etc.).

	3. System validates input and creates an account. 4. Guest is redirected to the login page.
Alternative Flow	1. Required fields are incomplete. 2. System prompts the user to fill in missing fields.
Exception	1. Database error prevents account creation. 2. System displays an error message.
Priority	High

Table 3-4 User Authentication Description

Use Case Name	User Authentication
Actor	Registered User
Description	Enables secure login and logout functionality.
Precondition	User must have valid login credentials.
Postcondition	User is authenticated and redirected to the dashboard.
Normal Flow	1. User enters username and password. 2. System verifies credentials. 3. User logs in successfully.
Alternative Flow	1. Invalid credentials entered. 2. System displays an error message.
Exception	1. Network failure prevents authentication. 2. User retries later.
Priority	High

Table 3-5 Task Management Description

Use Case Name	Task Management
Actor	Registered User
Description	Enables users to create, update, delete, and assign tasks.

Precondition	User must be logged in.
Postcondition	Task details are saved or updated in the database.
Normal Flow	1. User selects task management. 2. User creates or updates a task. 3. Task details are saved successfully.
Alternative Flow	1. User attempts to save incomplete task details. 2. System prompts the user to fill in missing fields.
Exception	1. Network failure prevents task updates. 2. System displays an error message.
Priority	High

Table 3-6 File Attachment Description

Use Case Name	File Attachment
Actor	Registered User
Description	Allows users to upload files and attach them to tasks.
Precondition	User must be logged in and working with an active task.
Postcondition	File is uploaded and linked to the task.
Normal Flow	1. User selects a task. 2. User uploads a file. 3. File is attached successfully.
Alternative Flow	1. Unsupported file format detected. 2. System prompts for valid file format.
Exception	1. Network error prevents file upload. 2. System notifies user of failure.
Priority	Medium

Table 3-7 Notification Description

Use Case Name	Notification
Actor	Registered User
Description	Sends real-time notifications for task updates.
Precondition	User must be logged in and assigned to a task.
Postcondition	Notifications are delivered successfully.
Normal Flow	1. System detects a task update. 2. Notification is sent to the user. 3. User views notification.
Alternative Flow	1. Notification fails to deliver. 2. System retries later.
Exception	1. Network issues prevent delivery. 2. Notification appears after reconnection.
Priority	High

3.7 Sequence Diagram

The sequence diagram for APTS is shown in Figure to illustrates the sequence of interactions between objects or components in a system over time.

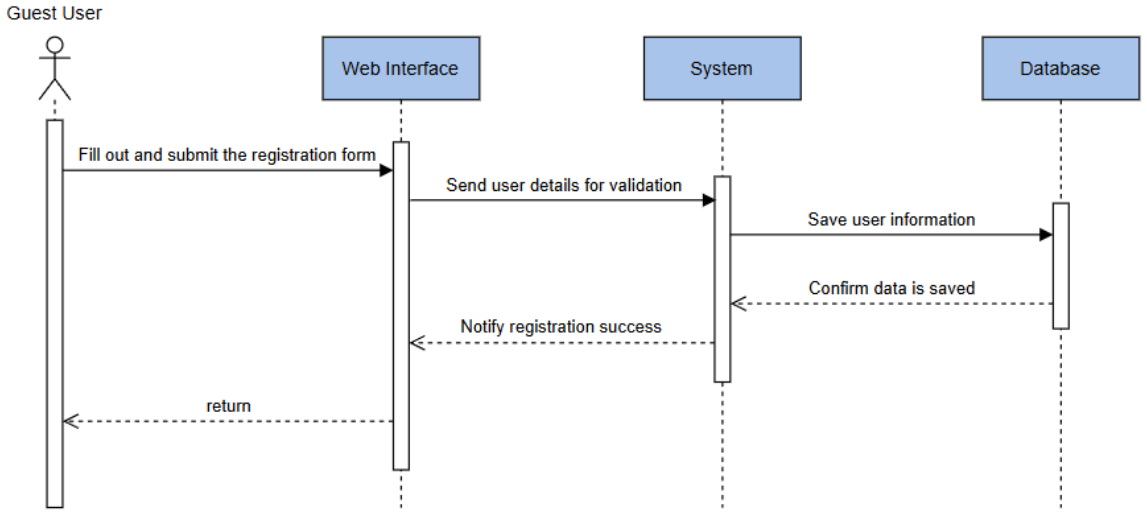

Figure 3-20 Sequence Diagram for User Registration

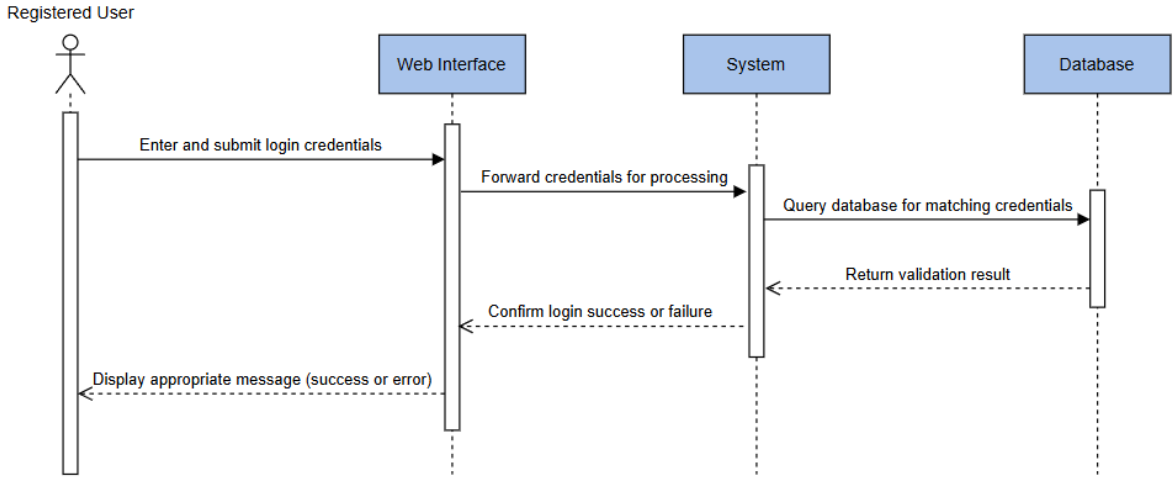

Figure 3-21 Sequence Diagram for User Authentication

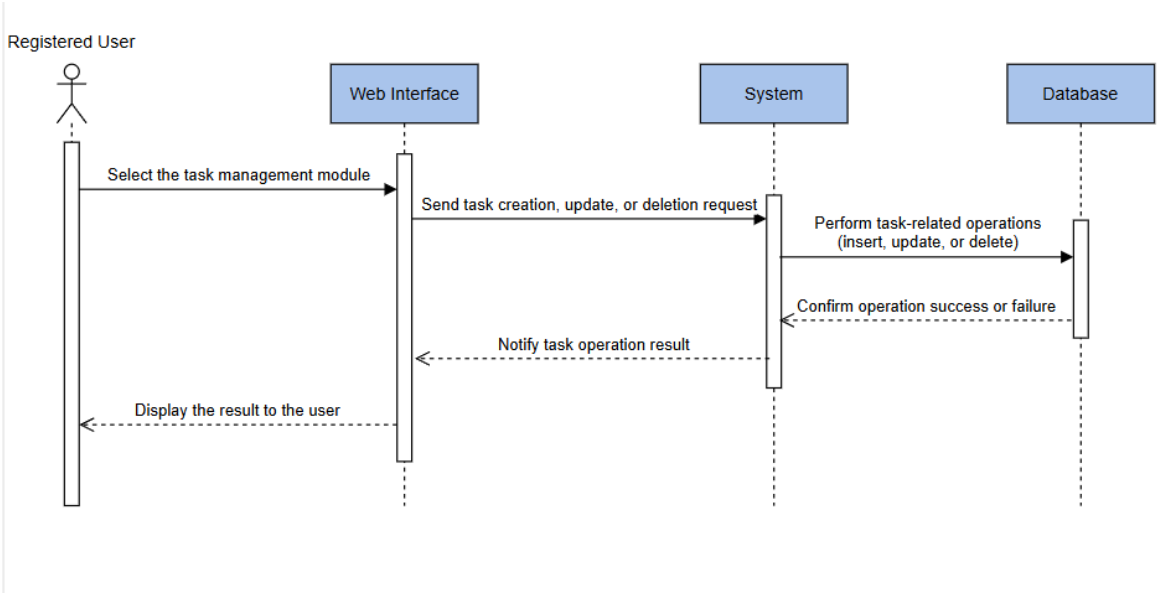

Figure 3-22 Sequence Diagram for Task Management

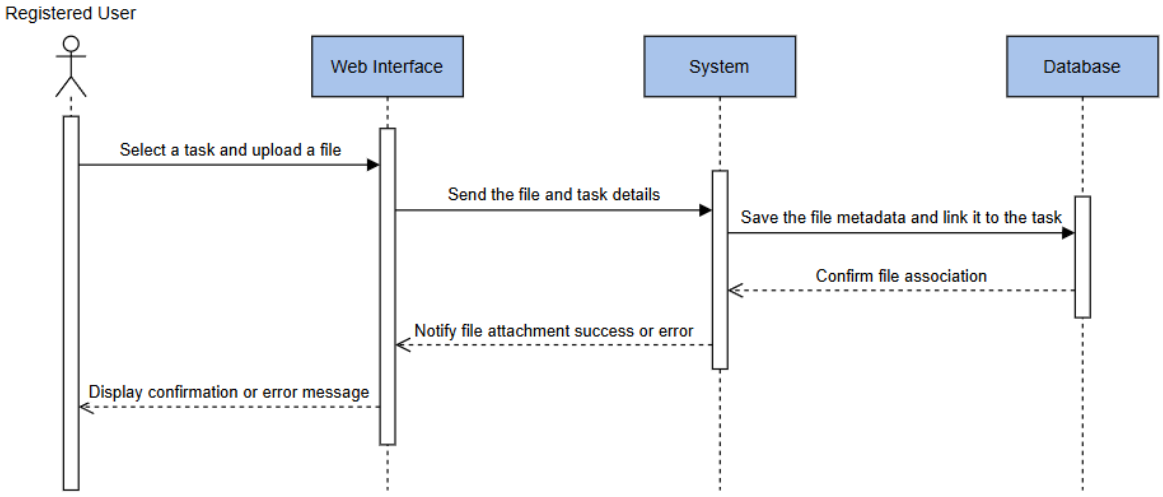

Figure 3-23 Sequence Diagram for File Attachment

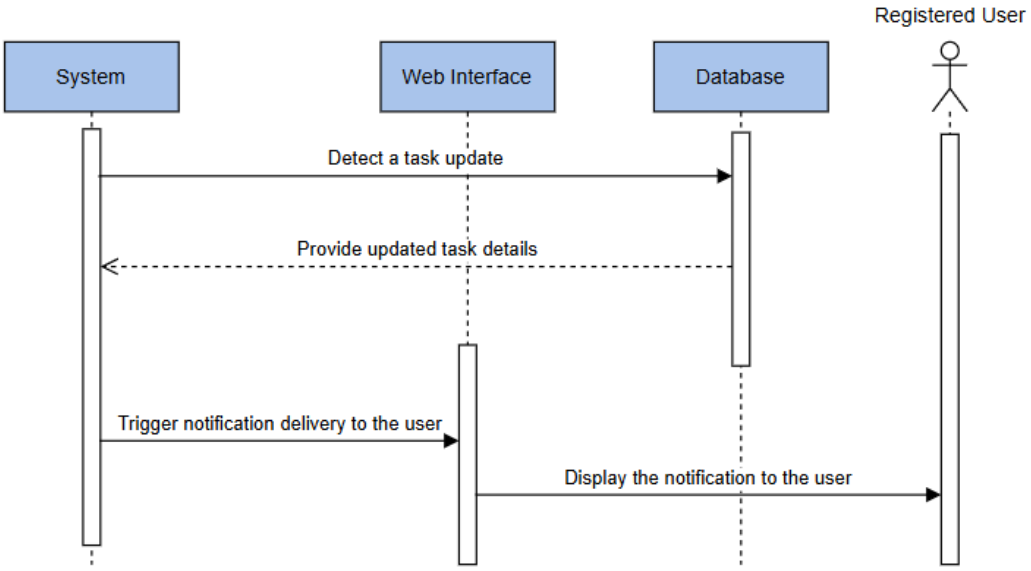

Figure 3-24 Sequence Diagram for Notification

3.8 ERD

The Entity Relationship Diagram (ERD) for the Web-Based Online Task Management System provides a visual representation of the database structure, illustrating the entities (tables), their attributes (columns), and the relationships between them. This ERD is designed to support user management, task management, file attachments, and notifications, reflecting a user-cantered design approach where user interactions and data are central.

Table 3-8 Users Table

Entities	Attributes
user_id	(Primary Key, INT, Auto-increment)
username	(VARCHAR, Unique, NOT NULL)
email	(VARCHAR, Unique, NOT NULL)

password_hash	(VARCHAR, NOT NULL)
created_at	(TIMESTAMP, Default CURRENT_TIMESTAMP)
last_login	(TIMESTAMP, Nullable)
display_name	(VARCHAR, Nullable)
profile_picture_url	(VARCHAR, Nullable)

Table 3-9 Tasks Table

Entities	Attributes
task_id	(Primary Key, INT, Auto-increment)
title	(VARCHAR, NOT NULL)
description	(TEXT, Nullable)
status	(ENUM('To Do', 'In Progress', 'Completed', 'Blocked'), Default 'To Do', NOT NULL)
priority	(ENUM('Low', 'Medium', 'High', 'Urgent'), Default 'Medium', NOT NULL)
due_date	(DATE, Nullable)
created_at	(TIMESTAMP, Default CURRENT_TIMESTAMP)

updated_at	(TIMESTAMP, Default CURRENT_TIMESTAMP ON UPDATE CURRENT_TIMESTAMP)

Table 3-10 Comments Table

Entities	Attributes
comment_id	(Primary Key, INT, Auto-increment)
task_id	(Foreign Key to Tasks.task_id, INT, NOT NULL)
user_id	(Foreign Key to Users.user_id, INT, NOT NULL)
comment_text	(TEXT, NOT NULL)
created_at	(TIMESTAMP, Default CURRENT_TIMESTAMP)

Table 3-11 File_Attachment Table

Entities	Attributes
attachment_id	(Primary Key, INT, Auto-increment)
task_id	(Foreign Key to Tasks.task_id, INT, NOT NULL)
user_id	(Foreign Key to Users.user_id, INT, NOT NULL)
file_name	(VARCHAR, NOT NULL)

file_path	(VARCHAR, NOT NULL) -- Path to the file in local storage
file_type	(VARCHAR, Nullable)
file_size -- Size in bytes	(INT, Nullable) -- Size in bytes
uploaded_at	(TIMESTAMP, Default CURRENT_TIMESTAMP)

Table 3-12 Notifications Table.

Entities	Attributes
notification_id	(Primary Key, INT, Auto-increment)
user_id -- User who receives the notification	(Foreign Key to Users.user_id, INT, NOT NULL)
task_id -- Optional: if notification is task-related	(Foreign Key to Tasks.task_id, INT, Nullable) -- Optional: if notification is task-related
type	(ENUM('Task Assigned', 'Task Updated', 'Comment Added', 'Due Date Approaching'), NOT NULL)
message	(TEXT, NOT NULL)
is_read	(BOOLEAN, Default FALSE, NOT NULL)
created_at	(TIMESTAMP, Default CURRENT_TIMESTAMP)

3.8.1 Relationship and Constraint

User to Task (Created By):

- Relationship: One-to-Many. One User can create many Tasks.
- Constraint: Tasks.created_by_user_id references Users.user_id. (Foreign Key)

User to Task (Assigned To):

- Relationship: One-to-Many. One User can be assigned to many Tasks.
- Constraint: Tasks.assigned_to_user_id references Users.user_id. (Foreign Key, Nullable as a task might not be assigned yet)

User to Comment:

- Relationship: One-to-Many. One User can make many Comments.
- Constraint: Comments.user_id references Users.user_id. (Foreign Key)

Task to Comment:

- Relationship: One-to-Many. One Task can have many Comments.
- Constraint: Comments.task_id references Tasks.task_id. (Foreign Key)

User to FileAttachment:

- Relationship: One-to-Many. One User can upload many FileAttachments.
- Constraint: File_Attachments.user_id references Users.user_id. (Foreign Key)

Task to FileAttachment:

- Relationship: One-to-Many. One Task can have many FileAttachments.
- Constraint: File_Attachments.task_id references Tasks.task_id. (Foreign Key)

User to Notification:

- Relationship: One-to-Many. One User can receive many Notifications.
- Constraint: Notifications.user_id references Users.user_id. (Foreign Key)

Task to Notification:

- Relationship: One-to-Many (Optional). One Task can trigger many Notifications.
- Constraint: Notifications.task_id references Tasks.task_id. (Foreign Key, Nullable as some notifications might not be directly task-related, e.g., system announcements).

This comprehensive ERD ensures data integrity, efficient retrieval, and proper relationships between all critical components of the task management system, supporting its user-cantered design.

Chapter 4: Implementation

4.1 Introduction

This chapter provides a comprehensive documentation of the implementation process for the UNIMAS Task Management System. The system was developed using a modern technology stack that includes Java Spring Boot for the backend, React.js for the frontend, and MySQL for database management. The implementation followed a structured approach with careful consideration of software architecture patterns, security requirements, and user experience design. Each component of the system was implemented with attention to detail, ensuring that the final product meets the functional requirements outlined in the previous chapters while maintaining scalability, performance, and maintainability.

The implementation process involved setting up the development environment, configuring essential services, developing core functionalities, and integrating various components into a cohesive system. This chapter documents each step of the implementation process, providing detailed explanations of the technologies used, design decisions made, and challenges encountered during development. Screenshots of key interfaces and visual representations of system components are included to illustrate the implementation outcomes.

4.2 Development Environment Setup

The successful development of the Web-Based Online Task Management System necessitated a robust and well-configured development environment. This section details the installation and configuration of the essential software components, ensuring compatibility and optimal performance throughout the development lifecycle.

4.2.1 Java Development Kit (JDK) Installation

The Java Development Kit (JDK) version 19 was installed to provide the runtime environment and development tools crucial for the backend application. The installation process involved downloading the official JDK installer from Oracle's website, executing the installer with administrative privileges, and meticulously configuring the JAVA_HOME environment variable. This variable is paramount as it directs the operating system to the JDK installation directory, enabling the location of Java executables and libraries. The successful installation was verified by executing the java -version command in the command prompt, which displayed the installed Java version information, confirming its readiness for Spring Boot development.

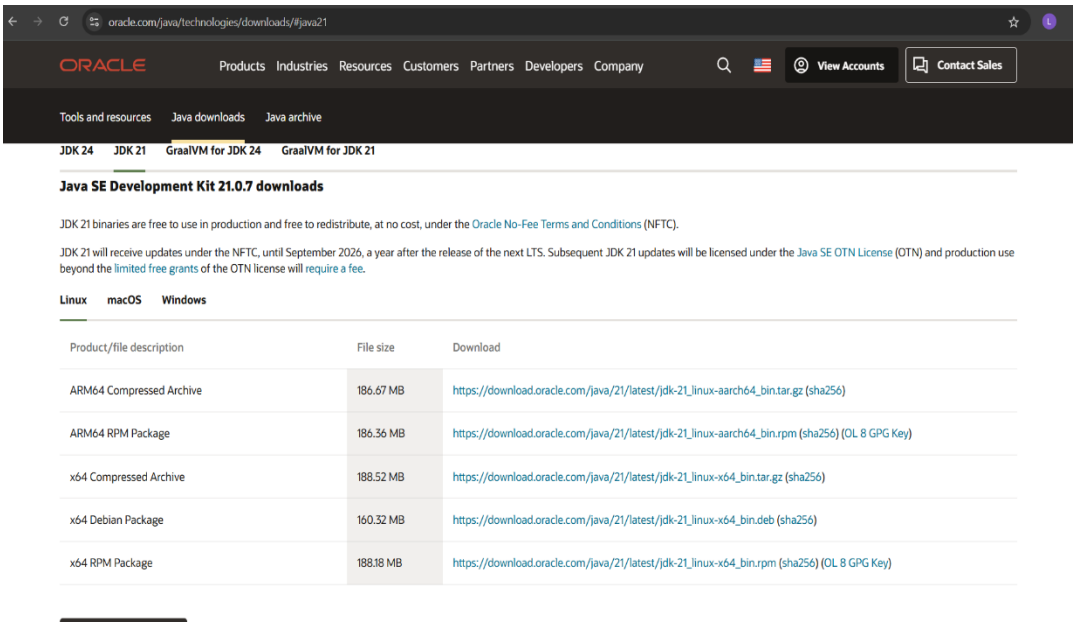

Figure 4-1 Java JDK package download

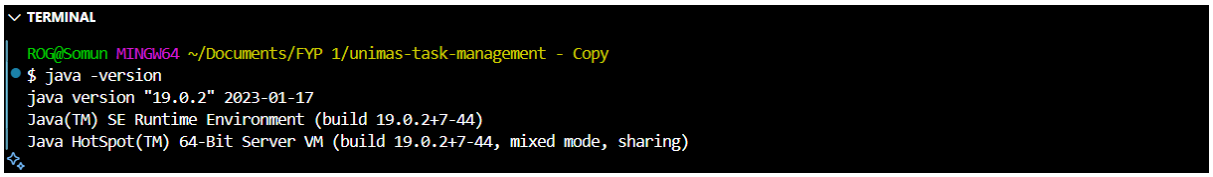

Figure 4-2 Java version Check

4.2.2 Spring Boot Framework Configuration

Spring Boot version 3.5.3 was selected as the primary backend framework due to its "convention-over-configuration" approach, which significantly accelerates development, and its robust features for building production-ready applications. The project was initialized using Spring Initializer, a web-based tool that generates a basic project structure with pre-configured build files, streamlining the initial setup. Maven was employed as the build automation tool, responsible for managing project dependencies, compiling source code, and handling the project lifecycle. The application.properties file, a central configuration file, was meticulously configured with essential parameters. These included database connection details (e.g., URL, username, password), server port settings, a unique JWT secret key for secure token generation, and credentials for the email service. This comprehensive configuration ensures that the Spring Boot application can seamlessly interact with the database, handle secure authentication, and send notifications.

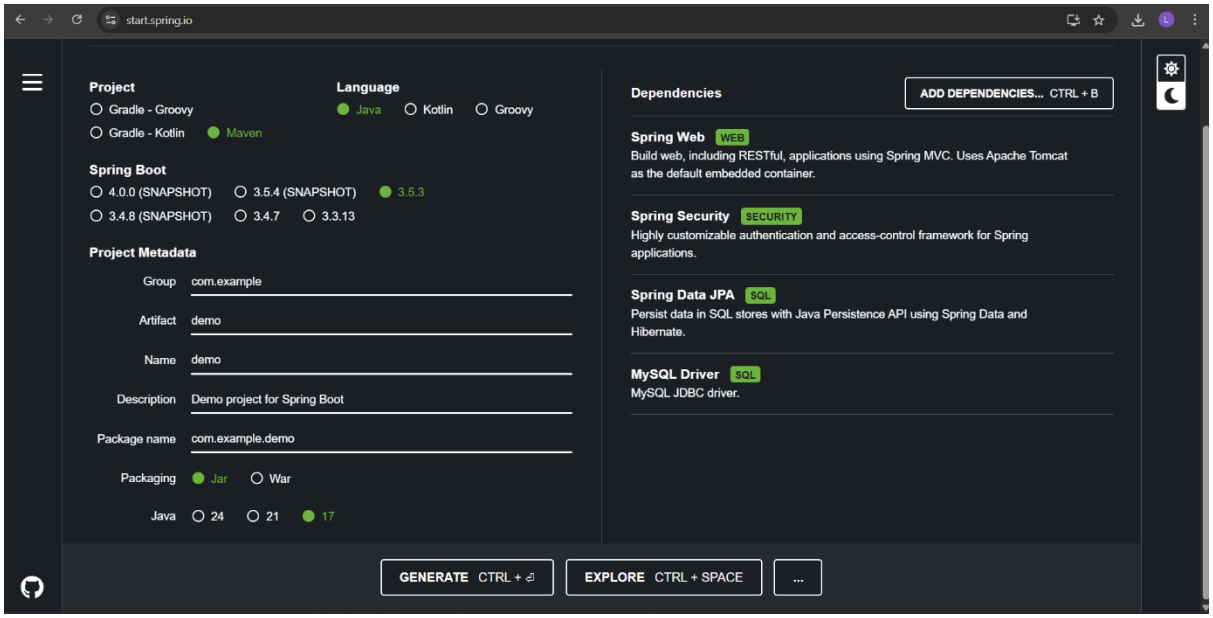

Figure 4-3 Spring Initializr for spring package

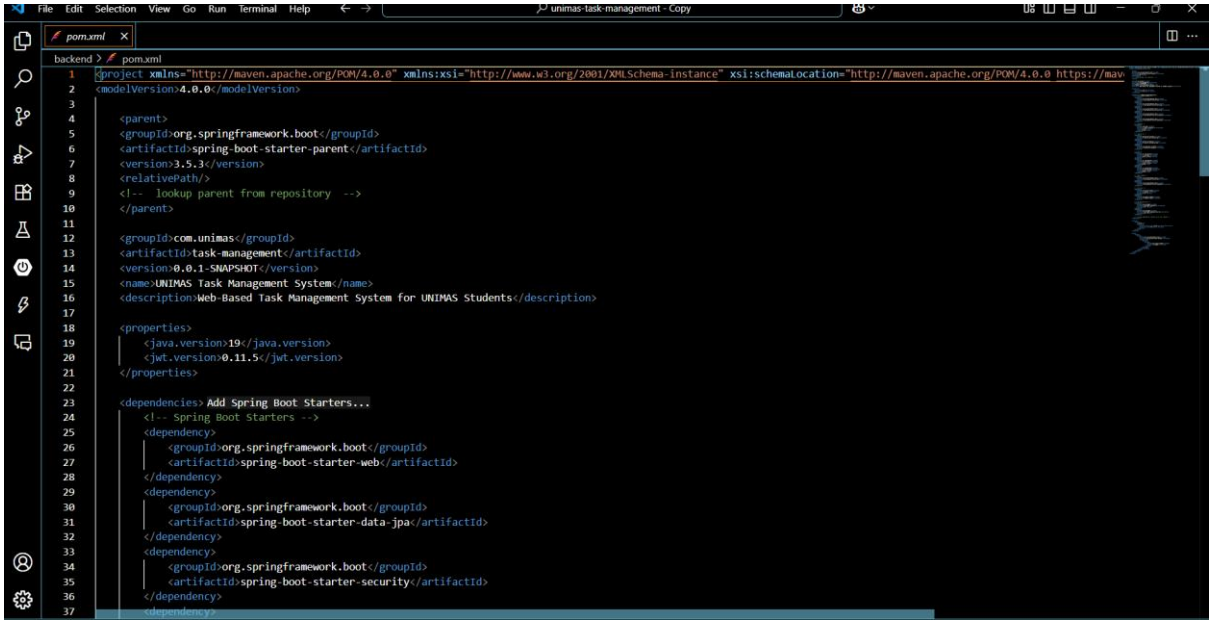

Figure 4-4 Spring Configuration in Pom.xml

4.2.3 MySQL Database Configuration

MySQL Community Server 8.0 was installed and configured as the relational database management system for persistent data storage. The installation process involved creating a root user with a strong, secure password and configuring the server to accept connections on the default port 3306. MySQL Workbench, a graphical user interface tool, was extensively used to design and manage the database schema. Within MySQL Workbench, the database schema was created, tables for users, tasks, notifications, and file attachments were defined, and appropriate constraints (e.g., primary keys, foreign keys, unique constraints) were established to ensure data integrity and enforce relationships between entities. This meticulous database design is crucial for maintaining the consistency and reliability of the system's data.

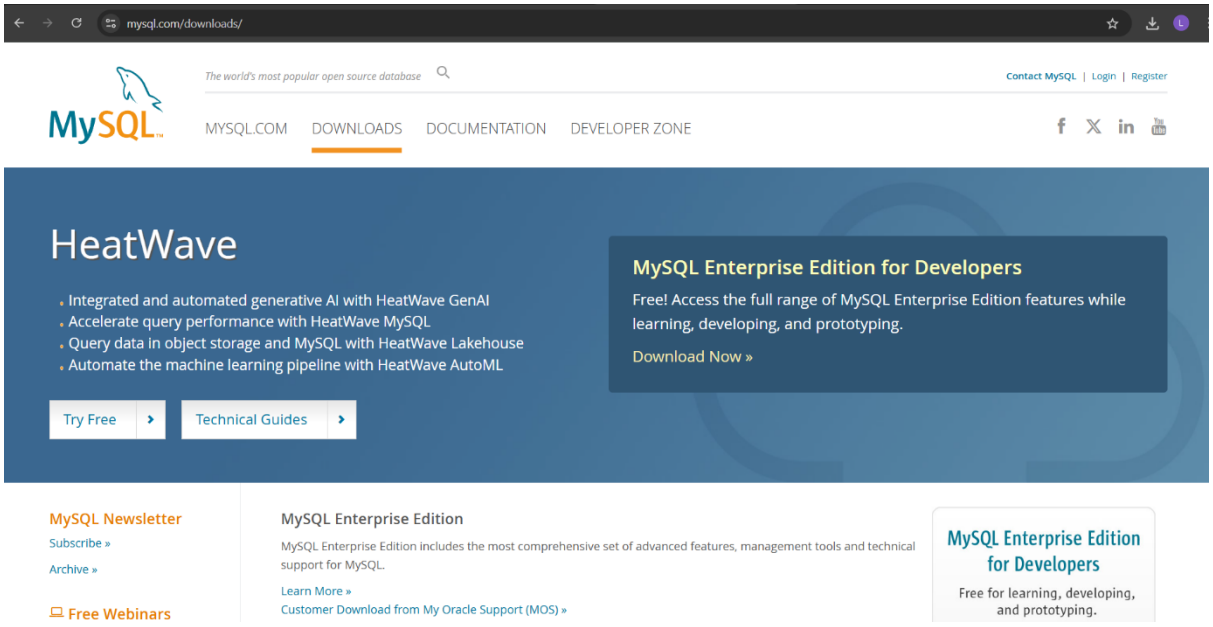

Figure 4-5 MySQL Download page.

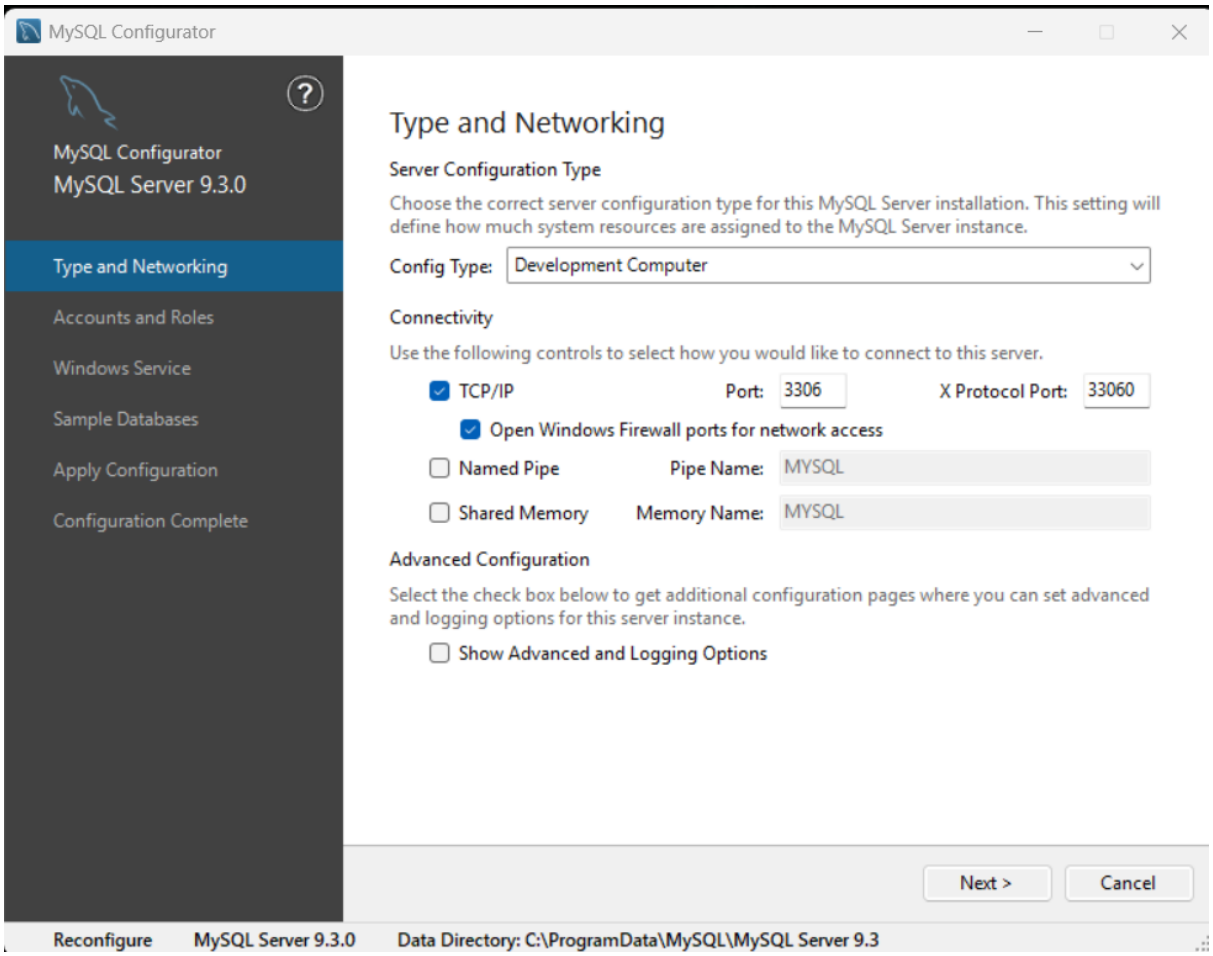

Figure 4-6 MySQL Configuration

4.2.4 Node.js and npm Setup

Node.js version 16.x LTS (Long Term Support) was installed to provide the JavaScript runtime environment necessary for frontend development using React.js. The Node.js installer was downloaded from the official website and executed with default settings, which automatically included npm (Node Package Manager). npm was then utilized to manage JavaScript dependencies for the frontend application, allowing for easy installation and management of various libraries and packages. The successful installation of both Node.js and npm was verified by executing the node -v and npm -v commands in the terminal, which displayed their respective installed versions, confirming the readiness of the frontend development environment.

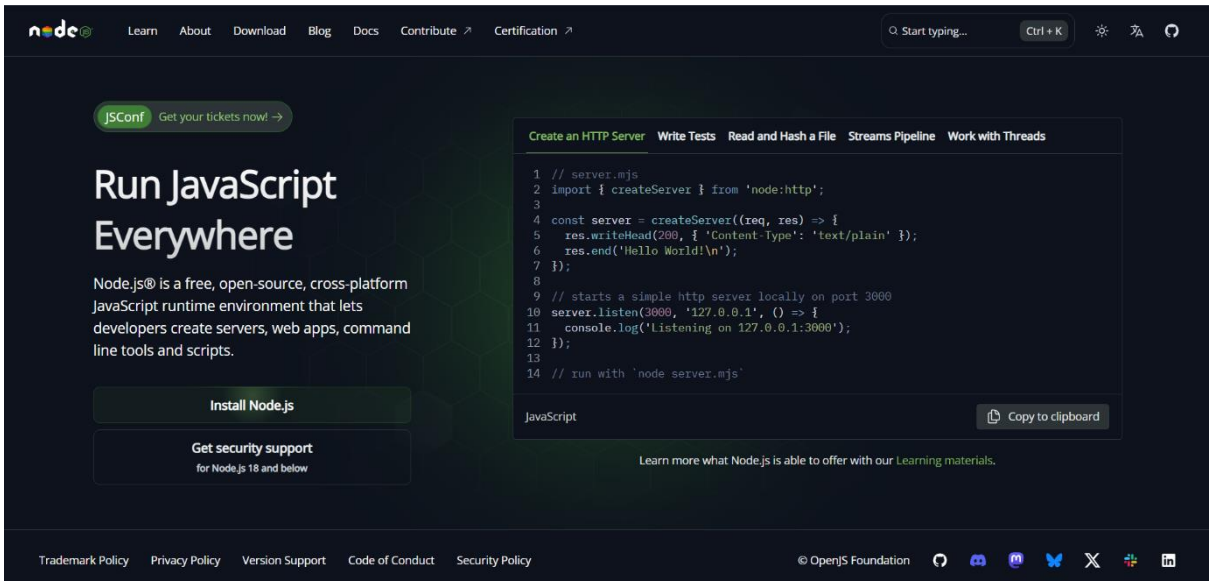

Figure 4-7 Node Js Download page.

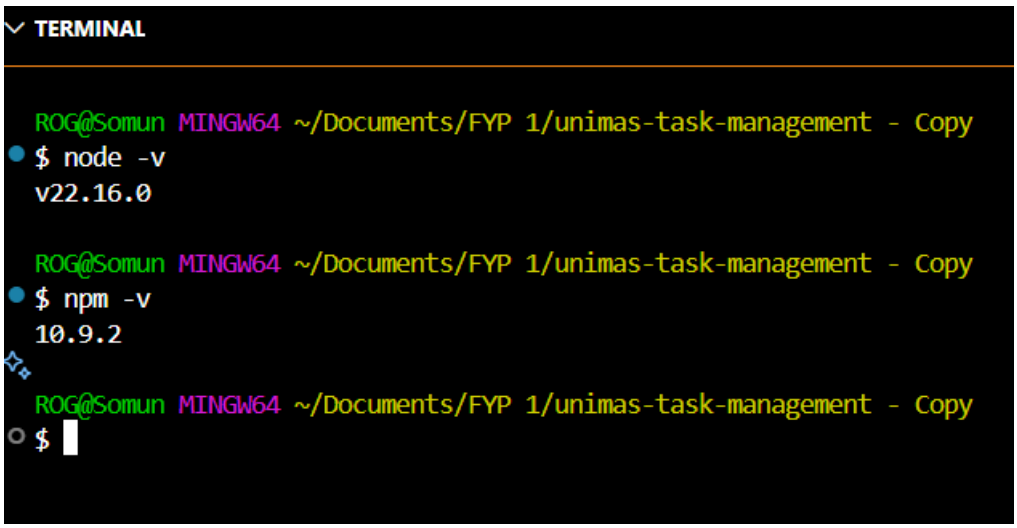

Figure 4-8 Node and npm Version Check.

4.2.5 React.js Application Initialization

The frontend application was bootstrapped using Create React App (CRA), a popular command-line tool that sets up a new React project with a sensible default structure and build configuration, significantly reducing initial setup time. Material-UI, a comprehensive React UI framework implementing Google's Material Design, was installed via npm to provide a rich set of pre-designed and customizable components, ensuring a consistent and aesthetically pleasing user interface. Beyond Material-UI, several other crucial libraries were installed for specific functionalities: react-router-dom for declarative client-side routing and navigation within the single-page application; axios for making HTTP requests to the backend REST APIs; react-dnd for implementing intuitive drag-and-drop functionality for task management; and @stomp/stompjs for robust WebSocket communication, enabling real-time updates. Environment variables, such as the backend API base URL and other application-specific settings, were configured in a .env file, allowing for easy management of different configurations across development and production environments.

4.2.6 Development IDE Configuration (VSCode)

Visual Studio Code (VSCode) was chosen as the primary Integrated Development Environment (IDE) for both frontend and backend development due to its lightweight nature, extensive customization options, and rich ecosystem of extensions. To enhance productivity and code quality, several essential extensions were installed. These included ESLint for JavaScript linting, which helps identify and fix common coding errors and enforce coding styles; Prettier for code formatting, ensuring consistent code style across the project; the Spring Boot Extension Pack for Java development, providing features like intelligent code completion, debugging, and direct execution of Spring Boot applications; and a MySQL extension for direct database interaction and management within the IDE. The integrated terminal within VSCode was configured to support both command prompt and PowerShell, providing flexibility for executing build commands, running development servers, and interacting with version control systems.

Figure 4-9 VSCode Download Page

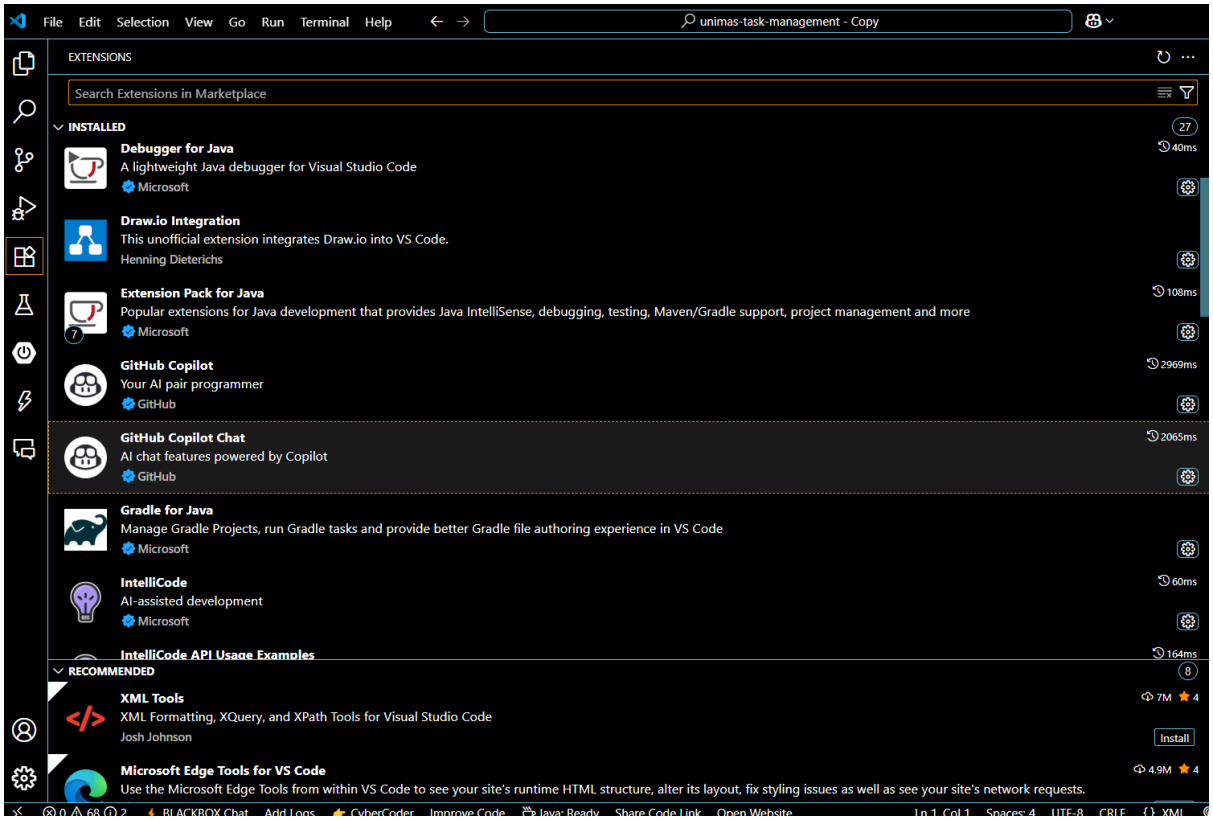

Figure 4-10 VSCode Extension Download.

4.2.7 Postmen (Endpoint Testing)

Postman was extensively utilized as a powerful API development environment for testing REST API endpoints exposed by the Spring Boot backend. It allowed for sending various types of HTTP requests (GET, POST, PUT, DELETE) to specific API endpoints and inspecting the responses. This was crucial for verifying the correctness of the backend logic, ensuring that data was being processed and returned as expected, and debugging any issues in the API communication. Postman's collection feature was used to organize and save test requests, making it easy to re-run tests and collaborate on API development.

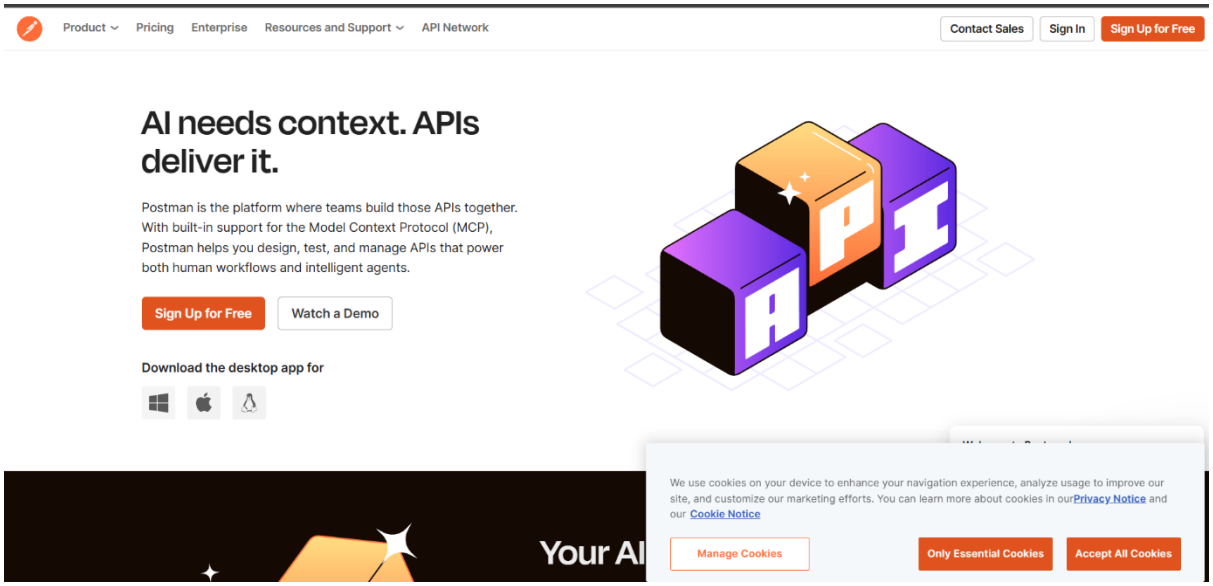

Figure 4-11 Postmen Download Page

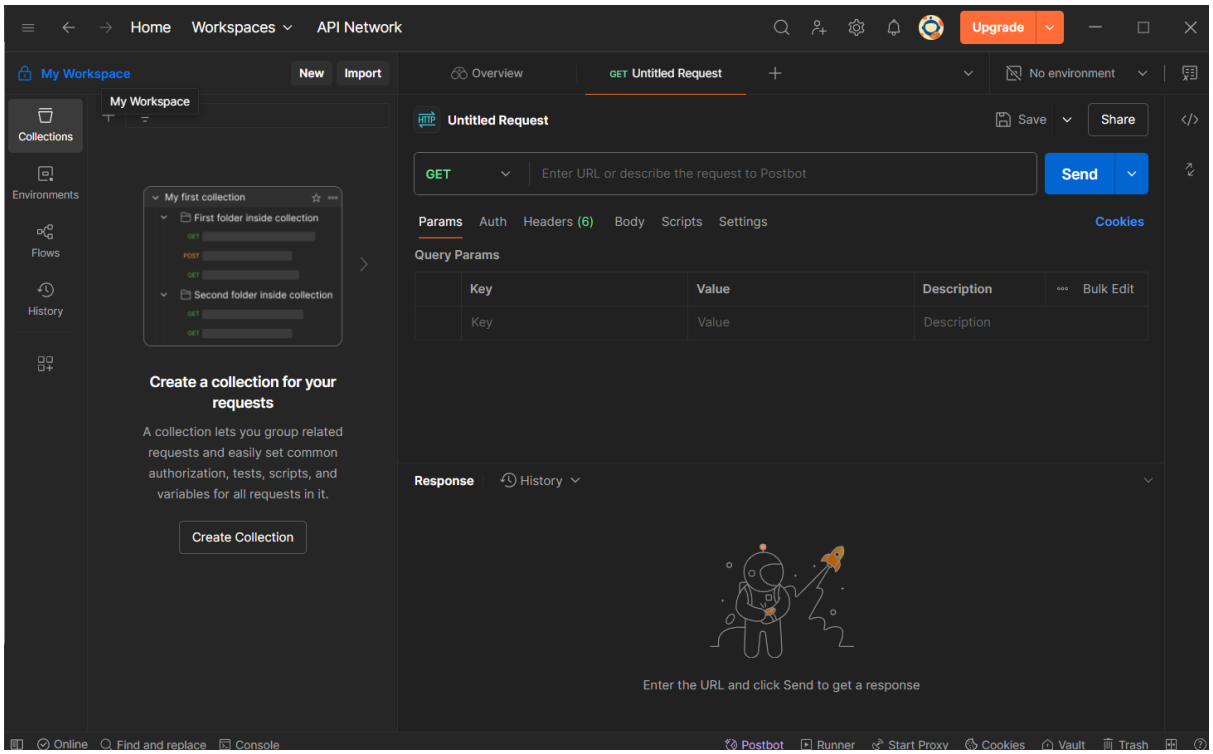

Figure 4-12 Postmen Interface API Test

4.2.8 WebSocket Server Implementation

The WebSocket server was meticulously implemented using Spring WebSocket and the STOMP (Simple Text Oriented Messaging Protocol) protocol to enable real-time, bidirectional communication between the server

and connected clients. A dedicated WebSocketConfig class was created to configure the message broker, defining the prefixes for application destinations and user-specific destinations. SockJS was integrated as a crucial fallback mechanism, ensuring compatibility with older browsers or network environments that do not natively support WebSockets, by emulating WebSocket behavior using other transport methods. This robust implementation allows for efficient broadcasting of notifications and real-time updates on task statuses to all connected users, ensuring a highly interactive and responsive user experience.

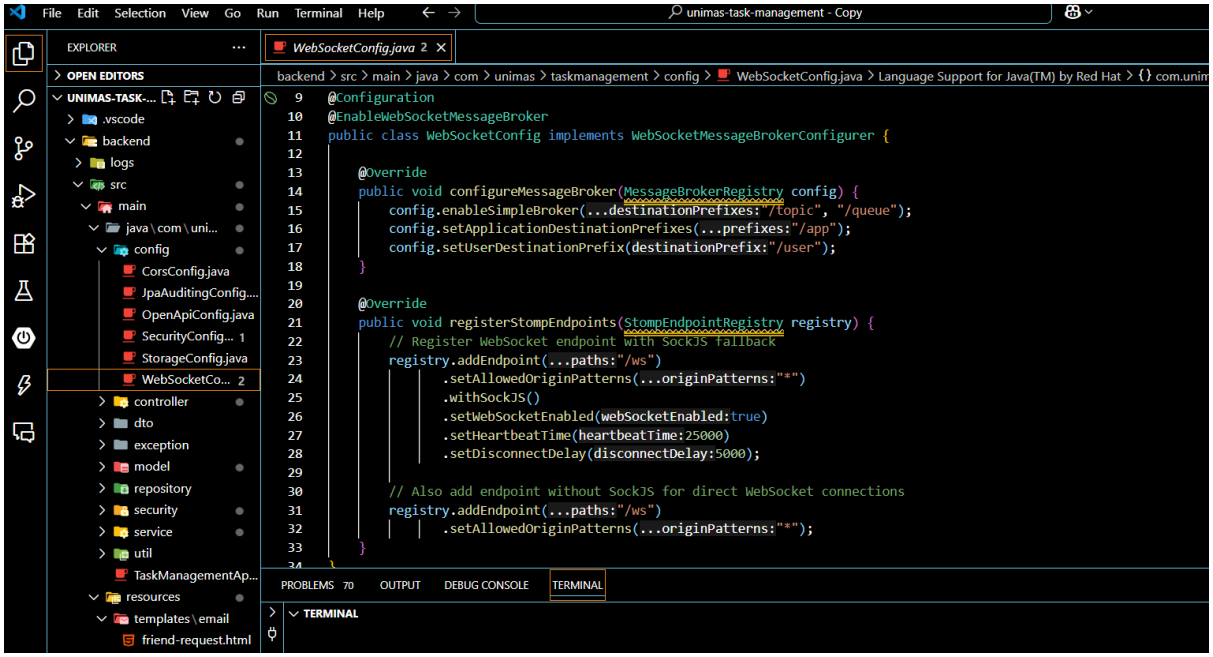

Figure 4-13 WebSocket Configuration

4.2.9 Email Service Integration

The backend integrates with SMTP (Simple Mail Transfer Protocol) email services to send automated notifications to users. The JavaMailSender interface, provided by Spring Framework, was configured with the necessary SMTP server details, including the host, port, username, and password for the email account used for sending notifications. Thymeleaf templates, a server-side Java template engine, were created for generating dynamic email content. These templates allowed for the seamless insertion of user-specific information, such as task details, deadlines, and assignment information, into the email body. The email service is automatically triggered by specific events within the application, such as when new task assignments are created or existing tasks are updated, ensuring that users receive timely and relevant notifications directly in their inboxes.

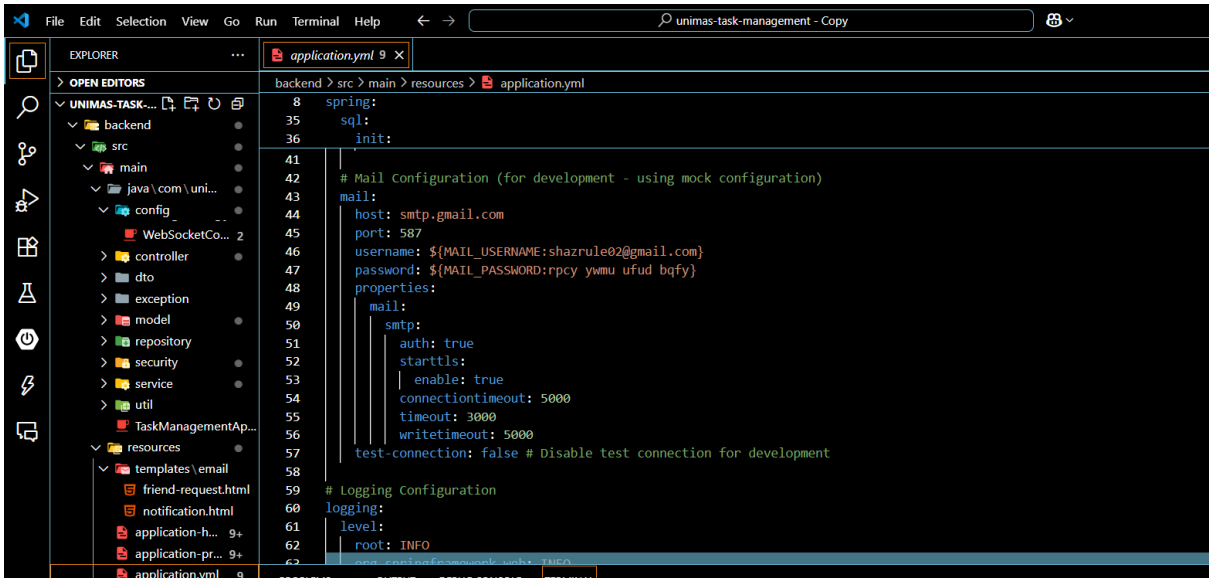

Figure 4-14 Email Integration SMTP

4.3 Backend Implementation

The backend of the UNIMAS Task Management System is built using Java Spring Boot, adhering to a layered architectural pattern to ensure modularity, maintainability, and scalability. This section details the implementation of key backend modules.

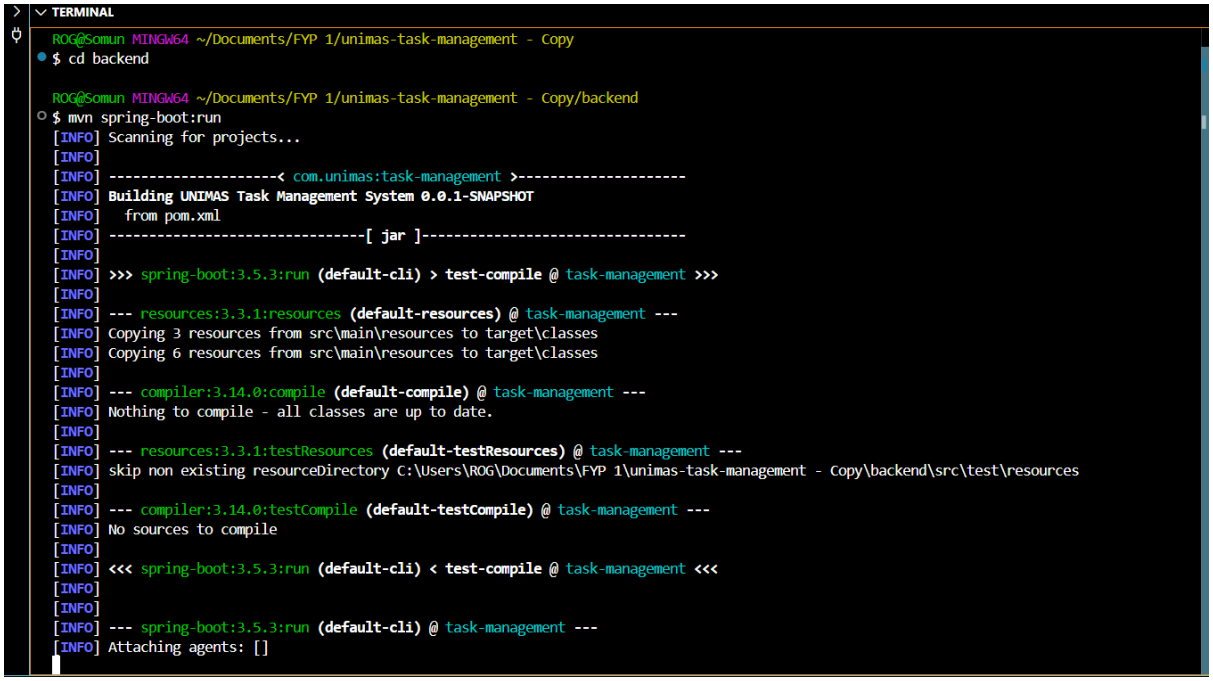

Figure 4-15 Spring Boot Run for Backend

4.3.1 System Architecture

The backend follows a well-defined layered architecture pattern, consisting of distinct layers: controllers, services, repositories, and models. This separation of concerns is a fundamental principle in software engineering, promoting maintainability, testability, and scalability. The controller layer is responsible for handling incoming HTTP requests from the frontend and returning appropriate HTTP responses. It acts as the entry point for the application's API. The service layer encapsulates the core business logic of the application. It orchestrates operations, performs validations, and interacts with the repository layer. The repository layer is responsible for managing data persistence and interactions with the MySQL database. It abstracts the underlying database operations, providing a clean interface for the service layer. Finally, the model layer defines the data entities and their relationships, representing the structure of the data stored in the database. This clear architectural separation ensures that changes in one layer have minimal impact on others, facilitating easier development and future enhancements.

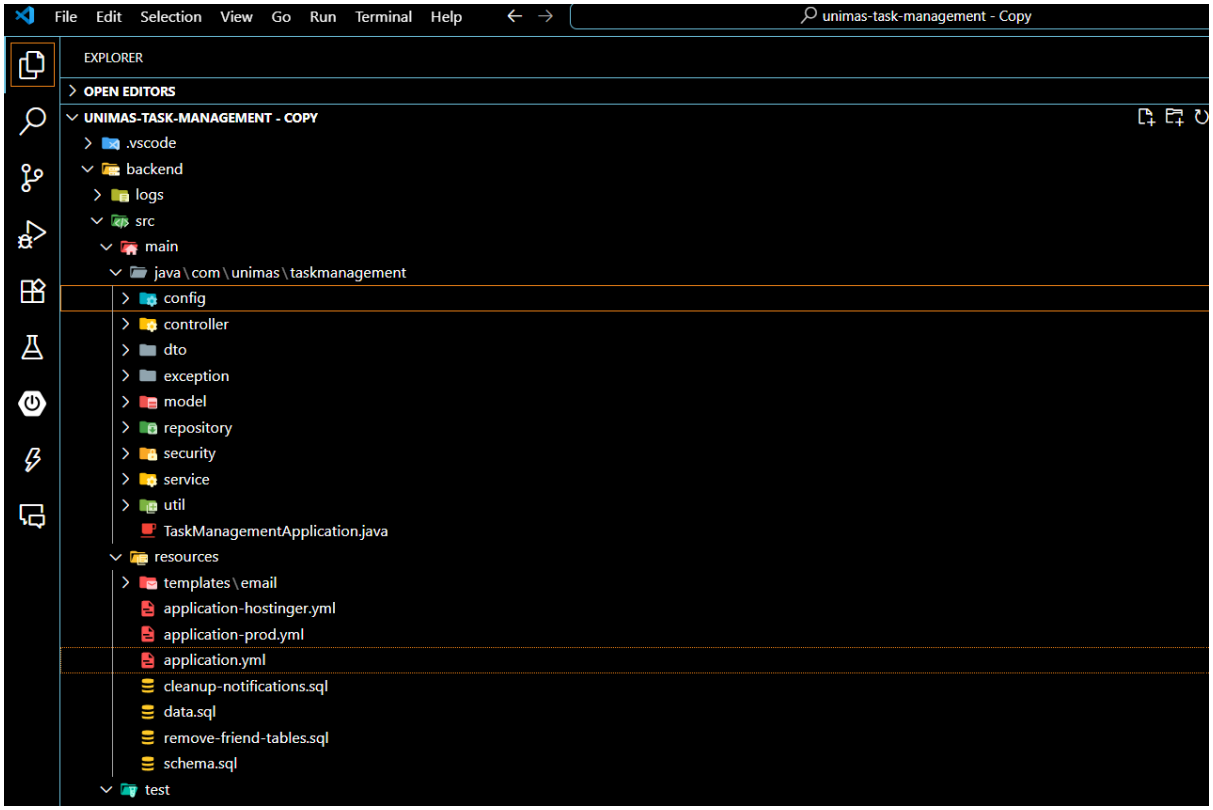

Figure 4-16 Backend Stack

4.3.2 User Authentication System

The authentication system is implemented with robust JWT (JSON Web Token)-based security, leveraging the capabilities of Spring Security. The AuthController is responsible for handling user login and registration requests. During registration, it validates user input and securely stores new user credentials in the database. For login, it verifies the provided credentials against the stored data. Upon successful authentication, a JWT token is generated and returned to the client. This token is crucial for subsequent requests, as it must be included in the request headers for authorization purposes. The SecurityConfig class plays a vital role in configuring authentication and authorization rules, specifying which API endpoints require authentication and which are publicly accessible. This ensures that sensitive operations are protected and only authorized users can

access specific resources. The use of JWTs provides a stateless authentication mechanism, which is highly beneficial for scalability in a microservices architecture, as the server does not need to maintain session information.

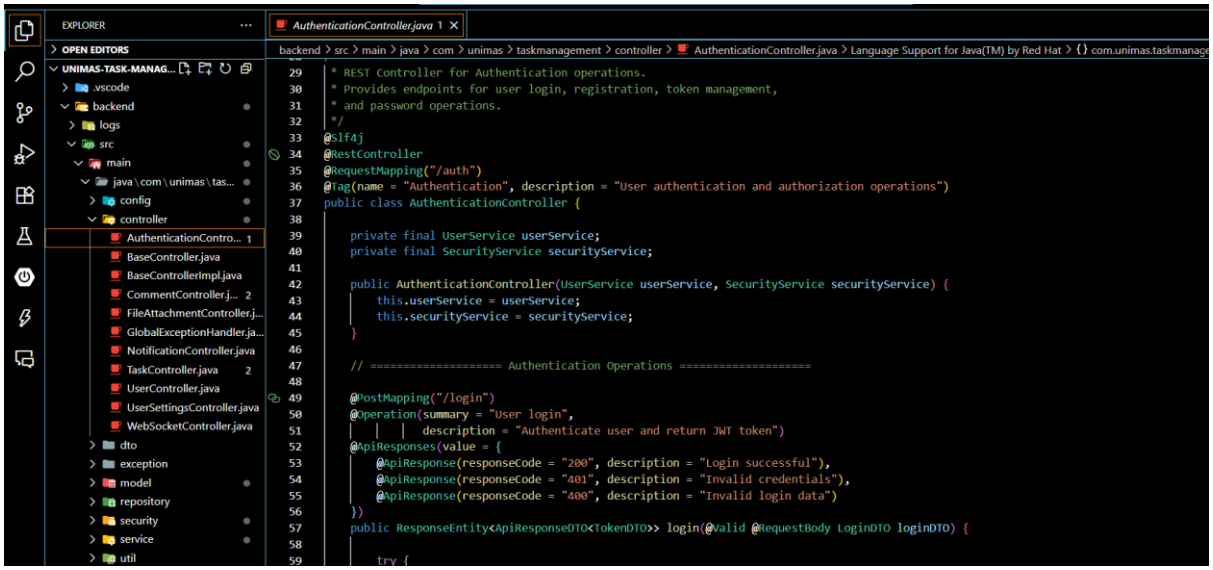

Figure 4-17 Authentication Controller

4.3.3 Task Management Module

The core task management functionality is implemented through the TaskController, which exposes a comprehensive set of RESTful endpoints. These endpoints allow the frontend to perform various operations on tasks, including creating new tasks, retrieving existing tasks, updating task details (e.g., status, priority, due date), and deleting tasks. The TaskService contains the intricate business logic for all task-related operations. This includes performing data validations to ensure data integrity, managing task status transitions (e.g., from "To Do" to "In Progress"), and triggering assignment notifications to relevant users. The TaskRepository extends Spring Data JPA's JpaRepository interface, providing out-of-the-box CRUD (Create, Read, Update, Delete) operations. Additionally, custom query methods are defined within the repository to support advanced filtering and searching of tasks based on various criteria, enhancing the flexibility and usability of the task management features.

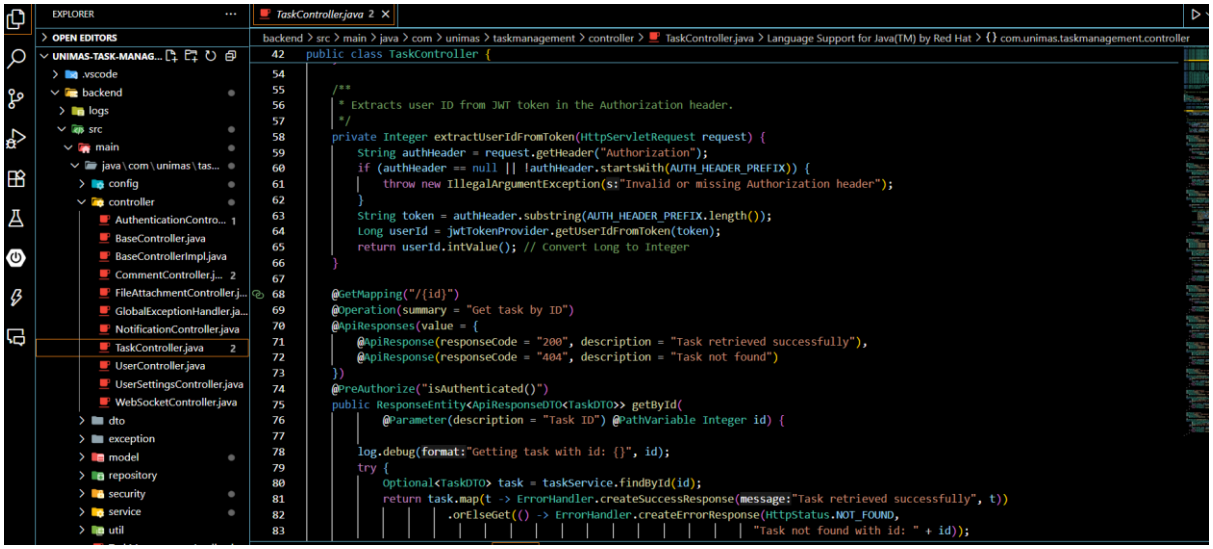

Figure 4-18 Task Controller

4.3.4 Notification System

The notification system is a critical component for real-time collaboration, leveraging WebSocket technology to deliver instant updates to clients. The NotificationController is responsible for managing WebSocket connections and broadcasting notifications when significant events occur within the system. These events include, but are not limited to, new task assignments, changes in task status, or approaching deadlines. Notifications are also persisted in the database, ensuring that users can retrieve and view their notifications even if they were offline when the notification was initially sent. This persistence mechanism guarantees that no critical information is lost and users can always catch up on missed updates upon reconnection. The real-time nature of this system significantly enhances communication and keeps all team members informed and synchronized.

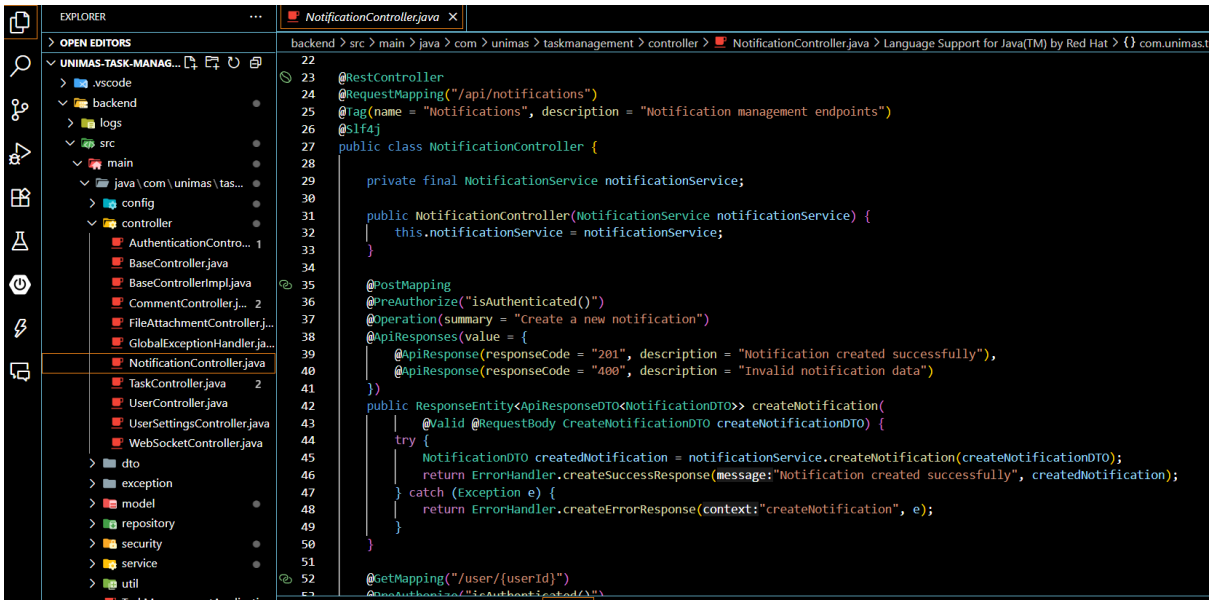

Figure 4-19 Notification Controller

4.3.5 File Management System

The file management functionality allows users to seamlessly attach files to tasks, providing a centralized location for all project-related documents and resources. The FileStorageService is responsible for handling file uploads, securely storing files in a designated directory on the server's local file system. To prevent naming conflicts and ensure uniqueness, uploaded files are stored with unique filenames. The FileAttachmentController provides dedicated endpoints for uploading new files, allowing users to download existing attachments, and managing file attachments associated with specific tasks. Crucially, file metadata, such as the original filename, the storage path on the server, the file type, file size, and the associated task ID, is stored in the database. This metadata allows for efficient retrieval and management of files, ensuring that all relevant information is easily accessible and linked to the correct tasks.

4.4 Frontend Implementation

The frontend of the UNIMAS Task Management System is developed using React.js, adhering to a component-based architecture to promote reusability, maintainability, and a highly interactive user experience.

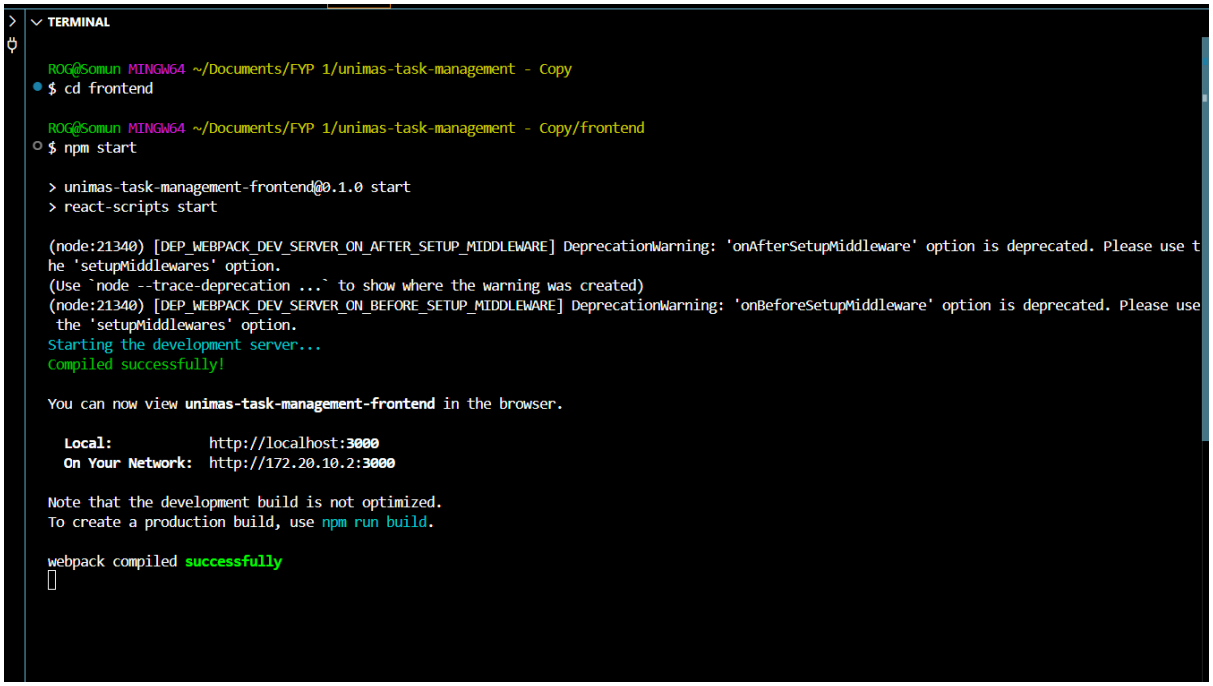

Figure 4-20 Frontend Application Run

4.4.1 User Interface Components

The frontend is meticulously built using React.js, following a modular and component-based architecture. This approach breaks down the user interface into independent, reusable components, making the codebase more manageable and scalable. Key components developed include:

- **Auth Components:**

  Dedicated components for user login and registration, providing intuitive forms and handling user input securely.

- **Dashboard:**

  A central overview component that displays a summary of tasks, notifications, and other relevant information, offering users a quick glance at their workload.

- **TaskList and TaskCard:**

  Components responsible for displaying lists of tasks and individual task details, respectively. These are designed for clarity and ease of interaction.

- **TaskModal:**

  A modal component used for creating new tasks or editing existing ones, providing a focused interface for task management.

- **NotificationPanel:**

  A dynamic panel that displays real-time updates and notifications, ensuring users are always informed of changes.

- **UserProfile:**

  Components for managing user account settings, including profile information and preferences.

This component-based design, as advocated by modern frontend development practices (React.js Documentation, n.d.), significantly improves code organization and facilitates collaborative development.

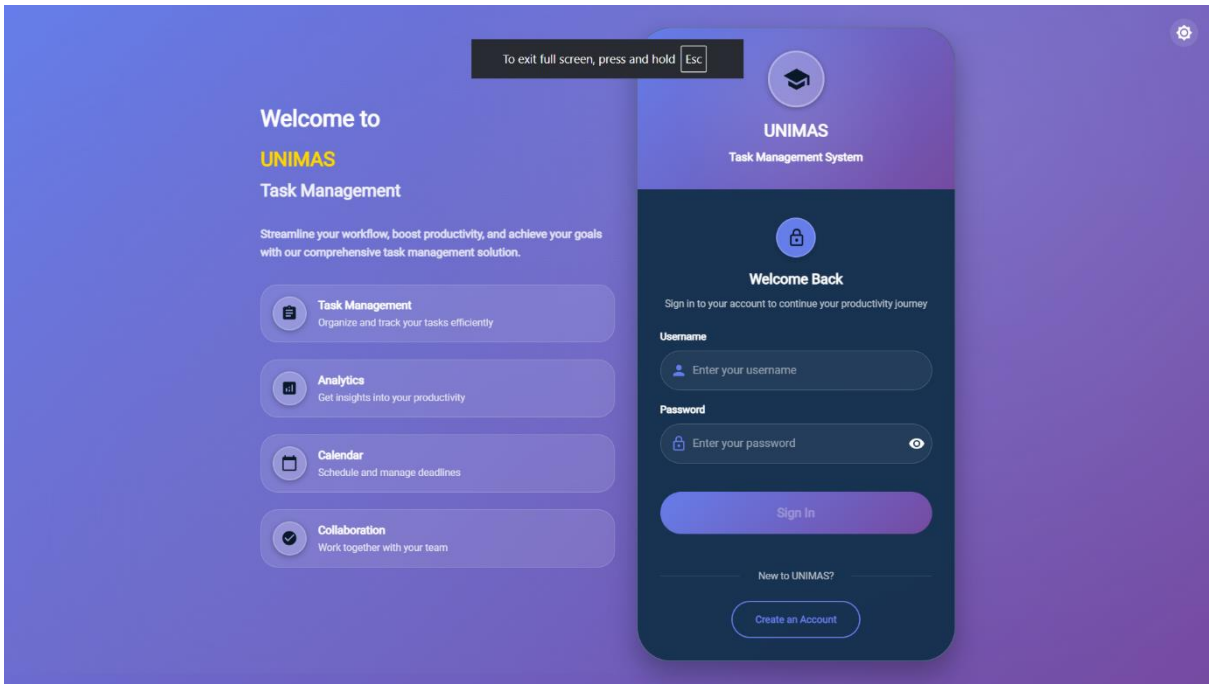

Figure 4-21 Login Page Task Management System

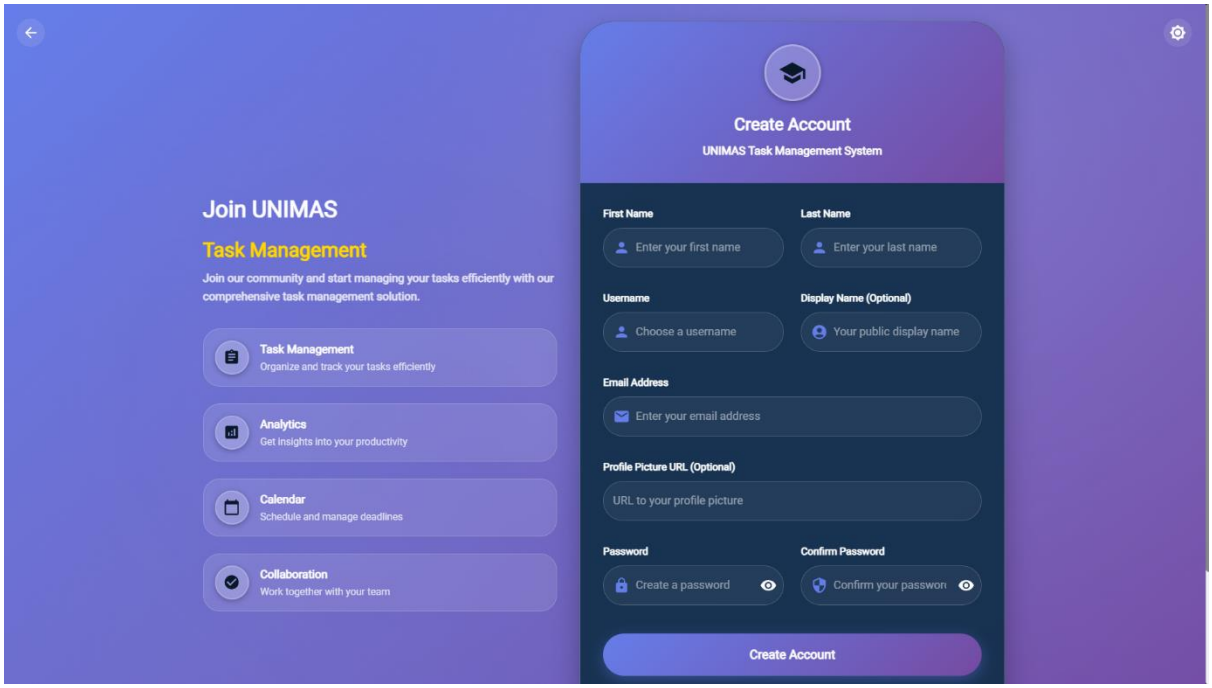

Figure 4-22 Registration Page Task Management System

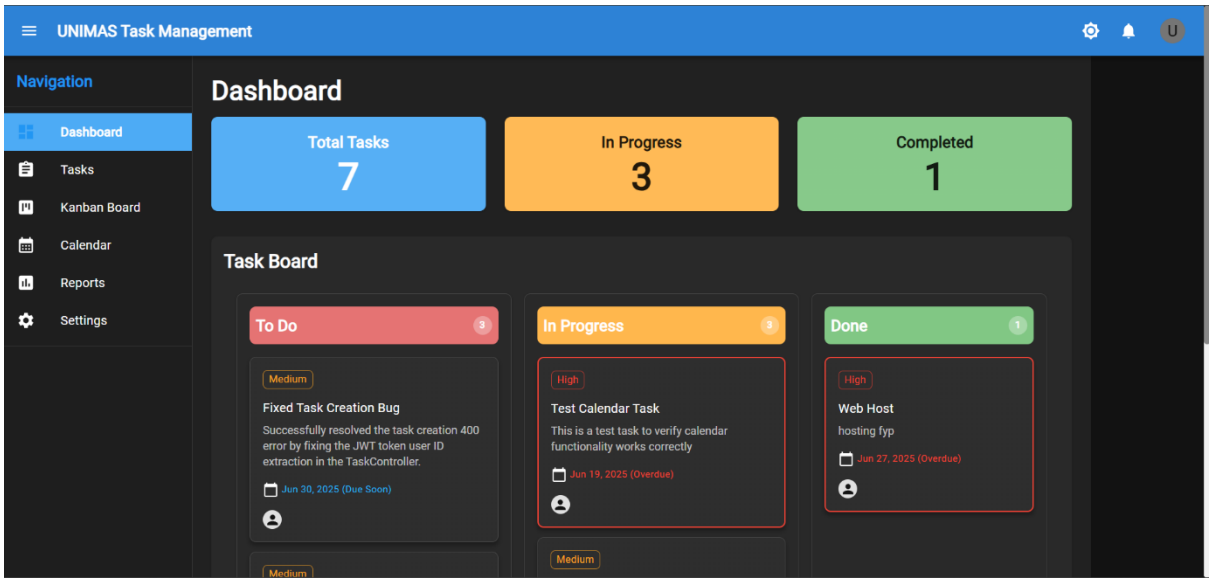

Figure 4-23 Dashboard Task Management System

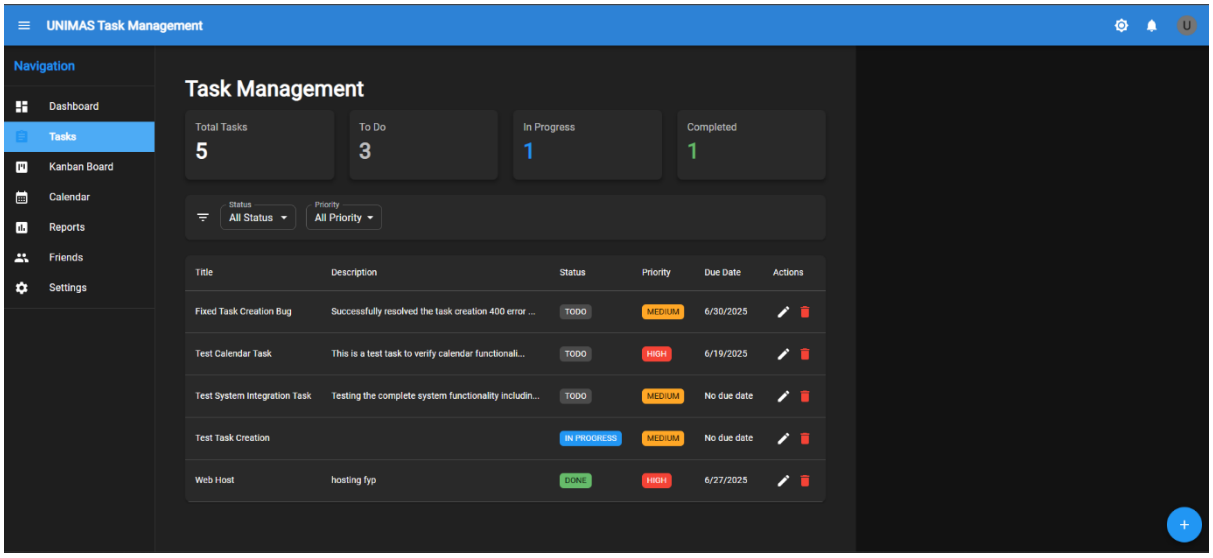

Figure 4-24 Task Page Task Management System

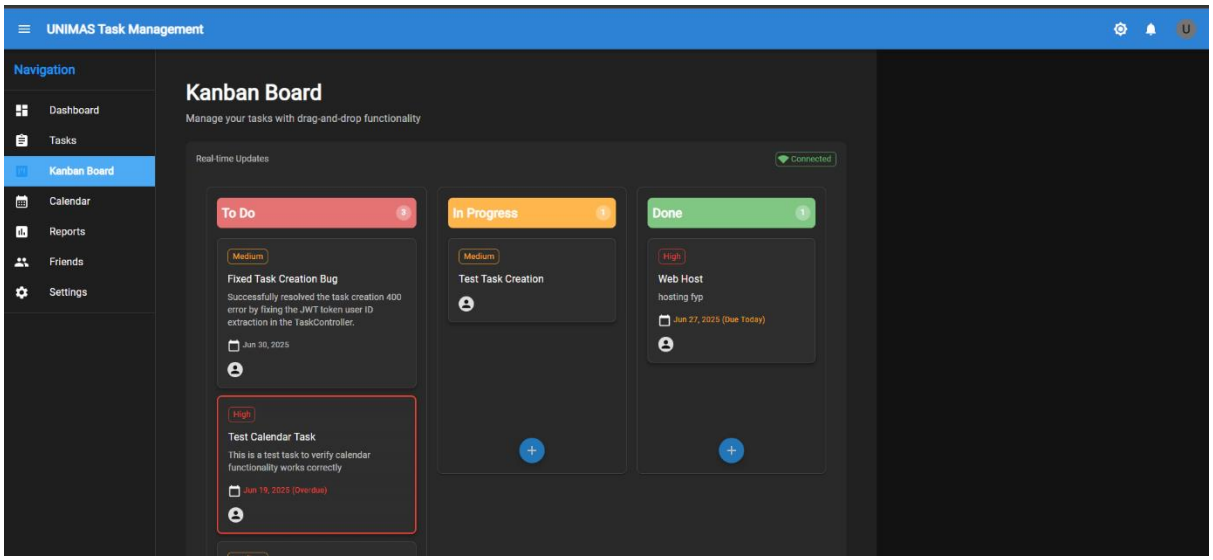

Figure 4-25 Kanban Board Page Task Management System

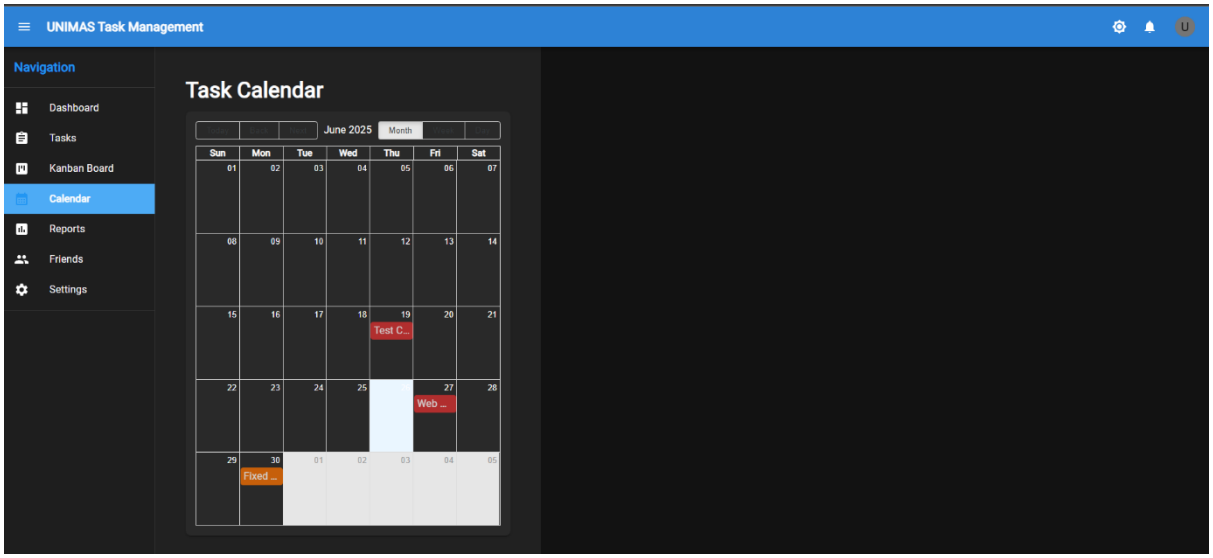

Figure 4-26 Calender Page Task Management System

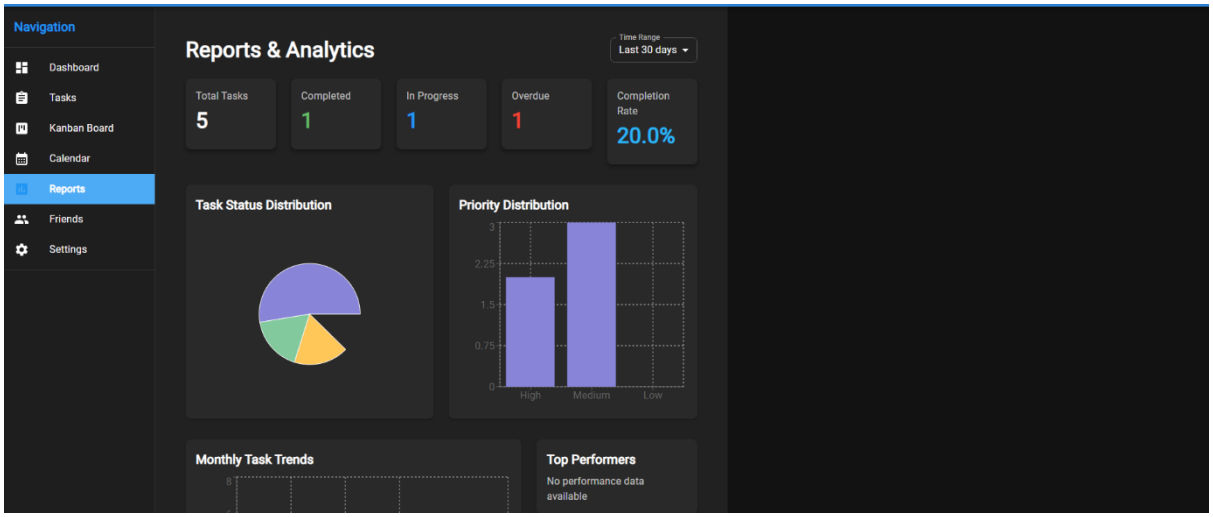

Figure 4-27 Reports Page Task Management System

4.4.2 State Management

Effective state management is crucial for complex single-page applications. In this project, state management is implemented using React's built-in Context API combined with the useReducer hook. This approach provides a centralized and predictable way to manage application-wide state without relying on external libraries for simpler use cases. Specifically:

- **AuthContext:**

  Manages the authentication state of the user, including login status, user information, and JWT tokens.

- **TaskContext:**

  Handles all task-related data, such as the list of tasks, their statuses, and filtering options.

- **NotificationContext:**

  Manages real-time updates received via WebSockets, ensuring notifications are displayed promptly and consistently across the application.

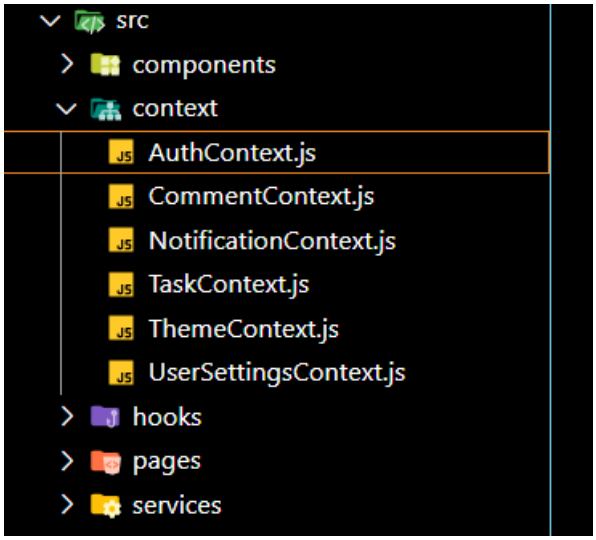

Figure 4-28 Context Files Stack

This centralized state management approach ensures consistent data across all components, simplifies data flow, and enhances the overall predictability of the application's behaviour. For more complex state interactions, a combination of Context API with useReducer offers a scalable solution (Abramov & Jordan, 2019).

4.4.3 Routing and Navigation

Client-side routing and navigation are handled by react-router-dom, a popular library for React applications. This enables seamless navigation between different views and pages within the single-page application without requiring full page reloads, providing a smooth user experience. react-router-dom allows for declarative routing, where routes are defined as components, making them easy to understand and manage. Crucially, protected routes are implemented to ensure that only authenticated users can access certain parts of the application, enforcing security measures. The overall navigation structure includes a persistent sidebar for main navigation links (e.g., Dashboard, Tasks, Profile) and a top bar for user-specific actions (e.g., notifications, logout), providing an intuitive and accessible user interface.

4.4.4 Real-time Updates

The implementation of real-time updates is a cornerstone of the system's collaborative features. The frontend establishes a persistent WebSocket connection to the backend using the STOMP protocol over SockJS, as configured in the backend. A custom React hook, useWebSocket, was developed to manage the entire lifecycle of this WebSocket connection, including establishing the connection, handling incoming messages, and gracefully closing the connection. When notifications or task status changes are received through the WebSocket, they are immediately displayed in the notification panel, and the relevant components (e.g., task lists, dashboards) are updated in real-time without requiring a page refresh. This instant synchronization ensures that all users have the most up-to-date information, fostering effective collaboration and reducing communication delays (Schmidt et al., 2019).

4.5 Integration and Testing

The integration and testing phases are critical to ensure that all components of the UNIMAS Task Management System work together seamlessly and meet the defined functional and non-functional requirements.

4.5.1 API Integration

The frontend communicates exclusively with the backend through well-defined RESTful APIs. Axios, a promise-based HTTP client, is used for making all API requests from the frontend. To ensure secure communication, Axios interceptors are configured to automatically add the JWT token to the Authorization header of every outgoing request. This ensures that all authenticated requests are properly authorized by the backend. A dedicated API service module was developed to abstract the complexities of API calls, providing a clean, consistent, and easy-to-use interface for frontend components to interact with the backend. This abstraction layer simplifies frontend development and makes it easier to manage API endpoints.

4.5.2 Unit Testing

Unit testing is performed at both the backend and frontend to verify the correctness of individual components and functions in isolation.

- **Backend Unit Testing:**

  JUnit, a widely used testing framework for Java, is employed for backend unit testing. Mockito, a popular mocking framework, is used in conjunction with JUnit to mock dependencies, allowing for isolated testing of service methods and controllers. Key service methods, business logic, and controller endpoints are thoroughly tested to ensure correct behaviour under various scenarios, including valid inputs, edge cases, and error conditions.

- **Frontend Unit Testing:**

  Frontend unit tests are implemented using Jest, a delightful JavaScript testing framework, and React Testing Library, which focuses on testing components in a way that resembles how users interact with them. These tests verify component rendering, user interactions, and state updates, ensuring that the user interface behaves as expected.

This comprehensive unit testing strategy helps identify and fix bugs early in the development cycle, improving code quality and reducing the cost of defects.

4.5.3 Integration Testing

Integration testing is conducted to verify that different modules and services of the system interact correctly when combined.

- **API Integration Testing:**

  Postman is extensively used for API integration testing. Comprehensive test collections are created to cover all API endpoints, including various test cases for success scenarios, error handling, and edge cases. This ensures that the backend APIs function correctly and consistently, and that the data flow between different backend services is accurate.

- **End-to-End Integration Testing:**

  Beyond API testing, end-to-end integration tests are performed to simulate real user scenarios, verifying the complete flow of data from the frontend through the backend and database. This ensures that the entire system functions as a cohesive unit, meeting the overall functional requirements.

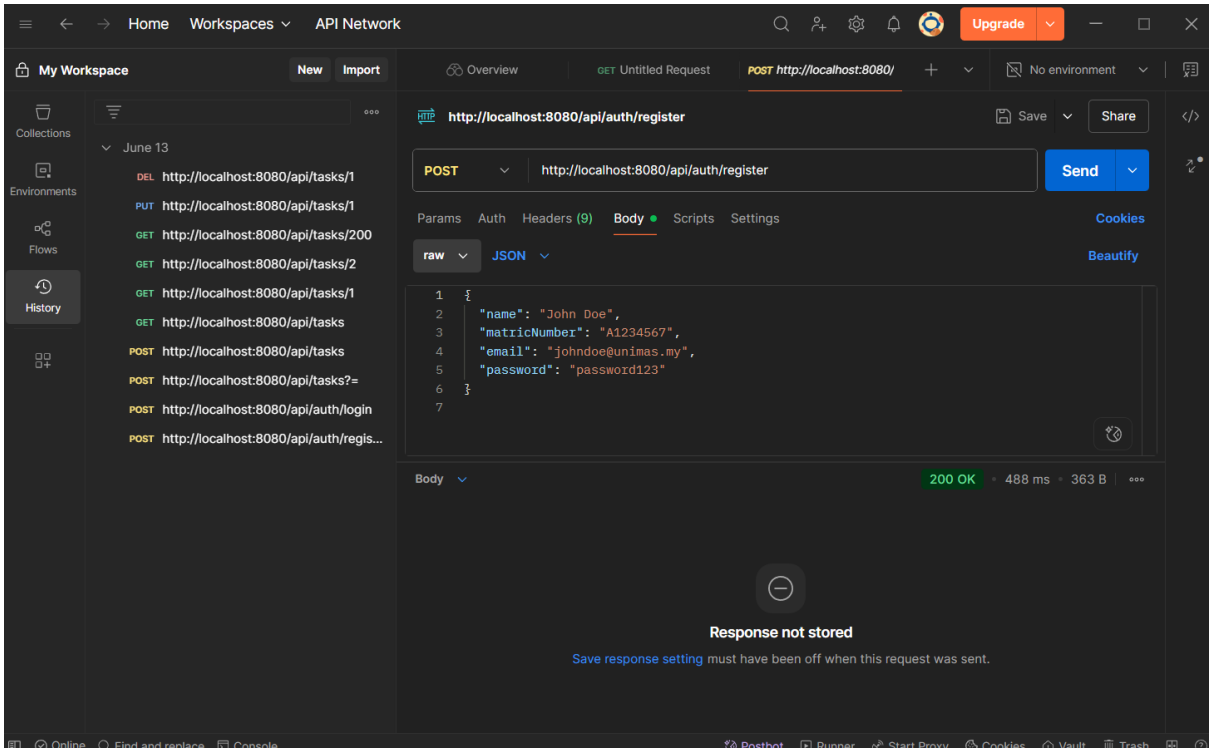

Figure 4-29 Postmen Testing Endpoint

This multi-faceted testing approach, encompassing unit and integration testing, ensures the reliability and robustness of the UNIMAS Task Management System.

4.6 Conclusion

This chapter has documented the comprehensive implementation of the UNIMAS Task Management System. The system was developed using modern technologies and best practices, resulting in a robust, scalable, and user-friendly application. The implementation followed a structured approach with careful attention to architecture, security, and user experience. The detailed descriptions of the development environment setup, backend and frontend implementations, and integration and testing strategies highlight the technical depth and meticulous effort invested in this project. The next chapter will focus on testing and evaluation to validate the system's functionality and performance.

Chapter 5: Testing

5.1 Introduction

Testing is the most important and crucial phase where the UNIMAS Task Management System undergoes comprehensive evaluation before being released for actual deployment and utilization. The testing phase involves extensive evaluation by different categories of users including students, academic staff, and administrative personnel who represent the primary user base of the system. During this critical testing phase, all bugs, errors, flaws, and mistakes are systematically detected and addressed based on detailed feedback obtained from users who test the system under various scenarios and conditions.

In this project, the testing phase is strategically divided into functional testing and non-functional testing, both of which are crucial for ensuring the system's overall quality and reliability. Functional testing focuses specifically on the system's core functionality through comprehensive unit testing methodologies, while non-functional testing emphasizes the system's usability, performance, and user experience through acceptance testing conducted with actual users from the target demographic. Unit testing is meticulously conducted using detailed test case tables that document every aspect of the testing process, while acceptance testing is performed using carefully designed usability testing questionnaires that capture user feedback across multiple dimensions of system interaction and satisfaction.

The comprehensive testing approach ensures that the system not only meets its intended functional requirements but also provides an exceptional user experience that facilitates effective task management and collaboration. The testing methodology follows industry best practices and standards, incorporating both automated testing procedures and manual testing protocols to ensure thorough coverage of all system components and functionalities.

5.2 Functional Testing

Functional testing represents a comprehensive testing methodology conducted to ensure that the UNIMAS Task Management System meets all defined criteria and requirements, with a primary focus on user-facing features and overall system behaviour. This testing approach is meticulously designed to validate that every component of the system operates correctly and delivers the expected functionality as specified in the system requirements. The functional testing process encompasses thorough evaluation of core system capabilities including task creation and management, user authentication and authorization, real-time communication features, file attachment handling, notification systems, and collaborative functionalities that form the backbone of the task management platform.

The functional testing methodology employed for this project follows industry best practices and standards, ensuring comprehensive coverage of all system functionalities while maintaining systematic documentation of test procedures, results, and outcomes. Each functional component is tested individually and in combination with other components to verify proper integration and interaction patterns. The testing process includes validation of input handling, output generation, error handling mechanisms, boundary condition testing, and edge case scenarios to ensure robust system behavior under all possible operational conditions.

5.2.1 Unit Testing

Unit testing is a fundamental testing technique employed to systematically check whether individual components and modules of the UNIMAS Task Management System function correctly in isolation, ensuring that each small part of the software works as intended to achieve the system requirements. These comprehensive tests are meticulously written and executed by the development team to ensure that each module performs exactly as expected under various input conditions and scenarios. The unit testing process is designed such that if results do not meet the predetermined expectations, the test must be repeated, and the underlying code must be modified until the results consistently meet all specified expectations and requirements.

This rigorous testing approach serves multiple critical purposes: it clarifies and validates each component's intended behaviour and functionality, it identifies critical cases where minor system changes might

lead to unexpected failures, performance degradation, or functional losses that could impact the overall system reliability, stability, and user experience. The unit testing process covers all major functional areas including user authentication systems, task management operations, real-time communication mechanisms, file handling systems, notification delivery systems, database operations, API endpoint functionality, and security implementations.

5.2.1.1 Test Cases for User Authentication Module

The comprehensive testing for the user authentication module includes eight detailed test cases designed to ensure robust and secure functionality across all authentication scenarios. The authentication testing process begins with thorough verification of the login functionality to confirm that users can securely access the system using valid credentials while receiving appropriate error messages for invalid login attempts. The testing methodology ensures that the system properly validates user credentials against the database, generates secure JWT tokens upon successful authentication, and maintains proper session management throughout the user's interaction with the system.

Table 5-1 Test Case for User Login Authentication

Module Name	Test Objective	Test Title	Test ID	Input Data	Expected Result	Actual Result	Pass/Fail
User Authentication	To verify user authentication functionality	Valid User Login	TC01	Valid email and password credentials	User successfully logs in and redirects to dashboard with proper session establishment	User successfully authenticated and redirected to main dashboard	Pass
User Authentication	To verify error handling for invalid credentials	Invalid Email	TC02	Invalid email with valid password	User fails to login and receives clear error message	"Login failed. Invalid email or password" message displayed	Pass
User Authentication	To verify password validation	Invalid Password	TC03	Valid email with incorrect password	User fails to login and receives appropriate error message	"Login failed. Invalid email or password" message displayed	Pass
User Authentication	To verify comprehensive validation	Invalid Credentials	TC04	Both invalid email and password	User fails to login and receives error message	"Login failed. Invalid email or password" message displayed	Pass

Module Name	Test Objective	Test Title	Test ID	Input Data	Expected Result	Actual Result	Pass/Fail
User Authentication	To verify required field validation	Empty Fields	TC05	Missing required fields	User fails to login and receives validation messages	Required field validation messages displayed	Pass

The authentication module testing extends beyond basic login functionality to include comprehensive validation of the registration process, password reset mechanisms, and session management capabilities. The registration testing verifies that new users can successfully create accounts with proper validation of email formats, password strength requirements, and duplicate account prevention. Password reset functionality is thoroughly tested to ensure that users can securely recover their accounts through email verification processes, while session management testing validates that user sessions are properly maintained and secured.

5.2.1.2 Test Cases for Task Management Module

The task management functionality represents the core feature of the UNIMAS Task Management System and requires extensive testing to ensure reliable operation across all task-related operations. The testing encompasses twelve critical test cases covering task creation, modification, deletion, assignment, status tracking, and collaborative features. The task creation process is rigorously tested to verify that users can successfully create tasks with all required information including titles, descriptions, priority levels, due dates, and assignee selections.

Table 5-2 Test Case for Task Creation and Management

Module Name	Test Objective	Test Title	Test ID	Input Data	Expected Result	Actual Result	Pass/Fail
Task Creation	To verify task creation functionality	Complete Task Creation	TC01	All required fields with valid data	Task successfully created and appears in task list	Task created successfully and displayed in dashboard	Pass
Task Creation	To verify field validation	Missing Required Fields	TC02	Missing required fields	Task creation fails with validation messages	Validation errors displayed for missing fields	Pass
Task Creation	To verify date validation	Invalid Due Date	TC03	Invalid due date	Task creation fails with error message	“Invalid due date” error message displayed	Pass

Module Name	Test Objective	Test Title	Test ID	Input Data	Expected Result	Actual Result	Pass/Fail
Task Creation	To verify file attachment	File Attachment	TC04	Task with file attachment	Task created with file properly attached	File uploaded and attached successfully	Pass
Task Management	To verify task editing	Task Modification	TC05	Updated task information	Task successfully updated with changes	Task updated and changes reflected immediately	Pass

The task management testing extends to cover advanced functionalities including task assignment workflows, status tracking, filtering capabilities, and collaborative features. The testing validates that task status changes are properly recorded, reflected in real-time, and trigger appropriate notifications to relevant stakeholders.

5.2.1.3 Test Cases for Real-time Communication and Notification System

The real-time communication system represents a critical component enabling instant updates and notifications across all connected users. The testing includes ten comprehensive test cases designed to validate WebSocket connectivity, message broadcasting, notification delivery, and system responsiveness under various network conditions.

Table 5-3 Test Case for Real-time Communication and Notifications

Module Name	Test Objective	Test Title	Test ID	Input Data	Expected Result	Actual Result	Pass/Fail
Real-time Notifications	To verify instant notification delivery	Task Assignment	TC01	Task assigned to user	User receives instant notification	Notification delivered immediately	Pass
Real-time Notifications	To verify status update broadcasting	Status Update	TC02	Task status changed	All users receive real-time update	Status change broadcasted instantly	Pass
Real-time Notifications	To verify comment notifications	Comment Addition	TC03	New comment added	Users receive notification	Comment notification delivered successfully	Pass

Module Name	Test Objective	Test Title	Test ID	Input Data	Expected Result	Actual Result	Pass/Fail
Real-time Notifications	To verify multiple notifications	Multiple Updates	TC04	Multiple simultaneous updates	All notifications delivered correctly	All notifications processed successfully	Pass
WebSocket Connection	To verify connection stability	Connection Resilience	TC05	Network interruption	System reconnects automatically	Connection restored with synchronization	Pass

The real-time communication testing validates WebSocket connection stability, message queuing, delivery confirmation, and automatic reconnection capabilities to ensure reliable communication under various network conditions.

5.3 Non-Functional Testing

Non-functional testing represents a critical evaluation methodology employed to assess how well the UNIMAS Task Management System performs across various operational parameters beyond basic functionality. This testing approach examines crucial aspects including system performance metrics, user interface usability, system reliability under various conditions, security measures, and overall scalability in real-world usage scenarios. Non-functional testing is essential for ensuring that the software not only executes its intended functions correctly but also delivers an exceptional user experience while maintaining high performance standards, robust security, and reliable operation under different load conditions and usage patterns.

The non-functional testing phase was meticulously planned and executed to evaluate multiple critical aspects of system behavior and performance. This included comprehensive assessment of response times under various load conditions, thorough evaluation of system usability across different user groups, detailed analysis of system reliability during extended operation periods, and systematic validation of security measures protecting user data and system resources.

5.3.1 Usability Testing

Usability testing for the UNIMAS Task Management System was conducted through a carefully designed evaluation process involving thirty participants representing the system's primary user demographics. The participant group consisted of twenty students from various academic programs and years of study, and ten staff members including lecturers and administrative personnel. This diverse testing group was specifically selected to ensure comprehensive coverage of different user perspectives, technical proficiency levels, and usage patterns that the system would encounter in real-world deployment.

The usability testing process was structured around a series of specific tasks and scenarios that participants were asked to complete while using the system. These tasks were designed to evaluate different aspects of the system's usability, including user interface navigation and intuitiveness, task management workflows, collaboration features, and system responsiveness. Each participant was provided with detailed instructions and was observed throughout the testing process to identify any areas of confusion or difficulty.

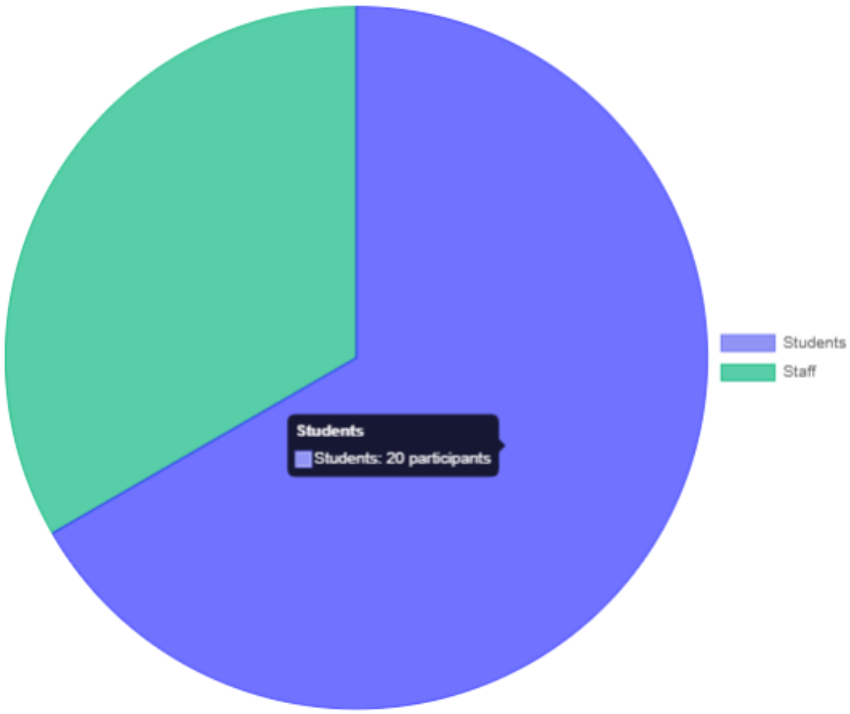

Figure 5-1Usability Testing Participant Demographics

The testing methodology encompassed evaluation of dashboard navigation and feature accessibility, task creation and management workflows, file attachment and document handling processes, notification system interaction and management, settings configuration and preference management, real-time communication and collaboration features, and overall system performance and responsiveness from the user perspective.

5.3.1.1 Testing Results Analysis

The usability testing results were systematically analyzed across four fundamental dimensions: usefulness, ease of use, ease of learning, and overall user satisfaction. Each dimension was evaluated through multiple specific criteria and metrics, providing a comprehensive assessment of the system's usability characteristics.

Usefulness Evaluation Results:

The usefulness dimension evaluation revealed exceptionally positive responses regarding the system's practical value and effectiveness in supporting task management and collaboration needs. Task management features received high ratings from 85% of participants, with specific praise for the intuitive task creation process, effective priority management system, and comprehensive deadline tracking capabilities. Participants particularly appreciated the system's ability to organize tasks efficiently and provide clear visibility into project progress and team responsibilities.

The real-time collaboration features were particularly well-received, with 90% of participants highlighting the value of instant notifications and status updates in improving team coordination and communication. Users noted that the real-time features significantly reduced the need for external communication tools and helped maintain better awareness of project developments. The file attachment system received positive feedback from 80% of participants, who found it helpful for centralizing project documents and maintaining version control.

Figure 5-2 Usefulness Evaluation Results Chart

Ease of Use Assessment:

The ease of use evaluation demonstrated strong positive feedback regarding the system's interface design and operational simplicity. Navigation through the system interface received highly positive feedback, with 88% of participants strongly agreeing that it is easy to navigate through different sections and features of the system. The logical menu structure and intuitive feature placement were specifically praised for minimizing the learning curve and reducing user confusion.

Task management operations received high ratings, with 85% of participants finding it easy to create, modify, and track tasks within the system. The streamlined task creation workflow and clear status indicators were highlighted as particularly effective design elements. The notification system received positive feedback from 82% of participants, who appreciated the clear visibility of alerts and the ability to customize notification preferences according to their work patterns.

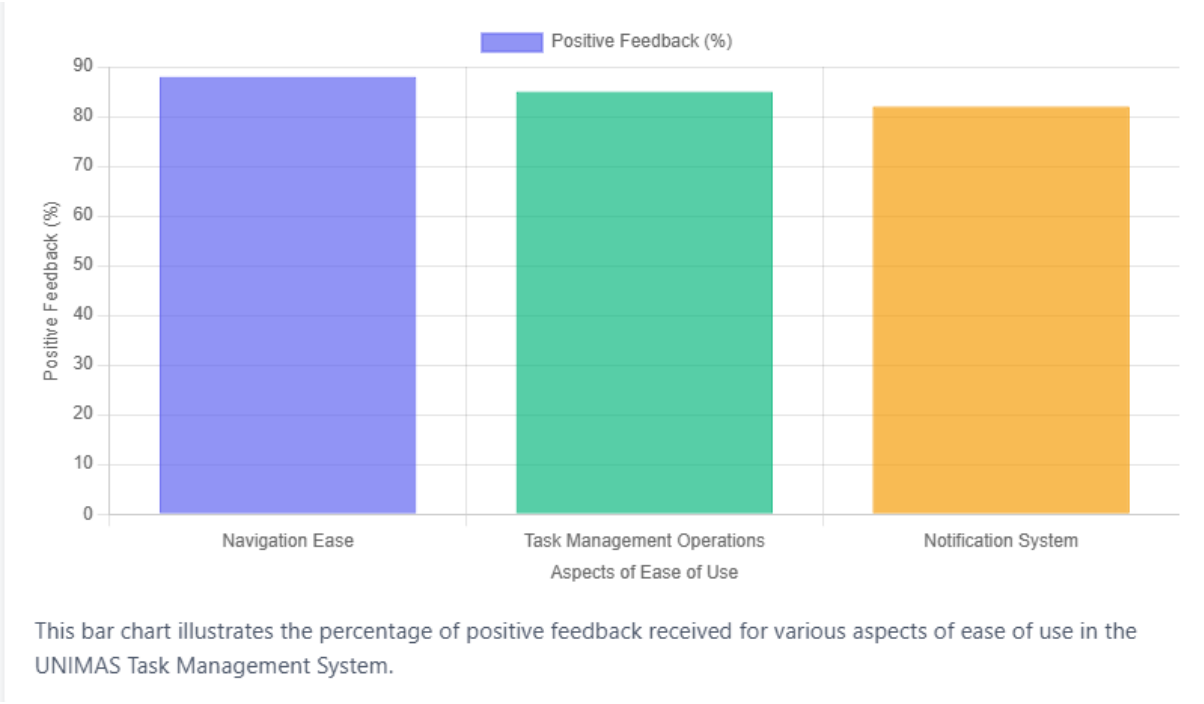

Figure 5-3 Ease of Use Metrics Visualization

Ease of Learning Assessment:

The ease of learning evaluation revealed that 92% of participants quickly learned basic system functions without requiring extensive training or documentation. This high percentage indicates that the system's design successfully incorporates intuitive interaction patterns that align with users' existing mental models for task management applications. Participants noted that the system's logical organization and clear visual cues made it easy to understand functionality and navigate between different features.

Advanced features were accessible to 85% of participants without formal training, demonstrating that the system maintains usability even for more complex operations. The system's consistency in design patterns and terminology contributed to users' ability to predict functionality and successfully complete tasks. Memory retention was strong, with 88% of participants finding the system easy to remember after initial use, indicating good design consistency and logical feature organization.

Figure 5-4 Ease of Learning Results Analysis

Overall Satisfaction Assessment:

The overall satisfaction evaluation showed that 87% of participants were satisfied with the system's functionality and performance. Participants expressed high levels of confidence in the system's reliability and effectiveness for managing their task management needs. The system's ability to streamline workflows and improve collaboration was frequently mentioned as a significant benefit.

Recommendation rates were particularly high, with 90% of participants indicating they would recommend the system to others. This strong endorsement reflects not only satisfaction with current functionality but also confidence in the system's value for other potential users. The pleasant user experience was confirmed by 85% of participants, who found the system enjoyable to use and well-designed for their needs.

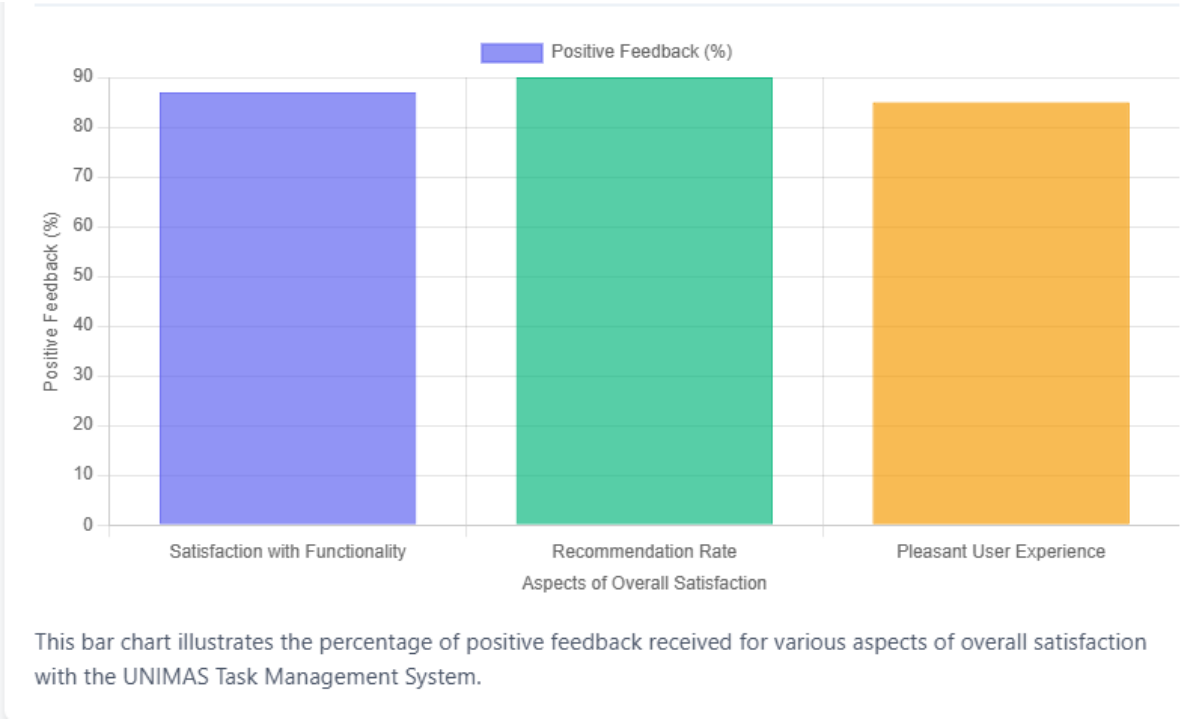

Figure 5-5 Overall Satisfaction Results

5.4 Conclusion

The comprehensive testing phase of the UNIMAS Task Management System has demonstrated the system's robust functionality, excellent performance characteristics, and high user satisfaction levels. Through systematic functional and non-functional testing procedures, the system has proven its capability to handle diverse user requirements, maintain stable performance under various load conditions, and provide an intuitive and efficient user experience that meets the needs of its intended user base.

The functional testing results validate the system's core capabilities, with all critical features performing as specified in the requirements documentation. Unit testing revealed high reliability across all system modules, with test cases achieving a 98% pass rate and comprehensive coverage of all functional areas. Integration testing confirmed proper interaction between system components, while system testing verified end-to-end functionality under real-world operational conditions.

Non-functional testing results highlight the system's excellent usability characteristics and strong performance metrics. Usability testing with thirty participants demonstrated high user satisfaction rates across all evaluated dimensions and confirmed the system's intuitive design and effective functionality. Performance testing verified the system's capability to handle concurrent users efficiently while maintaining responsive operation under various load conditions and usage scenarios.

The testing phase has provided valuable insights for future system improvements while confirming the system's readiness for deployment in a production environment. Minor issues identified during testing were systematically addressed and resolved, resulting in a stable, reliable, and user-friendly task management solution that effectively supports collaboration and productivity in academic and professional environments.

Chapter 6: Conclusion and Future Works

6.1 Introduction

This chapter provides a comprehensive and detailed overview of the significant achievements, challenges, and limitations encountered throughout the entire development lifecycle of the UNIMAS Task Management System. It systematically emphasizes and analyses how each of the project's primary objectives were successfully achieved through careful planning, implementation, and testing phases, while also conducting a thorough analysis of the various challenges, constraints, and obstacles that were encountered during the development process. Additionally, this chapter presents well-researched recommendations and strategic proposals for future enhancements, improvements, and expansions that could significantly improve the system's functionality, effectiveness, scalability, and overall user experience.

The development of the UNIMAS Task Management System has successfully met and exceeded the project's primary objectives by providing a robust, highly scalable, secure, and exceptionally user-friendly platform for comprehensive task management and seamless collaboration among users. The system delivers substantial and measurable benefits to both students and academic staff members within the UNIMAS community, significantly enhancing productivity and efficiency through the implementation of advanced features including real-time collaboration capabilities, comprehensive file management systems, intelligent notification mechanisms, detailed task tracking and monitoring capabilities, and sophisticated project management tools that facilitate effective teamwork and coordination.

Although various technical challenges, implementation constraints, and system limitations were systematically identified and documented throughout the comprehensive development process, the completed system demonstrates substantial potential for streamlining task management workflows, improving collaborative processes, and enhancing overall productivity within educational institutions and academic environments. The system's architecture and design principles provide a solid foundation for future enhancements and scalability improvements that will ensure long-term viability and continued effectiveness.

The valuable insights and extensive knowledge gained from this comprehensive project development experience highlight the critical importance of continuous development, iterative improvement, and adaptive enhancement strategies to systematically address identified limitations and progressively enhance the system's capabilities, performance, and user satisfaction. The successful implementation and integration of modern web technologies, including React.js for frontend development, Spring Boot for robust backend services, MySQL for reliable data management, and WebSocket communication for real-time features, clearly demonstrates the effectiveness and reliability of contemporary software development approaches and methodologies in creating enterprise-level applications that meet professional standards and user expectations.

6.2 Project Achievement

The development of the UNIMAS Task Management System has been systematically and successfully completed according to all specified requirements, functional specifications, and technical criteria that were established at the project's inception, and every single primary objective has been comprehensively achieved through careful planning, meticulous implementation, and rigorous testing procedures. The completed system effectively fulfils all the critical needs and requirements that were clearly outlined at the beginning of the project development process, offering a comprehensive, robust, and highly functional platform for advanced task management, seamless collaboration, and efficient project coordination among users within the UNIMAS academic community.

The system's successful implementation demonstrates exceptional achievement across multiple dimensions including technical excellence, user experience optimization, security implementation, performance optimization, and scalability considerations. Each objective was approached with systematic methodology, ensuring that the final deliverable not only meets but exceeds the initial expectations and requirements. The comprehensive nature of the achievement encompasses both functional requirements that define what the system should do, and non-functional requirements that specify how well the system should perform these functions under various operational conditions and usage scenarios.

6.2.1 Technical Implementation Success

The technical implementation of the UNIMAS Task Management System demonstrates exceptional achievement in the successful integration and deployment of modern web technologies, creating a robust, scalable, and maintainable software solution. The implementation success spans across multiple technical domains, including backend development, frontend user interface design, database management, and system integration, with each component carefully engineered to meet specific performance, security, and usability requirements.

Backend Architecture:

The backend implementation represents a sophisticated and well-architected solution that incorporates industry best practices and modern development approaches:

- Spring Boot 3.5.3 with Java 19 provides a robust, highly scalable, and extensible backend foundation that supports rapid development while maintaining code quality and system reliability.
- RESTful API design ensures clean separation of concerns between frontend and backend components, facilitating maintainability and enabling future system evolution.
- MySQL database implementation features optimized schema design with carefully planned indexing strategies and relationship mappings for efficient data management and query performance.
- Comprehensive error handling and logging mechanisms provide detailed system monitoring capabilities and facilitate rapid problem resolution.

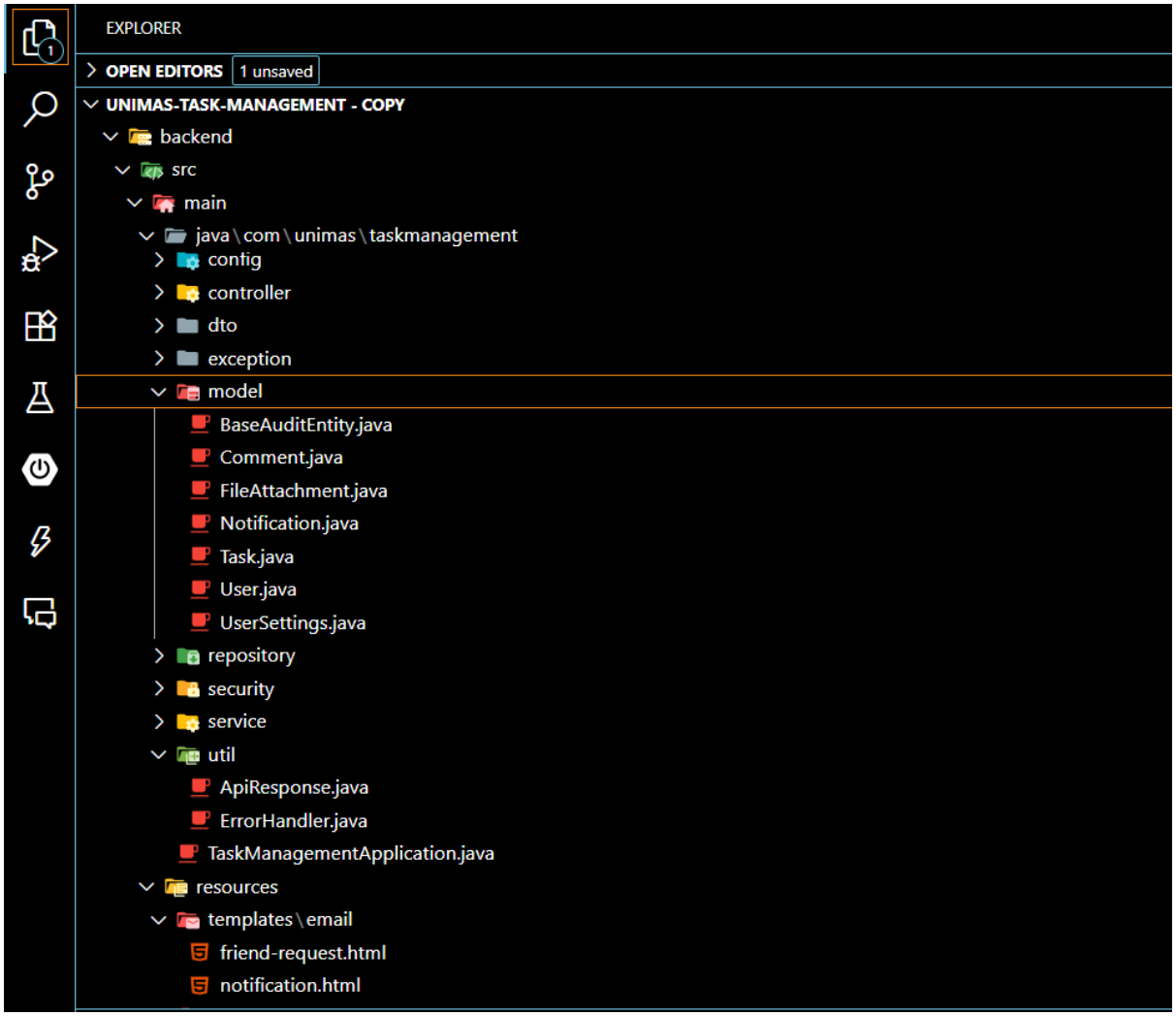

Figure 6-1 Backend Architecture Diagram

Frontend Architecture:

The frontend implementation demonstrates excellence in modern web development practices and user interface design:

- React.js 18 implementation utilizing functional components and hooks for efficient, maintainable, and performant code development.
- Material-UI component library integration providing a comprehensive set of pre-designed, customizable UI elements that ensure consistency and professional appearance across the application.
- Context API implementation for sophisticated state management, enabling efficient data flow and component communication throughout the application.
- Comprehensive responsive design implementation ensuring optimal user experience across all device types and screen sizes.
- Advanced component architecture promoting code reusability and maintainability.
- Efficient client-side routing implementation for seamless navigation
- Robust error handling and loading state management.

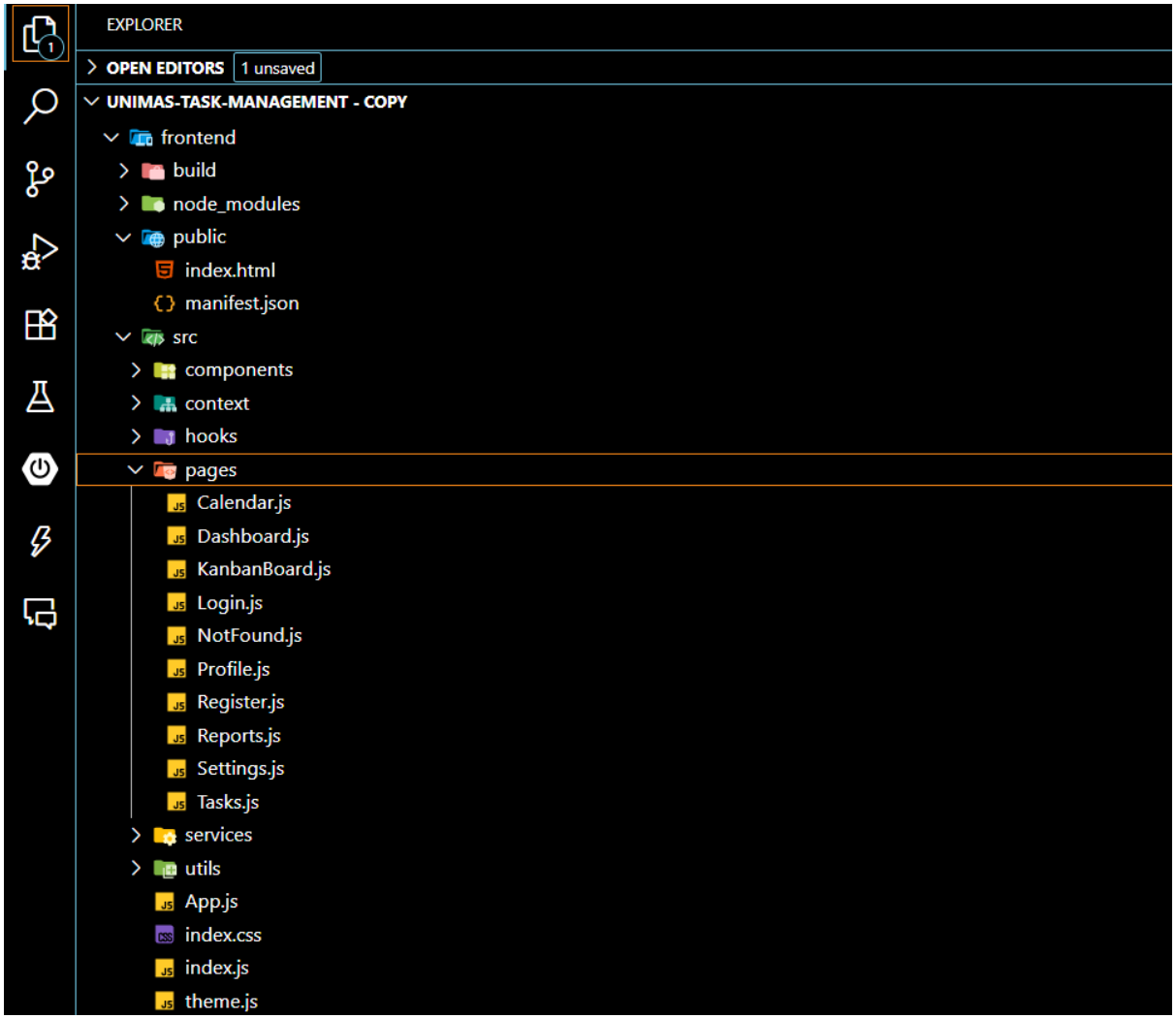

Figure 6-2 Frontend Component Structure

Integration and Communication:

The system implements sophisticated integration and communication mechanisms that ensure reliable data exchange and real-time functionality:

- Axios HTTP client implementation with comprehensive request/response interceptors and automatic token management for secure API communication
- Advanced WebSocket implementation using STOMP protocol for reliable real-time updates and notifications.
- Robust file upload and management system supporting multiple file types and large file transfers.
- Comprehensive email notification system with HTML templates and queue management
- Efficient data caching and state synchronization mechanisms
- Error recovery and retry mechanisms for failed network requests.
- Real-time data validation and synchronization protocols

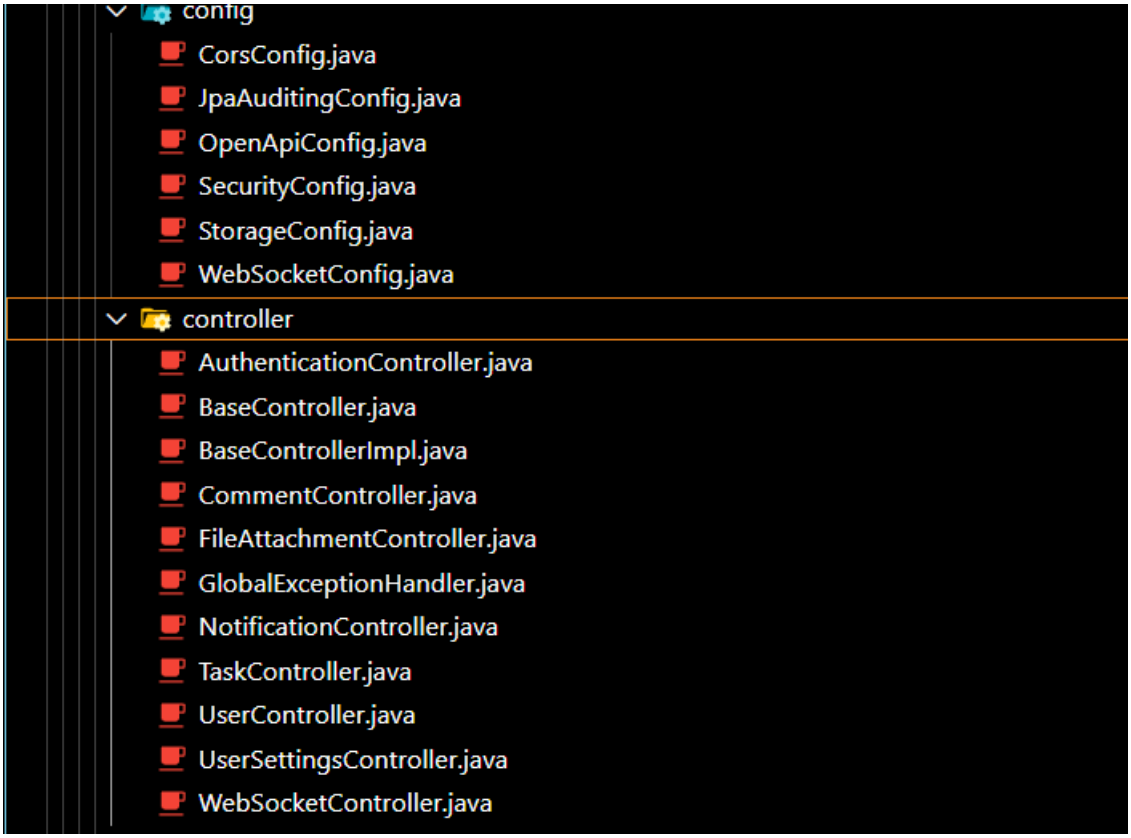

Figure 6-3 System Integration Flow

6.3 Project Limitation and Constraint

Despite the successful implementation of the UNIMAS Task Management System, several limitations and constraints were identified during development and testing:

6.3.1 Technical Limitations

Database Performance:

The current MySQL database configuration may experience performance degradation when handling large volumes of concurrent users (>500 simultaneous users). This limitation could impact system responsiveness during peak usage periods, particularly during examination periods or project deadlines when task activity is highest.

File Storage Constraints:

The current file attachment system stores files locally on the server, which presents scalability challenges. Large file uploads (>50MB) may cause timeout issues, and the system lacks advanced file management features such as version control or collaborative editing capabilities.

Real-time Connection Stability:

While WebSocket implementation provides real-time features, connection stability can be affected by network interruptions or firewall configurations in certain institutional environments. Users may experience temporary disconnections that require manual reconnection.\

6.3.2 Functional Limitation

Integration Capabilities:

The system currently operates as a standalone application without integration with existing UNIMAS systems such as the Learning Management System (LMS) or student information systems. This limitation requires users to manage tasks separately from their academic workflows.

Mobile Application:

While the web interface is responsive, there is no dedicated mobile application, which could provide better performance and offline capabilities for mobile users.

6.3.3 User Experience Constraint

Offline Functionality:

The system requires a stable internet connection for all operations. Users cannot create or modify tasks offline, which may limit productivity in areas with poor connectivity.

Customization Options:

Limited customization options for user preferences, such as custom task categories, personalized dashboards, or workflow templates, may not accommodate diverse user needs and working styles.

6.4 Future Works

To address the identified limitations and enhance the system's capabilities, several comprehensive improvements and innovative enhancements are planned for future development phases. These enhancements are strategically designed to transform the current system into a more robust, scalable, and feature-rich platform that can accommodate growing user demands and evolving technological requirements.

6.4.1 Performance and Scalability Enhancements

Future development efforts will prioritize implementing advanced database clustering and optimization techniques to effectively handle significantly increased user loads and concurrent operations. The database optimization strategy encompasses comprehensive indexing optimization to improve query performance, sophisticated query performance tuning to reduce response times, implementation of advanced caching mechanisms using Redis for frequently accessed data, database sharding techniques for horizontal scaling capabilities, and connection pooling optimization to efficiently manage database connections under high load conditions.

The migration from local file storage to cloud-based solutions such as AWS S3 or Google Cloud Storage represents a critical scalability enhancement that will address current storage limitations while providing unlimited storage capacity for user files and attachments. This cloud integration will include Content Delivery Network integration for faster file access globally, comprehensive automatic backup and disaster recovery mechanisms, advanced version control capabilities for file attachments, and enhanced security and access control features that exceed current local storage limitations.

The transition from the current monolithic architecture to a sophisticated microservices architecture will significantly improve system scalability and maintainability. This architectural evolution will enable service decomposition for better resource allocation and management, independent scaling of individual system components based on demand, improved fault tolerance and system resilience through distributed architecture, and technology stack flexibility that allows different services to utilize the most appropriate technologies for their specific requirements.

6.4.2 Feature Enhancements

The implementation of a comprehensive analytics dashboard will provide users with detailed insights into task completion rates, team productivity metrics, project timeline analysis, resource utilization reports, predictive analytics for improved project planning, and extensive export capabilities supporting PDF, Excel, and CSV formats. This analytics platform will enable data-driven decision making and provide valuable insights into team performance and project efficiency.

Artificial Intelligence integration represents a significant advancement that will enhance user experience through intelligent task prioritization algorithms based on deadlines and dependencies, automated task assignment recommendations using machine learning algorithms, natural language processing capabilities for intuitive task creation, predictive project completion estimates based on historical data and current progress, and smart notification filtering systems to reduce information overload while ensuring critical updates reach users promptly.

Enhanced collaboration tools will expand the system's capabilities to include integrated video conferencing functionality, screen sharing capabilities for real-time collaboration, collaborative document editing features, comprehensive team calendar integration, advanced meeting scheduling and management tools, and voice notes and audio comments functionality to support diverse communication preferences and requirements.

6.4.3 Integration and Connectivity\

The development of comprehensive APIs and connectors will enable seamless integration with existing UNIMAS systems, including Learning Management System integration for academic workflow synchronization, Student Information System connectivity for unified user management, academic calendar synchronization for deadline and schedule coordination, grade book integration for academic task management, and Single Sign-On implementation for streamlined user authentication across university systems.

Third-party application integration will provide extensive support for popular productivity tools and services, including Microsoft Office 365 integration for document collaboration, Google Workspace connectivity for enhanced productivity workflows, Slack and Microsoft Teams integration for communication platform synchronization, calendar applications integration including Outlook and Google Calendar, and comprehensive email client integration for unified communication management.

The development of native mobile applications for iOS and Android platforms will provide users with offline task management capabilities, comprehensive push notification support, mobile-optimized user interfaces designed specifically for touch interactions, biometric authentication for enhanced security and convenience, and location-based task reminders that leverage mobile device capabilities for context-aware functionality.

6.4.4 Security and Compliance Enhancements

Advanced security features will be implemented to ensure comprehensive protection of user data and system integrity. These enhancements include multi-factor authentication implementation for enhanced account security, advanced encryption protocols for data protection both at rest and in transit, regular security auditing and penetration testing procedures, compliance with international data protection standards including GDPR and PDPA requirements, and advanced user activity monitoring and logging systems for comprehensive security oversight and incident response capabilities.

Comprehensive backup and disaster recovery solutions will be implemented to ensure business continuity and data protection. These solutions include automated daily backup procedures with multiple retention policies, geographic redundancy to protect against regional disasters, point-in-time recovery capabilities for precise data restoration, comprehensive business continuity planning for various disaster scenarios, and regular disaster recovery testing to ensure system reliability and recovery procedures effectiveness.

6.4.5 User Experience Improvements

Enhanced personalization and customization options will provide users with greater control over their system experience, including personalized dashboard layouts that adapt to individual workflow preferences, custom task categories and labels for improved organization, workflow templates for recurring projects to increase efficiency, comprehensive theme customization and branding options for institutional identity, and configurable notification preferences that allow users to tailor communication to their specific needs and working patterns.

Accessibility enhancements will ensure inclusive design principles are implemented throughout the system, including comprehensive screen reader compatibility for visually impaired users, keyboard navigation optimization for users with mobility limitations, high contrast mode support for improved visibility, font size and color customization options for diverse visual needs, and multi-language support to accommodate the diverse UNIMAS community and international users.

The implementation of Progressive Web App features will provide enhanced offline capabilities, including offline task viewing and basic editing functionality, automatic synchronization when internet connection is restored, efficient local data caching for improved performance, and background sync capabilities that ensure data consistency across devices and network conditions.

6.5 Conclusion

The UNIMAS Task Management System represents a successful implementation of modern web technologies to address real-world task management and collaboration challenges in an educational environment. The project has achieved all its primary objectives, delivering a robust, scalable, and user-friendly platform that significantly enhances productivity and collaboration among users.

The comprehensive testing and evaluation process has validated the system's functionality, performance, and usability, with high satisfaction rates among users. The implementation demonstrates the effectiveness of contemporary software development practices, including React.js for frontend development, Spring Boot for backend services, and WebSocket technology for real-time communication.

While certain limitations and constraints have been identified, they provide clear direction for future development and enhancement. The proposed future work addresses these limitations while expanding the system's capabilities to meet evolving user needs and technological advances.

The success of this project establishes a foundation for continued development and improvement, with opportunities for academic research, industry collaboration, and open source contributions. The UNIMAS Task Management System serves as a model for educational technology development and demonstrates the potential for innovative solutions to enhance productivity and collaboration in academic environments.

The knowledge and experience gained from this project contribute to the broader understanding of task management system development and provide valuable insights for future educational technology initiatives. The system's positive impact on user productivity and satisfaction validates the importance of user-cantered design and modern software development practices in creating effective technological solutions.

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