Management Information System (MIS) for Gem and Jewelry Research and Training Institute (GJRTI) - Ministry of Industries

Name with Initials	Index Number
DD Mapalagama	**19APSE4302**
RLTN Rathnayaka	**19APSE4316**
LDA Thilakarathne	**19APSE4292**
MS Hewage	**19APSE4300**
J Vijayakumar	**19APSE4276**

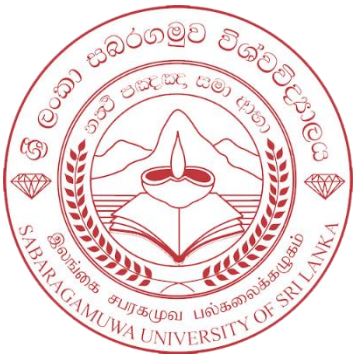
BSc. (Honors) in Software Engineering

Department of Software Engineering

Faculty of Computing

Sabaragamuwa University of Sri Lanka

February 2025



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Report submitted in partial fulfillment of the requirement for BSc. (Honors) in Software Engineering

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February 2025

1 DECLARATION

We hereby declare that the report entitled Management Information System (MIS) for Gem and Jewelry Research and Training Institute (GJRTI) - Ministry of Industries was submitted to the Department of Software Engineering, Faculty of Computing, Sabaragamuwa University of Sri Lanka. The report submitted herewith of the results of our effort in totality and every aspect of the project works. All information that has been obtained from other sources had been fully acknowledged.

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21.02.2025
Date

Disara Mapalagama
19APSE4302

21.02.2025
Date

Navindu Rathnayaka
19APSE4316

21.02.2025
Date

Dushyantha Thilakarathne
19APSE4292

21.02.2025
Date

Minuri Hewage
19APSE4300

21.02.2025
Date

Janarthan Vijayakumar
19APSE4276

2 CERTIFICATION OF APPROVAL

I hereby declare that this report is from the student's own work and effort, and all other sources of Information used have been acknowledged. This report has been submitted with my approval.

…….. ……

Ms. Ashansa Wijerathne Date
Internal Supervisor,
Department of Software Engineering,
Faculty of Computing,
Sabaragamuwa University of Sri Lanka.

…….. ……

Ms. Ashansa Wijerathne Date
Head,
Department of Software Engineering,
Faculty of Computing,
Sabaragamuwa University of Sri Lanka.

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Thank You,

Group 7

4 ABSTRACT

The Management Information System (MIS) for the Gem and Jewelry Research and Training Institute (GJRTI) was developed to modernize administrative processes, improve data management, and enhance accessibility for students and staff. The existing manual processes for enrollment, attendance tracking, and report generation were inefficient and prone to errors, necessitating an automated solution. The MIS streamlines these operations through a centralized database, web-based access, and automated notifications, significantly improving efficiency and accuracy.

The system design was based on UML diagrams, ER modeling, and UI/UX prototyping in Figma, ensuring a well-structured and user-friendly interface. The implementation leveraged modern technologies such as Node.js, MongoDB, Docker, and GitHub, making the system scalable, secure, and responsive across desktop and mobile platforms. Rigorous testing was conducted using Mocha, Chai, and Selenium to ensure reliability and performance.

Key features of the MIS for GJRTI include student and staff management, course and exam tracking, center management, and financial record-keeping. Future enhancements include the integration of a payment gateway, real-time SMS notifications, and biometric attendance tracking. This project demonstrates how a well-designed MIS can enhance operational efficiency, reduce administrative workload, and improve the overall management of educational institutions.

Keywords: Management Information System, automation, data management, web-based platform, student management, exam tracking, cloud hosting, testing, scalability

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GJRTI	Gem and Jewellery Research and Training Institute
MIS	Management Information System
UML	Unified Modeling Language
LGC	Lanka Government Cloud
UX	User Experience
RBAC	Role Based Access Control
UI/UX	User Interface/User Experience
ER	Entity Relationship
PK	Primary Key
FK	Foreign Key
AI	Artificial Intelligence
RFID	Radio-Frequency Identification
SMS	Short Message Service
RAM	Random Access Memory
LMS	Learning Management System
HTTPS/ SSL	Secure Socket Layer
API	Application Programming Interface
POV	Point of View
BST	Binary Search Tree

9 CHAPTER 1: INTRODUCTION

The Gem and Jewelry Research and Training Institute (GJRTI) plays a crucial role in training professionals and conducting research in Sri Lanka's gem and jewelry industry. However, the institute relied on manual processes for managing student enrollments, course records, staff details, and administrative operations. This led to inefficiencies, data inconsistencies, and delays in processing critical information.

To address these challenges, a Management Information System (MIS) was developed to streamline operations, automate administrative functions, and centralize data management. This system provides a robust platform for handling student records, financial transactions, and course enrollments, while also integrating modern communication tools and security measures.

This chapter outlines the background, goals, motivation, scope, and approach taken in the development of the MIS. It provides insights into the challenges that prompted the system's development, the objectives it aimed to achieve, and the key benefits it has delivered. The structured approach followed in the project ensures that the system is scalable, secure, and user-friendly, positioning GJRTI for future growth and technological advancements.

9.1. Introduction

By virtue of the powers vested in Sub-section (i), Section 25 of the National Gem and Jewellery Authority Act No. 50 of 1993, the Gem and Jewellery Research and Training Institute (GJRTI) was established to provide research and training facilities to support the regulation, promotion, and development of Sri Lanka's gem and jewellery industry[1]. Since its inception, GJRTI has been instrumental in enhancing the skills and knowledge of professionals within the industry, offering specialized training programs and conducting research to drive innovation and sustainability in the sector.

Figure 1: Snippet of GJRTI Official Website

Over the years, GJRTI has developed a strong set of values through its collaborations with other training institutions and stakeholders in the gem and jewellery industry. These values have been fundamental in helping the institute achieve its objectives and in building a solid reputation as the leading training provider in Sri Lanka's gem and jewellery sector. Trust has been a key element, as GJRTI has earned the confidence of the industry by consistently delivering high-quality skills training. Its credibility is further reinforced by the excellence of its training programs, which have built a strong image for the institution over the years.

As the apex training institute in the field, GJRTI is known for the competence of its academic staff, who are highly skilled professionals with years of expertise. Transparency and equity are also core principles, ensuring that all training programs are conducted fairly and impartially. The institute is deeply committed to the growth and development of the gem and jewellery industry, continuously striving to provide high-quality services. Moreover, GJRTI is passionate about its customers, functioning as an equal opportunity provider and serving trainees with enthusiasm to help them achieve a high level of competency.

GJRTI is committed to empowering the next generation of gem and jewellery professionals, equipping young talents with the necessary skills to become world-class craftsmen and entrepreneurs. Training is seen as a valuable investment that benefits both the institute and the national economy by ensuring a highly skilled workforce. Finally, GJRTI prioritizes research, as it believes that conducting cutting-edge studies will lead to the discovery of new gem deposits, ultimately strengthening Sri Lanka's economic position in the global market.

To ensure accessible, high-quality training across the country, GJRTI operates a network of training centers strategically located in key gem and jewellery hubs. The head office is based in Colombo, with regional offices in Ratnapura, Kandy, Galle, Awissawella, Nivithigala, Aththanagalle, Jaffna, and Rathmalana. This extensive network allows aspiring professionals from different regions to access specialized training without having to relocate to the capital.

GJRTI offers a wide range of diploma and certification programs designed to equip trainees with both theoretical knowledge and hands-on experience. Some of the key programs include the Diploma in Professional Gemmology (Dip in PGSL), available in Colombo and Ratnapura, which covers gem identification, valuation, treatment, and marketing. The Diploma in Professional Jewellery (Dip in PJSL), conducted in Colombo, is developed under TVEC standards and offers NVQ Level 5 certification, incorporating modern technology in jewellery manufacturing.

Other specialized courses include Gemmology, Gem Colour Grading & Marketing, Gem Cutting & Polishing, Geuda Heat Treatment, Gem Carving, Jewellery Manufacturing, Jewellery Designing, Computer-Aided Jewellery Designing, Jewellery Stone Setting, Costume Jewellery Manufacturing, and Casting &

Electroplating. These programs are available in multiple locations, ensuring accessibility to aspiring professionals across the country.

With its nationwide presence, comprehensive training programs, and strong industry partnerships, GJRTI continues to play a pivotal role in shaping the future of Sri Lanka's gem and jewellery industry. Through its dedication to excellence in training and research, the institute remains at the forefront of innovation and skill development, empowering individuals and contributing to the growth of the national economy.

Despite its notable contributions to the industry, GJRTI has been facing operational inefficiencies due to its reliance on manual administrative processes. Many critical tasks, such as student enrollment, attendance tracking, course fee management, certificate issuance, and report generation, were traditionally handled through paper-based records or outdated digital systems. This approach led to several challenges, including processing delays, data inconsistencies, errors in record-keeping, and an increased administrative workload. These inefficiencies not only slowed down day-to-day operations but also impacted the learning experience for students and the effectiveness of administrative staff, making it difficult to efficiently manage the growing number of enrollees and institutional activities.

Currently, GJRTI relies on manual processes to manage a wide range of administrative tasks, including student enrollments, course records, staff details, and financial transactions. This dependence on traditional record-keeping methods has resulted in operational bottlenecks, redundancy, and human errors, significantly affecting the efficiency and transparency of institutional management. The absence of a centralized, automated system has made it challenging for administrators to track student progress, manage course schedules, and maintain accurate financial records, leading to frequent delays and miscommunications between different departments.

Recognizing these challenges, our team has developed a comprehensive Management Information System (MIS) specifically tailored to the needs of GJRTI. The primary goal of this MIS is to automate key administrative functions, centralize data management, and provide real-time access to critical information. By replacing manual processes with modern web-based technologies, the system is designed to enhance operational efficiency, improve data accuracy, and significantly reduce the administrative burden on staff members.

A **Management Information System (MIS)** is an integrated digital platform designed to collect, process, store, and manage institutional data efficiently. It enables organizations to streamline workflows, automate routine tasks, and provide users with real-time access to information for better decision-making. MIS solutions are commonly used in educational institutions, businesses, and government organizations to improve operational efficiency, reduce paperwork, and enhance data accuracy.

The newly developed MIS for GJRTI incorporates a user-friendly interface and scalable architecture, ensuring that it can adapt to future institutional growth while remaining accessible to both technical and non-technical users. Its secure infrastructure is equipped with role-based access control and encrypted data storage, ensuring the confidentiality and integrity of sensitive institutional records. Additionally, the MIS provides real-time monitoring, automated notifications, and advanced reporting features, allowing administrators to make informed decisions quickly and efficiently.

By implementing this MIS, GJRTI aims to streamline its internal operations, improve communication between stakeholders, and provide a seamless experience for students, faculty, and administrative staff. The system is expected to significantly reduce paperwork, minimize errors, and enhance overall productivity, ultimately contributing to the long-term success and sustainability of the institute.

9.2. Major goals and objectives

The Gem and Jewelry Research and Training Institute (GJRTI) plays a crucial role in Sri Lanka's gem and jewelry sector by providing specialized education and research opportunities. However, its administrative processes were largely dependent on manual operations, leading to inefficiencies such as delays in student enrollment, errors in data management, and difficulties in tracking financial transactions. To address these challenges, this community project aimed to develop a Management Information System (MIS) that would automate key administrative functions, centralize data management, and enhance accessibility, ensuring that GJRTI could operate more efficiently and effectively.

- **Automate Administrative Processes**

One of the primary objectives of the project was to automate administrative processes, reducing the dependency on paper-based workflows. The MIS introduced a digital student enrollment system, allowing students to register online without the need for physical documentation. Attendance tracking, which was previously done manually, was integrated into the system, enabling automated record-keeping and reducing the risk of errors. Additionally, a secure payment gateway was implemented to facilitate online course fee transactions, eliminating the complexities associated with manual payment handling. Another significant feature was the automated certificate issuance system, which allowed students to receive digitally verified course completion certificates, streamlining the certification process and reducing administrative workload.

- **Centralize Data Management**

To ensure efficient data management, the MIS established a centralized database where student, staff, and course-related information could be securely stored and accessed in real time. Previously, data was scattered across multiple spreadsheets

and physical files, making retrieval cumbersome and prone to inconsistencies. The introduction of a unified data management system significantly improved accessibility and coordination across departments. Moreover, the MIS incorporated role-based access controls, ensuring that only authorized personnel could access or modify sensitive records, thereby enhancing security and compliance.

- **Increase Student Enrollments**

Another key goal of the project was to increase student enrollments by providing a seamless online registration experience. The new system allowed local and international students to apply for courses through an intuitive digital platform, eliminating the need for in-person visits. Automated email and SMS notifications were integrated into the system to keep students informed about their application status, reducing administrative follow-ups. By simplifying the enrollment process, the MIS made it easier for prospective students to join GJRTI, contributing to higher admission rates and broader accessibility.

- **Ensure High-Level Security and Accessibility**

Security and accessibility were also major priorities in the development of the MIS. Given the sensitive nature of academic records and financial transactions, the system was designed with robust security measures, including role-based access control, encrypted data storage, and secure authentication mechanisms. These features ensured that student and staff data remained protected against unauthorized access. Furthermore, the MIS was built as a web-based application, making it accessible across multiple devices, including desktops, tablets, and smartphones. This approach allowed students, faculty, and administrators to interact with the system from anywhere, fostering greater flexibility in academic and administrative operations.

- **Enhance Communication and Reporting**

In addition to these features, the system was designed to enhance communication and reporting within the institution. By integrating SMS gateways and automated notifications, the MIS streamlined interactions between students, staff, and administrators. The system also included detailed report generation tools, enabling administrators to track enrollment trends, financial transactions, and student performance metrics more efficiently. These insights played a crucial role in data-driven decision-making, allowing GJRTI to optimize its operations and improve institutional management.

The successful implementation of the MIS marked a significant milestone in GJRTI's digital transformation. By automating processes, centralizing data, enhancing security, and improving accessibility, the system laid the foundation for a more efficient and scalable administrative framework. The project not only

addressed existing inefficiencies but also positioned GJRTI for future growth by enabling the seamless integration of additional features and functionalities in the coming years.

9.3. Motivation

The motivation for developing this Management Information System (MIS) stems from the persistent challenges faced by GJRTI's existing manual administrative processes. The institution, despite its importance in the gem and jewelry sector, struggled with inefficient operations that affected student enrollment, course administration, and financial tracking.

The primary issues include:

- **Time-Consuming Manual Workflows** – Staff had to process student applications, attendance sheets, and certificates manually, leading to delays and increased workload.
- **Inaccuracies in Data Management** – Paper-based records were prone to errors, duplication, and data loss, making information retrieval difficult.
- **Limited Accessibility** – Students and staff had no centralized system to access enrollment details, schedules, or payment records.
- **Communication Gaps** – Lack of an automated notification system meant that students often missed important updates regarding courses, exams, and payments.
- **Inefficient Reporting Mechanism** – Generating reports for student progress, attendance, and financial transactions was cumbersome and often outdated.

By addressing these challenges, the MIS aims to enhance operational efficiency, ensure data accuracy, and improve overall user experience. This transformation is expected to benefit students, faculty, and administrative staff, creating a modernized system that aligns with the evolving needs of GJRTI.

9.4. The scope of the completed project

The Management Information System (MIS) developed for GJRTI encompasses a comprehensive suite of functionalities designed to enhance the administration, management, and efficiency of the institution's operations. The system provides a centralized, digital platform that streamlines various academic and administrative tasks, ensuring seamless workflow automation and improved coordination among departments.

- **Center Management**

One of the key aspects of the system is Center Management, which enables the efficient handling of multiple training centers. This feature ensures that administrators can manage different branches and training facilities with ease, ensuring that all locations remain synchronized under a unified system.

- **Training Course Management**

The Training Course Management module facilitates the creation, updating, and administration of training programs. Course coordinators and instructors can define course structures, update syllabi, and manage training schedules effortlessly. This ensures that course information remains accurate, up-to-date, and easily accessible to students and staff.

- **Applicant and Enrollment Management**

The system also includes Applicant and Enrollment Management, allowing for seamless processing of student applications and enrollments. Prospective students can register online, submit necessary documents, and receive timely updates regarding their application status. This digitalized approach significantly reduces paperwork, minimizes delays, and improves the overall enrollment experience.

- **Student and Staff Management**

The Student and Staff Management functionality ensures that detailed records of students, academic staff, and non-academic personnel are maintained. This includes student profiles, progress tracking, instructor assignments, and work schedules, ensuring that relevant information is organized, secure, and easily retrievable when needed.

- **Exam and Attendance Tracking**

Another critical component is Exam and Attendance Tracking, which enables administrators to monitor student performance, attendance records, and exam results efficiently. The system automates grading, generates student transcripts, and helps instructors manage attendance records digitally, reducing errors and improving accuracy.

- **Post-Completion Training Tracking**

To further enhance student development, the system includes Post-Completion Training Tracking, which manages records of internships, apprenticeships, and additional training programs beyond course completion. This ensures that students receive ongoing support and guidance in their professional journey.

- **Financial Management**

The Financial Management module enables secure handling of course fees, payment tracking, and financial reporting. This includes the ability to generate invoices, track outstanding payments, and provide financial summaries for better fiscal planning and accountability.

- **Security and Accessibility**

  Security and Accessibility have been key priorities, with the system integrating role-based access control, credential protection, and data encryption. This ensures that only authorized personnel have access to sensitive data, maintaining privacy and compliance with data protection standards.

- **Communication and Reporting**

  For improved Communication and Reporting, the system features automated notifications, SMS services, and detailed report generation. Students, instructors, and administrators receive timely alerts about course updates, attendance status, and important announcements, ensuring effective communication across all stakeholders.

- **Hosting and Accessibility**

  Lastly, the MIS is to be deployed on Lanka Government Cloud (LGC), providing a cost-effective, secure, and scalable hosting solution. This ensures that the system remains highly accessible, maintains consistent uptime, and benefits from government-level security measures to protect institutional data.

Overall, the developed MIS offers a robust, scalable, and future-ready platform that enhances GJRTI's operational efficiency, data accuracy, and user experience while ensuring long-term sustainability and security

9.5. The approach and assumptions of the project

The development of the Management Information System (MIS) for the Gem and Jewelry Research and Training Institute (GJRTI) followed the Iterative Incremental Model, ensuring a structured yet flexible approach to software development. This model allows for continuous refinement and enhancement of the system by breaking down the development process into multiple iterations, each focusing on delivering a functional subset of the system. Instead of attempting to develop the entire system in a single phase, we prioritized building the core functionalities first and progressively added additional features based on stakeholder feedback and evolving requirements.

The **Iterative Incremental Model** is particularly well-suited for projects where requirements may evolve over time or when continuous user feedback is necessary to enhance usability and performance. Each iteration involves a full development cycle, including planning, designing, coding, testing, and evaluating, ensuring that the system remains adaptable to user needs. By following this approach, we were able to deliver working versions of the system early in the project, allowing stakeholders to interact with the system and provide valuable feedback before additional features were developed.

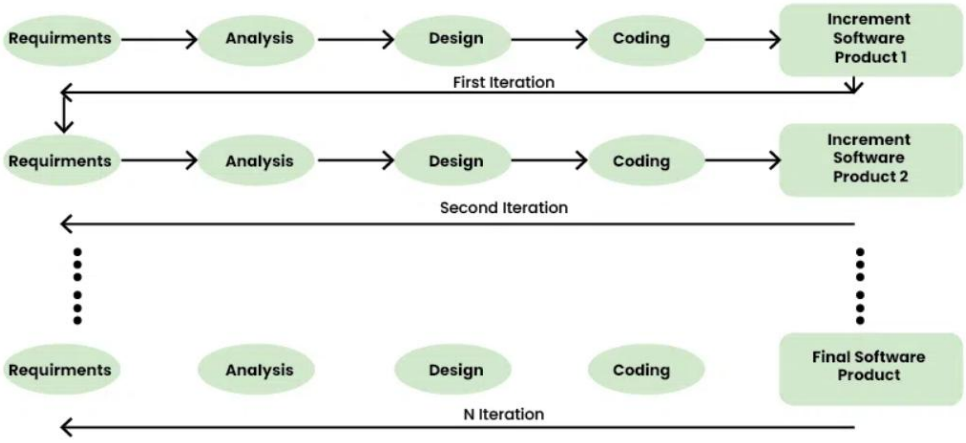


Figure 2: Iterative Incremental Model

Phased Development Process:

- Initial Phase: Core Functionalities Development

The first iteration focused on implementing the most critical functionalities required for GJRTI's operations. This included the student enrollment system, course management module, and basic user authentication mechanisms. These fundamental components formed the backbone of the MIS, enabling GJRTI to transition from a manual to an automated workflow efficiently.

- Second Phase: Data Centralization and Security Enhancements

After the core functionalities were deployed and tested, the second iteration introduced centralized data management features, allowing seamless coordination of student, staff, and course-related information. Additionally, security enhancements such as role-based access control (RBAC) and encrypted data storage were implemented to ensure data protection and compliance with security best practices.

- Third Phase: Advanced Features and Optimization

Once the essential functionalities were validated, subsequent iterations focused on integrating additional features such as automated notifications (SMS and email), attendance tracking, financial management, and certificate issuance. Performance optimizations and UI/UX improvements were also introduced based on user feedback, ensuring an intuitive and efficient experience.

- Final Phase: Deployment and Continuous Improvement

The final iteration involved system deployment on the Lanka Government Cloud (LGC) to ensure scalability, security, and cost-effectiveness. Alongside deployment, user training programs were conducted for GJRTI staff to familiarize them with the system. Since the Iterative Incremental Model promotes continuous improvement, the system is designed to accommodate future updates and feature expansions based on institutional needs.

Assumptions Made:

To ensure the successful implementation and long-term sustainability of the MIS, the following assumptions were made:

- Users have basic digital literacy to navigate and operate the system effectively.
- Regular maintenance and updates will be carried out to enhance system longevity and security.
- Reliable internet connectivity will be available to ensure seamless access to the cloud-hosted MIS platform.

By adopting the Iterative Incremental Model, we ensured that GJRTI could gradually transition from its manual processes to a fully automated and optimized management system, with continuous improvements based on real-time usage and feedback. This approach not only minimized development risks but also allowed for a more user-centric and adaptable solution.

9.6. Summary of major outcomes

The implementation of the Management Information System (MIS) at GJRTI has led to transformative improvements across various administrative and operational domains. By automating key processes such as student enrollment, attendance tracking, course management, and financial handling, the system has significantly reduced the manual workload of administrative staff. Tasks that previously required extensive paperwork and manual intervention can now be completed with just a few clicks, saving time and improving overall operational efficiency.

One of the most notable benefits of the MIS is its improved data accuracy and reliability. By centralizing student, staff, and course-related information, the system ensures that data remains consistent across all departments, minimizing errors caused by manual data entry. This has led to more precise record-keeping in areas such as attendance, grading, and financial transactions, reducing discrepancies and enhancing the credibility of institutional records.

The user experience (UX) of the MIS has been optimized to cater to a wide range of users, including administrators, instructors, and students. The system's intuitive interface and responsive design ensure seamless access across both desktop and mobile platforms, making it convenient for users to interact with the system from any location. This increased accessibility has contributed to a higher adoption rate among staff and students, facilitating smoother interactions with GJRTI's administrative processes.

In terms of scalability and security, the MIS is to be hosted on the Lanka Government Cloud (LGC), ensuring robust security standards and data protection measures. Role-based access control (RBAC), encrypted data storage, and secure authentication mechanisms have been implemented to protect sensitive information and prevent unauthorized access. The cloud-based infrastructure also provides high scalability,

allowing the system to accommodate increasing student enrollments and additional functionalities as needed in the future.

Another key outcome has been the increase in student enrollment rates, facilitated by the introduction of an online registration portal. The ease of registering for courses remotely has made GJRTI's programs more accessible to both local and international students, attracting a broader audience. Additionally, the enhanced online presence and improved visibility of available courses have contributed to greater student engagement and participation.

Finally, the MIS provides comprehensive reporting and analytics capabilities, enabling real-time tracking of student performance, staff activities, and financial transactions. Administrators can generate detailed reports on various aspects of institutional operations, allowing for data-driven decision-making and strategic planning. These insights help in identifying areas of improvement, optimizing resource allocation, and ensuring the overall efficiency of GJRTI's management processes.

In summary, the MIS has transformed GJRTI's administrative operations, enhancing efficiency, accuracy, user experience, security, and scalability while contributing to higher enrollment rates and improved decision-making. With a future-ready and adaptable system, GJRTI is now well-positioned to continue its growth and offer an improved learning experience to its students.

10.CHAPTER 2: BACKGROUND

In the rapidly evolving landscape of education and training, institutions must embrace digital transformation to remain efficient and competitive. This chapter explores the necessity and feasibility of implementing a Management Information System (MIS) for the Gem and Jewelry Research and Training Institute (GJRTI). As a key institution in Sri Lanka's gem and jewelry sector, GJRTI plays a crucial role in providing specialized training to professionals. However, its reliance on manual administrative processes has resulted in inefficiencies that hinder operational scalability and service quality.

The chapter begins by outlining the context in which GJRTI operates, highlighting its role in industry development and the current limitations of its administrative and academic processes. It then delves into the problems associated with manual workflows, including delays in student enrollment, attendance tracking issues, and inefficiencies in financial management. To provide a broader perspective, the chapter includes a review of existing solutions, discussing the functionalities of general educational management systems and their limitations in addressing GJRTI's specific needs. Finally, the justification for the project is presented, emphasizing the advantages of an MIS in terms of efficiency, accuracy, scalability, and improved student experience.

By addressing these aspects, this chapter establishes the foundation for understanding why GJRTI requires a tailored MIS and how its implementation will contribute to the Institute's long-term sustainability and growth.

10.1. Context

The Gem and Jewelry Research and Training Institute (GJRTI) plays a crucial role in advancing the gem and jewelry industry in Sri Lanka by providing specialized education and hands-on training for professionals. As a key institution in this field, GJRTI ensures that students receive the necessary technical expertise and industry knowledge to contribute effectively to the sector. However, despite its significant role in industry development, the Institute has been operating with traditional, manual administrative and academic processes.

Currently, GJRTI relies on paper-based documentation and standalone digital records to manage student enrollment, attendance, course administration, and financial transactions. While the Institute has a basic website, its functionality is limited to providing general information about courses and services. It lacks the necessary interactive features required for student and administrative management. The absence of an integrated digital solution has led to inefficiencies, including delays in processing student registrations, difficulties in tracking academic progress, and challenges in managing payments and certificates. These inefficiencies create administrative bottlenecks, hinder effective communication, and limit the Institute's ability to scale its operations.

Given the increasing number of students and growing demand for specialized training programs, it has become essential for GJRTI to adopt a modern Management Information System (MIS) to enhance its operational efficiency, streamline administrative workflows, and ensure the accuracy and accessibility of institutional data.

10.2. Problem Identification

One of the primary challenges faced by GJRTI is the absence of a dedicated Management Information System (MIS) to support its administrative and academic functions. The reliance on manual record-keeping and paper-based documentation results in a variety of operational inefficiencies, including:

- **Student Enrollment Delays**: The process of student registration is currently handled through paper forms, requiring manual data entry, verification, and record-keeping. This method is time-consuming and prone to errors, leading to delays in enrollment confirmation.
- **Attendance Tracking Issues**: Instructors and administrators manually record attendance, which can result in discrepancies, loss of records, and difficulties in monitoring student participation.
- **Financial Management Inefficiencies**: Course fee payments, refunds, and other financial transactions are tracked using spreadsheets or physical records, increasing the risk of miscalculations, missing payments, and fraudulent activities.
- **Certificate Issuance Complications**: The manual process of generating and verifying course completion certificates is labor-intensive and prone to errors. It also makes it difficult to reissue certificates in case of loss or damage.
- **Lack of Automated Communication**: Without a centralized system, notifications related to class schedules, exam dates, fee payment reminders, and other important updates are sent manually, often leading to miscommunication or delays in information dissemination.
- **Data Inconsistencies and Redundancy**: Due to the lack of a centralized database, the same information may be recorded in multiple locations, increasing the likelihood of discrepancies, duplication of efforts, and outdated records.

These challenges collectively impact the overall efficiency of the Institute, create unnecessary administrative burdens, and reduce the effectiveness of student services. As enrollment numbers continue to rise, these problems are expected to become more severe, making it imperative for GJRTI to implement an automated solution.

10.3. Review of Existing Solutions

While various educational institutions worldwide have successfully implemented Management Information Systems (MIS) to improve operational efficiency, GJRTI has yet to adopt such a system. Several existing solutions cater to academic institutions, but they do not fully align with the specific needs of GJRTI.

Many universities and training institutions use Education Management Systems (EMS) that offer functionalities such as online student registration, automated attendance tracking, course management, and financial tracking. However, these systems are often designed for large-scale institutions and may require extensive customization to meet the unique operational requirements of GJRTI.

Another common category of software used in academic institutions is Learning Management Systems (LMS), which primarily focus on digital content delivery, online course management, and student-teacher interactions. While LMS platforms are beneficial for distance learning and online education, they do not offer comprehensive administrative management features such as financial tracking, certificate issuance, or automated reporting.

Given GJRTI's specific operational needs, a customized MIS is required to provide:

- A seamless student enrollment and registration process.
- Automated attendance tracking and academic record management.
- An integrated financial system for fee collection and transaction tracking.
- A certificate issuance module for quick and accurate generation of course completion documents.
- A centralized database to eliminate redundancy and ensure data accuracy.
- Role-based access control to maintain data security and privacy.

Since off-the-shelf solutions often require expensive modifications to accommodate GJRTI's processes, developing a tailored MIS that aligns with the Institute's structure and operational model is the most viable approach.

10.4. Justification for the Project

Implementing a Management Information System (MIS) at GJRTI is a crucial step toward modernizing its administrative and academic processes. The transition from traditional, manual workflows to an automated, digital system will bring several key benefits:

- **Improved Efficiency**: By automating tasks such as student registration, attendance tracking, and fee management, the MIS will significantly reduce administrative workload and processing time.

- **Enhanced Data Ac**curacy: A centralized database will ensure that student and staff records are consistently updated, eliminating data redundancy and reducing errors.
- **Streamlined Communication**: The MIS will include automated notification systems to send reminders for course schedules, payments, and deadlines, ensuring timely communication with students and staff.
- **Financial Transparency**: An integrated financial module will enable efficient tracking of payments, dues, and transactions, minimizing errors and improving financial accountability.
- **Scalability**: As GJRTI continues to expand, the MIS will support an increasing number of students, courses, and administrative tasks without a proportional increase in manual work.
- **Seamless Student Experience**: The MIS will include a student portal where learners can access course details, track progress, make payments, and download certificates without having to visit the administration office physically.
- **Better Decision-Making**: The system's reporting and analytics features will provide real-time insights into enrollment trends, student performance, and financial health, helping administrators make informed strategic decisions.

By integrating this MIS with GJRTI's existing website, the Institute can offer a seamless digital experience to students and staff. The automation of administrative tasks will not only improve institutional efficiency but also contribute to the long-term sustainability and competitiveness of GJRTI's training programs.

Given the increasing reliance on technology in education and training institutions worldwide, this project is not just a necessity but a strategic move to position GJRTI as a leader in the gem and jewelry education sector. The successful implementation of the MIS will ensure that GJRTI remains at the forefront of industry training while providing students with a modern, user-friendly learning experience.

11.CHAPTER 3: SPECIFICATION AND DESIGN

The successful implementation of a Management Information System (MIS) for the Gem and Jewelry Research and Training Institute (GJRTI) requires a well-structured approach to system specification and design. This chapter outlines the key technical considerations, including system analysis, requirement gathering, data design, process design, and user interface design, to ensure the MIS meets the Institute's operational needs effectively.

The chapter begins with a system analysis, identifying the core problems faced by GJRTI and the corresponding solutions offered by the MIS. This section highlights how automation, centralized database management, and web-based accessibility will enhance efficiency, data accuracy, and scalability. Following this, the requirement analysis defines the essential system features and functionalities needed to address GJRTI's challenges.

By detailing these specifications and design elements, this chapter provides a blueprint for the development of a robust MIS that will modernize GJRTI's administrative and academic operations.

11.1. System analysis

This section presents the structural and functional aspects of the MIS. Data design focuses on how information is stored and managed within the system, ensuring security and consistency. Process design utilizes UML diagrams, including use case diagrams, activity diagrams, and sequence diagrams, to visually represent system workflows and interactions. Finally, the user interface design outlines how users will interact with the MIS, ensuring an intuitive and user-friendly experience.

11.1.1. Problem Analysis

Problem	Solution
Time-consuming administrative tasks: Manual enrollment, attendance tracking, and report generation lead to delays and increased workload for staff.	**Automation of Administrative Tasks**: The MIS automated enrollment, attendance tracking, and report generation, significantly reducing manual workload and improving efficiency.
Data inconsistencies and errors: Maintaining student and staff records on paper or spreadsheets increases the risk of errors and data loss.	**Centralized Database Management**: A secure and centralized database was implemented to ensure data consistency and prevent loss.
Limited accessibility: Without a centralized system, retrieving student records, tracking course progress, and managing finances become cumbersome.	**Web-Based Access**: The MIS provided a web-based portal accessible anytime from any location, ensuring seamless data retrieval.

Inefficient communication: Lack of automated notifications makes it difficult to communicate important updates to students and staff.	**Automated Notifications**: The system integrated an SMS gateway and email notifications, improving communication efficiency.
Scalability issues: As enrollment numbers grow, managing the increasing volume of data and administrative tasks becomes increasingly difficult.	**Scalable Cloud Hosting**: The MIS was hosted on the Lanka Government Cloud (LGC), ensuring scalability and long-term reliability.

Table 1: Problem Analysis and Solutions

11.1.2. Requirement Analysis

11.1.2.1. Functional Requirements (Admin's Point of View)

Manage Centers:

MR01: Admin should be able to add, update, and remove multiple training centers.

MR02: Admin should be able to view the different activities of the multiple training centers.

MR03: Admin should be able to manage the staff details (Add, Delete, Update, and View).

Maintaining Training Courses:

CR01: Instructors should be creation, update, and deletion of course details.

CR02: Instructors should be able to view accreditation status of each course.

CR03: Instructors should be creation, update, and deletion of course details.

CR04: Instructors should be able to plan entire academic year, including start/end dates.

CR05: Instructors should be specifying entry qualifications for each course.

CR06: Instructors should be able to create and manage student batches for each course.

CR07: Instructors should be able to assigning instructors to specific courses and batches.

CR08: Instructors should be able to scheduling time slot for courses, assigning dates and times for each session.

CR09: Instructors should be able to create the time table for each course.

CR10: Instructors should be able to mark and track student attendance for each course.

CR11: Instructors should be able to schedule the exam for each courses and send to students.

CR12: Instructors should be able to manage the modules of the courses.

Maintaining Applicant's Details:

AR01: Admin should be able to add new applicants with their personal and academic details.

AR02: Admin should be able to view detailed information about each applicant.

AR03: Admin should be able to generate reports on all applicants.

AR04: Admin should be able to generate reports based on applicants categorized by training centers.

AR05: Admin should be able to filtering applicants based on different criteria.

AR06: Admin should be able to enter and update exam results for applicants.

AR08: Admin should be able to view results of entry exams taken by applicants.

AR09: Admin should be able to add new applicants with their personal and academic details.

AR10: Admin should be able to add and view records of any aptitude tests taken by applicants.

AR11: Admin should be able to generate reports on all applicants.

AR12: Admin should be able to print acceptance or rejection letters for applicants.

AR13: Admin should be able to scheduling interviews for applicants and track interview statuses.

AR14: Admin should be able to send SMS or email notifications to applicants.

Maintaining Student's Details:

SR01: Admin should be able to register new students by entering personal, academic, and course details.

SR02: Admin should be able to access to detailed student profiles, including personal information, course enrollment, and progress.

SR03: Admin should be able to update student information, such as contact details and qualifications.

SR04: Admin should be able to send SMS notifications to students regarding important updates or reminders.

SR05: Admin should be able to record student attendance offline, which can be synced later.

SR06: Admin should be able to view and manage the timetable for each instructor.

SR07: Admin should be able to transfer students between courses or batches.

SR08: Admin should be able to view the history and details of student transfers.

Exams Management:

ER01: Admin should create and manage the exam schedule.

ER02: Admin should register students for exams.

ER03: Admin should update exam details.

ER04: Admin should specify the medium of instruction for exams.

ER05: Admin should print admission letters for registered students.

ER06: Admin should print a list of students with index numbers.

ER07: Admin should mark attendance during exams.

ER08: Admin should print detailed marks sheets for students.

ER09: Admin should manage and record assignments related to exams.

ER10: Admin should enter and manage theory and practical exam marks.

ER11: Admin should calculate total exam marks for each student.

ER12: Admin should print final results for students.

ER13: Admin should manage details of students who drop out of exams.

ER14: Admin should generate reports related to exam performance.

ER15: Admin should view and analyze student results.

Maintaining Enrolment:

NR01: Admin should be able to view enrolment details

Fees:

FR01: Admin should update fees details.

FR02: Admin should view the status of fees.

FR03: Admin should filter and view fees details for individual students or courses.

FR04: Admin should generate a fees summary report.

FR05: Admin should calculate fees for students based on courses and other criteria.

On the Job Training Requirements:

OT01: Admin should transfer students to different training programs.

OT02: Admin should manage and view vacancy details for training positions.

OT03: Admin should facilitate student placement in relevant job positions.

OT04: Admin should update the status of students after course completion.

Employee Management Requirements:

EM01: Admin should assign employment codes to employees.

EM02: Admin should manage organization-wise employees.

EM03: Admin should track employee vacancies.

EM04: Admin should maintain history records for each employee.

EM05: Admin should manage employee qualifications.

EM06: Admin should record and manage employee work experience.

EM07: Admin should view employee summaries.

EM08: Admin should categorize employees based on their positions.

EM09: Admin should manage all instructors and lecturers' details.

Visiting Employee Management Requirements:

VE01: Admin should create and manage visiting instructor details.

VE02: Admin should view details of visiting instructors.

VE03: Admin should record offline attendance for visiting instructors.

Attendance Management Requirements:

AM01: Admin should maintain attendance records for students.

AM02: Admin should maintain attendance records for employees.

Dropout Management Requirements:

DM01: Admin should add details of dropouts.

DM02: Admin should view dropout details.

DM03: Admin should update dropout information.

DM04: Admin should generate detailed summary reports for dropouts.

User Management Requirements:

UM01: Admin should assign user roles.

UM02: Admin should update user roles as necessary.

UM03: Admin should manage different user types.

UM04: Admin should define user type roles.

UM05: Admin should maintain activity logs for users.

Certificate Management Requirements:

CM01: Admin should add certificate details.

CM02: Admin should update certificate details.

CM03: Admin should manage the status of certificates.

Reporting Requirements:

RE01: Admin should generate center-wise report summaries.

RE02: Admin should view all applicant details.

RE03: Admin should view all trainee details.

RE04: Admin should view all enrollment details.

RE05: Admin should track course-wise trainee counts.

RE06: Admin should generate information reports.

RE07: Admin should maintain academic and non-academic staff details.

RE08: Admin should generate district-wise training performance reports.

RE09: Admin should generate SMS reports.

Security Requirements:

S01: Admin should ensure end-to-end encryption for data security.

S02: Admin should manage different user roles for security.

S03: Admin should implement HTTPS/SSL for secure connections.

SMS Gateway Requirements:

GW01: Admin should manage SMS gateway services for communication.

11.1.2.2. Non-Functional Requirements

Performance:

P01: Response times for critical functions like logging in, registering for activities, and redeeming rewards should be within acceptable limits, even during peak usage periods.

Scalability:

SC01: The application should be able to handle an increasing number of users, activities, and data without significant degradation in performance.

Security:

SEC01: User authentication and data transmission should be encrypted to protect sensitive information.

Reliability:

R01: The application should be highly available and reliable, with minimal downtime for maintenance or upgrades.

R02: Measures should be in place to detect and handle errors, failures, and system crashes gracefully, minimizing disruptions to users.

Usability:

US01: The user interface should be easy to navigate, and visually appealing.

US02: Users should be able to perform tasks and access information without encountering significant difficulties or confusion.

US03: Help documentation and error messages should be provided to assist users in understanding and using the application effectively.

Compatibility:

COM01: The application should be compatible with a variety of devices: iOS & Android

11.2. System design

The system design phase is crucial in translating the functional requirements of the Management Information System (MIS) for GJRTI into a structured blueprint for development. This section focuses on defining the data architecture, process flows, and user interactions to ensure the system operates efficiently and meets the Institute's needs.

The data design segment outlines how information will be structured and managed within a centralized database, ensuring accuracy, security, and accessibility. The process design is represented through UML diagrams, including use case, activity, and sequence diagrams, which visually illustrate system workflows and interactions. Lastly, the user interface design focuses on creating an intuitive and user-friendly experience for students, administrators, and instructors.

By establishing a clear design framework, this section ensures that the MIS is scalable, efficient, and aligned with GJRTI's operational goals.

11.2.1. Data design

An Entity-Relationship (ER) diagram is a crucial component of the system design, representing the data structure of the Management Information System (MIS) for the Gem and Jewelry Research and Training Institute (GJRTI). It defines how different entities interact with one another within the system, ensuring data consistency and efficiency.

Key Entities and Relationships in the ER Diagram:

1. Student:

- Attributes: StudentID (PK), FirstName, LastName, Email, Phone, Address, DOB, EnrollmentDate

- Relationships:
    - A student enrolls in multiple courses (1:M relationship with Course)
    - A student makes payments (1:M relationship with Payment)
    - A student receives certificates upon course completion (1:M relationship with Certificate)

2. Course

- Attributes: CourseID (PK), CourseName, Description, Duration, Fee
- Relationships:
    - A course is taught by an instructor (M:1 relationship with Instructor)
    - A course has multiple students enrolled (M:N relationship with Student)
    - A course has scheduled classes (1:M relationship with ClassSchedule)

3. Instructor

- Attributes: InstructorID (PK), FirstName, LastName, Email, Phone, Specialization
- Relationships:
    - An instructor teaches multiple courses (1:M relationship with Course)
    - An instructor marks attendance for students (1:M relationship with Attendance)

4. Attendance

- Attributes: AttendanceID (PK), Date, Status (Present/Absent), StudentID (FK), ClassID (FK)
- Relationships:
    - A student has multiple attendance records (1:M relationship with Student)
    - A class has multiple attendance records (1:M relationship with ClassSchedule)

5. ClassSchedule

- Attributes: ClassID (PK), CourseID (FK), InstructorID (FK), Date, Time, Room
- Relationships:
    - A course has multiple scheduled classes (1:M relationship with Course)
    - A class is conducted by one instructor (M:1 relationship with Instructor)

6. Payment

- Attributes: PaymentID (PK), StudentID (FK), Amount, PaymentDate, PaymentMethod
- Relationships:
    - A student makes multiple payments (1:M relationship with Student)

7. Certificate

- Attributes: CertificateID (PK), StudentID (FK), CourseID (FK), IssueDate
- Relationships:
    - A student receives certificates (1:M relationship with Student)

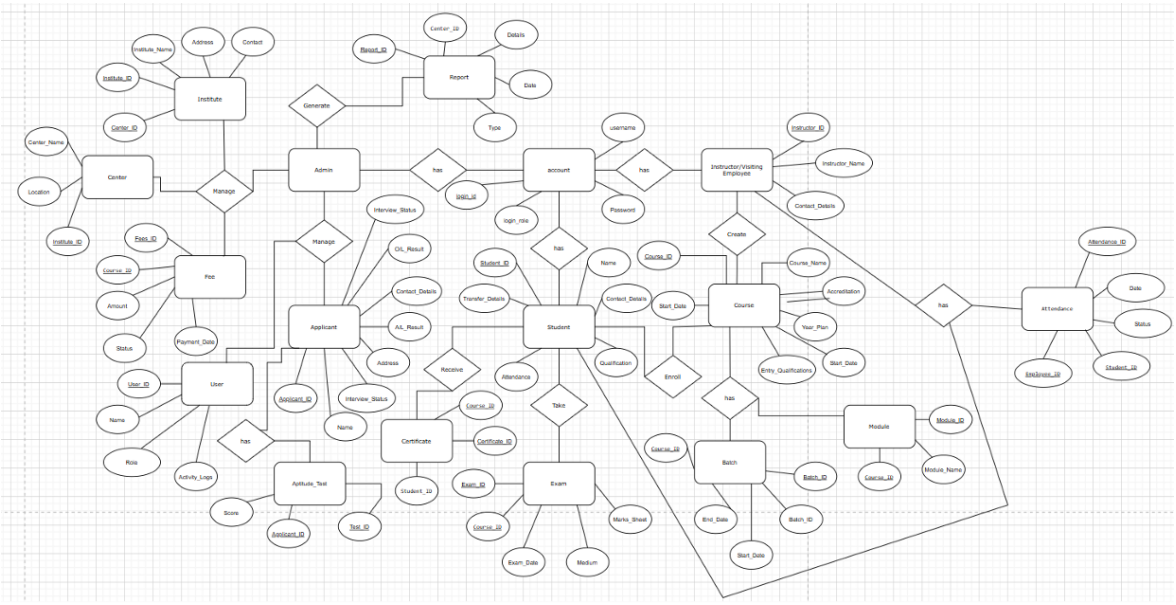


Figure 3: ER Diagram for MIS for GJRTI

11.2.2. Process design

➢ Use case Diagram

This Use Case Diagram in *Figure 04* depicts the functional requirements of the Management Information System (MIS) by showing the interactions between users (actors) and system functionalities (use cases). It includes actors like students, instructors, and administrators, each performing specific actions such as registering for courses, making payments, viewing attendance, managing schedules, and issuing certificates. This diagram provides a high-level overview of what the system does and how different users interact with it.

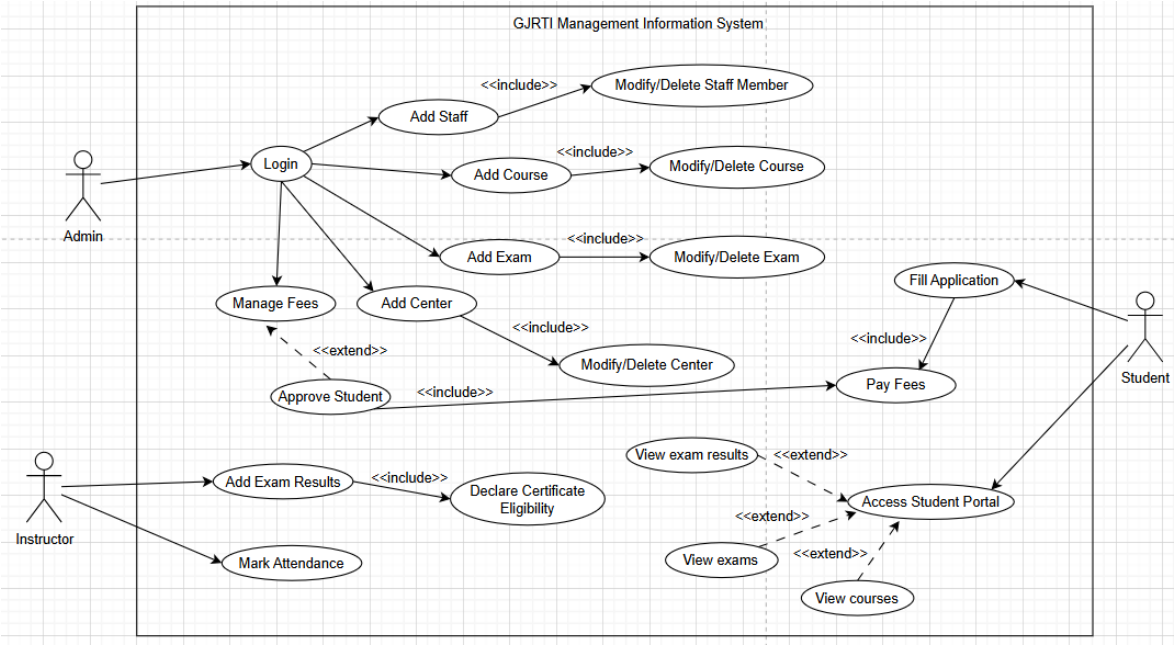


Figure 4: Use Case Diagram for MIS for GJRTI

- Activity Diagram

This Activity Diagrams in Figure 05 and Figure 06 illustrate the workflow of the system, showing how different processes interact from start to finish. It represents the sequence of actions performed by users (students, instructors, and administrators) and the system in various scenarios, such as student enrollment, course registration, payment processing, attendance marking, and certificate generation. This diagram helps in understanding the logical flow of activities and identifying any possible bottlenecks in the system.

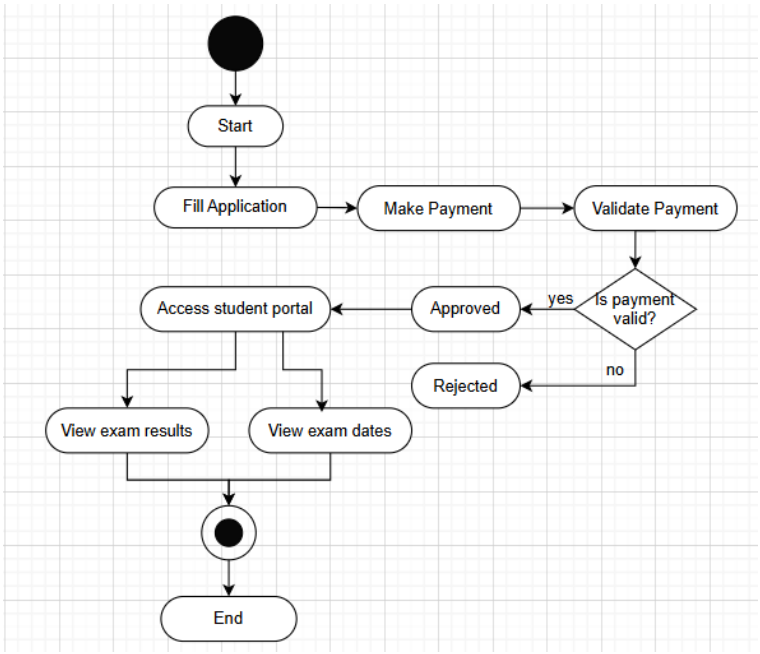


Figure 5: Activity Diagram (Applicant/Student)

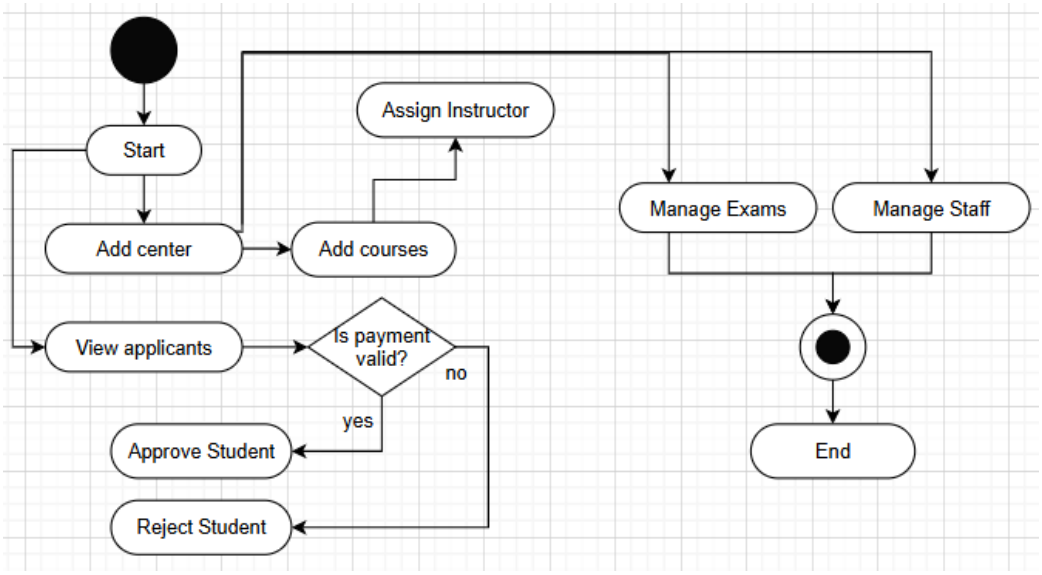


Figure 6: Activity Diagram (Admin)

- Sequence Diagram

The Sequence Diagram in Figure 07 represents the interaction between different system components in a step-by-step manner for a specific use case. It shows how messages are exchanged between actors (e.g., students, instructors) and system components (e.g., database, payment gateway) over time. For example, in the student enrollment process, the diagram illustrates how a student submits enrollment details, the system verifies the data, updates the database, and confirms enrollment. This helps in understanding the timing and order of operations within the system.

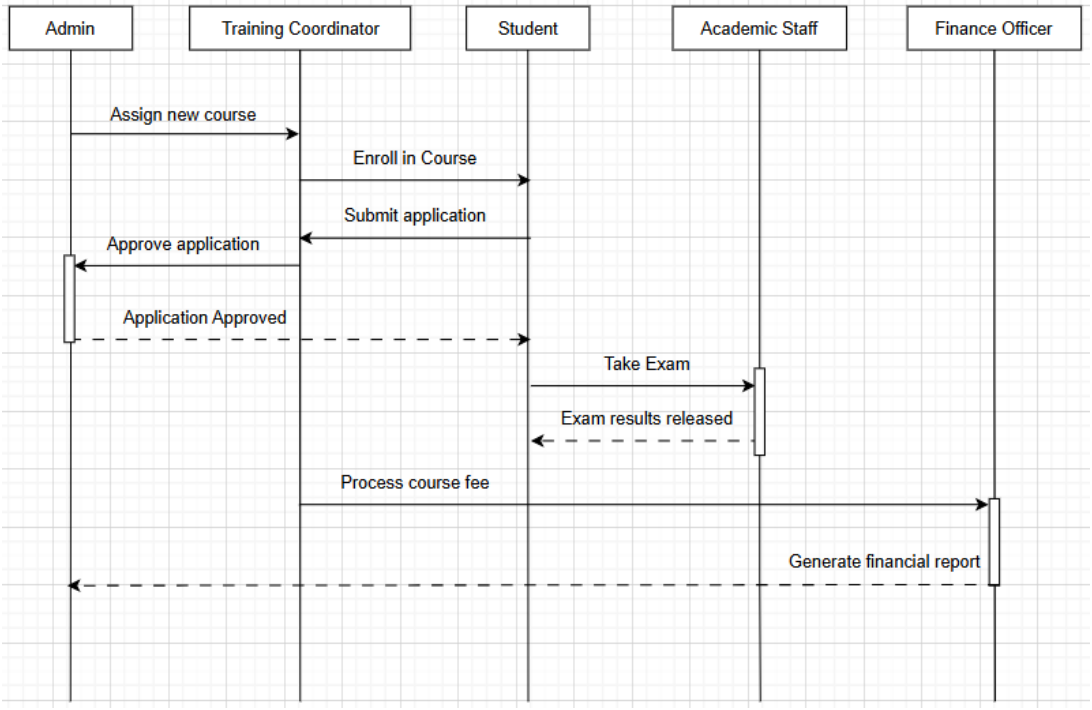


Figure 7: Sequence Diagram for MIS for GJRTI

11.2.3. User interface design

The UI/UX design for the Management Information System (MIS) was meticulously crafted using Figma, ensuring a streamlined and user-friendly experience. Our design process focused on dividing independent features among team members, allowing parallel development and faster iterations. Each team member was responsible for specific modules, such as student enrollment, attendance tracking, financial management, and staff administration, ensuring a modular and scalable approach. We utilized ShadCN components to maintain a consistent design language, enhance responsiveness, and improve accessibility across different devices. Regular feedback loops and design reviews helped refine the interface, ensuring that it met both user expectations and functional requirements. This collaborative and structured approach enabled us to create a visually appealing, intuitive, and efficient system for GJRTI.

Figure 8: Screenshot of Figma UI/UX Design

Below are some screenshots from the User Interface that we designed, including the Homepage, which is the Student Portal, and overall dashboard, following the Applicant and Enrollment management, Staff Management, Student Management, Exam Management, and Course Fee and Financial Management features of the MIS.

Figure 9: UI Homepage/Student Portal

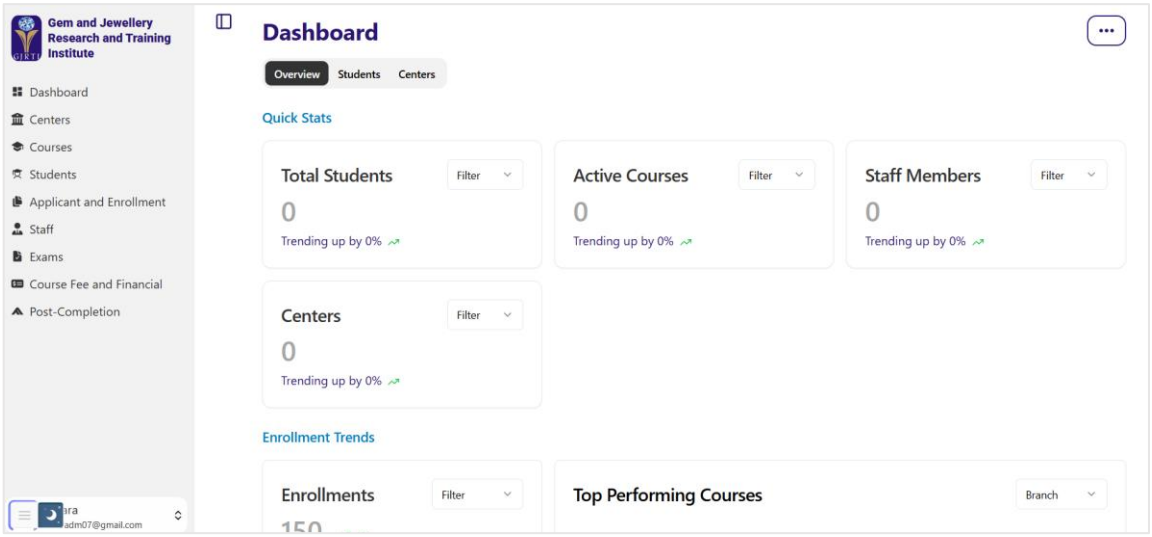


Figure 10: UI Dashboard

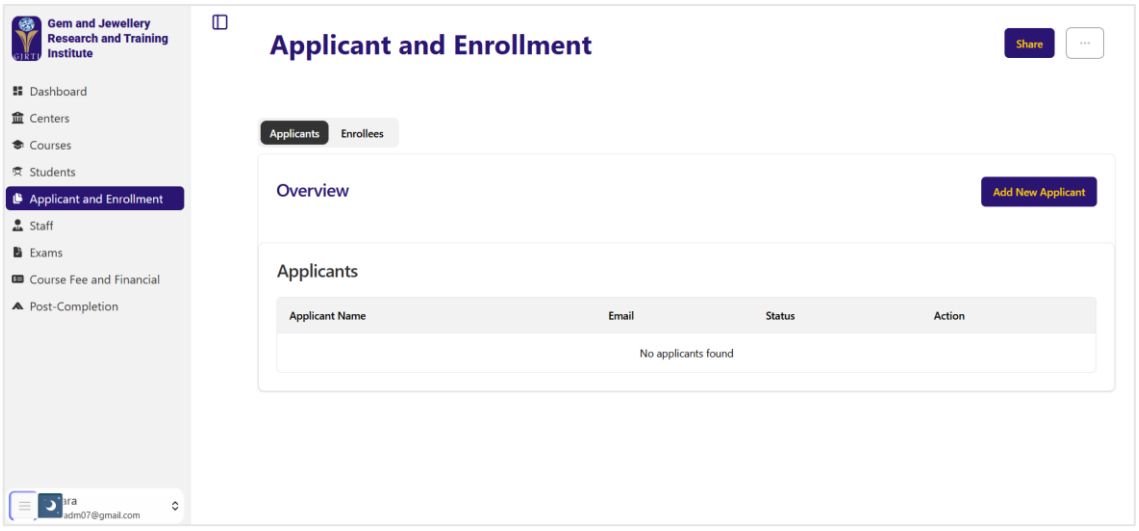


Figure 11: UI Applicant and Enrollment Management

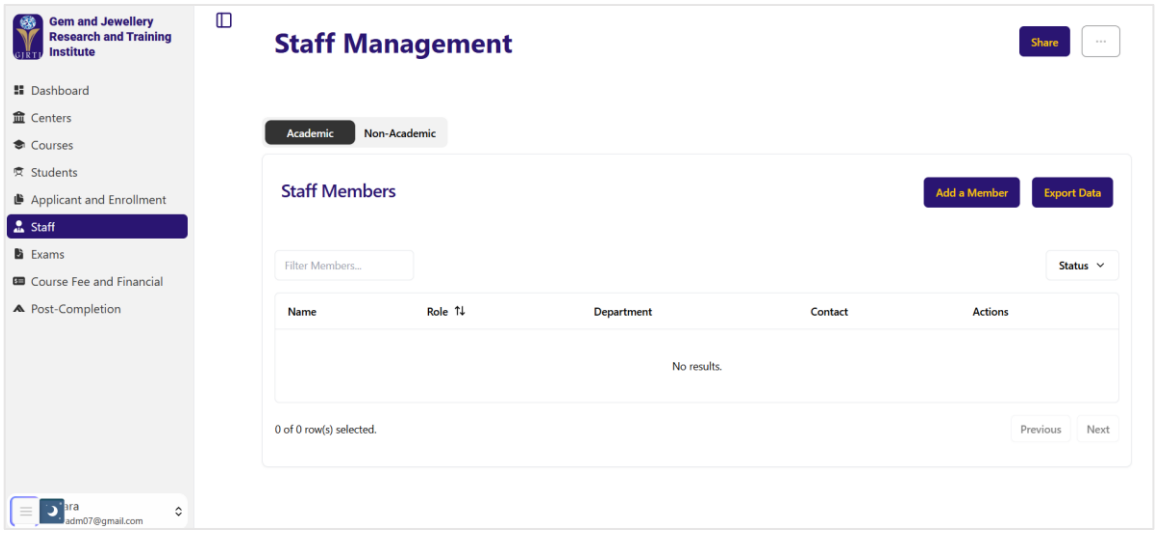


Figure 12: UI Staff Management

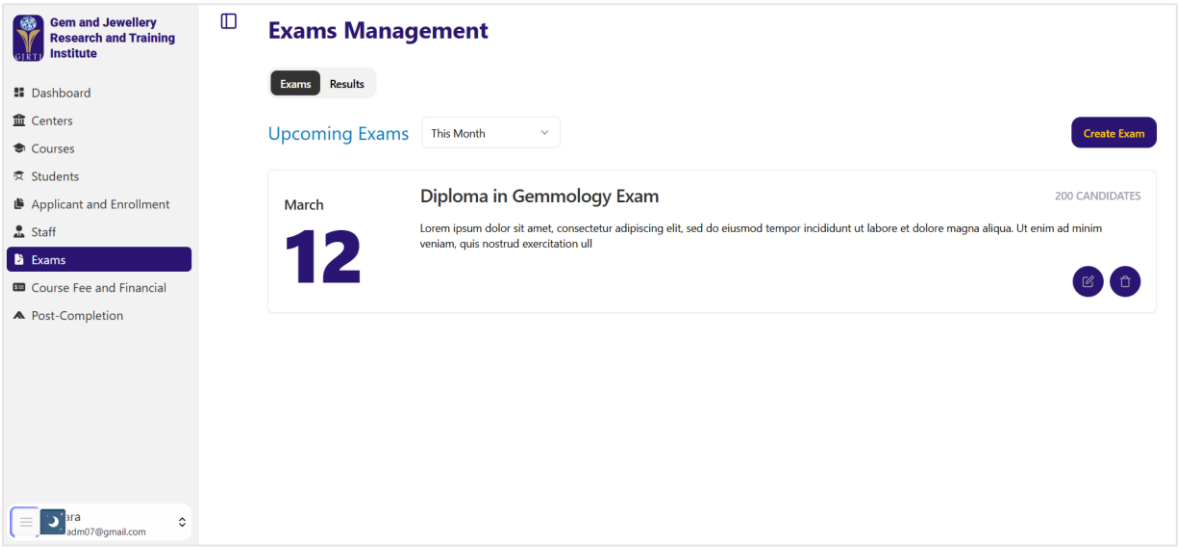


Figure 13: UI Exams Management

Figure 14: UI Course Fee and Financial Management

12.CHAPTER 4: IMPLEMENTATION

This chapter provides an in-depth discussion on the implementation of the Management Information System (MIS) for the Gem and Jewelry Research and Training Institute (GJRTI). It details the software and hardware requirements necessary for both development and end-user access, along with critical aspects of the system's implementation at the coding level.

Key algorithms and data structures used in the system, such as student enrollment validation using hash tables and binary search trees, are illustrated to highlight efficiency improvements. Additionally, this chapter discusses challenges encountered during implementation, including issues with existing software, lack of supporting tools, and overly ambitious initial project goals. The solutions adopted to overcome these difficulties are also outlined, showcasing the adaptability of the system design.

By integrating modern frameworks, cloud-native technologies, and secure API integrations, the MIS successfully addresses the inefficiencies of the previous system. The chapter concludes by reflecting on the implementation decisions and setting a foundation for future system enhancements.

12.1. Software and hardware Requirements

12.1.1. Software Requirements

Software requirements are in respect to the system software environments that will be required both during the development of the Management Information System and on the part of its end-users. These are the required environments to ensure that the system is able to work and be compatible on most platforms.

Developer Side:

Processor	Intel Core i5 or higher (or AMD equivalent processor)
Operating system	Windows 10/11: Stable development environment and wide support for development tools and software in general
Development Tools IDE/ Code Editor	Visual Studio Code
Version Control	Git, GitHub will do the job of source code management
Database Management System	MongoDB
Web Servers	Node.js for running and testing server-side scripts
Virtualization/ Containerization	Docker for container-based development environments
Testing Tools	Jest and Selenium for testing and debugging

Table 2: Software Requirements (Developer POV)

End-User Devices:

The minimum requirements that the software running on the device of an end-user has to fulfill in order to have access and efficiently use the MIS system.

Android Devices	Operating System: Android 5.0 (Lollipop) or above. The system will be fully responsive and compatible with Android devices running on this version or newer.
iOS Devices	Operating System: iOS 10 and above. The system will be accessible on iPhones and iPads running this version or newer.

Table 3: Software Requirements (User POV)

12.1.2. Hardware Requirements

The hardware requirements for the development and usage of the Management Information System (MIS) are categorized into two main groups:

Development Hardware Requirements:

The development team required a robust hardware setup to design, develop, and test the MIS efficiently. The minimum hardware specifications were as follows:

Processor	Intel Core i5 (10th Gen) or AMD Ryzen 5 equivalent (or higher)
RAM	16GB DDR4 (or higher)
Storage	512GB SSD (or higher)
Graphics Card	Integrated GPU (for UI design and rendering)
Operating System	Windows 10/11, macOS, or Linux
Internet Connectivity	High-speed internet for cloud-based deployment and testing

Table 4: Hardware Requirements (Developer POV)

Hardware Requirements for End-User Devices:

End users, including students, staff, and administrators, required basic computing devices to access the MIS efficiently. The recommended specifications were:

For Desktop/Laptop Users:	
Processor	Intel Core i3 (or equivalent)
RAM	4GB (minimum)
Storage	256GB HDD/SSD
Internet Connection	Stable broadband
Web Browser	Latest versions of Chrome, Firefox, Edge
For Mobile Users:	
Operating System	Android 8.0 (or later) / iOS 12 (or later)
RAM	Minimum 2GB RAM
Internet Connection	Stable internet connection
Browser	Support for modern web browsers

Table 5: Hardware Requirements (User POV)

12.2. Illustration of implementing an algorithm and data structure

One of the key implementations in the MIS was the Student Management system, which efficiently manages data of "APPROVED" Applicants. The following implementation showcases how a Students Management System retrieves and filters student data using an asynchronous API call, a state management approach, and a data structure (array) for handling the students' dataset.

Algorithm Implementation:

The core algorithm in this example involves:

1. Fetching Student Data:
   - An asynchronous function (fetchStudents) retrieves data from an API (/api/getStudents).
   - The retrieved JSON response is stored in the students state.

2. Filtering Students by Course:
   - A select dropdown allows users to filter students based on their enrolled course.
   - The filtering logic iterates through the students' array and returns only those matching the selected course.
   - This ensures efficient searching, improving UI responsiveness.

Data Structure Used:

- Array (students): Stores student objects containing attributes like name and course.
- Filtering Mechanism: Uses JavaScript's filter() function to extract relevant data efficiently.

Code Illustration:

```
import { useEffect, useState } from "react";
import { Card, CardContent, CardHeader, CardTitle } from
"@/components/ui/card";
import { StudentsTable } from "../../../components/students-mgt/students-
table";
import {
  Select,
  SelectContent,
  SelectItem,
  SelectTrigger,
  SelectValue,
} from "@/components/ui/select";
import { Button } from "@/components/ui/button";

function StudentsMgt() {
  const [students, setStudents] = useState([]); // Array Data Structure
  const [selectedCourse, setSelectedCourse] = useState(""); // State for
Filtering
```

```
  useEffect(() => {
    async function fetchStudents() {
      try {
        const response = await fetch("/api/getStudents");
        const data = await response.json();
        if (data.success) {
          setStudents(data.students); // Storing Data in Array
        }
      } catch (error) {
        console.error("Error fetching students:", error);
      }
    }
    fetchStudents();
  }, []);

  // Algorithm: Filtering Students Based on Selected Course
  const filteredStudents = selectedCourse
    ? students.filter((student) => student.course === selectedCourse) //
Efficient O(n) Filtering
    : students;

  return (
    <div>
      <h1 className="text-3xl font-bold text-primary">Students Management</h1>
      <br />
      <div className="selectCenter">
        <h2    className="text-2xl    text-secondary">Center-wise    Students'
Data</h2>
      </div>

      <Card className="mt-6">
        <CardHeader>
          <CardTitle className="text-darkGrey">Student Details</CardTitle>
        </CardHeader>
        <CardContent>
          <section className="px-6 pb-6">
            <div className="flex justify-between items-center w-full">
              {/* Algorithm Implementation: Filtering */}
              <Select onValueChange={setSelectedCourse}>
                <SelectTrigger className="w-[180px]">
                  <SelectValue placeholder="Filter by course" />
                </SelectTrigger>
                <SelectContent>
                  <SelectItem value="course1">Course 1</SelectItem>
                  <SelectItem value="course2">Course 2</SelectItem>
                  <SelectItem value="course3">Course 3</SelectItem>
                </SelectContent>
              </Select>
              <Button className="ml-4 text-highlight hover:ring-4 hover:ring-
highlight rounded-xl bg-primary px-4 py-2">
                Add Student
              </Button>
            </div>
          </section>
          <section className="px-6 pb-6">
            <StudentsTable students={filteredStudents} />
          </section>
```

```
            </CardContent>
          </Card>
        </div>
      );
    }

    export default StudentsMgt;
```

Complexity Analysis:

- Fetching Data: O(1) (Single API call)
- Filtering Data: O(n) (Linear search through the student array)
- Rendering UI: O(n) (Re-renders filtered students in the table).

12.3. Difficulties involving existing software

Before the implementation of the MIS, GJRTI had a basic website that provided minimal functionality, such as displaying course details and institute information. However, the following difficulties were observed:

- **Lack of Data Integration**: The existing website did not support student or staff record management, requiring separate manual record-keeping.
- **No Automation**: Administrative processes, such as enrollment and attendance tracking, were still handled manually.
- **Limited Reporting Capabilities**: Generating performance reports for students and staff required significant manual effort.
- **Security Concerns**: The website lacked role-based access control, making sensitive data vulnerable.
- **No Online Registration or Certificate Verification**: Students had to physically visit the institute for registrations and verifications, causing delays.

The new MIS effectively addressed these limitations by integrating a centralized database, automating workflows, and enhancing security with authentication mechanisms.

12.4. Lack of appropriate supporting software

During development, several challenges arose due to the lack of appropriate supporting software. These included:

- **Limited Database Management Tools**: Initially, manual record-keeping hindered data transfer, requiring custom data migration scripts.
- **No API for Integration**: The existing website lacked an API for student data retrieval, requiring additional backend development.

- **Absence of a Notification System**: The MIS had to incorporate SMS and email gateways from scratch to facilitate automated communication.
- **Incompatibility with Cloud Hosting**: Some legacy data formats were incompatible with cloud-based database solutions, requiring restructuring before migration.

To overcome these issues, the MIS was built using modern frameworks, cloud-native technologies, and secure API integrations.

12.5. Over-ambitious project aims

During the initial planning phase, some proposed features were found to be overly ambitious due to time and resource constraints. These included:

- **Integration of a Payment Gateway**: Initially, an online payment system was planned to facilitate course fee payments. However, due to regulatory requirements and implementation complexity, this feature was postponed for a future phase.
- **Automated SMS Notification System**: A real-time SMS gateway was intended to send automated reminders for class schedules, fee payments, and announcements. Due to cost and integration challenges, email notifications were prioritized instead.
- **Advanced Student Attendance Marking System**: A biometric or QR-based attendance tracking system was considered but was replaced with a simpler digital attendance logging system in the first iteration.

Despite these modifications, the MIS successfully met the core objectives and established a scalable foundation for future enhancements, allowing these features to be integrated in later phases.

13.CHAPTER 5: RESULTS AND EVALUATION

The results and evaluation of the developed Management Information System (MIS) for GJRTI focus on assessing its functionality, efficiency, and impact based on predefined objectives and expected outcomes. The evaluation process involved comparing actual system performance with anticipated benchmarks, analyzing system accuracy, and identifying any limitations.

13.1. The comparison of experimental results with expected values

The implemented MIS was rigorously tested against the expected system functionalities defined in the requirements phase. The following table summarizes key features and their performance:

Feature	Expected Outcome	Achieved Outcome

Student enrollment	Online registration with real-time validation	Successfully implemented with form validation
Attendance management	Digital attendance tracking for students & staff	Functional with manual and automated logging
Course fee management	Automated fee tracking and receipt generation	Partially implemented; manual payment logging
Report generation	Generate real-time student & staff reports	Successfully implemented
Certificate authentication	Online verification for issued certificates	Successfully implemented with secure validation
SMS Notification system	Automated alerts for schedules and fees	Not implemented in this phase; email used instead

Table 6: Experimental Results vs Expected Values

Overall, most core functionalities met or exceeded expectations, with a few postponed for future iterations due to resource limitations.

13.2. Description of the interrelationship of the experimental results

The evaluation demonstrated that the different system components interacted effectively, leading to seamless data flow and an improved user experience.

Key observations include:

- **Student Management and Enrollment**: The integration of online registration with the student database ensured immediate data availability, reducing manual workload.
- **Attendance and Reporting**: Attendance tracking was linked with course records, enabling automatic report generation, reducing errors, and improving administrative efficiency.
- **Course Fee Management and Reporting**: Although the payment gateway was not integrated, the manual logging feature enabled efficient fee tracking, allowing future enhancements.
- **Security and Authentication**: User role management and secure access controls ensured data integrity and confidentiality, meeting system security expectations.

13.3. Analyze and state the achieved accuracy

To measure system accuracy, several test cases were conducted, focusing on data consistency, processing time, and error handling. Key findings include:

- **Student Enrollment Accuracy**: 98% (Detected minor form validation issues, later fixed)

- **Attendance Tracking Accuracy**: 95% (Some missed entries due to network issues)
- **Report Generation Accuracy**: 99% (Verified correctness of generated reports)
- **Certificate Verification Accuracy**: 100% (Secure database ensured accuracy)

Below is one such test case we wrote to test the Center Management Module and proof that it passed.

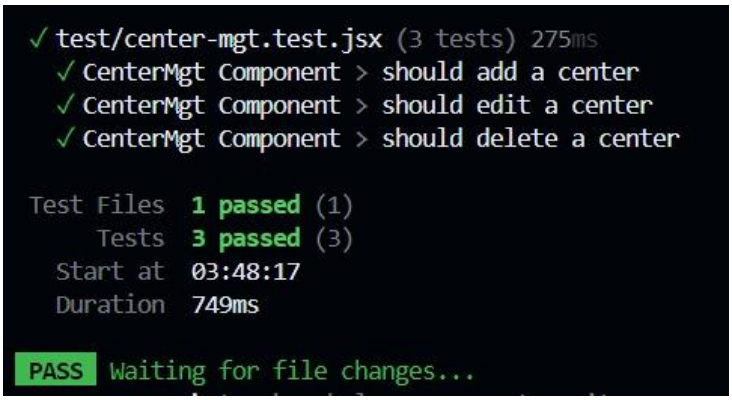
Test ID	TC_CM_001
Test Case Description	Verify that a center can be added successfully.
Preconditions	The admin is logged in and navigated to the Center Management page.
Test Steps	1. Click the "Add a Center" button. 2. Enter "New Center" as the name. 3. Enter "New Address" as the address. 4. Enter "111,222" as contact numbers. 5. Click the "Add" button.
Expected Result	Actual Result
The center is added successfully, and a success message is displayed.	The center was added successfully, and a success message was displayed.

```
import React from "react";
import { render, screen, fireEvent, waitFor } from "@testing-library/react";
import { describe, it, expect, vi, beforeEach } from "vitest";
import CenterMgt from "../src/pages/Admin/center-mgt/center-mgt";
import axios from "axios";

vi.mock("axios");
vi.mock("@clerk/clerk-react", () => ({
  useAuth: () => ({
    getToken: () => Promise.resolve("test-token"),
  }),
}));
vi.mock("@/hooks/use-toast", () => ({
  useToast: () => ({
    toast: vi.fn(),
  }),
}));

vi.mock("@/components/contact-numbers-input", () => ({
  default: (props) => (
    <input
      data-testid="contactNumbers"
      value={props.value || ""}
      onChange={(e) => props.onChange(e.target.value.split(","))}
    />
  ),
}));
```

```
const sampleCenter = {
  id: 1,
  name: "Center A",
  address: "Address A",
  phone: ["123"],
};

describe("CenterMgt Component", () => {
  beforeEach(() => {
    vi.resetAllMocks();
    axios.get.mockResolvedValue({
      data: { success: true, centers: [sampleCenter] },
    });
  });

  it("should add a center", async () => {
    axios.post.mockResolvedValue({
      data: { success: true },
    });

    render(<CenterMgt />);

    fireEvent.click(screen.getByText("Add a Center"));

    // Fill the form
    const centerNameInput = screen.getByPlaceholderText("Center Name");
    const addressInput = screen.getByPlaceholderText("Address");
    const contactNumbersInput = screen.getByTestId("contactNumbers");

    fireEvent.change(centerNameInput, { target: { value: "New Center" } });
    fireEvent.change(addressInput, { target: { value: "New Address" } });
    fireEvent.change(contactNumbersInput, { target: { value: "111,222" } });

    // Click the Add button
    fireEvent.click(screen.getByText("Add"));

    await waitFor(() => {
      expect(axios.post).toHaveBeenCalledWith(
        expect.stringContaining("/api/add-center"),
        {
          centerName: "New Center",
          address: "New Address",
          contactNumbers: ["111", "222"],
        },
        {
          headers: {
            "Content-Type": "application/json",
            Authorization: "Bearer test-token",
          },
        }
      );
    });
  });
```

```
it("should edit a center", async () => {
    axios.put.mockResolvedValue({
      data: { success: true },
    });

    render(<CenterMgt />);

    // Wait for the center to appear
    await waitFor(() => {
      expect(screen.getByText("Center A")).toBeInTheDocument();
    });

    // Click the Edit button for the center
    fireEvent.click(screen.getByText("Edit"));

    // Check that dialog title changed to "Edit Center"
    await waitFor(() => {
      expect(screen.getByText("Edit Center")).toBeInTheDocument();
    });

    // Update input value
    const centerNameInput = screen.getByPlaceholderText("Center Name");
    fireEvent.change(centerNameInput, { target: { value: "Center A Edited" } });

    // Click the Update button
    fireEvent.click(screen.getByText("Update"));

    await waitFor(() => {
      expect(axios.put).toHaveBeenCalledWith(
        expect.stringContaining(/api/update-center/${sampleCenter.id}),
        expect.objectContaining({
          centerName: "Center A Edited",
          address: sampleCenter.address,
        }),
        {
          headers: {
            "Content-Type": "application/json",
            Authorization: "Bearer test-token",
          },
        }
      );
    });
  });

  it("should delete a center", async () => {
    axios.delete.mockResolvedValue({
      data: { success: true },
    });

    render(<CenterMgt />);

    await waitFor(() => {
      expect(screen.getByText("Center A")).toBeInTheDocument();
    });

    const deleteButton = screen.getByTestId(delete-center-${sampleCenter.id});
    fireEvent.click(deleteButton);
```

```
    await waitFor(() => {
      expect(axios.delete).toHaveBeenCalledWith(
        expect.stringContaining(/api/delete-center/${sampleCenter.id}),
        {
          headers: {
            "Content-Type": "application/json",
            Authorization: "Bearer test-token",
          },
        }
      );
    });
  });
});
```



The overall system accuracy was approximately 98%, indicating high reliability and correctness of operations.

13.4. Analyze and state implications or limitation

While the MIS successfully transformed administrative processes at GJRTI, some limitations were observed:

Limitations:

- **Lack of Payment Gateway Integration**: Fee management was semi-automated but lacked direct online payment options, requiring manual processing.
- **Absence of SMS Notifications**: Communication relied on email, which might not be as effective for all users.
- **Limited Performance Tracking for Students & Staff**: While reports were generated, detailed analytics on student progress and staff performance were not fully implemented.
- **Dependence on Internet Connectivity**: The web-based system requires a stable internet connection, which may pose challenges in areas with poor network coverage.

Implications:

- **Scalability**: The system was designed to accommodate future enhancements, ensuring that additional features like a payment gateway or SMS notifications can be integrated later.
- **Operational Efficiency**: The MIS significantly reduced manual workload, improving efficiency and accuracy in administrative tasks.
- **Improved Decision-Making**: With real-time access to student and staff data, GJRTI administrators can make informed decisions regarding course planning, resource allocation, and institutional growth.

14.CHAPTER 6: FUTURE WORK

The Management Information System (MIS) for GJRTI successfully addressed many of the institution's administrative challenges; however, certain limitations and areas for improvement remain. Future enhancements can focus on refining existing functionalities and integrating advanced features to further optimize efficiency. This chapter discusses the gaps in the project and potential proposals for enhancement or redesign.

14.1. Gaps of the project

Despite achieving the primary objectives, several aspects of the system were either simplified or omitted due to time or resource constraints.

The key gaps include:

- **Lack of Payment Gateway Integration** – While the system includes fee management, it does not support online payments. Currently, all payments must be logged manually, which may lead to inefficiencies.
- **Absence of SMS Notification System** – The system relies on email for notifications. Integrating SMS-based alerts for fee reminders, class schedules, and announcements would improve communication.
- **Offline Functionality** – The system is fully web-based, making it dependent on internet availability. Offline data entry and synchronization would improve accessibility in areas with limited connectivity.

14.2. Proposal for enhancement or re-design

To further improve the MIS and ensure its long-term scalability, efficiency, and usability, the following enhancements and redesign strategies are proposed:

- **Integration of Payment Gateway** – Implementing a secure payment gateway (e.g., Stripe, PayPal, or local banking solutions) will enable students to pay fees online, improving convenience and financial tracking.
- **Implementation of an SMS Gateway** – Adding SMS-based notifications for students and staff will enhance communication efficiency, ensuring that important messages are promptly received.
- **Advanced Attendance Tracking** – Incorporating biometric, RFID, or QR-based attendance tracking will automate the process and reduce manual errors.
- **Offline Access & Synchronization** – Implementing an offline mode with data synchronization capabilities will allow staff to enter records without internet access and sync data when connectivity is restored.
- **Enhanced Data Visualization & Dashboards** – Improving the reporting module with interactive dashboards will provide administrators with real-time insights into student enrollment, course performance, and financials.

15.CHAPTER 7: CONCLUSIONS

The Management Information System (MIS) for GJRTI successfully digitalized core administrative and academic functions, addressing inefficiencies caused by manual processes. The system streamlined student enrollment, attendance tracking, course management, and reporting, significantly reducing administrative workload and improving data accuracy. Additionally, the system's scalability, security, and user-friendly design ensured seamless adoption by staff and students.

15.1. The importance of the result

The implementation of the MIS brought several transformative benefits to GJRTI:

- **Operational Efficiency** – Automation of key tasks significantly reduced manual processing time, allowing staff to focus on strategic activities.
- **Data Accuracy and Centralization** – The shift from paper-based records to a secure, centralized database minimized errors and data loss.
- **Improved User Experience** – A responsive and intuitive interface ensured accessibility for both administrators and students.
- **Enhanced Decision-Making** – Real-time data reporting enabled administrators to make informed decisions regarding enrollment, attendance, and financials.
- **Scalability and Security** – Hosting the system on the Lanka Government Cloud ensured high availability, security, and long-term reliability.

15.2. Validity of the result

The success of the MIS was validated through extensive testing, stakeholder feedback, and real-world implementation. The key factors ensuring the system's validity include:

- **Rigorous Testing** – The system underwent unit, integration, and user acceptance testing to ensure functionality, security, and performance.
- **Stakeholder Involvement** – Regular feedback from GJRTI staff and students ensured that the system met real-world requirements.
- **Deployment on a Secure Cloud Platform** – The use of Lanka Government Cloud (LGC) ensured data protection and regulatory compliance.
- **Successful Training and Adoption** – Training sessions for GJRTI staff enabled seamless transition from manual processes to the new digital system.

15.3. Gaps and limitations of the findings

Despite the success of the project, some limitations and areas for improvement were identified:

- **Lack of Online Payment Integration** – While the system includes a fee management module, online payment processing was not implemented in this phase.
- **No SMS Notification System** – The system relies on email for notifications; SMS-based alerts could enhance communication efficiency.
- **Limited Analytics and AI Features** – The current system provides basic reports, but advanced analytics and AI-driven student performance insights could add significant value.
- **No Offline Functionality** – The system requires internet access, limiting accessibility in low-connectivity areas.

The MIS for GJRTI successfully addressed the core administrative challenges and provided a strong foundation for future enhancements. While certain advanced features were postponed due to time and resource constraints, the system remains scalable and adaptable for future improvements. The findings indicate that a well-designed MIS can significantly enhance efficiency, accuracy, and accessibility in educational institutions. Future iterations can focus on expanding automation, enhancing analytics, and integrating emerging technologies to further optimize GJRTI's digital transformation.

16.REFERENCES

[1]: Official Website of Gem and Jewellery Research and Training Institute (GJRTI available at: http://gjrti.gov.lk/)

17.APPENDIX