Qreclaim: Smart Lost-and-Found System with AI-Powered Image and RFID Verification

By

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Qreclaim: Smart Lost-and-Found System with AI-Powered Image and RFID Verification

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Faculty of Computing and Information Technology
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Declaration

The project submitted herewith is a result of my own efforts in totality and in every aspect of the project works. All information that has been obtained from other sources had been fully acknowledged. I understand that any plagiarism, cheating or collusion or any sorts constitutes a breach of TAR University rules and regulations and would be subjected to disciplinary actions.

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Abstract

This project, Qreclaim: Smart Lost-and-Found System with AI-Powered Image and RFID Verification, was developed to address long-standing weaknesses in the lost-and-found process at TAR UMT Johor. The existing practice relies on informal channels such as WhatsApp and Facebook, which leads to poor accountability, inconsistent item recovery, and weak verification of ownership. The purpose of this project is to design a structured and secure platform that improves the way lost items are reported, matched, and claimed, ensuring greater efficiency and trust in the process. The scope of the system covers four main modules: a centralized reporting platform for both students and staff, an AI-powered image tagging and similarity matching engine using BLIP and CLIP models, a dual-factor claim verification process combining RFID student ID cards and facial recognition through a prototype kiosk, and an administrator dashboard with locker management and analytics. The project adopts the Incremental Model as its methodology, with system development supported by Firebase, Python, Hugging Face models, and Raspberry Pi integration. Requirements were gathered through research, surveys, and observation, leading to a structured Software Requirements Specification and detailed system design. Testing in this phase focused on functional correctness and usability feedback, ensuring that core modules performed as expected. Results showed that the system design successfully addressed the main problems identified, offering secure verification, improved item matching, and a user-friendly interface. However, limitations remain in scalability and mobile app support. Overall, this Project I report concludes that integrating AI, IoT, and usability principles provides a feasible and effective solution to campus lost-and-found challenges, and the outcomes of this stage lay a clear foundation for implementation and evaluation in Project II.

Acknowledgement

First and foremost, I would like to express my deepest gratitude to **Dr. Leong Pui Huang**, my project supervisor, for her continuous guidance, encouragement, and constructive feedback throughout the course of this Final Year Project. Her valuable insights and expertise have greatly contributed to the successful planning and development of this project.

I would also like to extend my sincere appreciation to the **moderators and academic staff** of the Faculty of Computing and Information Technology at TAR UMT Johor Branch for their support, suggestions, and evaluations during the project progress presentations and reviews.

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Lastly, I am grateful to my **friends and peers** who have provided moral support, ideas, and helpful feedback during discussions. Their input and encouragement have helped me refine the project and overcome challenges along the way.

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Chapter 1

Introduction

1 Introduction

This chapter introduces the Final Year Project titled **"Qreclaim: Smart Lost-and-Found System with AI-Powered Image and RFID Verification."** It explains the motivation for the project, its background, goals, unique contributions, technical plan, and project team. The system is designed to improve the current lost-and-found process at TAR UMT Johor Branch, which suffers from poor structure, inefficient item recovery, and unreliable identity verification. The chapter also defines the **scope** of the project clearly: it includes the development of a centralized web platform for reporting and matching items, AI-based image recognition for automatic tagging, and a self-service prototype with facial recognition and RFID technology for claim verification. The system also includes an administrative dashboard for decision-making regarding long-unclaimed items. However, this project will not cover mobile app development, full campus deployment, or social media integration. The main focus is to develop a working prototype and system to support lost-and-found activities within the Johor campus.

1.1 Background

TAR UMT Johor currently does not have an official or centralized system to handle lost-and-found cases. Instead, students and staff rely on community-driven social media platforms such as WhatsApp, Facebook, and Xiaohongshu groups to report or search for lost items. These channels are informal and unregulated, resulting in a lack of proper tracking, inconsistent item recovery, and poor accountability. Without an official system, it is difficult to trace ownership or know whether an item has been recovered or not. This lack of structure leads to confusion and prevents the university from managing these cases efficiently (OnlyTARCianKnow, n.d.; TAR UMT, n.d.; Shivaramakrishnaan & Logesh, 2025; Umo, 2023).

Another major problem is the absence of any intelligent or automated method to match lost items with those that have been found. Currently, staff must rely on memory or manually compare vague descriptions and photos to identify possible matches. This process is time-consuming and often inaccurate. Many lost items are never recovered simply because their descriptions are too general, or because no proper search or filtering mechanism exists. AI-driven systems such as LostNet and other deep learning models have demonstrated that intelligent visual recognition can significantly improve item recovery processes through accurate tagging and similarity matching (Zhou et al., 2024; Ghazal et al., 2016).

In addition, there is no secure way to verify whether someone claiming an item is the rightful owner. At present, items are usually returned based on verbal confirmation or guesses, which can be easily manipulated. This weak verification process increases the risk of false claims, impersonation, and theft. It also creates mistrust in the system. Research shows that institutions like Rutgers University implement strict identification processes to prevent such issues, while others propose biometric and RFID-based verification to enhance security (Shivaramakrishnaan & Logesh, 2025; Rutgers University, n.d.).

Lastly, there is no structured review of the system's usability or how well it works for students and administrators. Items that are not claimed over time are left in storage or discarded without proper review. The current process lacks tools for monitoring, analysis, or decision-making. This makes the system inefficient and unsustainable in the long term, especially as more items continue to be lost without a proper follow-up. Studies have shown that systems with poor usability tend to be abandoned by users, highlighting the importance of applying human-computer interaction (HCI) principles (Bringula & Basa, 2011).

1.2 Project Objectives

This project focuses on solving the four major weaknesses in TAR UMT Johor Branch's current lost-and-found system. These include the absence of a centralized platform, no intelligent way to match lost and found items, unreliable methods of verifying the identity of claimants, and the lack of a structured review process for unclaimed items or system usability. The goal of this project is to design and implement a smart web-based platform that integrates artificial intelligence (AI), Internet of Things (IoT), and secure verification technologies to improve how lost items are reported, matched, claimed, and managed across campus. Each of the following objectives is linked directly to one of the problems identified and is supported by a related research question.

1.2.1 To develop a centralized lost-and-found platform for structured and official item reporting

The first objective of this project is to design a single, centralized web platform that allows both students and administrative staff to submit, search, and manage lost-and-found item reports. Currently, TAR UMT Johor relies on informal channels such as WhatsApp, Facebook, and Xiaohongshu for this process, which leads to inconsistent tracking, data loss, and poor accountability. The proposed system will offer an organized digital form to report found or lost items, complete with item descriptions, location, timestamp, and image uploads. This data will be securely stored and managed in a Firebase cloud database. The system also supports real-time notifications and structured access roles for students and administrators (Google Cloud, 2023).

This objective directly addresses the lack of a centralized and official system and improves the university's ability to trace lost items, manage inventory, and maintain proper records. It provides a reliable structure for reporting that social media tools simply cannot offer. The corresponding research question is: "How can a centralized web application improve the consistency and efficiency of the campus lost-and-found process?"

1.2.2 To apply AI-powered image recognition for automatic item tagging and accurate matching using Hugging Face Bootstrapping Language-Image Pre-training (BLIP) Model

The second objective is to use artificial intelligence to improve how lost and found items are categorized and matched within the system. Currently, there is no intelligent way to match items, and staff rely on manual comparisons and vague descriptions. This process is inefficient, especially when items look similar or have generic features like "black wallet" or "red water bottle." To solve this, the system will integrate the BLIP (Bootstrapping Language-Image Pre-training) model developed by Salesforce and made available through Hugging Face. BLIP is a pre-trained vision–language model that can generate context-aware captions from uploaded images, which can then be transformed into structured hashtags for item tagging.

In this project, BLIP will not be developed from scratch, but adopted in two possible deployment approaches: either by accessing the Hugging Face Inference API for real-time captioning, or by downloading and running the BLIP model locally on a backend server through the Hugging Face Transformers library. Both methods ensure that the system can leverage state-of-the-art image captioning without requiring model training by the researcher. The generated tags will be used to compare new lost item reports with existing found item records using similarity scoring techniques. When the system identifies a high-probability match, it will notify the student for further action (Zhou et al., 2024; Ghazal et al., 2016).

This integration reduces the time spent on manual checking and significantly improves matching accuracy, especially when descriptions are unclear or incomplete. By reusing an advanced AI model within the system's design, the project demonstrates how existing research outputs can be effectively applied in practical applications. The research question related to this objective is: "How can AI image recognition improve the accuracy and speed of item matching in a campus lost-and-found system?"

1.2.3 To implement secure item claim verification using multi-factor authentication with RFID and facial recognition

The third objective is to make the claiming process more secure and trustworthy by requiring users to go through a two-step identity verification before they can retrieve a found item. In the current system, items are returned based on verbal descriptions or guesses, which can easily be faked or misused. This project will introduce a secure claim kiosk built with a Raspberry Pi, an RFID card reader, and a USB camera. Students must first complete a facial recognition check using a model hosted through Hugging Face, which generates a temporary QR code. At the kiosk, the students must present this QR code and scan their RFID student card. Only when both forms of identity are verified will the system allow the claim to proceed (Suárez-Armas & Caballero-Gil, 2017; Ismail et al., 2025).

This dual-verification system reduces the chances of impersonation or accidental item release and increases the reliability of the lost-and-found process. It ensures that the student claiming the item is the rightful owner and that all actions are logged securely. The related research question is: "In what ways can combining facial recognition and RFID technology improve the security and reliability of item claims?".

1.2.4 To evaluate the usability of the lost-and-found system through surveys

The fourth objective of this project is to ensure that the system is user-friendly, accessible, and easy to navigate for both students and administrators. While the main goal is to improve lost-and-found management, it is equally important that users can interact with the system confidently and without confusion. In the current process, there is no formal evaluation of how easy or effective the lost-and-found system is. Students are not guided properly, and staff have no tools to monitor how well the system is being used. Poor usability can lead to frustration, abandonment, and even system failure, regardless of how well the technical features work.

To solve this, the proposed system will follow Human-Computer Interaction (HCI) principles in its interface design. Guidelines such as Nielsen's usability heuristics and the Malaysia Government Design System (MYDS) will be used to design clear layouts, provide proper feedback messages, and reduce user errors (Nielsen, 2024; Malaysia Digital, 2024). Rounded buttons, simple icons, and step-by-step forms will be included to help users understand and complete their tasks easily. In addition, usability testing will be conducted with real users during development. Students and admins will provide feedback on the interface, and their responses will be used to improve the design iteratively (Moran, 2019; Bringula & Basa, 2011).

This objective ensures that the system is not only functional but also comfortable and satisfying to use, especially in a university environment where users may have different levels of digital experience. The corresponding research question is: "How can user-centered design and HCI evaluation improve the usability and acceptance of a smart campus lost-and-found system?"

1.3 Advantages and Contributions

The Qreclaim system offers major improvements over the traditional lost-and-found processes currently used at TAR UMT Johor Branch and many other institutions. Unlike manual methods or basic Google Forms shared on social media, Qreclaim introduces a smart, centralized, and secure platform for managing lost and found items. The following are the core advantages and contributions of the system:

1.3.1 Centralized Platform for Consistent Reporting and Accountability

Presently, students and staff resort to social media platforms like WhatsApp, Facebook, and Xiaohongshu to report lost items. This approach is prone to missing information, duplicate entries, and no formal supervision. In contrast, Qreclaim offers a structured web platform powered by Firebase. Every report including photos, descriptions, timestamps, and status updates are securely logged in one unified system. Both administrators and students access dashboard views customized to their roles, enabling accurate tracking, reliable updates, and real-time synchronization. This eliminates data loss, confusing duplicates, and manual errors in logs, ensuring full accountability.

Academically, this platform demonstrates how cloud-based database systems can enhance operational workflows in university contexts. The design reflects proven benefits such as improved data integrity, access control, and administration transparency (Shakil, Sethi & Alam, 2015). Practically, Qreclaim offers a scalable, cost-effective template that other institutions can adopt to formalize their own inventory or lost-and-found systems, replacing informal procedures with a dependable, centralized model.

1.3.2 AI-Powered Image Tagging and Matching for Efficient Recovery

Using only textual descriptions to match lost and found items is inefficient and often fails when descriptions are vague (“black wallet,” “red bottle”). Qreclaim solves this by leveraging the BLIP model to automatically extract image tags that describe visual features such as color, texture, shape, or object type. These tags feed into a similarity-scoring algorithm that rapidly identifies probable matches between reported lost and found items. This speeds up recovery, reduces manual workload, and minimizes errors all without relying on human interpretation.

This solution advances research on vision-language models like BLIP by applying them in a real-world campus scenario. It builds on systems such as LostNet, which achieved high accuracy (96.8%) in matching lost objects based on image similarity (Zhou et al., 2023). Qreclaim demonstrates that AI-based visual tagging can be effectively deployed within a live environment to automate previous labor-intensive processes, making the system proactive and responsive.

1.3.3 Secure Dual-Factor Verification to Prevent False Claims

Traditional claim processes often lack verification and can result in items being taken by unauthorised individuals. Qreclaim addresses this through a dual-factor authentication kiosk: claimants must scan their RFID student card and pass facial recognition verification before the system releases an item. Each claim is logged with time, user identity, and confirmation status, increasing trust and preventing impersonation or fraudulent retrieval.

This project exemplifies practical integration of IoT and biometric authentication in a campus setting. Studies show that combining RFID scans and facial recognition provides stronger security than single-factor systems (Yadav et al., 2019). Qreclaim offers real-world insight into deploying these technologies safely and efficiently, particularly for institutional use, and supports research into robust, accessible authentication methods.

1.3.4 Human-Centered Usability Design for Better Adoption and Accessibility

Even advanced systems fail if real users find them difficult to navigate. Qreclaim prioritizes usability by following established HCI principles (e.g. Nielsen's heuristics) and the Malaysia Government Design System (MYDS). The interface includes clear icons, step-by-step forms, contextual feedback, and accessible visual elements. Usability testing with students and staff is embedded in the development cycle, with iterations made based on actual user feedback. This human-centered approach ensures the system is intuitive and reduces errors.

By integrating iterative user studies and HCI best practices into system design, Qreclaim contributes to the body of usability research especially in the Malaysian higher-education context, where such evaluations are sparse. It provides empirical evidence that user-centered design leads to higher adoption rates, fewer errors, and greater satisfaction. It serves as a viable model for future systems prioritising accessibility and real-world usability.

1.4 Project Plan

The project is divided into two main phases: Project I and Project II, with clearly defined goals and deliverables in each stage.

During Project I, the focus is on research, problem analysis, and system planning. This includes identifying the main problems in TAR UMT's current lost-and-found process, reviewing existing academic solutions, and deciding on the key technologies to be used. Functional requirements are collected, and early design work is completed, such as creating case diagrams, system architecture, wireframes, and the project proposal documentation.

In Project II, the development of the actual system begins. The web-based platform is built using Firebase for backend data storage and Python for AI integration. The Raspberry Pi-based prototype is implemented to handle identity verification through RFID card scanning and facial recognition. Once the system modules are completed, the project enters the testing phase, which includes functional testing, integration testing, and usability testing involving real students and admin users. Their feedback will be used to improve the user interface and fix any technical issues.

This project plan ensures that the system can be developed within the academic schedule while meeting all functional, security, and usability goals.

1.4.1 Milestone/Schedule

Table 1.1 and Table 1.2 below show the estimated completion data for each activity and also the expected result will come out of each stage.

Table 1.1 Project I Schedule

ACTIVITIES	EXPECTED OUTCOME	COMPLETION DATE
Complete Project Proposal (includes Form 1, Form 2 & Form 3)	Submit Project Proposal (includes Form 1, Form 2 & Form 3)	04 July 2025
Complete Moderation of Project Proposal (All)	Moderation of Project Proposal (All)	18 July 2025
Complete Chapter 1 Introduction	Submit Chapter 1 Introduction	25 July 2025
Complete Chapter 2 Research Background	Submit Chapter 2 Research Background	08 August 2025
Complete Chapter 3 Methodology and Requirements Analysis	Submit Chapter 3 Methodology and Requirements Analysis	29 August 2025
Complete Chapter 4 System Design	Submit Chapter 4 System Design	19 September 2025
Complete Project I Portfolio (individual)	Submit Project I Portfolio (individual)	25 September 2025

Table 1.2 Project II Schedule

ACTIVITIES	EXPECTED OUTCOME	COMPLETION DATE
Preparation of test plan/cases or experiment plan System Preview with Supervisor	Show test plan/cases or experiment plan System Preview with Supervisor	10 November 2025

Preparation of test plan/cases or experiment plan System Preview with Supervisor	Show test plan/cases or experiment plan System Preview with Supervisor	21 November 2025
Final System Testing with Supervisor and Moderator	Show Final System Testing with Supervisor and Moderator	28 November 2025
Complete Draft FYP Report (individual)	Submission of Draft FYP Report (individual)	12 December 2025
Complete Final FYP Report (individual) and all associated deliverables stated in guidelines.	Submission of Final FYP Report (individual) and all associated deliverables stated in guidelines.	19 December 2025

1.5 Project Team and Organization

This project is developed by Lee Song Yan, an undergraduate student from the Bachelor of Information Technology (Hons) in Software Systems Development programme at TAR UMT Johor Branch. As an individual project, the student is fully responsible for all stages of the project, including research, system design, development, testing, and documentation. The supervisor for this project is Dr. Leong Pui Huang, who will provide academic guidance, technical advice, and evaluation throughout the development cycle.

Figure 1.1 shows the overall structure of the Qreclaim system, which is divided into two main modules: the User Module and the Administrator Module. At this introductory stage, the modules are presented only at a high level to show how the system is separated according to user roles. The User Module is intended for students, while the Administrator Module is intended for campus admin.

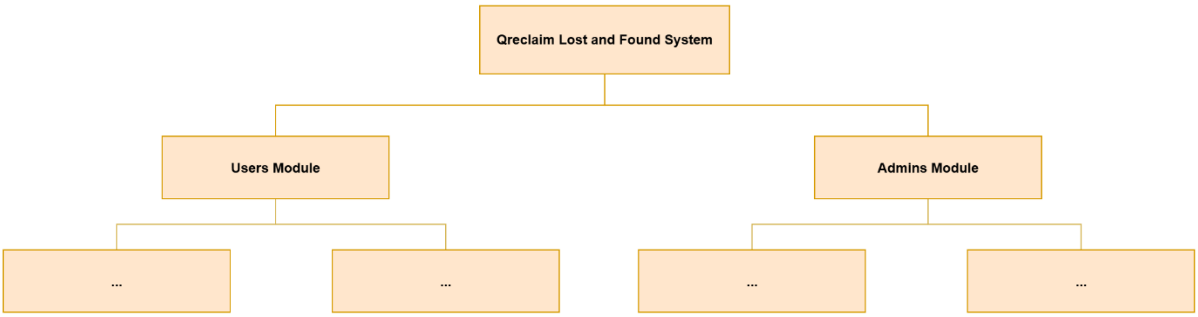


Figure 1.1 System Modules

1.6 Chapter Summary and Evaluation

This chapter has provided an overview of the Qreclaim project, highlighting its motivation, background, objectives, contributions, and implementation plan. The chapter began by establishing the need for a structured and intelligent lost-and-found solution at TAR UMT Johor Branch, noting the limitations of the current reliance on informal social media platforms and manual processes. The background section emphasized four key issues that currently affect item recovery on campus: the absence of a centralized reporting platform, the lack of intelligent item matching, weak verification procedures, and the absence of usability evaluation or structured handling of unclaimed items. These challenges served as the foundation for the formulation of the project objectives.

The project objectives were then defined in detail, aligning each objective with one of the identified problems. These include developing a centralized web platform for reporting lost and found items, implementing AI-based image recognition for automatic tagging and similarity matching, integrating a dual-factor claim verification system using RFID and facial recognition, and improving system usability through user-centered design and iterative evaluation. The chapter also described the unique contributions of Qreclaim, emphasizing how it combines cloud technology, artificial intelligence, and IoT to create a secure, efficient, and user-friendly system.

Furthermore, the project plan and milestone schedule were outlined to ensure that the project is completed in a structured and timely manner. Project I focuses on research, analysis, and design, while Project II emphasizes system development, integration, and usability testing. Finally, the project team and organization section clarified the roles and responsibilities of the student developer and supervisor, ensuring accountability throughout the project.

In evaluating this chapter, it successfully establishes the importance and relevance of the project by connecting the identified problems with practical and research-based solutions. The objectives are well-defined, measurable, and logically aligned with the issues highlighted in the background section. The chapter also demonstrates a clear technical and methodological direction, ensuring that the project is feasible within the allocated timeframe. Overall, Chapter 1 sets a strong foundation for the subsequent chapters by defining the problem space, justifying the need for the system, and presenting a clear roadmap for its development and evaluation

Chapter 2

Literature Review

2 Literature Review

This chapter presents a detailed review of relevant literature related to the development of Qreclaim, a Smart Lost and Found System designed for the TAR UMT campus. It includes a study of the current problems in the existing campus lost and found process, such as lack of proper tracking, manual matching, and unreliable claim verification. In addition, this chapter explores existing systems implemented by other institutions to highlight their strengths and weaknesses. By understanding the limitations of current practices and reviewing similar systems, this literature review helps justify the need for Qreclaim and supports the design decisions made during system development.

2.1 Similar System Study

This section reviews existing lost and found systems implemented by other universities in Malaysia, identifying their key features, benefits, and limitations. These examples provide insight into current practices and help establish a foundation for the design of Qreclaim.

A comparative analysis was conducted to explore existing lost and found systems implemented in Malaysian university environments. This study focuses on four relevant examples: the FoundeLost system from Universiti Kebangsaan Malaysia (UKM), an RFID-based prototype developed at UiTM Arau, a faculty-level portal from Universiti Malaysia Sarawak (UNIMAS), and the e-Aduan module from Universiti Teknikal Malaysia Melaka (UTeM). Each system is analyzed in terms of key features, benefits, and limitations, with the objective of identifying gaps that Qreclaim aims to address through enhanced functionality and user experience.

2.1.1 FoundeLost (UKM)

One of the most structured university-level lost and found systems is FoundeLost, developed by students at Universiti Kebangsaan Malaysia (UKM). It is a web and Android-based platform that allows users to register using their matriculation number and post listings for lost or found items. Each item listing includes a title, image, category, and description, and users can manage submissions through a personal dashboard. The system is also programmed to automatically delete any listing that exceeds 30 days, which helps maintain listing relevancy and prevents database clutter (Tan & Chong, 2023).

As illustrated in Figure 2.1, the FoundeLost system flow begins with user login, followed by manual item submission or search navigation. Users are expected to browse the entire listing library, visually identify potential matches, and initiate contact or claims based on descriptive alignment. All verification is handled manually, which places significant responsibility on the user to ensure accuracy. This traditional flow lacks backend intelligence or security layers, relying instead on human effort and memory.

The key advantage of FoundeLost is that it creates a centralized platform within the university environment, reducing the reliance on social media groups or physical bulletin boards. It also provides users with direct access to reports and claims status in real-time. However, the system still depends entirely on manual navigation by users. There is no intelligent search or matching capability built into the system, so students must scroll through all available entries to find possible matches. In addition, there is no integrated verification mechanism beyond manual description matching, which could lead to false claims or mistaken identity. These weaknesses limit its scalability and security in larger institutions.

Qreclaim addresses these limitations by incorporating AI-based image-text similarity search using deep learning models such as BLIP or CLIP. Rather than requiring students to browse listings, the system can suggest potential matches based on uploaded images or textual clues. Additionally, Qreclaim includes RFID card scanning and facial recognition for claim verification, ensuring that the process is more accurate and secure for both students and campus staff.

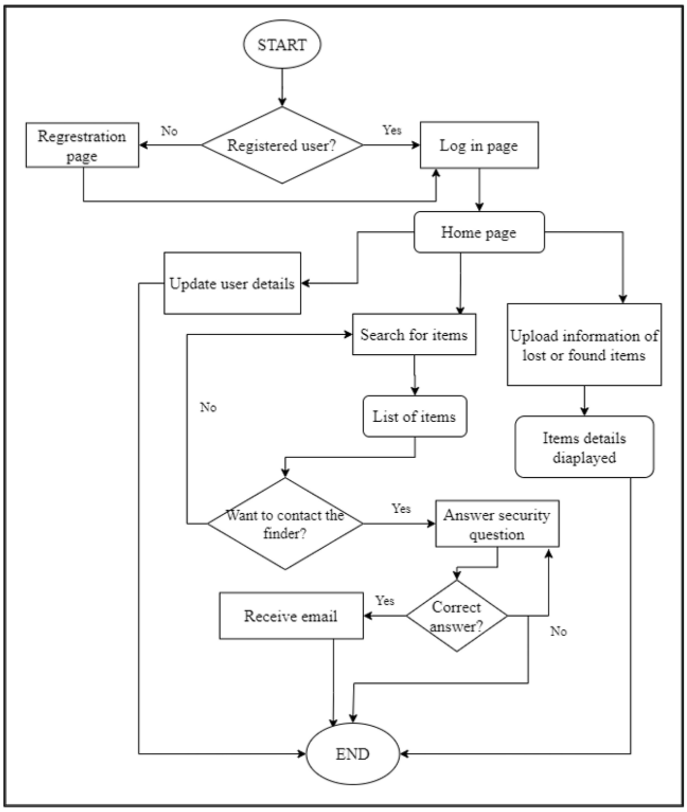


Figure 2.1 FoundeLost Application Flow Chart

2.1.2 RFID-Based System (UiTM Arau)

Another solution was introduced by Ilias et al. (2020) from UiTM Arau, who developed a web-based prototype tailored specifically for their university's lost and found operations. The system utilized RFID technology to help identify owners of misplaced items, and automated email notifications were sent to the rightful owners once a tagged item was scanned by staff. A reporting and tracking portal were also provided, allowing users to submit and view lost or found item records, as illustrated in Figure 2.2.

The system included enforced user login, featuring dedicated interfaces for both students and administrators (Figure 2.3). Additionally, only the original poster was permitted to edit or delete their submitted reports, which helped maintain accountability and prevent unauthorized modifications. For its intended scope within UiTM Arau, the system offered a practical and functional solution to improve lost and found management through basic digitalization and RFID-based identification.

Nevertheless, the prototype was limited to a single university context and lacked certain advanced features that would improve scalability and security, such as biometric verification or broader device accessibility. Qreclaim addresses these gaps by offering a mobile-responsive design suitable for both desktop and smartphones, and by integrating RFID with facial recognition to enable more secure and verifiable claim processes. This multi-layered approach enhances both usability and reliability, especially in larger campus environments like TAR UMT Johor.

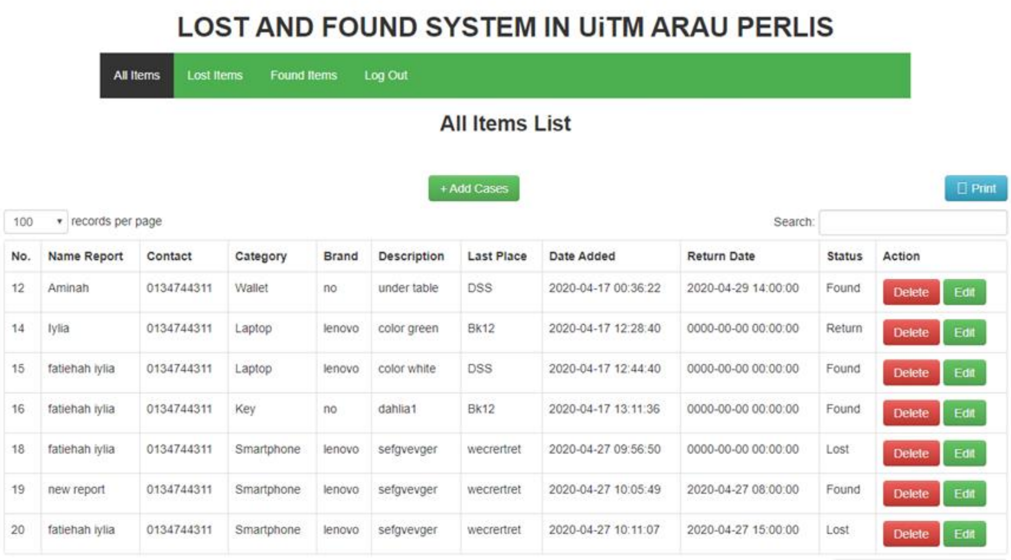


Figure 2.2 Lost and Found Items List

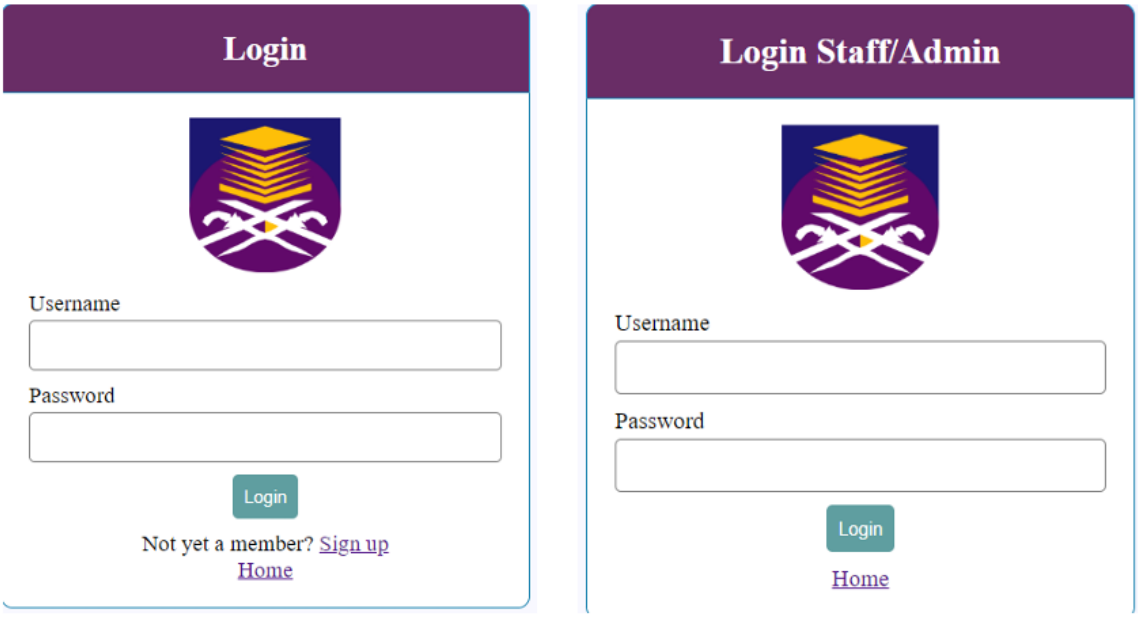


Figure 2.3 Login Page

2.1.3 Faculty Portal (UNIMAS FCSIT)

UNIMAS implemented a simple faculty-level lost and found portal within its Faculty of Computer Science and Information Technology (FCSIT) (Sadiah & Nyambong, 2020). The system allowed staff and students to post lost or found items using a form-based web interface, which was then made available on a shared online bulletin board for others to browse. The portal served as a digital replacement for traditional notice boards and simplified communication within the faculty.

While this system increased visibility for lost items within FCSIT, it was never scaled to support the entire university. The scope was limited to a single faculty, and the lack of AI search, feedback features, or claim verification protocols meant that the system relied heavily on manual effort. There was also no mechanism for ensuring only authorized users could submit or manage listings.

Qreclaim addresses these shortcomings by supporting a campus-wide user base and offering advanced AI-powered item search based on both image and text inputs. Its Firebase backend enables real-time synchronization across multiple departments, and administrative features ensure that only verified users can manage entries.

2.1.4 e-Aduan Lost & Found (UTeM)

At Universiti Teknikal Malaysia Melaka (UTeM), the e-Aduan module was designed as part of a broader complaint and request system for campus users. Among its functions, it enabled students to submit details about lost or found items online, receive claim status updates, and set pickup appointments for recovered belongings. The system was web-based and utilized Oracle and PHP technologies (Shamshur & Nabilah, 2016).

Figure 2.4 shows the navigation design chart of the e-Aduan platform, outlining how the web interface communicates with the Oracle back-end to manage item reports and user submissions. The framework reflects a traditional client-server model, where all verification and validation tasks are conducted manually by administrative staff.

Despite its functionality, e-Aduan was built more as a passive reporting tool than an intelligent matching system. As shown in Figure 2.5, the lost item report form was limited to manual text inputs without any support for image uploads or automated classification. The system did not leverage machine learning, image recognition, or tagging features, meaning the entire process of claim validation relied on human comparison by staff. It also lacked mobile responsiveness, limiting accessibility for students who primarily use smartphones.

In contrast, Qreclaim enhances this concept by introducing image upload capabilities and automatic tag generation using AI-based object detection and captioning. These features allow the system to semantically match reported and found items more accurately without full reliance on manual inputs. Combined with a mobile-friendly interface and integrated biometric and RFID verification, Qreclaim offers a more intelligent, secure, and user-centric solution for managing lost and found processes in modern university environments.

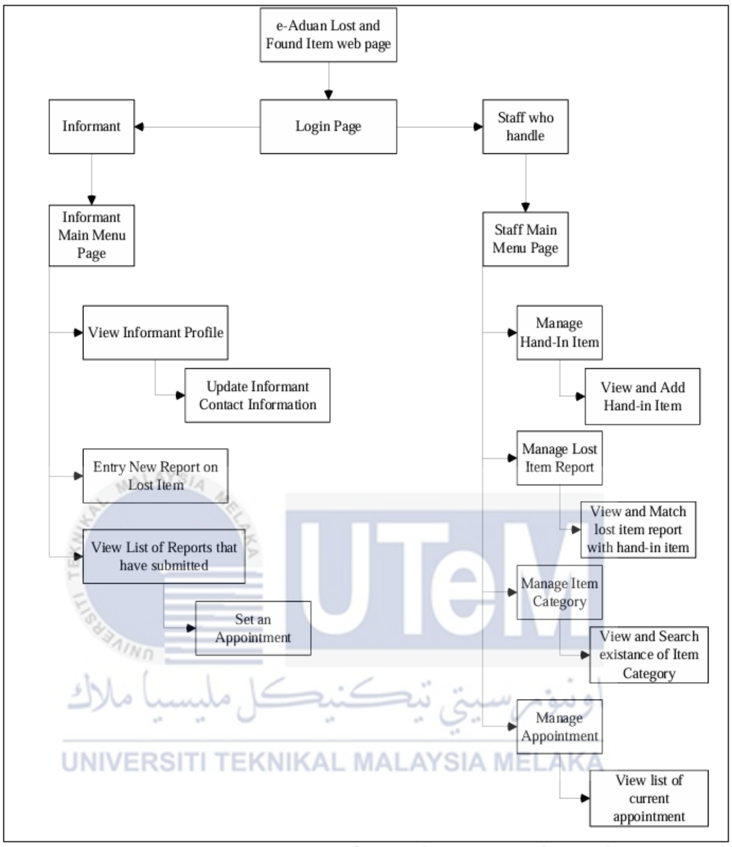


Figure 2.4 Navigation Design of UTeM System

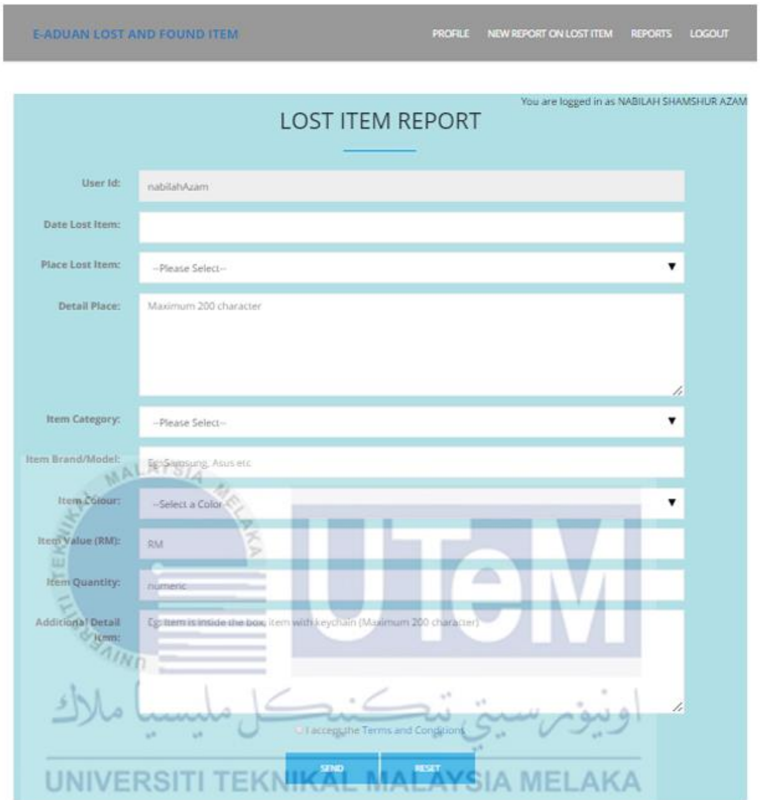


Figure 2.5 Manual Lost Item Report Form

2.2 Project Background

In recent years, university campuses such as TAR UMT Johor have encountered growing challenges in managing lost and found operations due to the absence of a centralized digital system. Currently, students and staff rely on fragmented communication tools such as WhatsApp, Telegram, and Facebook groups to report and search for lost items. These informal platforms are not designed for structured item tracking and often result in missed connections between lost and found reports. Consequently, many items remain unclaimed, leading to frustration among students and additional burden for administrative staff responsible for storing and verifying items.

In response to address these issues, the proposed system Qreclaim introduces a structured, AI-powered platform that streamlines the entire lost and found process through the integration of image recognition, RFID verification, and real time data synchronization. This system aims not only to enhance the efficiency of item recovery but also to reduce false claims and ensure greater transparency throughout the item's lifecycle. This section highlights the major limitations of TAR UMT's current system and presents the specific solutions that Qreclaim offers to overcome them.

2.2.1 Limitations of Current Systems

Lack of a Centralized and Structured Reporting Platform

Currently, the lost and found process at TAR UMT Johor campus lacks a centralized platform for managing item reports. Students who lose belongings often turn to informal channels such as WhatsApp, Telegram, or WeChat groups to post about missing items (Figure 2.6). However, these communication methods are disorganized and difficult to track. Since different faculties or departments may operate their own separate groups, the process becomes fragmented and inconsistent.

This disconnection results in redundancy and wastes time, as students may post on multiple social media platforms or visit various offices without knowing whether an item has already been recovered elsewhere. This becomes particularly frustrating in urgent cases involving important items like student ID cards, wallets, or laptops. The reliance on unstructured platforms such as the "OnlyTARCianKnow Lost and Found" Facebook group illustrates this problem while it helps publicize lost items, it lacks systematic categorization or verification, which reduces the chances of successful recovery (OnlyTARCianKnow, n.d.).

This weakness is similarly observed in other institutions such as UMP and UTeM, where item reporting is also conducted through general-purpose digital forms or community posts that do not provide centralized oversight. These systems, although digital, do not unify records across departments, resulting in siloed data and ineffective searches.

In the role to overcome this limitation, Qreclaim introduces a centralized web-based system that allows students and staff to submit, view, and manage lost and found records within a single digital platform. With real-time data synchronization, all records become accessible to authorized users, enabling consistent and traceable item management. This centralized approach eliminates communication gaps and promotes a more efficient and transparent recovery process.

No Structured Method to Categorize or Match Lost and Found Items

The current manual approach to handling lost and found items lacks a structured method for categorizing or matching records. Found items are often described vaguely, while lost item reports from students use inconsistent terminology. Without standardized tags or automated similarity detection, staff must rely on subjective visual inspection to attempt a match an inefficient and error-prone process.

This issue becomes more problematic when handling commonly lost items like USB drives, water bottles, or stationery. For example, if a student reports losing a "blue thumb drive," but the item is recorded as a "small black storage device," it becomes difficult to determine whether they refer to the same object. The inconsistency in item descriptions, along with the absence of photos or structured metadata, significantly reduces retrieval accuracy. Ghazal et al. (2016) emphasize that multi-feature image matching and structured metadata greatly improve object retrieval accuracy in digital systems.

Other universities, such as UMP and UTHM, also show this shortcoming, as their systems depend largely on user-written descriptions without any enforced categorization or AI-driven support. The absence of intelligent suggestion or tagging functions leads to inconsistencies, making it harder for staff to efficiently match found items with lost reports.

Qreclaim addresses this limitation by enforcing standardized metadata input during item submission, including fields for item type, color, brand, and optional photo uploads. Additionally, it leverages AI-based image-text similarity models to analyze visual and textual attributes, enhancing the system's ability to match lost and found reports. The combination of structured data and intelligent matching significantly improves item recovery accuracy.

Weak and Unreliable Claim Verification Process

In the current campus lost-and-found system, item claim verification relies primarily on manual checks and verbal descriptions provided by students. Staff typically assess ownership based on general item details or student assertions, such as claiming a "black umbrella" or a "generic charger." This method is highly subjective and poses a significant risk of misidentifying the rightful owner, especially when items lack unique identifiers. As a result, items may be released to the wrong person, which can undermine trust in the system and create conflicts between students and administrators.

This weak verification process becomes even more problematic for high-value items, such as personal electronics or branded accessories, where ownership cannot be easily proven. The manual nature of the process often causes delays, reduces operational efficiency, and lacks the accountability required in a structured institutional environment. As Ismail et al. (2025) highlight, integrating technologies such as RFID within campus operations improves both security and traceability by enabling the system to uniquely associate users with specific actions or transactions.

Similar verification issues have been observed in UTeM and UTHM's systems, where claims are processed through basic online forms or over-the-counter questioning, lacking secure and traceable ownership validation. Without biometric or ID-based checks, these systems are vulnerable to fraud or mistaken identity.

To address these issues, Qreclaim introduces a structured and secure verification approach through its prototype kiosk system. Students who wish to reclaim a lost item must first use the Qreclaim app to generate a personal QR code. This QR code is embedded with both the student's ID and facial data captured during registration. For valuable items, an admin approval process is required before QR generation, adding an extra layer of security. When the student visits the prototype kiosk, the system scans the QR code, automatically retrieving the encoded student ID and face data for further verification.

This two-step authentication mechanism not only ensures that the student claiming the item is likely the rightful owner, but it also helps prevent fraudulent claims. In cases where an item is mistakenly released to a person who is later found not to be the actual owner, the system still retains their registered student ID and facial data for post-investigation. This tracking capability allows administrators to identify, trace, and take appropriate actions against individuals attempting to commit fraud, thereby enhancing overall accountability and trust in the lost-and-found process.

Poor Usability and Lack of Human Centered Design

One of the often-overlooked issues in the current campus lost and found systems is poor usability. These systems, if any exist, are typically not designed with the end-user in mind. Interfaces are either too basic like spreadsheet logs and Facebook posts or too cluttered, making it hard for users to intuitively know how to report, search, or claim an item. There is no structured user feedback mechanism, and very few institutions ever conduct usability testing. As a result, users often feel frustrated or overwhelmed, especially when trying to report a lost item in a stressful situation.

From a Human-Computer Interaction (HCI) perspective, this creates a serious barrier to adoption. Students and staff are unlikely to use or trust a system that feels confusing or inconsistent. This usability gap not only reduces engagement but also contributes to more lost items remaining unclaimed. Bringula and Basa (2011) emphasized that system usability is a key factor affecting user satisfaction, and poor navigation or design directly impacts system adoption.

Many of the university systems studied, including those from TAR UMT's Facebook group and formal systems at UMP and UTHM, do not prioritize usability. Interfaces often lack mobile optimization, use unintuitive layouts, and fail to follow standard HCI heuristics. This discourages repeated use and limits the effectiveness of the system in high-stress moments when students urgently need assistance.

To address this, Qreclaim is built with usability and user-centered design as key priorities. The interface uses a clean, mobile-responsive layout with simple forms, meaningful icons, and progressive disclosure of options to avoid overwhelming first-time users. The design also follows established HCI heuristics such as those by Nielsen (2024), ensuring that users receive consistent feedback, error prevention, and visibility of system status. These design decisions aim to make the system easy to use, even for non-technical users, thus promoting wider adoption.

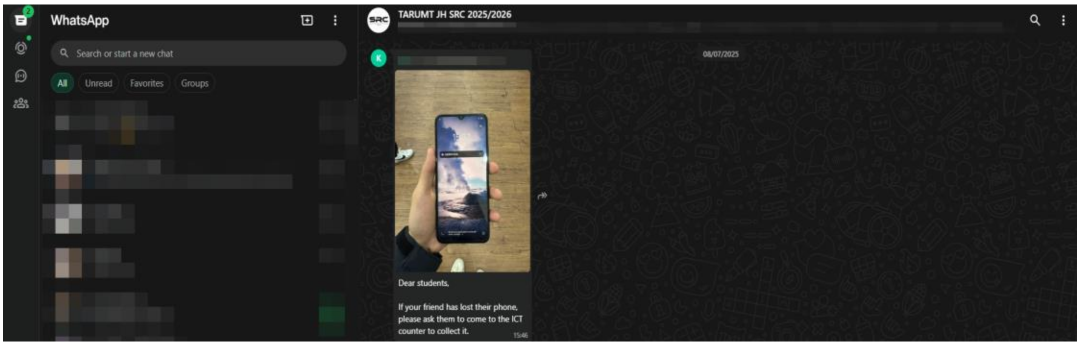


Figure 2.6 WhatsApp Lost Item Post

2.3 Target Market

The Qreclaim system is designed specifically for a campus environment, with its target users being students and staff of TAR UMT Johor. These individuals frequently move between various facilities across the campus throughout the day, increasing the likelihood of misplacing personal belongings. As such, there is a clear need for a centralized, reliable, and user-friendly digital platform that enables efficient reporting, searching, and claiming of lost items. By focusing on this user group, Qreclaim is tailored to the behavioral patterns, routines, and technological familiarity of campus users within a higher education setting.

2.3.1 TAR UMT Johor Students

Students represent the primary user group of Qreclaim, as they are the most frequent individuals affected by item loss on campus. At the TAR UMT Johor branch, students regularly move between the library, the ICT Centre (which contains numerous computer laboratories and classrooms), the ICT Business Centre (canteen), the DKC Block (lecture halls), the DSA Block (which includes gym and swimming pool facilities), and Block F. These high-traffic areas are common locations where personal items such as water bottles, power banks, books, umbrellas, student ID cards, and electronic accessories are often misplaced.

In the absence of a centralized system, students are typically forced to rely on informal communication platforms such as WhatsApp, Telegram, or Facebook to search for lost items. This fragmented approach leads to confusion and inefficiency, requiring students to physically visit different buildings or offices to inquire about their belongings. The emotional stress associated with losing important items such as a student ID required for examination access further exacerbates the problem.

The Qreclaim system addresses these challenges by offering a centralized, web-based platform through which students can submit reports for lost items, browse categorized found item listings, and receive claim status updates. Features such as AI-powered visual matching, location-based filtering, and submission tracking enhance the item recovery process and reduce unnecessary effort. As noted by Bringula and Basa (2011), user-centered design that aligns with the specific behaviors and needs of the target audience is essential for maximizing system usability and engagement.

2.3.2 TAR UMT Johor Staff

Staff members including security personnel, faculty assistants, and administrative personnel represent secondary yet critical users within the Qreclaim system. These individuals are directly involved in handling found items, ranging from initial acceptance and data recording to secure storage and facilitating the final item claim process. At present, these tasks are typically carried out manually using physical logbooks or basic spreadsheets. Such methods are not only time consuming but also highly susceptible to human error, data inconsistency, and loss of information over time.

In addition, staff members often face difficulties in verifying item ownership, especially when multiple students claim visually similar items such as black water bottles or plain pencil cases. Without technological support, the verification process is based primarily on subjective verbal descriptions and the staff's personal memory or judgment. This lack of a standardized verification protocol heightens the risk of misidentifying the rightful owner, which may lead to administrative disputes, loss of user trust, and increased workload.

Qreclaim addresses these inefficiencies by offering a structured and secure platform. Through digital logging, staff can now record found items along with rich metadata and supporting images, enabling more precise item tracking and retrieval. The system also facilitates automatic item-student matching, allowing staff to view potential matches based on reported lost items submitted by students. Furthermore, identity verification is streamlined with integrated RFID student ID scanning and facial recognition features, which reduce reliance on staff intuition and provide a clear audit trail.

Beyond operational improvements, Qreclaim also equips staff with analytics capabilities. The system collects and visualizes data trends related to item categories, frequency of claims, peak lost-and-found periods, and commonly misplaced items. This insight allows administrators to identify recurring issues, optimize locker usage, plan for resource allocation, and even launch awareness campaigns to reduce item loss. These features contribute to a more accountable and data-driven environment, aligning with Bringula and Basa’s (2011) observation that user satisfaction is closely tied to how effectively a system supports core institutional workflows and decision-making processes.

2.4 Domain Research

This section highlights the key technologies, frameworks, and tools selected to implement the Qreclaim system. Each technology has been carefully chosen to fulfill specific system requirements, including secure item claim verification, real-time updates, intelligent item matching, and cross-platform deployment. Domain research not only supports technical feasibility but also justifies the decision-making process by referencing proven methods in similar academic or enterprise-level systems.

2.4.1 Firebase (Google Cloud Platform)

Firebase (Figure 2.7) is adopted as the primary backend infrastructure for Qreclaim due to its real-time capabilities, scalability, and strong integration with mobile and web platforms. Firestore, a cloud-hosted NoSQL database within Firebase, is used to store item records, user profiles, and images, allowing seamless and consistent data updates across devices even during intermittent connectivity (Firebase, 2024). Firebase Authentication enables secure user login linked to institutional credentials (e.g., student IDs), while Firebase Storage provides a scalable solution for hosting item images.

Additionally, Firebase ML Kit assists in detecting and labeling images upon upload, which helps in generating searchable item tags. Firebase Cloud Messaging (FCM) and Cloud Functions are used to push instant notifications, such as status updates on matched or claimed items. These cloud services support scalability and responsiveness, making Firebase an ideal choice over more traditional self-hosted alternative.

Figure 2.7 Firebase

2.4.2 Python & Flask / FastAPI

Python is selected as the core backend programming language for implementing business logic and AI functionalities due to its extensive library ecosystem and ease of integration. Frameworks like Flask or FastAPI are lightweight, fast, and well-suited for building RESTful APIs, allowing Qreclaim to manage user actions, perform item tagging, and integrate with machine learning inference engines.

Python also enables integration with TensorFlow, PyTorch, and OpenCV tools that power image processing and facial recognition. This versatility makes Python a suitable foundation for rapid prototyping and production-ready deployment.

2.4.3 Hugging Face Transformers (CLIP/BLIP)

To overcome the limitations of manual keyword-based searches, Qreclaim integrates pre-trained transformer-based AI models such as CLIP and BLIP from Hugging Face (Figure 2.8). These models convert both images and textual descriptions into embeddings, allowing for semantic similarity matching. For example, when a user submits a lost item report with a description, the system can retrieve visually similar found items even if the keywords do not match exactly.

Radford et al. (2021) demonstrated that CLIP performs well in zero-shot visual understanding tasks, making it suitable for situations with incomplete or ambiguous data. Similarly, BLIP (Li et al., 2023) enhances visual-language alignment and caption generation, which is crucial for automatically generating descriptive tags from uploaded item photos. In this project, CLIP and BLIP are not developed from scratch but integrated as existing models via the Hugging Face platform. This integration can be achieved either through the Hugging Face Inference API for cloud-based processing or by downloading the pre-trained models and running them locally on the system’s backend server.

By leveraging these state-of-the-art models, Qreclaim significantly improves item tagging and matching accuracy. The integration ensures that users can quickly find their lost belongings, reducing reliance on exact keyword matches and increasing retrieval efficiency.

Figure 2.8 Hugging Face

2.4.4 You Only Look Once (YOLOv8)

To ensure that AI-generated tags describe the main lost item rather than the surrounding background, Qreclaim applies an advanced object detection model from the YOLO family, specifically YOLOv8, as a preprocessing stage. The role of YOLO is to detect bounding boxes around objects in uploaded images, allowing the system to crop and isolate each item before passing it to captioning and embedding models such as BLIP and CLIP. This object-isolation process minimizes the influence of background features, supports cases where multiple items appear in a single photo by producing one crop per detected object, and ultimately improves the accuracy and reliability of tag generation.

In this project, YOLO is not developed from scratch but integrated using pre-trained weights, with the possibility of fine-tuning on a curated dataset of campus-related items. For deployment, lightweight YOLO models or optimized inference builds can run directly on a Raspberry Pi to support real-time detection during item intake. When more computational power is required, inference can be redirected to a backend server (e.g., Flask or FastAPI) with GPU support, where the Raspberry Pi transmits either the original image or an initial crop for further processing.

The detection and tagging pipeline operates as follows: first, an image is submitted to Qreclaim; second, YOLO generates bounding boxes with associated confidence scores; third, each bounding box is cropped and normalized; fourth, the cropped regions are passed to BLIP for captioning and to CLIP for embedding and verification; and finally, the generated captions are transformed into standardized tags for similarity-based matching in the database. To further improve detection performance for locally relevant categories such as student ID cards, wallets, or bottles, YOLO may also be fine-tuned using tools like OIDv4_ToolKit in combination with the Open Images dataset.

By integrating YOLO as a targeted preprocessing step, Qreclaim minimizes false positives caused by background details, enables effective handling of images containing multiple items, and strengthens the accuracy of BLIP/CLIP-based tagging and matching. This design choice significantly enhances the overall reliability and retrieval effectiveness of the system (Redmon et al., 2016).

2.4.5 OpenCV & Facial Recognition

OpenCV is a widely used open-source computer vision library integrated into Qreclaim to support face detection and verification tasks. During claim processes, the system uses a webcam or Raspberry Pi camera to capture and verify the user's face in real-time. OpenCV helps with preprocessing images (e.g., converting to grayscale, cropping, aligning) before comparing them to registered facial templates.

This biometric verification method, when combined with RFID scanning, increases both accuracy and accountability. According to Singh and Sharma (2021), multimodal authentication (i.e., using both face and RFID) significantly reduces the chances of false claims and identity spoofing enhancing trust and security in unattended self-service environments like kiosks.

2.4.6 RFID Tagging with Raspberry Pi & RC522 Modules

Qreclaim uses RFID technology to identify student cards and, optionally, tag found items. The system integrates an RC522 RFID reader module with a Raspberry Pi to retrieve student data during claim verification. This low-cost hardware setup is commonly used in IoT-based student systems and has been tested in campus-level projects, such as the RFID lost-and-found system at UiTM Arau (Ilias, 2020).

The RFID mechanism allows for quick, touchless identification, especially useful in kiosk-based claim stations. In Qreclaim, RFID data is securely linked to Firebase-stored profiles and paired with biometric verification to ensure legitimate item retrieval. The combination improves usability and tamper resistance while remaining budget-friendly for educational institutions.

2.5 Chapter Summary and Evaluation

This chapter has presented a comprehensive review of literature and technologies related to the development of the Qreclaim system. It began by addressing four key limitations in the existing lost and found processes at TAR UMT Johor: the absence of a centralized and structured reporting mechanism, the lack of automated item matching, unreliable claim verification methods, and the absence of user-centered usability design. These limitations not only cause inefficiencies in item recovery but also contribute to miscommunication, unverified claims, and a lack of accountability within the current manual-based system.

To overcome these issues, Qreclaim is proposed as a smart and integrated solution tailored to a campus environment. It leverages cloud-based infrastructure, AI-powered image processing, and RFID or facial recognition for secure claim verification. These technologies work together to streamline workflows, reduce manual errors, and enhance user confidence in the lost and found system.

An analysis of the target market highlighted that TAR UMT students and staff frequently interact with multiple campus zones such as the library, ICT Centre, DKC Block, and DSA Block. By understanding the movement patterns and behavioral context of users in these locations, Qreclaim is designed to be both accessible and contextually relevant. This market insight ensures that usability is prioritized across all user interactions.

The chapter also reviewed multiple similar university systems to extract insights and identify performance gaps. For example, UKM's FoundeLost system digitized item reporting but lacked intelligent matching and identity verification features (Tan & Chong, 2024). UiTM's RFID-based notification system introduced automation but did not address usability design or intelligent classification of found items (Ilias, 2020). UNIMAS and UTeM implemented basic web systems, yet both relied heavily on manual processing and offered limited user verification features (Sadiah & Nyambong, 2020; Shamshur & Nabilah, 2016). These systems demonstrate that while progress has been made toward digitization, gaps still exist in secure verification and AI integration areas in which Qreclaim provides significant improvements.

From a technical perspective, this chapter justified the selection of tools used in Qreclaim’s implementation. Firebase was chosen for its robust cloud scalability and real-time database capabilities (Firebase, 2024), while Python and FastAPI serve as efficient back-end frameworks for handling AI-based tasks. The integration of advanced models like CLIP (Radford et al., 2021) and BLIP (Li et al., 2023), in combination with OpenCV and RFID hardware, enables the system to generate accurate tags, enhance visual matching, and ensure secure identity validation. These components were selected based on established academic research and their proven performance in similar applications, confirming the technical feasibility of the proposed approach.

In conclusion, the literature review and related studies in this chapter support the formulation of Qreclaim's core objectives and validate its overall feasibility. The analysis demonstrates how Qreclaim addresses the specific challenges faced by the current system at TAR UMT Johor by applying modern technologies and user-centered principles. The insights gathered here provide a strong conceptual and technical foundation for the system design and implementation phases that follow in subsequent chapters.

Chapter 3

Methodology and Requirements Analysis

3 Methodology and Requirements Analysis

This chapter outlines the methodological approach and the process of identifying and analyzing the requirements for the Qreclaim system. The methodology describes the software development model adopted for the project and justifies its suitability in guiding the development process. The requirements analysis section details how information was collected, recorded, and analyzed to derive both functional and non-functional requirements of the system. By systematically applying requirement recording techniques and fact analysis tools such as input/output analysis, decision tables, and structure charts, the collected data were transformed into a structured Software Requirements Specification (SRS). This chapter therefore establishes the foundation for the subsequent system design, ensuring that the proposed solution is technically feasible, user-centered, and aligned with the objectives of improving the campus lost-and-found process.

3.1 Methodology

The Incremental Model is a software development methodology that delivers the system in smaller, functional increments rather than as a single, final product. Each increment involves a complete cycle of requirements gathering, design, implementation, and testing, resulting in a working subset of the system that can be evaluated before moving to the next stage. Unlike the linear Waterfall model, incremental development allows partial deployment and early feedback, making it easier to refine the system progressively. According to GeeksforGeeks (2024), this model enables early delivery of core features, simplifies error detection through modularity, and allows feedback-driven improvements between iterations. This ensures a balance between structured planning and flexibility, which is particularly beneficial in research-oriented projects.

For this project, the Incremental Model was selected because it aligns with the modular and testable nature of the system while still maintaining a structured development process. Academic projects benefit from incremental delivery as they enable the researcher to focus on one functional area at a time, ensuring higher quality before moving on to the next. Since the proposed system consists of interdependent modules including authentication, AI-powered image tagging, automated lost–found item matching, RFID-based claim verification, and kiosk integration developing these features incrementally reduces the risk of large-scale integration issues and allows for earlier usability testing. Additionally, this approach supports supervisor feedback at multiple points, making it easier to adjust system features or workflows without reworking the entire project.

In applying this methodology, the project will progress through several iterative cycles, with each cycle targeting a specific set of features. During the requirements analysis of each increment, fact-gathering techniques such as observation and interviews will be used to refine user needs, which will then be captured in an updated Software Requirement Specification (SRS). The design phase will translate these requirements into architectural models, database schemas, and interface mockups for the targeted module, using tools such as Entity Relationship Diagrams (ERDs), flowcharts, and Unified Modeling Language (UML) diagrams. Implementation will focus on coding and integrating the selected feature set, beginning with fundamental modules like user authentication before advancing to higher-level components such as AI-powered image tagging, RFID verification, and kiosk operation.

Testing will be conducted for every increment to ensure reliability and consistency before integration into the full system. Unit testing will verify each module independently, while integration testing will confirm that newly developed modules work seamlessly with existing ones. For example, the automated matching and image tagging components will be evaluated using accurate metrics such as precision and recall, whereas RFID verification will be tested in real scenarios to confirm its reliability. After successful testing, the increment will be deployed in a controlled environment, such as a campus pilot, allowing stakeholders to provide feedback before the next cycle begins.

Figure 3.1 shows the Incremental Model process flow adopted for this project. The diagram shows how development begins with requirements definition and architecture design, followed by the construction of the first subsystem. Each subsequent subsystem is built and integrated in a stepwise manner, with verification tests performed at each stage to ensure correctness. Finally, the fully integrated system undergoes validation testing to confirm that all requirements have been met. This staged approach mirrors the planned development of the Qreclaim system, where early increments will deliver foundational functionality such as user authentication and item reporting, while later increments will integrate advanced modules like AI-powered image tagging, automated matching, and kiosk-based verification. By following this model, each phase produces a usable and testable outcome, reducing integration risks and ensuring that issues are detected early rather than at the end of development.

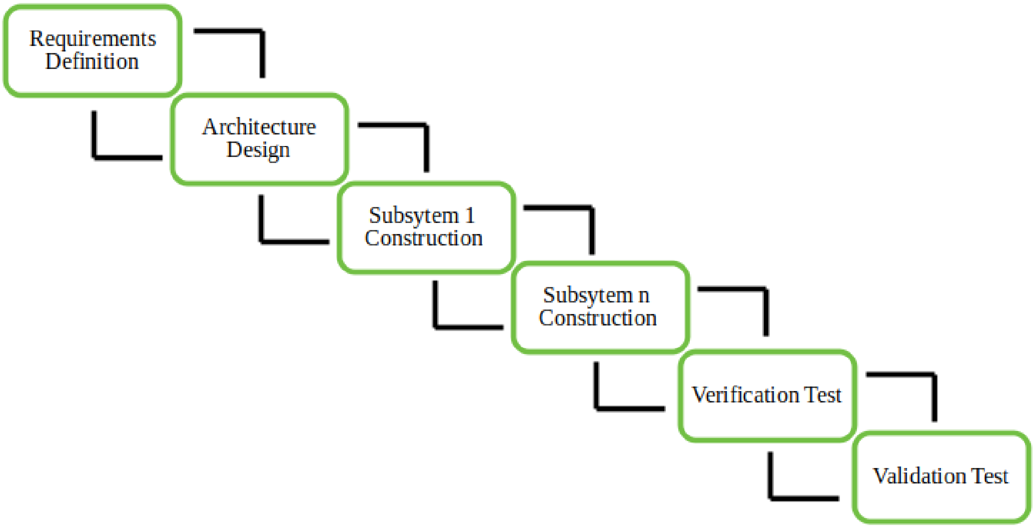


Figure 3.1 Incremental Model

By adopting the Incremental Model, the project gains both structure and flexibility. Each increment produces a tangible, working version of the system, which ensures continuous progress tracking and early risk detection. The combination of modular development, frequent testing, and stakeholder feedback supports the creation of a robust and user-centered solution that meets the project's objectives while minimizing last-minute issues. This methodology is therefore well-suited to the development of a complex, multi-module system within the constraints of a final-year project.

3.2 Requirements Gathering Techniques (Fact Gathering)

To ensure that the requirements of the Qreclaim system are accurately defined and aligned with user expectations, several fact-gathering techniques were applied during the early stages of development. Requirements gathering is a critical process in system development, as it helps bridge the gap between user needs and the final system design (Al-Badi, 2018). For this project, both qualitative and quantitative approaches were considered, ensuring that the collected requirements reflected both functional and non-functional perspectives.

3.2.1 Research

Research was carried out to understand the main problems in the current lost and found process. This included reading academic papers, looking at system documentation, and reviewing case studies from other universities. The research showed that manual systems often have problems like unstructured reporting, slow or no matching of lost and found items, and weak claim verification. These findings became the basis for proposing new solutions such as AI-powered image tagging and RFID verification. The use of AI APIs is especially powerful because they can automatically identify and tag objects from images, making the process faster and reducing human error. According to Sommerville (2020), research is a valuable fact-gathering method for identifying best practices and ensuring that new systems address real-world problems effectively.

3.2.2 Observation

Observation was done directly at TAR UMT Johor campus to see how the lost and found process works in real situations. This included watching how students report missing items, how staff keep records, and how they confirm who owns an item before returning it. The observation showed problems such as manual record-keeping and dependence on informal communication channels like word of mouth. As shown in Figure 3.2, many lost items were observed being placed openly in a common area without a structured storage or claim verification process. This practice highlights the lack of a centralized and secure system, where items are at risk of being misplaced or claimed by the wrong person. These findings matched what students and staff said during interviews and showed that automation is needed to improve the process. As Glinz (2020) states, observation helps capture what really happens in practice, which can sometimes be different from what people say in interviews.

Figure 3.2 Unclaimed Lost Item At ICT

3.2.3 Questionnaire

A questionnaire was created using Google Forms (Appendix 1.1) and shared with students through social media groups so they could easily access and fill it in. The questionnaire contained a mix of question types, including multiple-choice questions, Likert scale questions (to measure agreement with statements), and a few open-ended questions for additional feedback (Appendix 1.2 – Appendix 1.14). This combination allowed both quantitative and qualitative data to be collected, making the results more reliable and meaningful. The responses confirmed common issues such as delays in retrieving items, the absence of a notification system, and challenges in proving item ownership. Questionnaires were chosen because they allow collecting feedback from many people in a short amount of time, which is helpful to support the findings from interviews and observations (Pacheco & García, 2019).

3.3 Requirements Analysis (Fact Analysis)

Requirements Analysis is a foundational phase in the systems development lifecycle, focused on identifying, defining, and documenting the needs and constraints that a new system must fulfill. For the Qreclaim system, this process involves gathering quantitative and qualitative data directly from primary stakeholders students and administrative staff to formulate a clear and justified set of requirements. This ensures the final product is not based on assumption but is rigorously aligned with user expectations and operational realities, thereby maximizing its potential for adoption and success. The analysis synthesizes feedback from 20 survey respondents, and its outcomes directly inform the system's architectural design and feature prioritization, serving as a critical bridge between user needs and technical implementation.

The questionnaire results formed the empirical foundation for the Qreclaim system requirements. The survey gathered 20 valid responses, comprising 19 students primarily from the Faculty of Computing and Information Technology (FOCS) and the Faculty of Accountancy, Finance and Business (FAFB), and one staff member from the DCIT department. A thorough analysis of this dataset highlights not only the significant deficiencies in the current manual lost-and-found process but also precisely identifies the features, workflows, and quality attributes that users expect from a digital, AI-enhanced solution. The findings are systematically organized into three core parts: (i) an analysis of current process deficiencies that justify the project's necessity, (ii) a derivation of functional requirements that define the system's features, and (iii) a derivation of non-functional requirements that establish the system's quality standards.

3.3.1 Analysis of Current Process Deficiencies

The survey data establishes an unequivocal and pressing need for systemic intervention. A significant majority of student respondents (73.7%, n=14/19, Figure 3.3) rated the existing lost-and-found process at TAR UMT as “Average” (3) or worse on a 5-point scale, with over 42% (n=8/19) rating it as "Poor" (2) or "Very Poor" (1) (Appendix 2.6). This overwhelming sentiment indicates a process that is failing to meet basic user expectations for efficiency, transparency, and reliability. A qualitative analysis of the specific problems faced (Q5, Appendix 2.7) reveals four recurring and interconnected pain points that collectively define the systemic failures of the existing, fragmented approach.

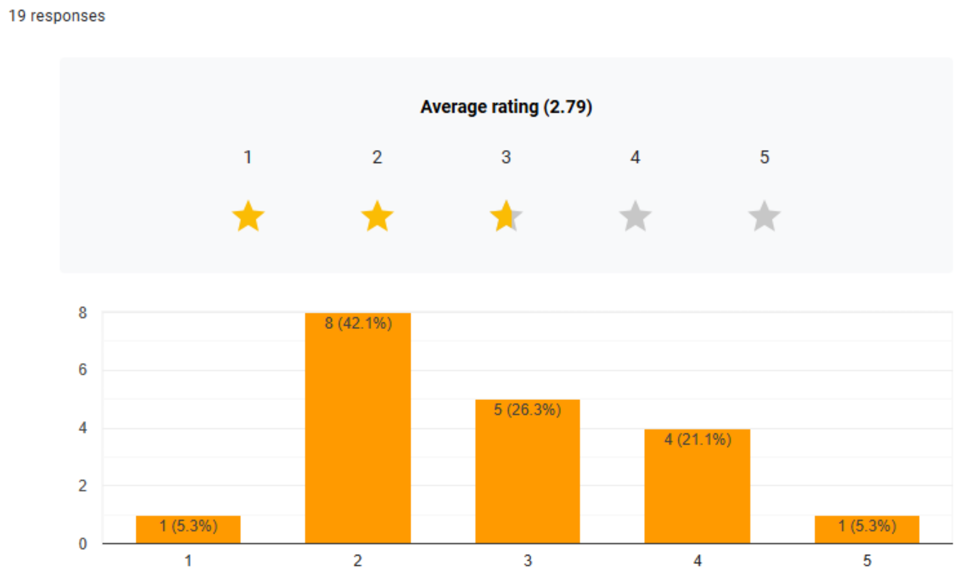


Figure 3.3 Student Response

Absence of a Centralized Platform – This was the most prominent problem, cited by 63.2% of student respondents (n=12/19, Figure 3.4). The current reliance on disparate, isolated locations (e.g., faculty offices, security desks, hostels) creates an inefficient and frustrating user experience. Individuals must rely on word-of-mouth or physically visit multiple locations to report or inquire about items, a process that is time-consuming and often figuring. This fragmentation drastically increases the probability of items remaining unclaimed and creates a inconsistent, confusing experience for users.

Lack of Proactive Communication – 57.9% of respondents (n=11/19, Figure 3.4) reported the absence of proper notifications or updates. The current process is almost entirely reactive, placing the burden of follow-up entirely on the user. Without proactive communication, users are quickly discouraged, leading to abandoned searches and prolonged item recovery times, if recovery happens at all. This deficiency highlights the critical need for automated feedback mechanisms to close the loop between item discovery and owner retrieval.

Ineffective Ownership Verification – 42.1% of respondents (n=8/19, Figure 3.4) highlighted significant difficulties in proving ownership of a found item. The ad-hoc nature of the current process lacks a standardized, reliable method for verification, which acts as a barrier for legitimate owners and introduces substantial security risks. It creates opportunities for false claims, misappropriation, and impersonation, undermining trust in the entire system.

Processing Delays – 31.6% of respondents (n=6/19, Figure 3.4) cited noticeable delays in retrieving items even after they were located. These delays, often caused by bureaucratic hurdles or the inability to locate the staff member holding the item, further erode user trust and increase the likelihood that items will be permanently lost or forgotten.

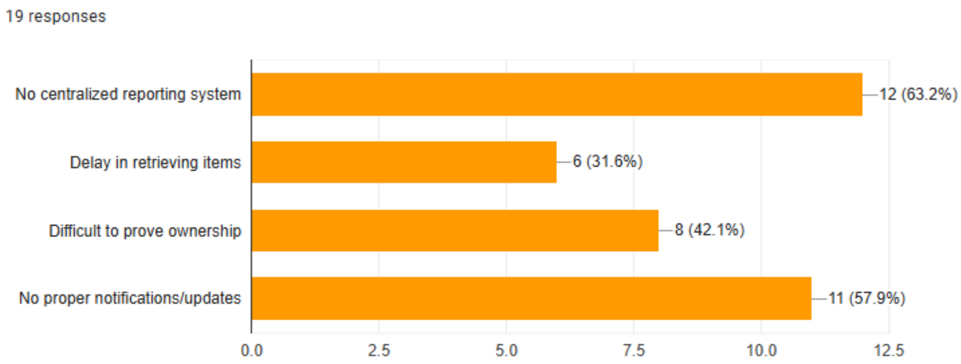


Figure 3.4 Existing Problems Response

Taken together, these deficiencies paint a clear picture of a process that is manual, opaque, and inefficient. They provide a compelling justification for the core purpose of the Qreclaim system: to replace this outdated model with a standardized, transparent, and efficient digital ecosystem that benefits all stakeholders.

3.3.2 Derivation of Functional Requirements

The user feedback strongly validated the proposed feature set of Qreclaim, allowing for the derivation of specific, data-driven Functional Requirements (FRs). These FRs form the blueprint for the system's architecture and development, ensuring every feature addresses an expressed user need or pain point.

FR1 – Centralized Digital Platform

The concept of a unified, online platform for all lost-and-found activities was deemed “Useful” or “Very Useful” (rated 4 or 5) by 84.2% of student respondents (n=16/19, Appendix 2.8, Figure 3.5). This overwhelming support mandates the development of a centralised system that acts as a single source of truth. This requirement directly translates into the creation of two core modules: a User Module for students to report and claim items, and an Admin Module for staff to manage the process, thereby solving the primary pain point of fragmentation.

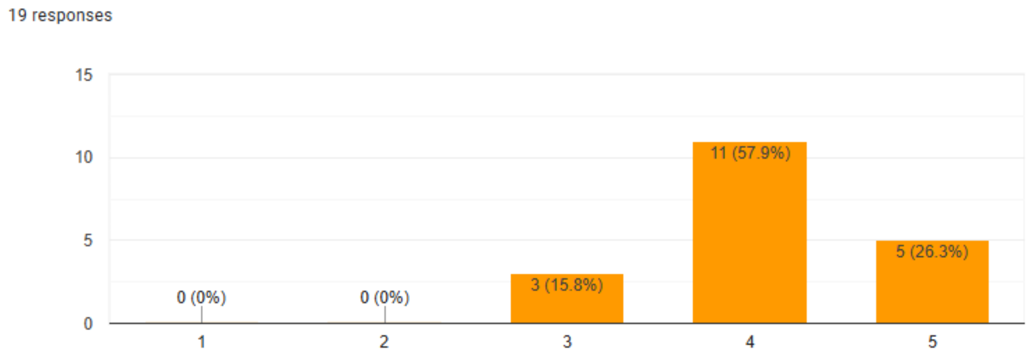


Figure 3.5 Centralized System Important Response

FR2 – Multimedia Support for Item Reporting

Respondents placed high importance on the ability to upload photographs, with 89.4% (n=17/19) rating it a 4 or 5 (mean score ~4.4/5, Appendix 2.9). This functionality is crucial as visual evidence significantly enhances the accuracy of item descriptions, aids owners in identifying their property, and reduces the potential for false claims. Consequently, the Lost and Found Module must be designed with robust image upload capabilities, including client-side cropping and resizing to optimize user experience and server storage, and secure cloud storage for efficient retrieval.

FR3 – Advanced Search and Filtering

An overwhelming 94.7% of student respondents (n=18/19, Appendix 2.10) confirmed a strong preference (answered "Yes") for browsing and searching items by attributes such as category, location, and date. This feedback necessitates the implementation of an advanced, intuitive search interface powered by optimized database queries and indexed metadata. The goal is to minimize the time and effort required for users to locate their lost items, directly addressing the inefficiencies of the current process.

FR4 – Secure, Dual-Factor Claim Verification

The survey revealed strong user demand for a secure claiming process. A significant 89.5% of respondents (n=17/19, Appendix 2.11) agreed or strongly agreed (rated 4 or 5) that claiming items should require a system-generated QR code. Furthermore, 78.9% (n=15/19, Appendix 2.12) expressed a preference for using an RFID student card as a secondary verification factor over facial recognition or having no preference. These responses directly guide the design of the Prototype Kiosk Module, which will implement a dual-factor authentication mechanism

(QR code + RFID) to ensure that only the legitimate owner can claim an item, thereby solving the critical problem of ownership verification.

FR5 – AI-Powered Image Tagging and Matching

The proposed AI-powered features were among the most positively received innovations. AI-based automatic image tagging (e.g., generating tags like "black wallet," "red umbrella") was rated 4 or 5 by 73.7% of respondents (n=14/19, Appendix 2.14, Figure 3.6). Even more compelling, the feature for receiving automatic notifications upon a found item matching a lost report was rated 4 or 5 by 84.2% (n=16/19, Appendix 2.15). This strong validation supports the inclusion of an AI Image Analysis Module for automated tag generation and an AI Tag Matching Module to provide real-time notifications, transforming the system from a passive database into a proactive recovery tool.

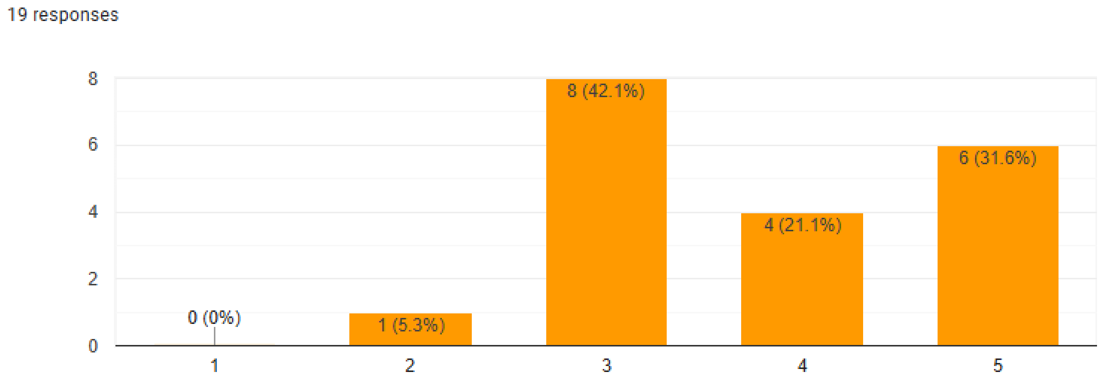


Figure 3.6 AI Feature Response

FR6 – Admin Approval Workflow for Valuables

The concept of requiring administrator approval for high-value items (wallets, electronics, ID cards) received the most unanimous support, with 94.7% of student respondents (n=18/19) rating it 4 or 5 (mean score ~4.4/5, Appendix 2.13). This requirement ensures a differentiated security workflow where such items are placed in a secure holding state. A designated administrator must manually verify the claimant's identity and approve the release within the system before a QR code for claiming is generated. This is implemented within the Lost and Found Module as a crucial additional security layer to protect sensitive and high-value assets.

3.3.3 Derivation of Non-Functional Requirements

Beyond defining what the system should do, the survey identified critical quality attributes that define how well the Qreclaim system must perform. These Non-Functional Requirements (NFRs) establish measurable benchmarks for system design, ensuring it is robust, secure, and user-friendly.

NFR1 – Performance

System responsiveness is a critical user expectation. 65% of all respondents (n=13/20) rated fast system response times (e.g., less than 5 seconds for search or tagging) as “Very Important” (5). When including those who rate it a 4, this importance rises to 90% (n=18/20, Appendix 2.17). This sets a strict performance benchmark that influences key architectural decisions, necessitating the use of caching strategies, optimized database indexing, efficient algorithms, and asynchronous processing for long-running tasks like AI tagging to maintain a snappy and responsive user interface underload.

NFR2 – Security and Data Privacy

Data protection was the highest-rated concern among all quality attributes. 80% of all respondents (n=16/20) rated the protection of personal data (IDs, RFID tags, facial recognition data) as “Very Important” (5), and 95% (n=19/20) rated it a 4 or 5 (Appendix 2.18). These findings mandate a security-first design approach. This includes end-to-end encryption of data in transit (HTTPS), robust hashing with salt for passwords, encryption of sensitive data at rest, adherence to the principle of least privilege through Role-Based Access Control (RBAC), and strict data governance policies to ensure user privacy is paramount.

NFR3 – Reliability and Availability

Users require a dependable system. System reliability (no frequent errors or downtime) was rated “Very Important” (5) by 65% of respondents (n=13/20), and 90% (n=18/20) when including a rating of 4 (Appendix 2.19). Furthermore, 90% of respondents (n=18/20, Appendix 2.20) required the system to be available 24/7, not just during campus operating hours. These requirements justify the need for fault-tolerant architecture. This includes implementing automated monitoring, regular backups, redundant server components, and a clear disaster recovery plan to ensure uninterrupted service and data integrity.

NFR4 – Scalability and Future Expansion

The strong consensus (95%, n=19/20, Appendix 2.21) that Qreclaim should be expanded to other TAR UMT campuses indicates that scalability must be a core design consideration from the outset. The database schema, application programming interface (API) design, and cloud server deployment strategy must all support horizontal scaling (adding more servers) and be designed with a multi-tenant architecture in mind to facilitate cost-effective and efficient future rollouts to other campuses.

NFR5 – Administrative Utility and Insights

The single staff respondent, whose role involves managing lost items, provided critical validation for administrative features. They rated a dashboard with statistics (e.g., most lost items, recovery time) as "Very Useful" (5) (Appendix 2.22) and also rated remote locker management as "Very Important" (5) (Appendix 2.23). They also confirmed that admin approval for valuable items is helpful (Appendix 2.24). While from a single data point, this feedback is vital as it confirms that the proposed Admin Module features align with the practical needs of the staff who will ultimately operate and manage the system, ensuring its long-term operational sustainability.

This comprehensive analysis demonstrates that the Qreclaim system is meticulously designed to address explicitly identified deficiencies through a feature set validated by end-users, while also adhering to stringent quality standards for performance, security, and reliability. This user-centered, data-driven approach forms a solid foundation for the system's subsequent design, implementation, and testing phases.

3.4 Project Scope

The Qreclaim system is specifically developed for use within the TAR UMT Johor Branch campus and is currently designed for two main user groups: students and administrators. The student module allows students to report lost items, view matched found items and verify their claims. The administrator module enables staff to manage to find item records, approve claims for valuable items, and handle locker management. At this stage of development, administrators do not have access to student module functions, as the system is intentionally separated to maintain clear role boundaries. However, future enhancements are planned to introduce extended administrative access and additional integrated functions that could support more efficient oversight and improve the overall usability of the platform.

Figure 3.4.1 illustrates the Qreclaim System Hierarchy Chart, and Figure 3.4.2 presents the Qreclaim Use Case Diagram, which together defines the overall functional scope of the project.

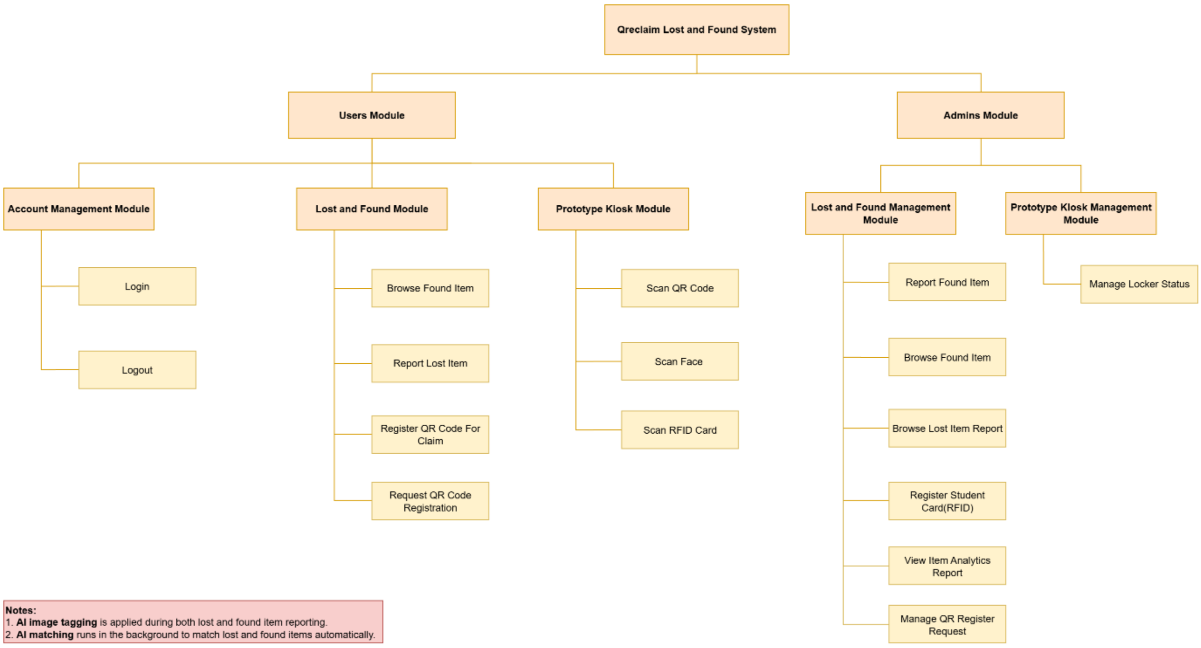


Figure 3.4.1 Qreclaim System Hierarchy Chart

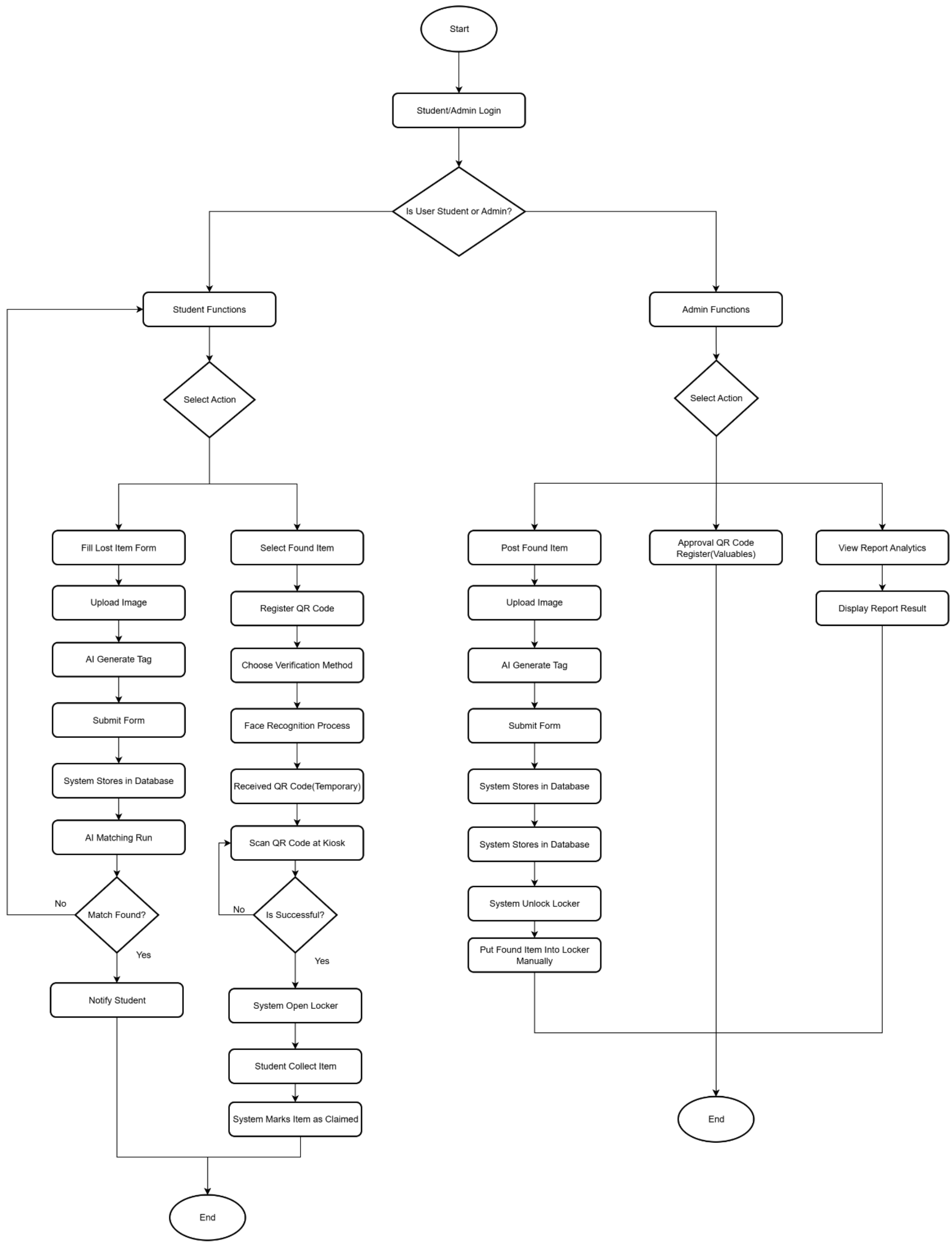


Figure 3.4.2 Qreclaim System Hierarchy Chart

3.5 Software Requirements Specification (SRS)

The Software Requirements Specification (SRS) is a formal document that defines what the system is expected to do and the conditions under which it must operate. It provides a detailed description of both the functional requirements, which specify the features and services the system must provide, and the non-functional requirements, which outline the quality attributes such as performance, security, usability, and reliability. The purpose of the SRS is to serve as a clear agreement between stakeholders, developers, and users, ensuring that the system is developed according to the intended objectives and meets the needs of its users.

3.5.1 Functional Requirement

The functional requirements of the Qreclaim system are derived from its hierarchical architecture, which consists of both user-facing and administrative modules. Each module provides specific capabilities that collectively ensure a structured, intelligent, and secure lost-and-found process within the campus environment.

A. Users Module

1. Account Management Module

The Account Management Module governs access to the system. When users (students or staff) launch the Qreclaim web application, they are presented with a secure login interface. They must enter their institutional credentials (student or staff ID and password) which are authenticated against the Firebase Authentication service. Upon successful verification, users gain access to the system dashboard based on their role. At the end of their session, users can log out to terminate their access. This process ensures that unauthorized individuals cannot access sensitive data or submit fraudulent reports.

2. Lost and Found Module

The Lost and Found Module forms the core of the system, allowing students to report and track misplaced items while also managing the process of reclaiming them. When a student loses an item, they complete a structured “Lost Item Report” form that captures key details such as the item name, category, location, and an optional photo. Similarly, when an item is found, a “Found Item Report” is submitted with supporting details and images, ensuring that all entries are stored in real-time through Firebase and visible to other users. Students can also browse categorized records of lost and found items, applying filters such as category, location, or date to simplify the search process.

The Lost and Found Module forms the core of the system, allowing students to browse, report, and reclaim items. Students are able to browse all available found items that have been posted by administrators, with the option to apply filters such as category, location, or date to narrow down the results and simplify their search process. When a student loses an item, they can use the “Report Lost Item” function to fill in the required information through a structured form, including details such as item name, category, and location. Once submitted, the report is sent to administrators, who will assist in checking records and notifying the student if a matching found item is identified.

A key feature of this module is the ability to register a QR code for item claiming. The QR code acts as a digital token that links a student to a specific claim request and is mandatory for retrieval at the prototype kiosk. The registration process, however, differs depending on whether the item is categorized as valuable or non-valuable:

For non-valuable items (e.g., stationery, umbrellas, water bottles), students can directly register a QR code after confirming their intent to claim. During this process, the system requires the student to first complete a facial recognition check, which serves as an initial verification step. Once their face is verified, they are prompted to select their preferred second verification method either RFID student card scanning or facial recognition which will be used later at the kiosk for completing the dual verification process. After these steps, the QR code is successfully generated and stored in the student’s profile.

For valuable items (e.g., wallets, electronics, student ID cards), the QR registration process requires additional approval. When a student attempts to register a QR code for such items, the request is automatically sent to an administrator for review. The administrator evaluates the claim based on the available records and supporting details. Only after the administrator grants approval can the student proceed with QR code registration. As with non-valuable items, the student must still complete the facial recognition step and select a preferred second verification method (RFID or face recognition) before the QR code is generated.

This distinction between valuable and non-valuable items ensures that higher-value possessions receive stricter oversight, while common items can still be reclaimed efficiently. Regardless of the category, the QR registration process guarantees that every claim is tied to a verified identity and a preselected verification method, thereby ensuring security and accountability at the kiosk.

3. Prototype Kiosk Module

The Prototype Kiosk Module provides secure item claim verification through a dual-factor authentication process. When a student arrives at the kiosk to retrieve their item, they must first present their QR code for scanning. The system validates the QR code and retrieves the student's chosen verification method, which was specified during QR registration. The student then completes the second step of verification using either facial recognition or RFID student card scanning, depending on the option they selected earlier.

- **Facial Recognition Path**: The kiosk camera captures a live image of the student and compares it to the registered facial template. If the match is successful, the claim process continues.
- **RFID Path**: The student taps their registered RFID enabled student card on the kiosk reader. The card ID is verified against the student's profile in the database.

Only when both steps are successfully completed will the system instruct the kiosk locker to unlock and release the stored item. This process ensures that items are claimed only by their rightful owners, with every transaction logged securely for accountability.

B. Admins Module

1. Lost and Found Management Module

The Lost and Found Management Module equips administrators with tools for monitoring and controlling the system. When campus staff or security personnel submit found items, administrators verify the submissions and may attach additional details if needed. Administrators can browse both student-submitted lost item reports and existing found item records, allowing them to quickly cross-check and identify potential matches. They are also responsible for managing QR register requests by reviewing and approving or rejecting applications for valuable item claims.

In addition, administrators are responsible for registering student RFID cards into the system to support future claim verifications. Beyond item management, administrators have access to a dashboard that provides analytics on lost-and-found trends, such as the most frequently misplaced items, average recovery times, and unclaimed item statistics. This data supports informed decision-making, for example, planning awareness campaigns or optimizing storage space. These combined capabilities ensure administrators can maintain a well-organized, secure, and efficient lost-and-found process.

2. Prototype Kiosk Management Module

The Prototype Kiosk Management Module allows administrators to oversee the physical kiosk lockers. They can remotely view locker availability, assign lockers to specific found items, and monitor locker usage. In cases of technical issues or disputes, administrators may manually override the system to lock or unlock a locker. These controls ensure that items are stored securely until retrieval and that the kiosk infrastructure remains reliable and tamper resistant.

C. AI Features

1. AI Image Tagging

The AI Image Tagging feature is applied during both student lost item reporting and administrator found item reporting. When an image is uploaded, the system prompts the user to crop the photo to focus on the object of interest. The cropped image is then analyzed by the BLIP model, which automatically generates descriptive AI tags (e.g., “red water bottle,” “black wallet,” “blue umbrella”). These tags are stored as metadata in the database and linked to the item record. Users can review, add, or remove tags to ensure the description is accurate before submission. This process standardizes item descriptions and improves searchability for faster matching.

2. AI Matching

The AI Matching feature intelligently links lost and found records by comparing their generated tags. Each time a new report is submitted, the system performs a similarity comparison between the new record and existing records using semantic matching techniques. For example, if a student reports a “black wireless mouse,” the system will search for found item records with similar tags and calculate a similarity score. If a strong match is detected, the student receives a notification with the potential match details, enabling them to verify the result and proceed with QR code generation for claiming.

3.5.2 Non-Functional Requirement

Non-functional requirements (NFRs) specify the quality attributes that define how a system performs its functions rather than what the functions are. Unlike functional requirements, which describe specific tasks such as item reporting or claim verification, NFRs determine the overall system qualities such as reliability, security, usability, and scalability. These attributes are particularly critical for Qreclaim, as the system is expected to handle sensitive student data and support AI-powered services like automated tagging and RFID verification. The following NFRs are essential to ensure Qreclaim meets both user expectations and institutional standards.

Performance

Performance is a key requirement for Qreclaim, as both students and administrators expect the system to deliver fast and seamless interactions. When reporting or searching for lost and found items, delays can cause frustration and reduce system adoption. Specifically, AI-powered image tagging, which automatically extracts metadata from uploaded item images, must be executed within a few seconds to provide real-time feedback. Similarly, database queries for lost and found matching should return results quickly, even as the number of records increases over time. If the system takes too long to respond, users may perceive it as inefficient, which can directly reduce trust and usability. Therefore, Qreclaim must be optimized at both the application and database layers to ensure consistent performance.

Usability

Usability is crucial because the system targets a wide range of students, some of whom may not possess advanced technical skills. The interface of Qreclaim must be designed to be intuitive, with straightforward navigation and minimal learning effort. For example, the web platform should allow students to report or search for items in just a few steps, while the prototype kiosk must provide clear step-by-step instructions during claim verification using RFID or facial recognition. Prior studies confirm that usability directly impacts adoption rates in university service systems, where poorly designed interfaces discourage participation (Nielsen, 2012). By adhering to usability heuristics and prioritizing a user-centered design, Qreclaim can ensure inclusivity and encourage consistent usage.

Reliability

Reliability ensures that Qreclaim consistently delivers its services without frequent errors, crashes, or data loss. Since the system is expected to store critical records of lost and found items, students must be confident that their data will not be corrupted or lost due to technical failures. The AI tagging module, RFID verification, and facial recognition components must operate with high accuracy and consistency, as even small errors could lead to wrongful claim approvals or unclaimed items. As emphasized in software engineering literature, reliability builds user trust and is one of the most important attributes of institutional systems that handle sensitive processes (Avizienis et al., 2004). Consequently, Qreclaim must implement thorough error handling, redundancy, and robust testing strategies to achieve this requirement.

Security

Security is one of the most critical attributes for Qreclaim, as it processes personal and sensitive data such as student IDs, face recognition profiles, and contact details. To prevent misuse or unauthorized access, the system must enforce strict authentication, access control, and encryption policies. For instance, claim verification must ensure that only the rightful owner of an item can retrieve it, whether through RFID scanning or facial recognition. As universities are often targets of data breaches, adherence to data protection principles such as confidentiality, integrity, and availability is mandatory (Shamala et al., 2017). By incorporating secure coding practices and compliance with relevant data protection regulations, Qreclaim can safeguard student information while maintaining trust and institutional credibility.

Maintainability

Maintainability refers to the ease with which Qreclaim can be updated, modified, or extended in the future. Since the system includes multiple components such as the student module, admin module, and AI tagging module, its architecture must be modular and well-documented. This will enable future developers to implement improvements, fix issues, or integrate new technologies without causing disruptions. Maintainability is also a critical factor in reducing the long-term cost of software ownership, as systems that lack modularity are harder to adapt to evolving requirements. For Qreclaim, maintainability ensures that the system remains sustainable and adaptable even after the initial deployment.

Scalability

Scalability is essential because Qreclaim was initially designed for TAR UMT Johor campus but has the potential to expand to other branches of the university. As more students, staff, and lost-and-found records are added to the system, its performance and reliability must not degrade. For example, the database must support a growing volume of records, while AI tagging should remain efficient as more images are processed daily. Studies confirm that scalability is fundamental for systems in educational institutions, as they often evolve from small-scale deployments to larger, multi-campus environments (Almorsy, Grundy, & Müller, 2016). By designing Qreclaim with scalability in mind, the system can support both current and future institutional needs without requiring major redesign.

Availability

Availability ensures that Qreclaim is accessible whenever users need it, particularly during university operational hours when students are most likely to report or search for items. Downtime can disrupt the lost-and-found process, leading to unclaimed items and reduced trust in the system. The web platform should achieve high uptime with mechanisms for fault tolerance and recovery in the event of system failures. As noted in research on availability engineering, even short downtimes can significantly affect user satisfaction and institutional operations (Torres et al., 2017). By prioritizing high availability, Qreclaim guarantees continuous service delivery and reinforces reliability for students and administrators alike.

3.6 Chapter Summary and Evaluation

This chapter presented the methodology and requirements analysis that form the foundation of Qreclaim’s development. The project adopts the Incremental Software Development Model, which breaks the development process into multiple, manageable increments rather than a single release. Each increment delivers a subset of system features, starting with essential components such as user and admin account management, structured lost-and-found reporting, and search and browsing functions. Subsequent increments focus on AI-powered features such as image tagging and similarity matching, followed by prototype kiosk integration for secure claim verification. This phased approach enables early release of core functionality, continuous requirement validation, iterative refinement, and timely risk mitigation—an essential strategy for a time-constrained academic project.

The chapter also introduced a detailed Software Requirements Specification (SRS) that formally defines what Qreclaim must achieve and the conditions under which it will operate. The functional requirements were organized into clear modules for both students and administrators. For students, the system provides secure login/logout, the ability to submit lost item reports with image uploads and AI-generated tags, browse and filter items using advanced search options, and register QR codes to claim items. Distinct workflows are implemented for valuable and non-valuable items, with valuable items requiring administrator approval before QR code generation. Verification at the prototype kiosk uses dual-factor authentication, allowing students to validate ownership through QR code scanning and either RFID card verification or facial recognition.

For administrators, the functional requirements specify key capabilities including posting found item reports with AI-generated tags, verifying and approving item records, managing QR register requests for valuables, assigning lockers, registering RFID cards, and monitoring claim activity. An analytics dashboard provides statistics such as the most frequently lost items and average claim times, while locker management functions enable remote control and manual override of the kiosk when required. Together, these features create a secure, structured, and transparent process for managing lost-and-found operations on campus.

The non-functional requirements complement the functional aspects by focusing on critical quality attributes. Performance expectations include fast system response (<5 seconds), optimized database queries, and real-time synchronization through Firebase. Usability requirements ensure that both the web interface and kiosk remain intuitive and user-friendly, lowering the learning curve for students. Reliability and availability requirements emphasize fault tolerance, automated backups, and 24/7 access to ensure data integrity and minimal downtime. Security requirements enforce strict authentication, encryption, and role-based access control (RBAC) to protect sensitive data such as student IDs, RFID tags, and facial recognition records. Scalability and maintainability are also prioritized to support future expansion to other campuses and ensure the system remains adaptable to evolving needs.

In conclusion, this chapter translates the findings from fact-finding and questionnaire analysis into a well-defined set of functional and non-functional requirements. The adoption of the incremental model ensures progressive delivery, early user feedback, and continuous improvement, which are crucial for a multi-feature solution like Qreclaim. The comprehensive SRS serves as a shared reference point for all stakeholders, minimizing ambiguity and aligning expectations. By clearly defining both the system's capabilities and quality standards, this chapter lays a solid groundwork for the design and implementation phases, ensuring Qreclaim is developed systematically and remains aligned with user needs and institutional objectives.

Chapter 4

System Design

4 System Design

In this phase, all analyzed system requirements will be transformed and visualized as several types of diagrams not only to help the development team for better understanding but also document readers. This chapter covers Software Architecture Design, Process Design, Data Design, Security Design, Report Design, and User Interface Design.

4.1 Software Architecture Design

Figure 4.1 shows the updated software architecture design of Qreclaim, which adopts a modular, layered approach to ensure scalability, maintainability, and security while fulfilling the functional requirements of the system. The architecture follows a three-tier structure comprising the Presentation Layer, Application Layer, and Data Layer, all connected via a RESTful API built with Flask. This layered design enforces a clear separation of concerns, simplifies debugging, and supports future enhancements such as improved AI matching, mobile application integration, or additional verification mechanisms.

The Presentation Layer consists of two primary components: the Student/Admin Web Browser and the Prototype Kiosk. The web browser provides a responsive interface for students and administrators to report lost and found items, generate QR codes, manage claims, and monitor system activity. The Prototype Kiosk is designed to handle in-person claim verification by sending verification requests, such as RFID scans or facial recognition data, to the backend. All communication between this layer and the Flask API is secured via HTTPS, protecting sensitive user data during transmission.

The Application Layer is the core of the system and is powered by the Flask API. It handles all incoming HTTPS requests, applies server-side validation, and coordinates communication between the front end and the database. This layer is organized into several key modules:

- **Login Authentication** – Handles user login by validating credentials directly against Firestore collections, without relying on Firebase Authentication.
- **Session Management** – Maintains user sessions securely, ensuring that only authenticated users can access protected resources.
- **Users Module** – Manages user profiles, including registration, updates, and access control.
- **Admins Module** – Provides administrators with management tools for overseeing reports, claims, and system operations.

- **AI Tagging and Matching Features** – Uses AI models to automatically generate descriptive tags for found items and match them with reported lost items, reducing manual workload and improving efficiency.
- **Notification Module** – Sends alerts to users when item matches are found or claim statuses are updated, improving user engagement and response time.

The Data Layer is implemented using Firebase Firestore, a cloud-hosted NoSQL database. It stores structured data for users, lost and found items, claims, and system logs. Firestore's real time update capability ensures that any data changes, such as new item postings or claim status updates, are immediately reflected in the web interface, creating a seamless user experience. All read and write operations are routed through the Flask API to ensure centralized access control and data validation.

Overall, this architecture is designed to be modular, secure, and scalable. Its clear separation of layers allows easy maintenance and future feature expansion, while its use of Flask as the API gateway ensures consistent request handling. By integrating AI-powered tagging, matching, and notification features, Qreclaim provides an efficient, intelligent, and user-friendly platform for automating TAR UMT Johor's lost-and-found process.

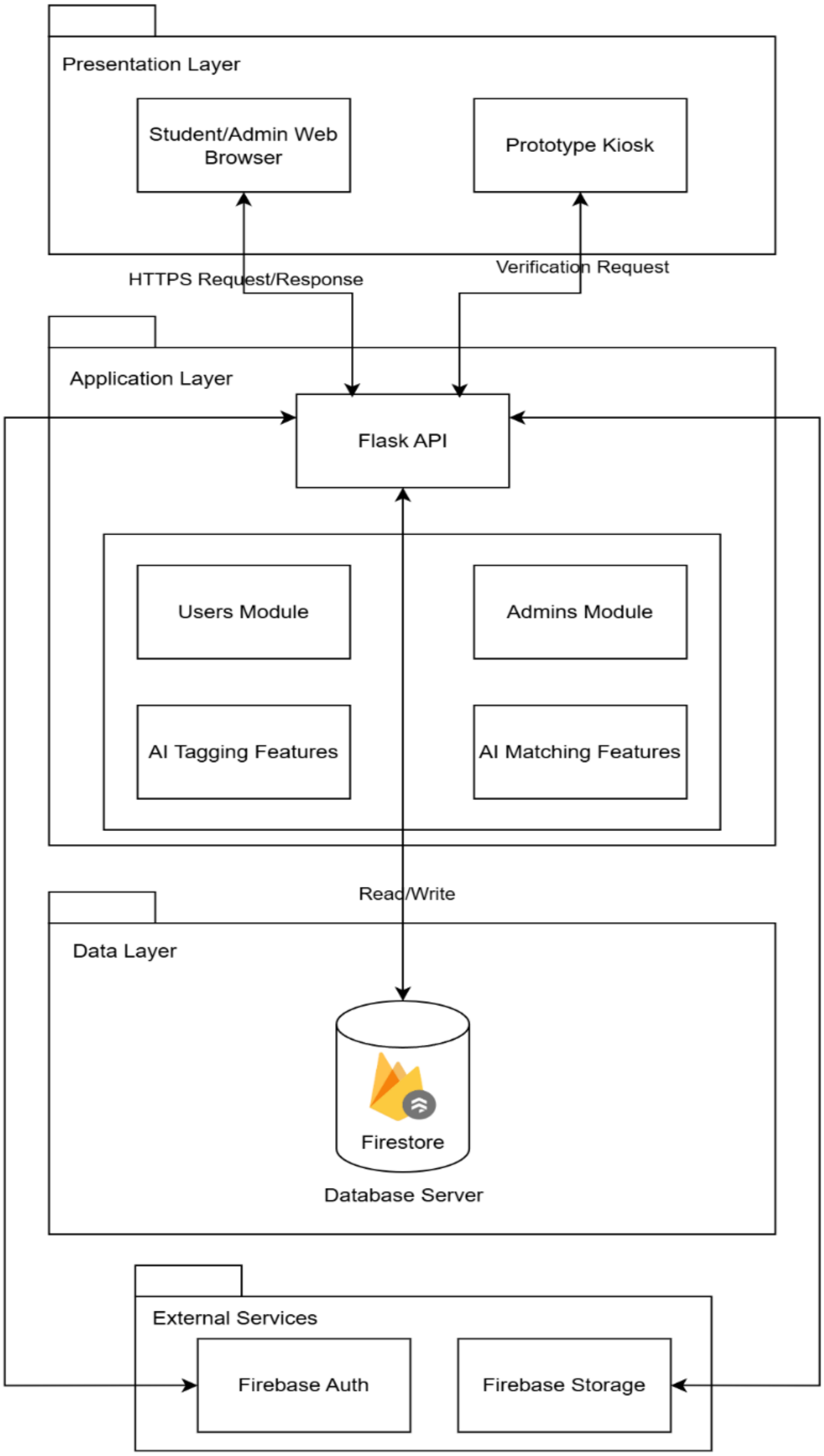


Figure 4.1 Software Architecture Diagram

4.2 Use Case Diagram

The use case diagram (Figure 4.2) illustrates the main interactions between users and the Qreclaim system. It identifies the primary actors, including students and administrators, and shows the key functions they can perform such as reporting lost items, posting found items, generating and scanning QR codes, verifying claims using RFID or facial recognition, and managing item records. This diagram provides a high-level overview of the system's functionality and ensures that all user requirements are addressed during development.

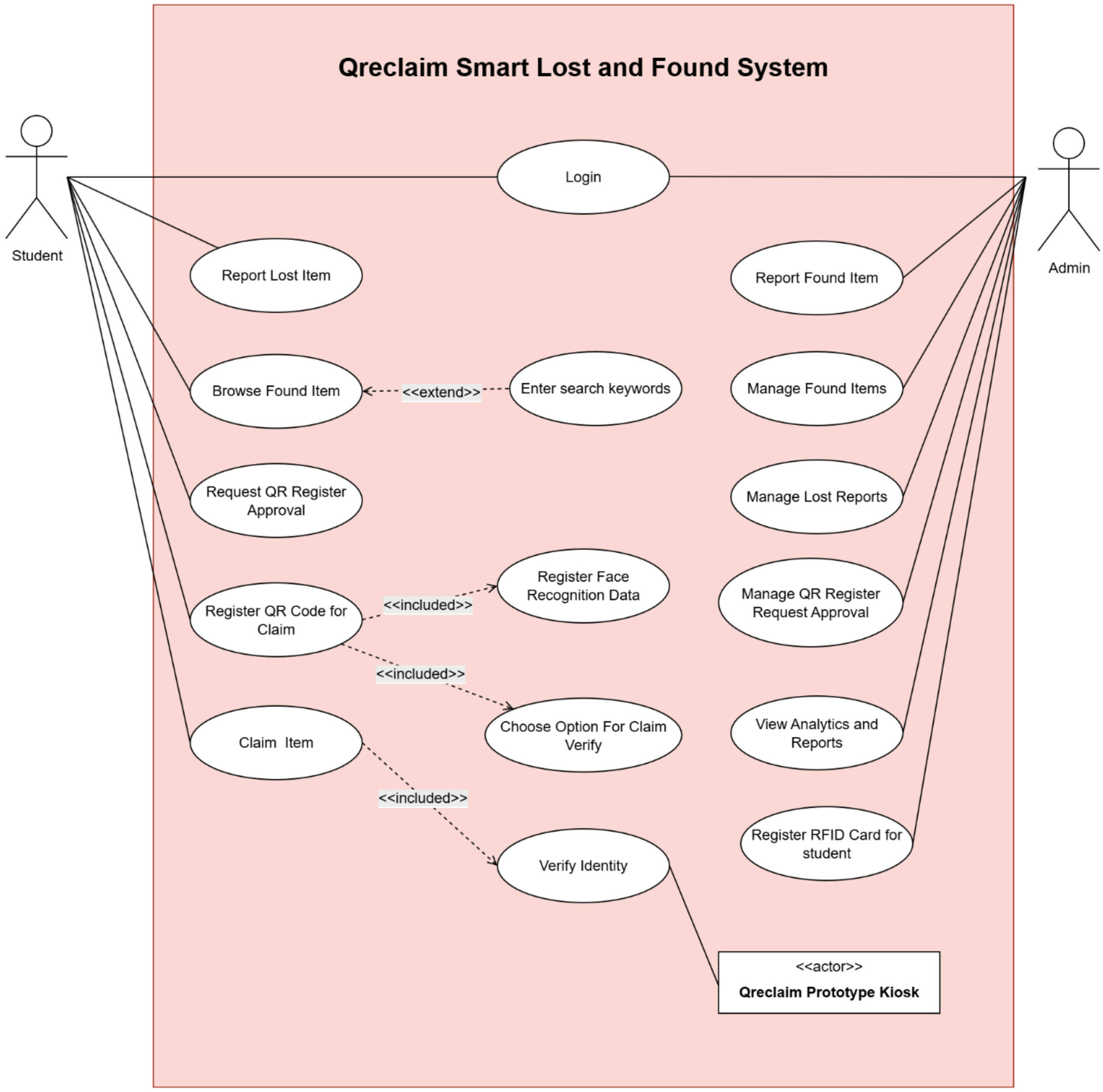


Figure 4.2 Use Case Diagram of Qreclaim

4.2.1 Use Case Description

A use case description is a textual representation that details how different actors interact with the system to achieve specific objectives. It outlines the preconditions, triggers, step-by-step interactions, alternative flows, and postconditions associated with each function. While the use case diagram provides a visual overview of the system, the use case description explains the processes in greater depth by capturing the logical sequence of actions and outcomes. In the context of Qreclaim, the use case descriptions illustrate the complete working flows of the system, such as reporting a lost item, submitting a found item, verifying claims through RFID or facial recognition, and managing locker storage. By documenting these flows, the use case descriptions provide a clear understanding of how Qreclaim supports both students and administrators in streamlining the lost-and-found process. The following tables present the use case descriptions for each main function of the system.

Table 4.1 Use case of Login

<table>
<tr><td colspan="2">Name of Use Case: Login</td></tr>
<tr><td colspan="2">Brief Description: This module allows user enters their ID and password to access the system. The system validates credentials and grants access to their respective dashboard (student or admin).</td></tr>
<tr><td colspan="2">Actors: Student, Admin</td></tr>
<tr><td colspan="2">Precondition: User must be registered in the system.</td></tr>
<tr><td>Actor Action</td><td>System Response</td></tr>
<tr><td>2. Actor enters their id and password.</td><td>1. System displays the login page with the login form.
3. System validates information.
4. System redirects the actor to respective dashboard.</td></tr>
<tr><td colspan="2">Alternative Flow:
A1. Step 3: If Actor enters an invalid information or leaves input fields empty then system will prompt the error messages.</td></tr>
<tr><td colspan="2">Postcondition: User is successfully logged in or receives an error message for invalid credentials.</td></tr>
</table>

Table 4.2 Use case of Report Lost Item

<table>
<tr><td colspan="2">Name of Use Case: Report Lost Item</td></tr>
<tr><td colspan="2">Brief Description: This module allows students to report their lost item to admin.</td></tr>
<tr><td colspan="2">Actors: Student</td></tr>
<tr><td colspan="2">Precondition: Student must be logged in. Student must have an image of their lost item.</td></tr>
<tr><td>Actor Action</td><td>System Response</td></tr>
<tr><td>1. Student clicks on “Report Lost Item” button.
3. Student fills up the detail’s information of lost item.
4. Student uploads the image of the lost item (mandatory).
7. Student may delete unwanted tags or add new custom tags but must keep at least one tag before submission.
8. Student check and submits the report.</td><td>2. System navigates and displays the form with required fields (item name, description, date, location, image upload).
5. System runs AI image tagging and generates a set of suggested tags
6. System displays the auto-generated tags to student.
9. System saves the lost item record with image, description, and final tag list.</td></tr>
<tr><td colspan="2">Alternative Flow:
A1. Step 3: Student must fill up all the required field before submitting the form.</td></tr>
<tr><td colspan="2">Postcondition: Lost item record is created in the database.</td></tr>
</table>

Table 4.3 Use case of Browse Found Item

<table>
<tr><td colspan="2">Name of Use Case: Browse Found Item</td></tr>
<tr><td colspan="2">Brief Description: This module allows students to view all found items in the system and use search/filter features.</td></tr>
<tr><td colspan="2">Actors: Student</td></tr>
<tr><td colspan="2">Precondition: Student must be logged in.</td></tr>
<tr><td>Actor Action</td><td>System Response</td></tr>
<tr><td>1. Student clicks on “Browse Found Item” button.
3. Student enters some criteria and filter by category, date, etc.
5. Student clicks an item to view full details.</td><td>2. System navigate and displays all available found items posted by admin.
4. System filters and display all available found items based on criteria.</td></tr>
<tr><td colspan="2">Alternative Flow: -</td></tr>
<tr><td colspan="2">Postcondition: System displays a list of found items matching criteria.</td></tr>
</table>

Table 4.4 Use case of Request QR Register Approval

Name of Use Case: Request QR Register Approval	
Brief Description: This module allows students to send QR register request for get the QR register permission for valuables.	
Actors: Student, Admin	
Precondition: Student must be logged in and navigated to found item details page that is marked as a valuables item.	
Actor Action	**System Response**
1. Student clicks on "Request Approval" button. 3. Student enters the information that can proof found item belong to them and submit.	2. System display a remark input box for student to provide proof that the item belongs to them. 4. System validates the input and store the request in the database and mark the request as Pending. 5. System display a successful message to students and send to admin for approval. 6. Admin approval the request and student get the notification.
Alternative Flow: A1. Step 3: If student leave the input field empty, the system will prompt error messages.	
Postcondition: Students can register QR code for valuables item.	

Table 4.5 Use case of Register QR Code for Claim

Name of Use Case: Register QR Code for Claim	
Brief Description: This module allows students to generate and register a QR code containing their student ID and face recognition data for self-claim back lost item.	
Actors: Student	
Precondition: Student must be logged in and click to view the item details page. If the item is valuables, student must pass by User case of Request QR Register Approval.	
Actor Action	**System Response**
1. Student clicks "Register QR Code for Claim" button. 3. Student makes confirm. 5. Student chooses the option.	2. System prompts out a confirmation messages box.

7. Student scan and registers face data.	4. System display an option box for student to choose verification method (e.g., face recognition registration). 6. System display a face recognize box to capture user face data. 8. System generate a temporary QR code to student.
Alternative Flow: A1. Step 3: If student click no, then close the QR register window.	
Postcondition: Student get a temporary QR code and able to scan for collect the item.	

Table 4.6 Use case of Claim Item

Name of Use Case: Claim Item	
Brief Description: This module allows students to claim a found item using QR code and identity verification at the prototype kiosk.	
Actors: Student	
Precondition: QR code must be registered.	
Actor Action	**System Response**
1. Student scans QR code at prototype kiosk. 4. Student completes the double verifications. 7. Student collects the found item.	2. System reads the student's QR code data. 3. System prompts the double verification method (student have been chosen when register QR) and required student inputs. 5. System validate all the information 6. System unlocks the locker.
Alternative Flow: A1. Step 4: If student fail the double verification, system retry maximum 3 times, after that invalid the QR code and end the process.	
Postcondition: Student successful collect the item from the locker.	

Table 4.7 Use case of Report Found Item

Name of Use Case: Report Found Item	
Brief Description: This module allows admin to record items that have been found and stored in the locker.	
Actors: Admin	
Precondition: Admin must be logged in	
Actor Action	**System Response**
1. Admin clicks "Report Lost Item" button. 3. Admin fills up the detail's information of found item. 4. Admin uploads the image of the lost item (mandatory). 7. Admin may delete unwanted tags or add new custom tags but must keep at least one tag before submission. 8. Admin checks and submits the form.	2. System displays a form with required fields (item name, description, date, location, image upload). 5. System runs AI image tagging and generates a set of suggested tags 6. System displays the auto-generated tags to student. 9. System saves the lost item record with image, description, and final tag list.
Alternative Flow: A1 – Step 9: After submitting and store the report found data in the system, if found any record that got the high similarity with the lost item that student posted, the system will send the notification to user.	
Postcondition: Found item record is saved to database and locker is updated as occupied.	

Table 4.8 Use case of Manage Found Items

Name of Use Case: Manage Found Items	
Brief Description: This module allows admin to search, filter, edit, or delete found items they reported.	
Actors: Admin	
Precondition: Admin must be logged in.	
Actor Action	**System Response**
1. Admin click on "Manage Found Items" button. 3. Admin searches/filters to find a specific item with enter the criteria. 5. Admin clicks item to view or edit details.	2. System navigates to "Manage Found Items" page and displays list of all found items. 4. System display the result based on criteria. 6. System updates information and saves changes.

<table>
<tr><td>Alternative Flow: -</td></tr>
<tr><td>Postcondition: Selected item is updated or removed.</td></tr>
</table>

Table 4.9 Use case of Manage Lost Reports

<table>
<tr><td colspan="2">Name of Use Case: Manage Lost Reports</td></tr>
<tr><td colspan="2">Brief Description: This module allows admin to view all reported lost items, mark them as matched, or close reports when item is claimed.</td></tr>
<tr><td colspan="2">Actors: Admin</td></tr>
<tr><td colspan="2">Precondition: Admin must be logged in. Student have been posted the lost item report.</td></tr>
<tr><td>Actor Action</td><td>System Response</td></tr>
<tr><td>1. Admin clicks on "Manage Lost Reports" buttons.
3. Admin selects a report to view details.
5. Admin can update status (pending, matched, closed).</td><td>2. System navigates to “Manage Lost Reports” page and displays all lost item reports.
4. System display the selected lost item report details.
6. System update the selected lost item report status.</td></tr>
<tr><td colspan="2">Alternative Flow: -</td></tr>
<tr><td colspan="2">Postcondition: Lost report status is updated.</td></tr>
</table>

Table 4.10 Use case of Manage QR Register Request Approval

<table>
<tr><td colspan="2">Name of Use Case: Manage QR Register Request Approval</td></tr>
<tr><td colspan="2">Brief Description: This module allows admin verifies claim requests and approves or rejects them.</td></tr>
<tr><td colspan="2">Actors: Admin</td></tr>
<tr><td colspan="2">Precondition: Student must have submitted the QR register request. Admin must be logged in</td></tr>
<tr><td>Actor Action</td><td>System Response</td></tr>
<tr><td>1. Admin click on "Manage QR Requests" button.
3. Admin manually verifies student’s identity proof and click approval.
5. Admin makes confirm.</td><td>2. System navigate to “Manage QR Requests” page and displays all pending approve QR request.
4. System prompt a confirmation messages.
6. System approval the student QR register request.</td></tr>
<tr><td colspan="2">Alternative Flow:</td></tr>
</table>

A1. Step 5: If admin click no, then go back to Step 2.
Postcondition: QR register request status is updated, and student is notified**.**

Table 4.11 Use case of View Analytics and Reports

Name of Use Case: View Analytics and Reports	
Brief Description: This module allows admin to view dashboard statistics and generate reports (e.g., number of lost items, claim success rate).	
Actors: Admin	
Precondition: Admin must be logged in	
Actor Action	**System Response**
1. Admin clicks on "View Report Analytics" button. 3. Admin select the graphs or statistics they want to export.	2. System navigates to “View Report Analytics” page then generates and display the graphs and statistics. 4. System export the selected as the reports.
Alternative Flow: -	
Postcondition: Reports are displayed or exported.	

Table 4.12 Use case of Register RFID Card for Student

Name of Use Case: Register RFID Card for Student	
Brief Description: The module allows admin to register the RFID card to student.	
Actors: Admin	
Precondition: Student must be registered. RFID and RFID writer/reader was prepared.	
Actor Action	**System Response**
1. Admin click on "Register RFID" button. 3. Admin select the student id that want to register	2. System navigates to “Register RFID” page and display all the available student in list. 4. System prompt admin to tap the RFID at the reader. 4. System write the data into RFID card and update the data in the system.
Alternative Flow: -	
Postcondition: RFID card ID is saved to student profile.	

4.2.2 Activity Diagram

The activity diagram shows the sequence of actions and decision points that take place within the Qreclaim system. It maps out how processes are carried out step by step, including the flow of activities, the conditions that guide different paths, and the outcomes of each process. In Qreclaim, the activity diagram represents workflows such as reporting a lost item, submitting a found item, verifying a claim, and storing items in lockers. This helps to clearly illustrate how the system operates and how each function progresses from start to finish. The following figures present each activity diagram to illustrate how these processes are executed within the system from start to finish.

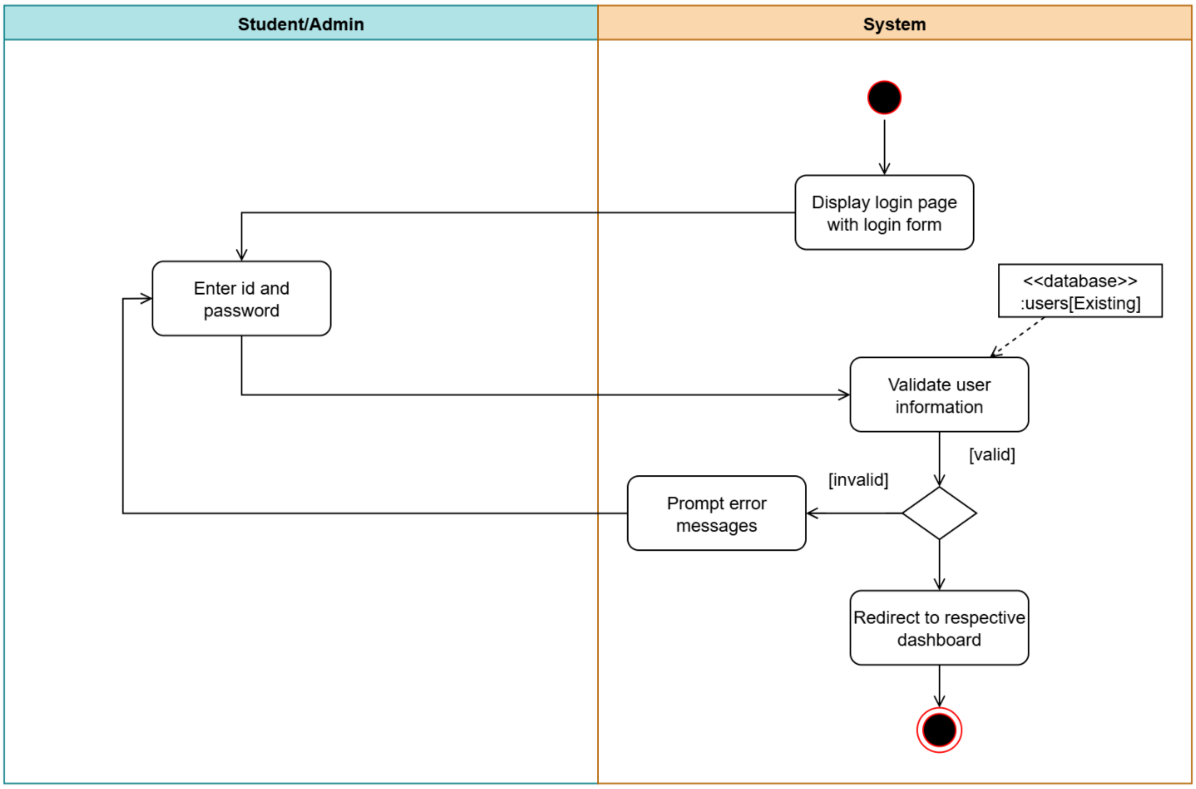


Figure 4.3 Activity Diagram for Login

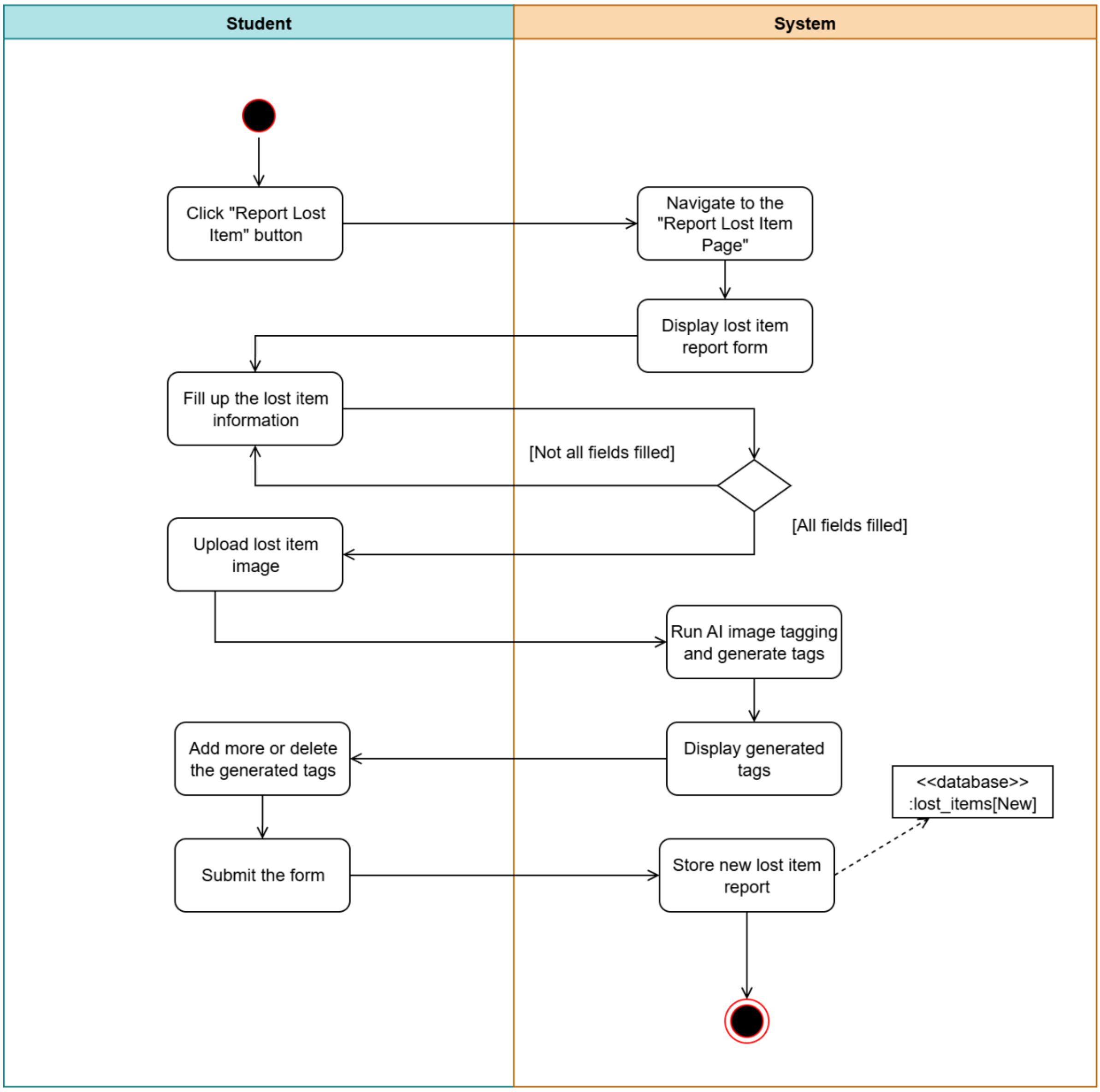


Figure 4.4 Activity Diagram for Report Lost Item

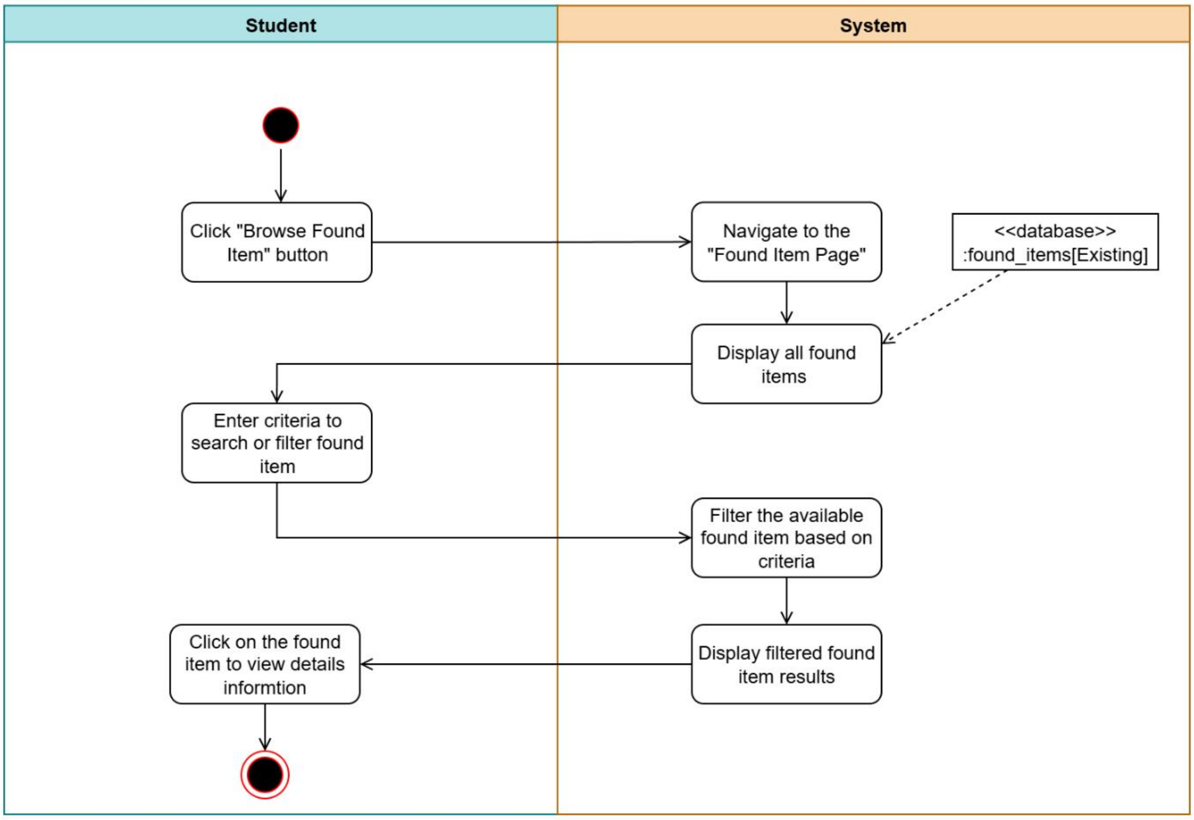


Figure 4.5 Activity Diagram for Browse Found Item

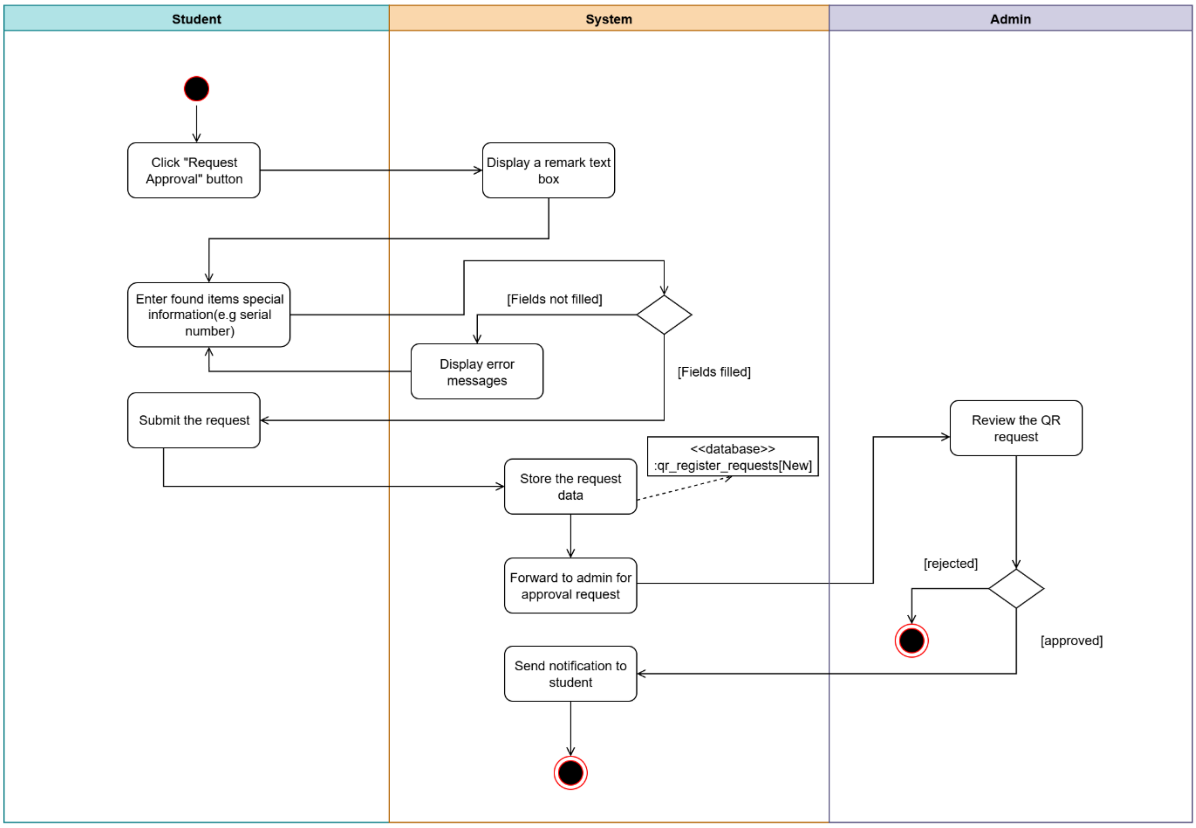


Figure 4.6 Activity Diagram for Request QR Register Approval

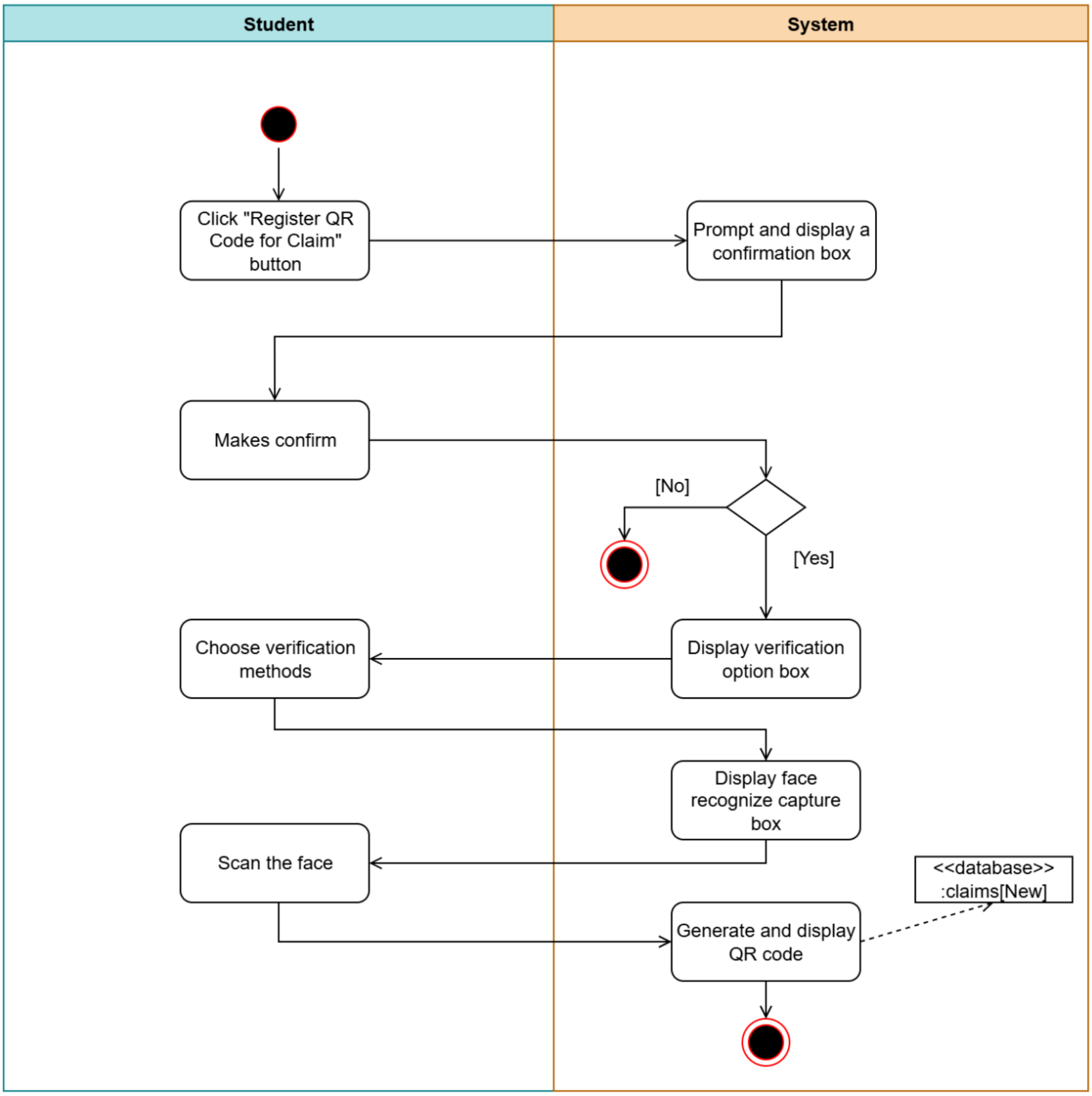


Figure 4.7 Activity Diagram for Register QR Code for Register QR Code for Claim

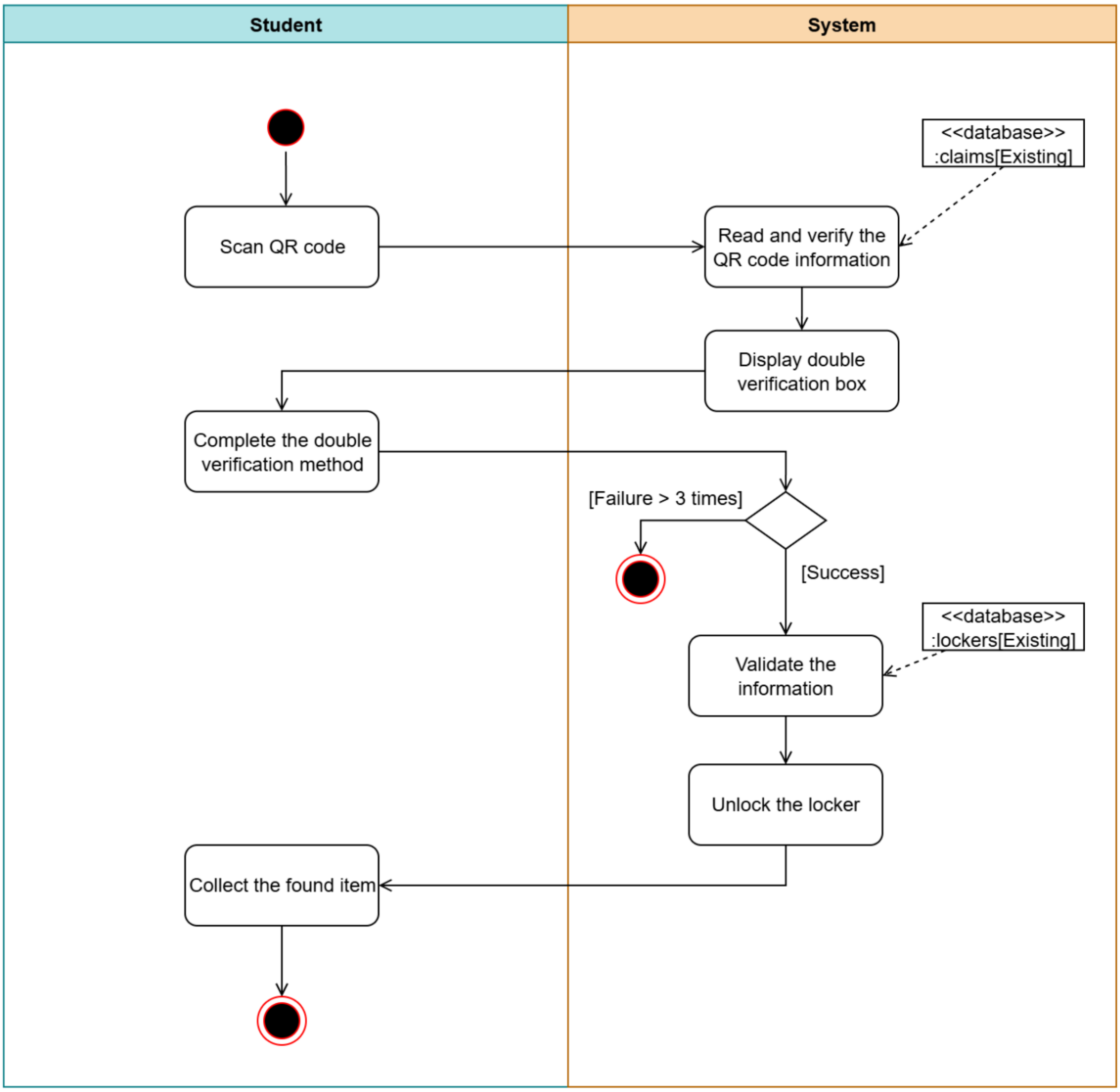


Figure 4.8 Activity Diagram for Claim Item

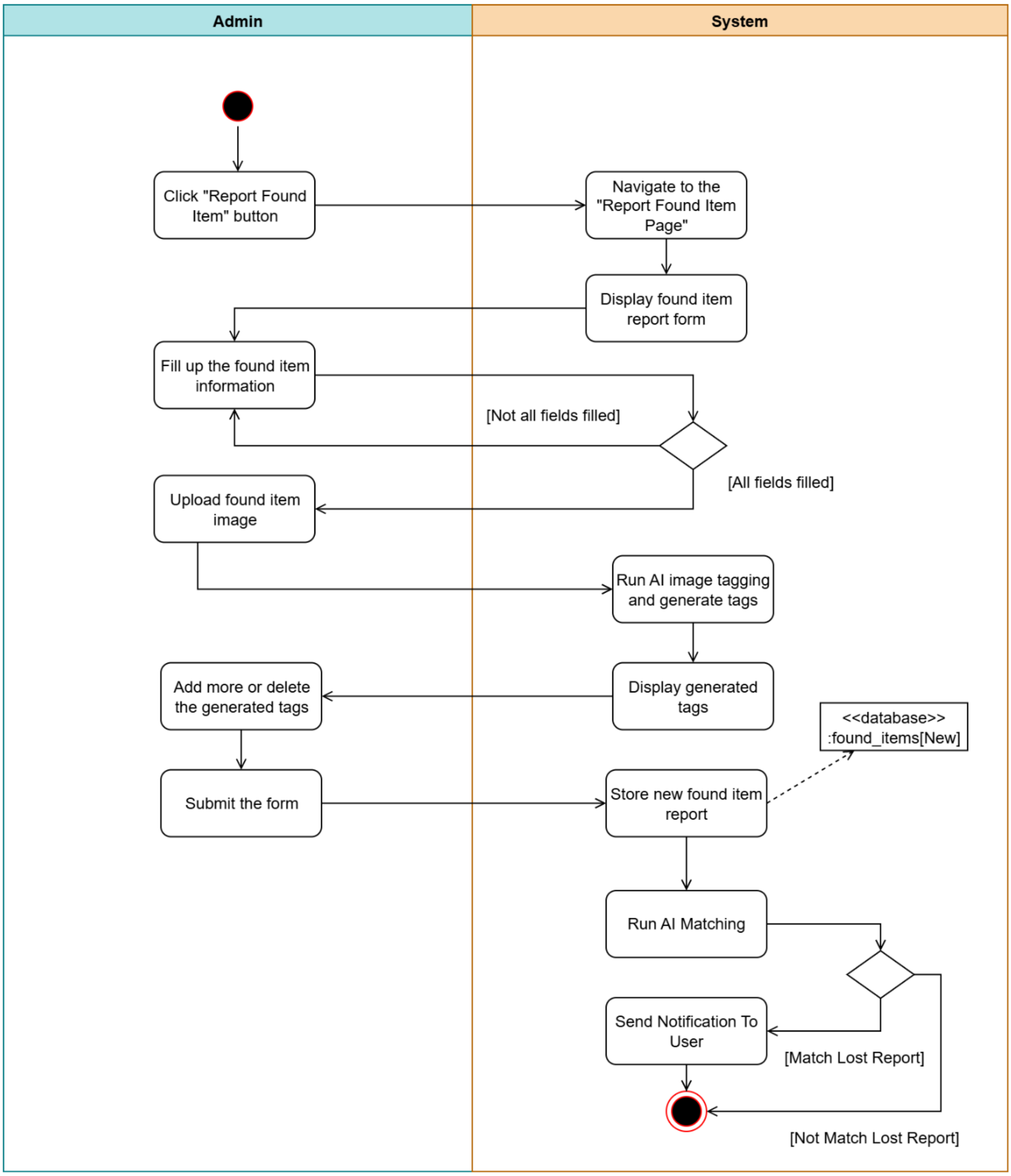


Figure 4.9 Activity Diagram for Report Found Item

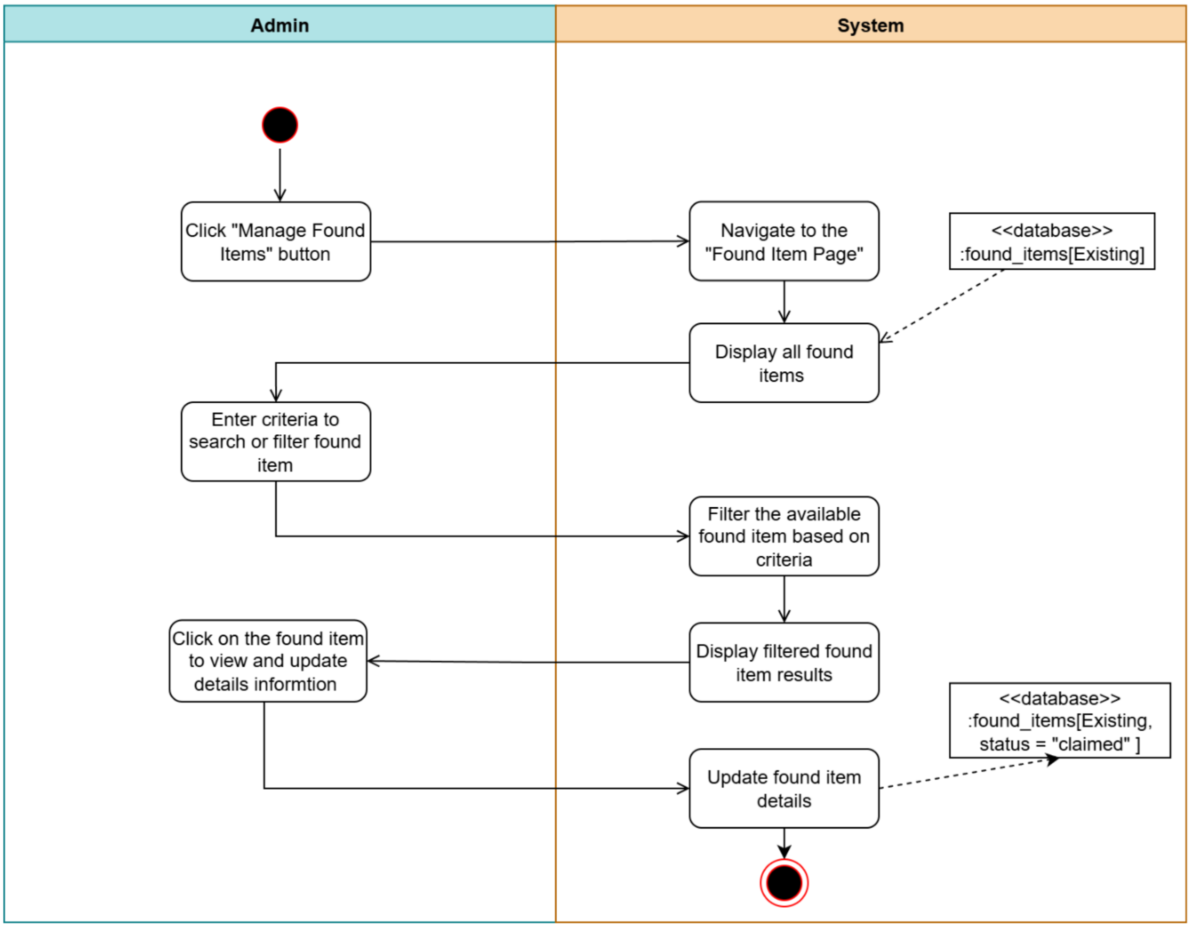


Figure 4.10 Activity Diagram for Manage Found Items

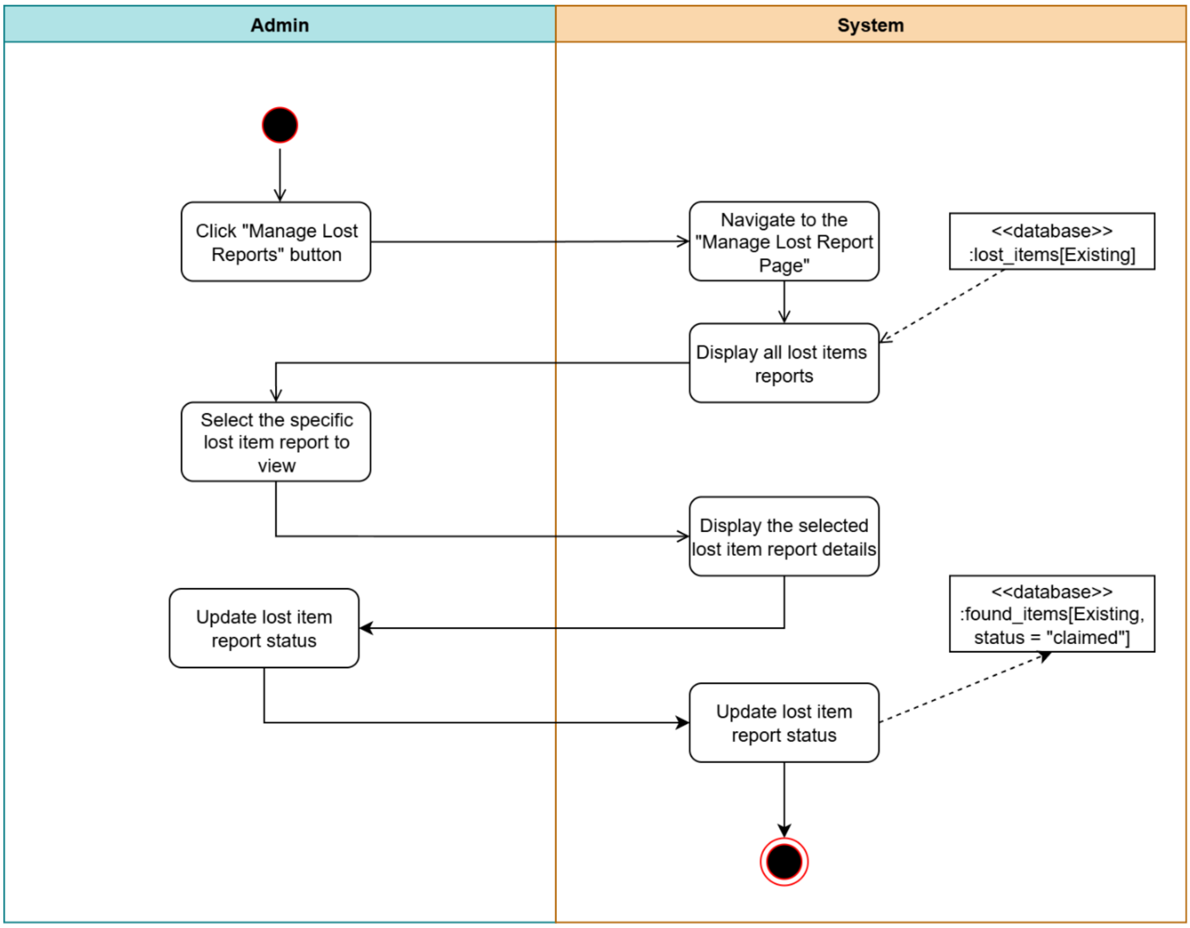


Figure 4.11 Activity Diagram for Manage Lost Reports

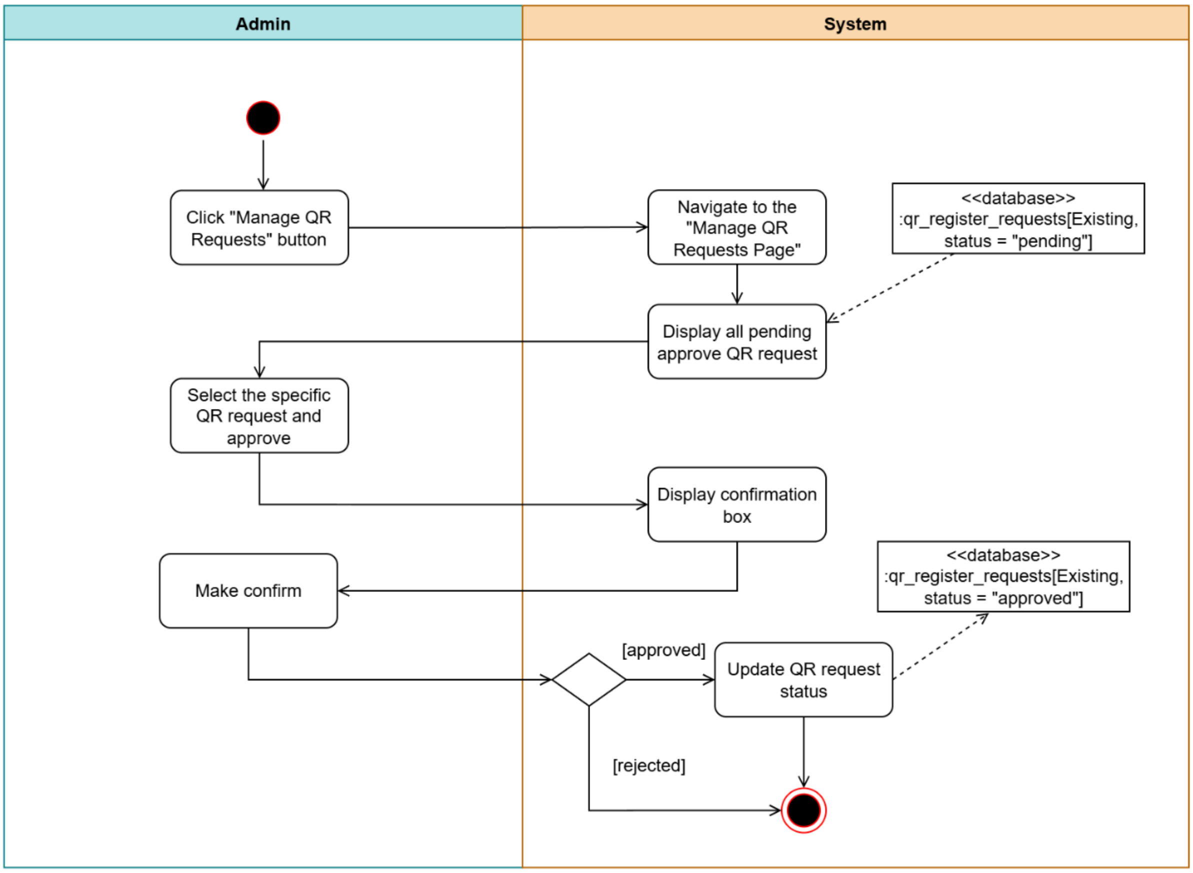


Figure 4.12 Activity Diagram for Manage QR Register Request Approval

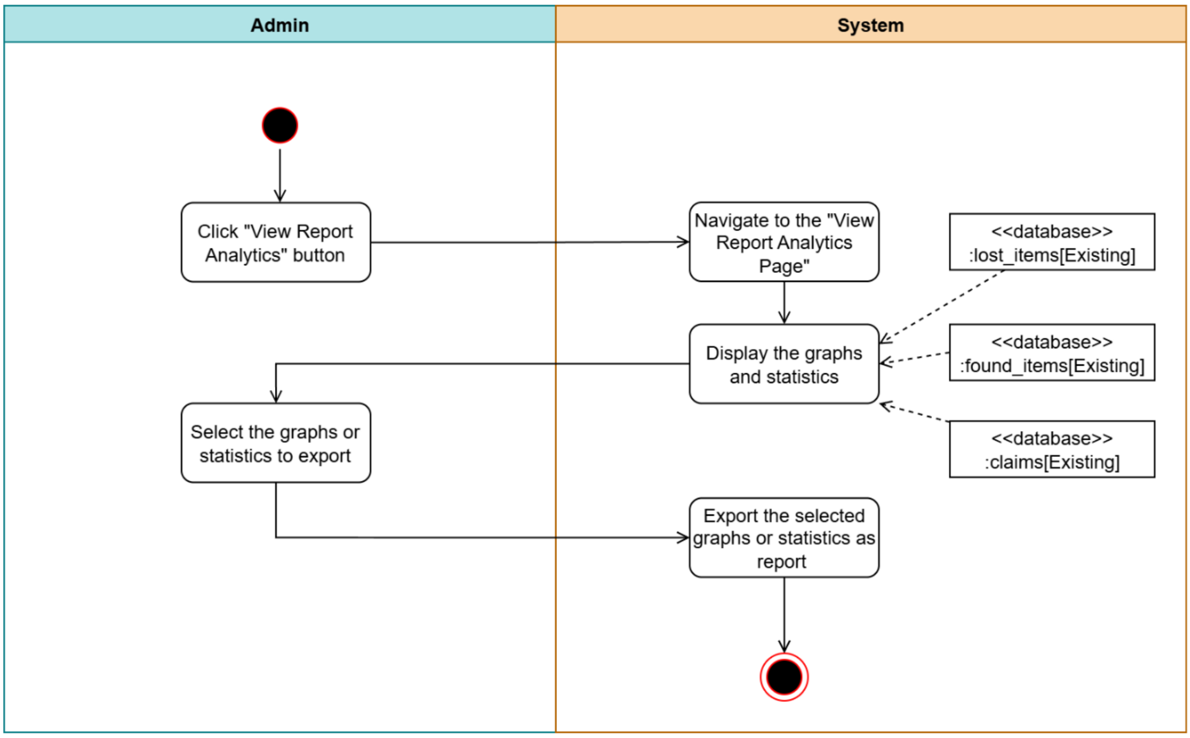


Figure 4.13 Activity Diagram for View Analytics and Reports

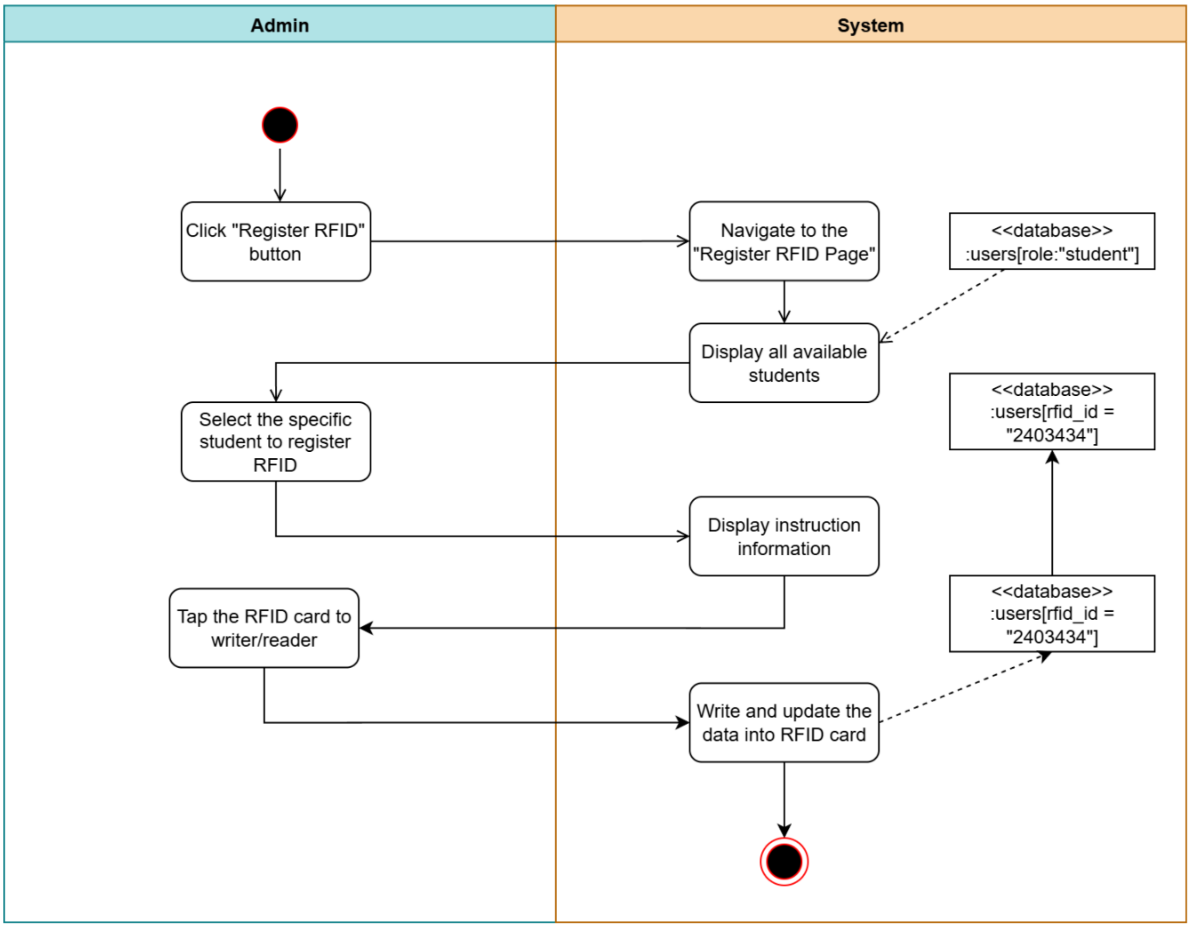


Figure 4.14 Activity Diagram for Register RFID Card for Student

4.3 Data Design

The data design of Qreclaim defines the overall structure and organization of information that supports the system’s operations. It specifies how data is stored, managed, and connected to ensure reliability, accuracy, and efficiency across all processes. Since Qreclaim is built to handle sensitive information such as student details, lost and found item records, and claim verification data, the data design plays a critical role in maintaining data integrity and security. A well-planned data design also ensures that different modules of the system, such as item reporting, claim verification, and locker management, can work seamlessly together by relying on a consistent and structured data foundation.

4.3.1 ERD Diagram

The Entity Relationship Diagram (ERD) models the logical structure of the Qreclaim database by identifying the main entities, their attributes, and the relationships between them. It provides a clear representation of how data related to users, lost items, found items, claims, and lockers are connected within the system. Through this diagram, the database structure ensures that each process such as reporting a lost item, submitting a found item, or verifying a claim supported by accurate and well-linked data. By organizing information into entities and defining their relationships, the ERD helps maintain data consistency, reduces redundancy, and ensures efficient retrieval of records, which is crucial for the smooth functioning of Qreclaim. Figure 4.15 shows the ERD diagram of Qreclaim system.

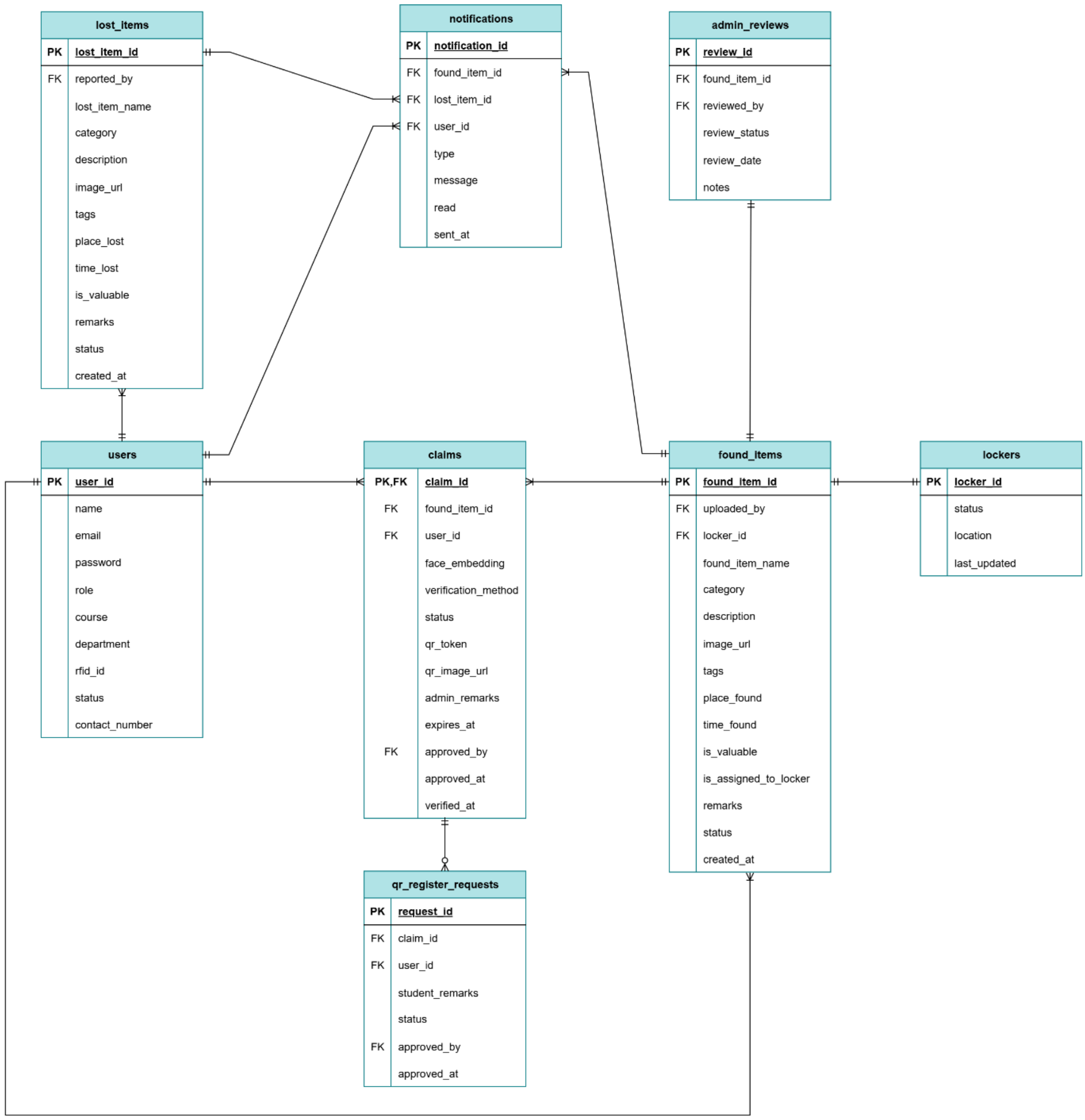


Figure 4.15 Qreclaim ERD Diagram

4.3.2 Class Diagram

The class diagram represents Qreclaim from an object-oriented perspective by modeling the system's main classes, their attributes, methods, and associations. It translates the database structure into objects that interact with one another during system operations. In Qreclaim, the class diagram captures essential components such as users, items, claims, and lockers, along with their relationships and behaviors. This allows developers to understand not only how data is stored but also how it is manipulated within the application. By defining these classes and their interactions, the class diagram provides a blueprint for system implementation and ensures that the design remains consistent with the functional requirements.

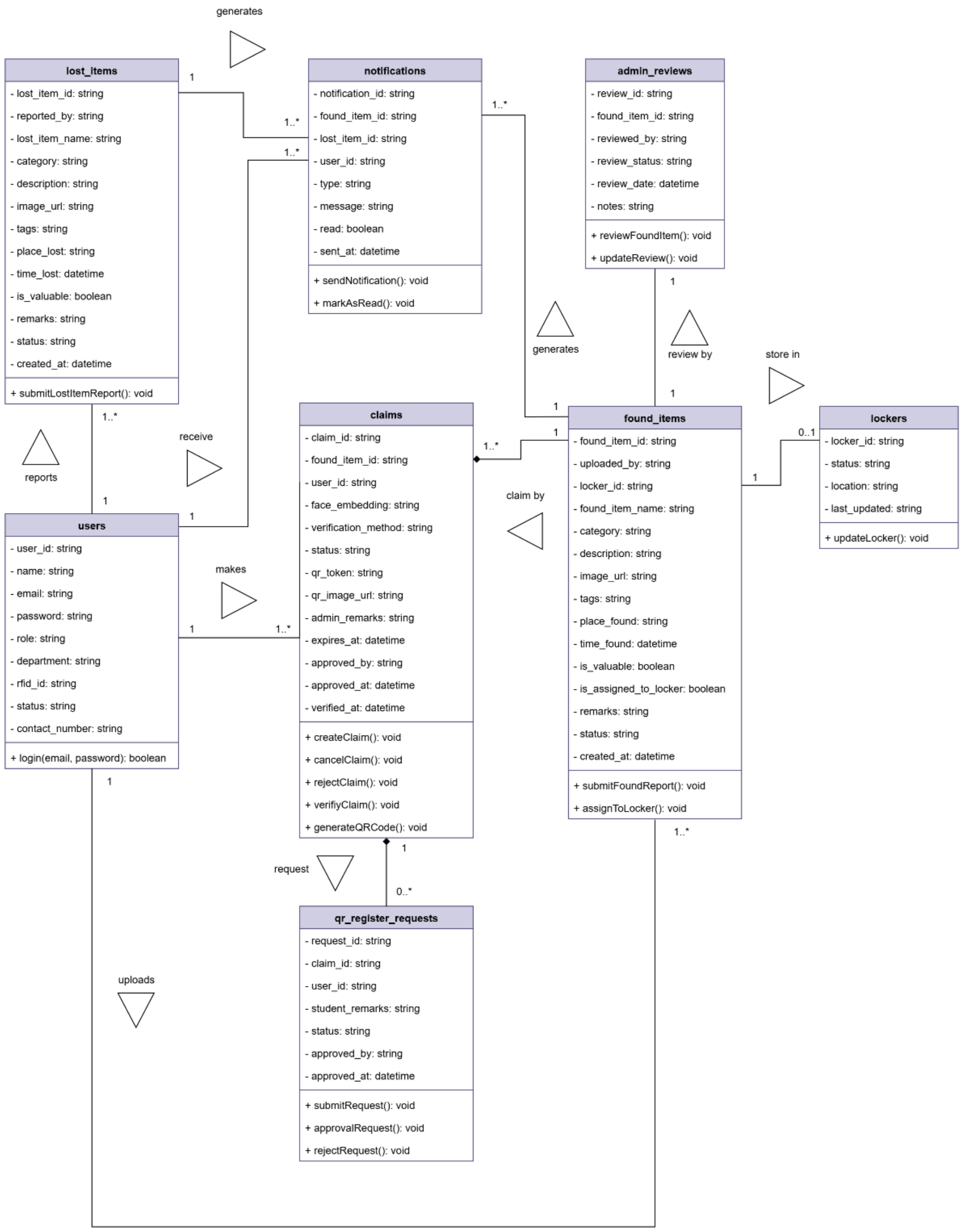


Figure 4.16 Qreclaim Class Diagram

4.3.3 Data Dictionary

The data dictionary provides a detailed description of the collections and attributes used in the Qreclaim system. Since the system is built on Firestore, a NoSQL document-oriented database, attributes do not require fixed lengths as in relational databases (e.g., varchar (50)). Instead, each field is defined by general data types such as string, number, boolean, or timestamp. The data dictionary documents the key constraints, data types, nullability, and descriptions of each attribute, ensuring clarity and consistency in data management. The following tables(Table 4.13 – Table 4.20) show the data dictionary of Qreclaim system.

Table 4.13 user table

users				
Key Constraint	Attributes	Description	Data type	Nullable
	user_id	Unique identifier for the user (student/admin).	string	No
	name	Full name of the user.	string	No
	email	Email address used for login and notifications.	string	No
	password	Hashed password for authentication.	string	No
	role	Role of the user (student or admin).	string	No
	department	Department of the user (for students).	string	No
	rfid_id	RFID tag ID associated with the student card.	string	No
	status	Current account status (active, inactive).	string	No
	contact_number	User’s phone number for communication.	string	No

Table 4.14 lost_items table

lost_items				
Key Constraint	Attributes	Description	Data type	Nullable
PK	lost_item_id	Unique identifier for the lost item record.	string	No
	reported_by	User ID of the student who reported the lost item.	string	No
	lost_item_name	Name or title of the lost item.	string	No
	category	Category (e.g., electronic, card, stationery).	string	No
	description	Detailed description of the lost item.	string	No
	image_url	URL of the lost item's image.	string	No
	tags	Keywords/tags for search and matching.	string	No
	place_lost	Location where the item was lost.	string	No
	time_lost	Date and time when the item was lost.	datetime	No
	is_valuable	Indicates if the item is valuable (requires admin review).	boolean	No
	remarks	Additional remarks provided by the reporter.	string	No
	status	Current status (pending, matched, closed).	string	No
	created_at	Timestamp when the record was created.	datetime	No

Table 4.15 found_items table

found_items				
Key Constraint	Attributes	Description	Data type	Nullable
PK	found_item_id	Unique identifier for the found item record.	string	No
	uploaded_by	User ID of the admin who uploaded the record.	string	No
	locker_id	Locker where the item is stored (nullable if not stored).	string	Yes
	found_item_name	Name or title of the found item.	string	No
	category	Category (e.g., electronic, card, stationery).	string	No
	description	Detailed description of the found item.	string	No
	image_url	URL of the found item's image.	string	No
	tags	Keywords/tags for search and matching.	string	No
	place_found	Location where the item was found.	string	No
	time_found	Date and time when the item was found.	datetime	No
	is_valuable	Indicates if the item is valuable (requires admin approval).	boolean	No
	is_assigned_to_locker	Whether the item has been placed in a locker.	boolean	No
	remarks	Admin's remarks on the found item.	string	No
	status	Current status (available, claimed).	string	No
	created_at	Timestamp when the record was created.	datetime	No

Table 4.16 lockers table

lockers				
Key Constraint	Attributes	Description	Data type	Nullable
PK	locker_id	Unique identifier for the locker.	string	No
	status	Locker status (occupied, empty).	string	No
	location	Physical location of the locker.	string	No
	last_updated	Timestamp of last update to locker status.	string	No

Table 4.17 claims table

claims				
Key Constraint	Attributes	Description	Data type	Nullable
PK, FK	claim_id	Unique identifier for the claim record.	string	No
	found_item_id	ID of the found item being claimed.	string	No
	user_id	ID of the user making the claim.	string	No
	face_embedding	Face data embedding for identity verification.	string	No
	verification_method	Selected verification method (rfid, face).	string	No
	status	Claim status (pending, approved, rejected).	string	No
	qr_token	Unique token embedded in generated QR code.	string	No
	qr_image_url	URL to the generated QR code image.	string	No
	admin_remarks	Remarks added by admin during claim processing.	string	No
	expires_at	Expiration date of the claim request.	datetime	No
	approved_by	Admin ID who approved the claim.	string	No
	approved_at	Date and time when claim was approved.	datetime	No

	verified_at	Date and time when claim was verified at kiosk.	datetime	No

Table 4.18 qr_register_requests table

qr_register_requests				
Key Constraint	Attributes	Description	Data type	Nullable
PK	request_id	Unique identifier for the QR register request.	string	No
	claim_id	ID of the claim linked to this request.	string	No
	user_id	ID of the student making the request.	string	No
	student_remarks	Optional remarks added by the student.	string	No
	status	Request status (pending, approved, rejected).	string	No
	approved_by	Admin ID who approved the request (if applicable).	string	No
	approved_at	Date and time when request was approved.	datetime	No

Table 4.19 notifications table

notifications				
Key Constraint	Attributes	Description	Data type	Nullable
PK	notification_id	Unique identifier for the notification.	string	No
	found_item_id	Related found item ID (if applicable).	string	Yes
	lost_item_id	Related lost item ID (if applicable).	string	Yes
	user_id	Target user receiving the notification.	string	No
	type	Type of notification (match, reminder, info).	string	No
	message	Notification message content.	string	No
	read	Whether the notification has been read.	boolean	No
	sent_at	Date and time when the notification was sent.	datetime	

Table 4.20 admin_reviews table

admin_reviews				
Key Constraint	Attributes	Description	Data type	Nullable
PK	review_id	Unique identifier for the admin review record.	string	No
	found_item_id	ID of the found item under review.	string	No
	reviewed_by	Admin user ID who performed the review.	string	No
	review_status	Review outcome (approved, rejected).	string	No
	review_date	Date and time of the review.	datetime	No
	notes	Additional notes from the admin reviewer.	string	No

4.4 Security Design

The security design of Qreclaim establishes the measures and mechanisms needed to protect sensitive data and ensure safe interactions between users and the system. Because the platform manages critical information such as student details, lost-and-found records, and identity verification data, it must be safeguarded against unauthorized access, misuse, and system threats. The design covers multiple layers of security, including access control, authentication, session management, data validation, and logging, as well as specific protections for the kiosk, RFID, facial recognition, and QR-based claim process. By applying these measures, Qreclaim ensures confidentiality, integrity, and availability of information while maintaining user trust and system reliability.

4.4.1 Access Control

Qreclaim applies to a role-based access control (RBAC) model to ensure users can only perform permitted actions. Students can view their own profile, register QR codes, and submit claims, while administrators have additional permissions to approve valuable claims, manage lockers, and view all records. These permissions are enforced through Firebase security rules, which check the user's role before allowing read or write operations. This approach follows established RBAC principles, where permissions are tied to roles and verified server-side to prevent privilege escalation (Firebase, n.d.; Sandhu et al., 1996).

4.4.2 Authentication

All users must authenticate via Firebase Authentication before interacting with the system. Students and staff log in with their registered credentials, while administrators use separate privileged accounts to access management features. Firebase Authentication helps ensure only verified users can perform actions, reducing the likelihood of unauthorized data access (Firebase, n.d.-b).

4.4.3 Session Management

Session tokens generated by Firebase maintain the login state and expire after a fixed period. When a token expires or a user remains inactive for too long, re-authentication is required. This reduces the risk of unauthorized users exploiting an unattended session (Firebase, n.d.-b).

4.4.4 QR Token and Claim Security

Each claim is associated with a unique QR code containing the claim ID and student ID. The kiosk verifies this code against Firestore before permitting the claim process to continue. Once the QR code is used, its status is updated so it cannot be reused, mitigating replay attacks. Using dynamic, single-use QR codes is a recommended countermeasure against QR code cloning and replay attempts (Hong Kong Computer Emergency Response Team Coordination Centre

[HKCERT], 2023; Pageloot, 2024). For valuable items, QR code registration is allowed only after administrative approval, ensuring only legitimate owners proceed.

4.4.5 Biometric and RFID Security

The kiosk supports RFID card scanning and facial recognition for additional verification. The scanned RFID UID or facial data is compared against stored records in Firestore. Only successful matches allow the locker to be unlocked. This multi-step verification prevents unauthorized students from claiming items even if they gain access to a valid QR code.

4.4.6 Input Validation

Qreclaim validates all user inputs, such as student ID, item information, and claim details, on both the client and server sides. This prevents invalid or malicious data from being written into Firestore and maintains system reliability (OWASP Foundation, 2021).

4.4.7 Logging

The system records key actions such as QR code generation, claim attempts, verification results, and locker unlocking events. These logs provide administrators with the ability to trace activity, investigate misuse, and resolve disputes when necessary

4.4.8 Kiosk Security

The Raspberry Pi kiosk is configured to work only with Qreclaim's backend. Locker unlocking occurs only after Firestore confirms the claim's validity. Failed verifications are logged for administrator review, helping detect and prevent misuse at the kiosk level.

4.5 Report Design

The report design in Qreclaim focuses on presenting information in a professional, structured, and user-friendly format. Reports serve as an important feature for monitoring claim activities and providing administrators with accurate records of lost-and-found operations. To achieve clarity and readability, the design follows key reporting principles, ensuring that printed reports are both attractive and easy to interpret.

In particular, the report layout considers essential elements such as report headers and footers, page headers and footers, column headings with proper alignment, and the grouping of detail lines to organize related information. These design principles allow reports to highlight important details while maintaining a consistent format across different sections. By following these guidelines, Qreclaim ensures that generated reports not only provide accurate data but also support effective decision-making by administrators and clear references for students.

Figure 4.18 presents the on-demand claims report designed for Qreclaim, which demonstrates how these reporting principles are applied in practice.

Claim Report

Qreclaim – Smart Lost & Found System
Date Generated: September 18, 2025 at 08:28 PM
Generated By: Admin User

Claim ID	Item ID	Item Name/Description	Student ID	Student Name	Claim Date & Time	Verification Method	Locker ID	Status	Admin Verified By
C0001	FI0005	Black Razer Mouse	21WMD12345	John Smith	Sep 15, 2023, 10:30 AM	RFID Card	LK0003	Approved	Admin001
C0002	FI0008	Blue Water Bottle	22WMD54321	Jane Doe	Sep 14, 2023, 02:45 PM	Face Recognition	LK0005	Approved	Admin002
C0003	FI0012	Samsung Charger	20WMD98765	Robert Johnson	Sep 13, 2023, 09:15 AM	RFID Card	LK0002	Pending	Admin001
C0004	FI0015	Apple AirPods	23WMD45678	Emily Wilson	Sep 12, 2023, 04:20 PM	Face Recognition	LK0007	Rejected	Admin003
C0005	FI0018	Notebook	21WMD87654	Michael Brown	Sep 11, 2023, 11:05 AM	RFID Card	LK0001	Approved	Admin002

Page of

This report is auto-generated by Qreclaim. For internal use only.

Figure 4.18 Report Design Table

4.6 User Interface (UI) Design

The user interface (UI) design of Qreclaim provides a clear and user-friendly platform for students and administrators to interact with the system. It focuses on simplicity and ease of use, ensuring that users can perform key tasks such as reporting lost items, submitting found items, and verifying claims without confusion.

The interface uses consistent layouts, clear labels, and simple navigation to guide users through each process. Forms, buttons, and feedback messages are designed to be straightforward, helping users' complete actions efficiently. The design also supports accessibility across different devices, including desktops, laptops, and kiosks.

The following figures show the general layout and design of Qreclaim's user interface.

A. User Module

This page shows the login for both user and admin, they can choose either login as user or admin.

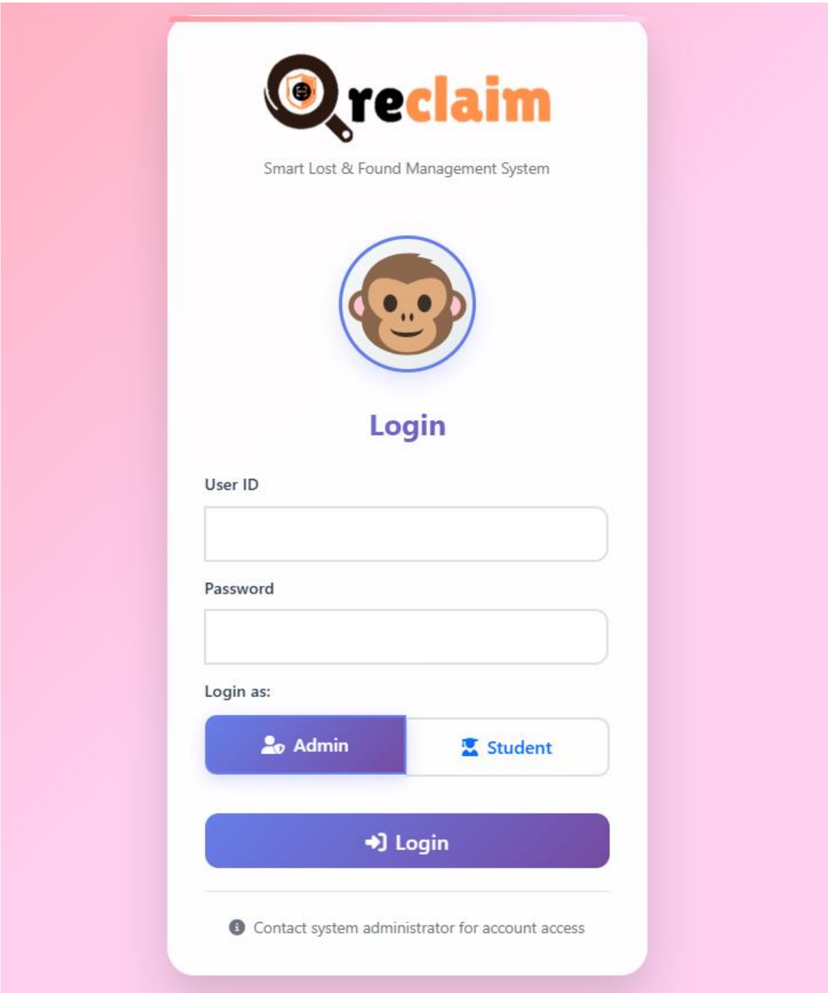


Figure 4.19 Login Page

This page shows the students dashboard(main) page

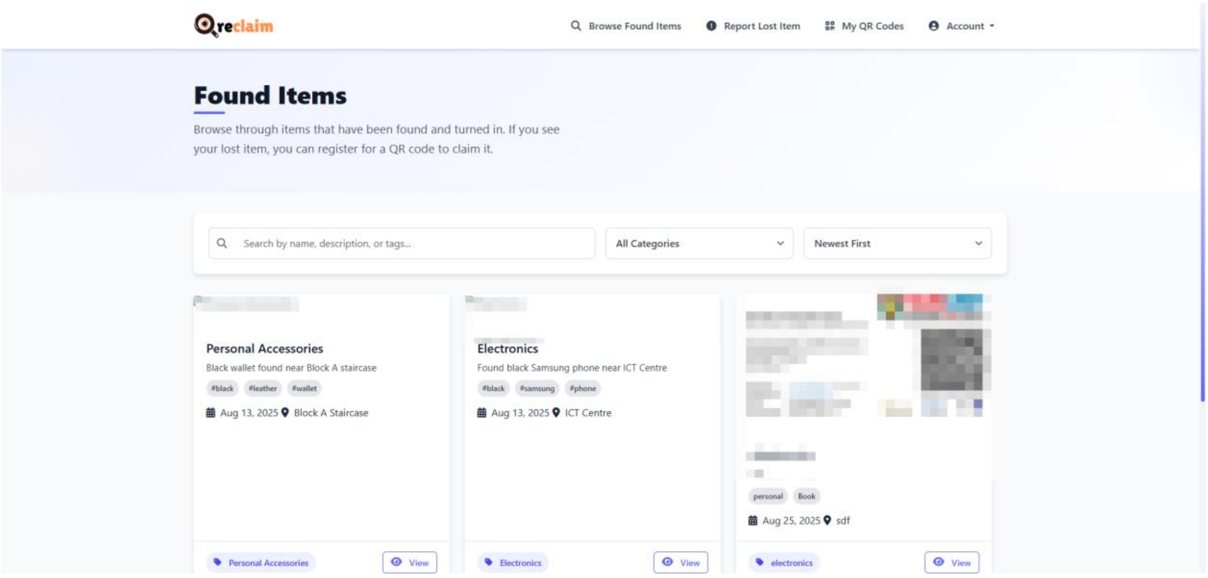


Figure 4.20 Student Dashboard Page

This page shows the lost item report form for user(student) to report and submit their lost item to admin, once the admin receives the report, they can help to take notes on the lost item. At the same time, after the student posted the report once they are any posted found items in the system got high similarity, then the student will receive the notifications.

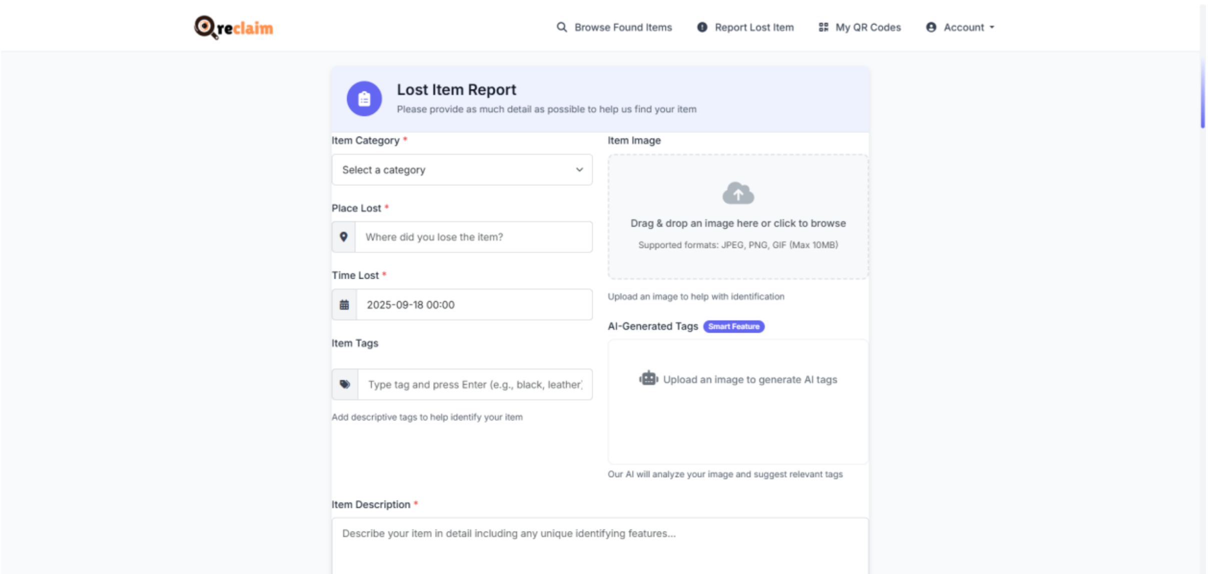


Figure 4.21 Report Lost Item Page

This page shows the details information of the found items, the users can also click “Register For QR code ” button to register the QR for claim.

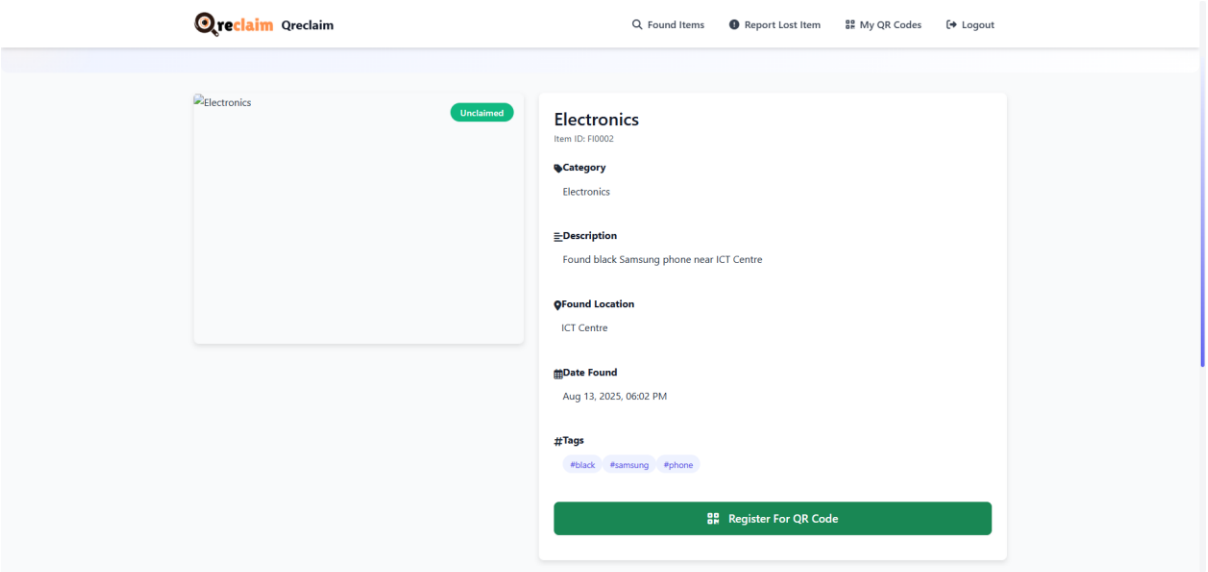


Figure 4.22 Found Item Details Page

This page shows the QR register process when the user want to register the QR for claim, there will be a box pop out for user to choose what is the double verification that want to use.

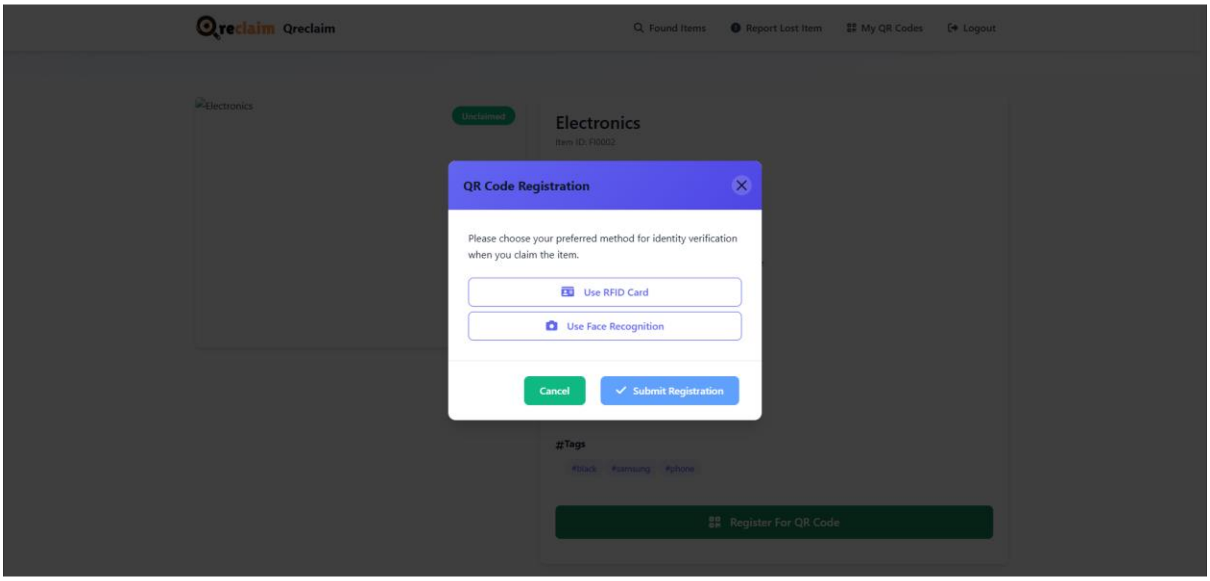


Figure 4.23 QR Register Page

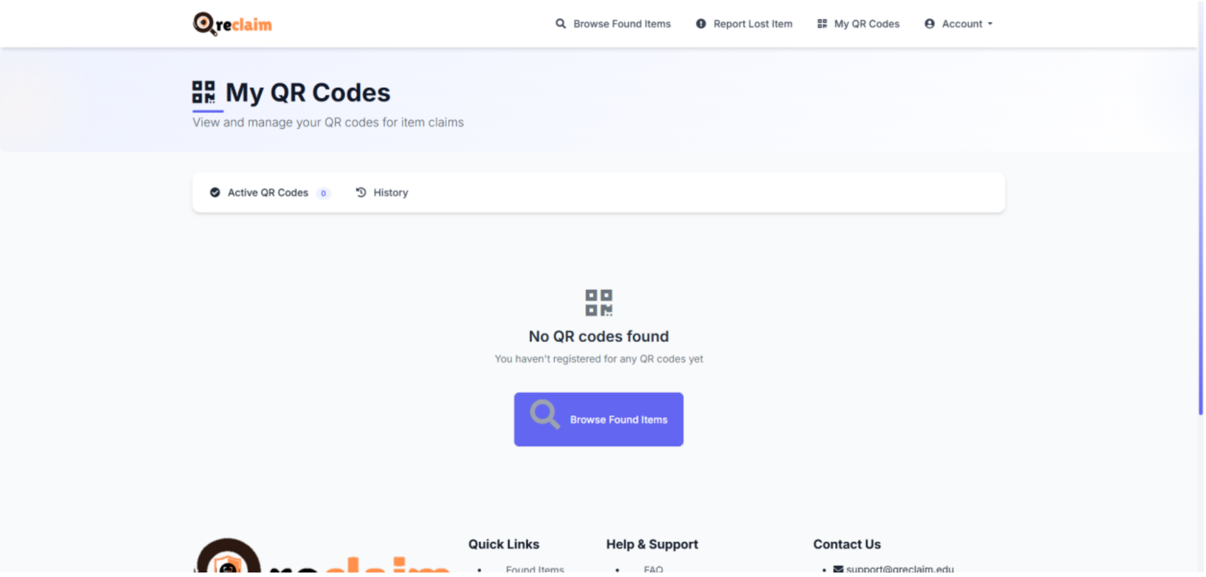


Figure 4.24 QR Code History Page

B. Admin Module

This page shows the post found item form for admin to fill up all the found items details and store them in the system.

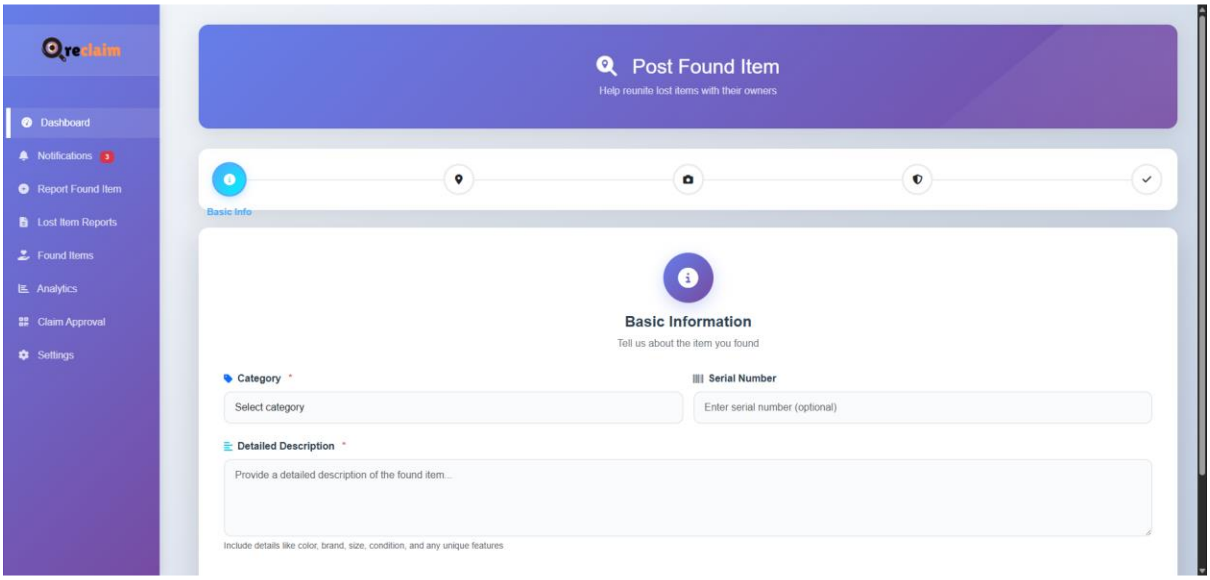


Figure 4.25 Report Found Item Page

This page shows all the lost item reports posted by users for admin to view. Admins are allowed to update the lost item reports status manually once the item is found and view the details of the lost item report.

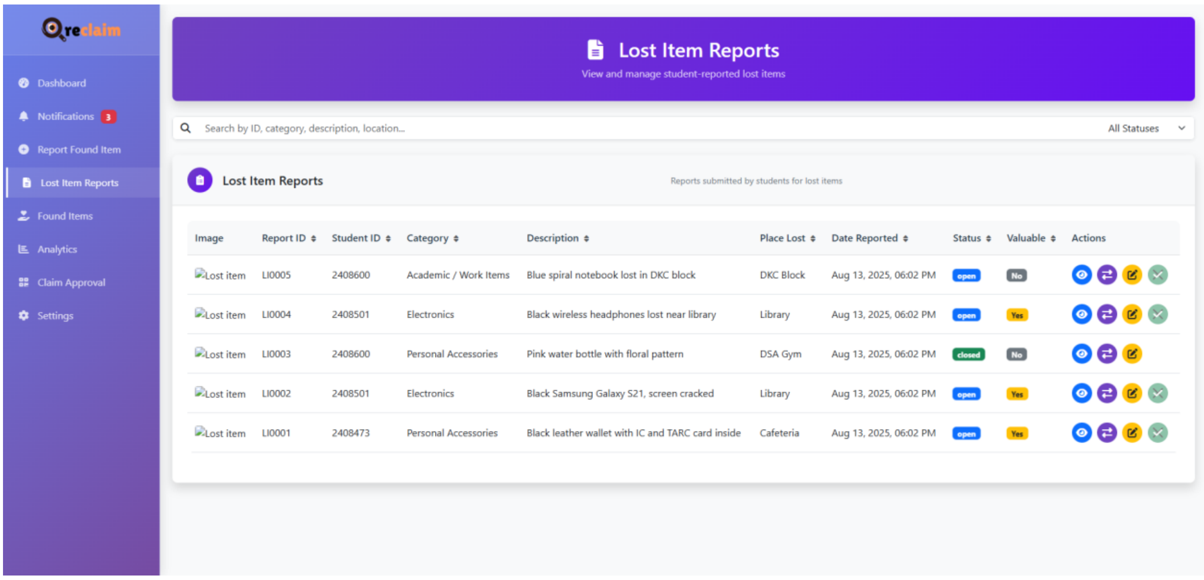


Figure 4.26 Manage Lost Item Report Page

This page shows all the found items that are posted by admins in the table format to view. Admin are allowed to click on each found item to edit the details.

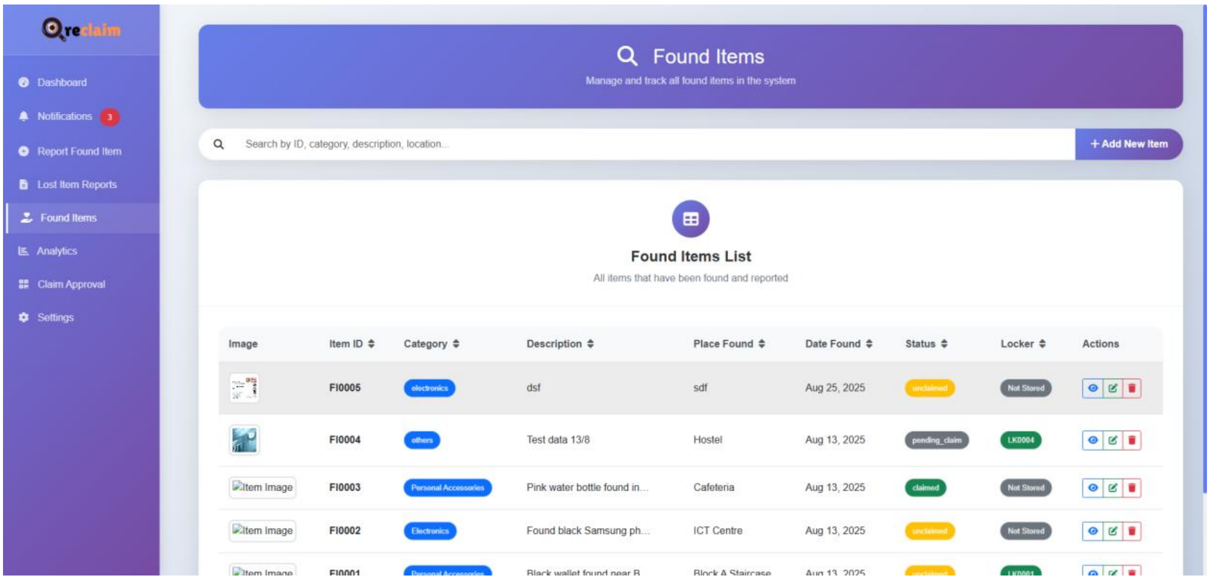


Figure 4.27 Manage Found Items Page

This page shows the analytics for admin to view the deep details numbered graph or table.

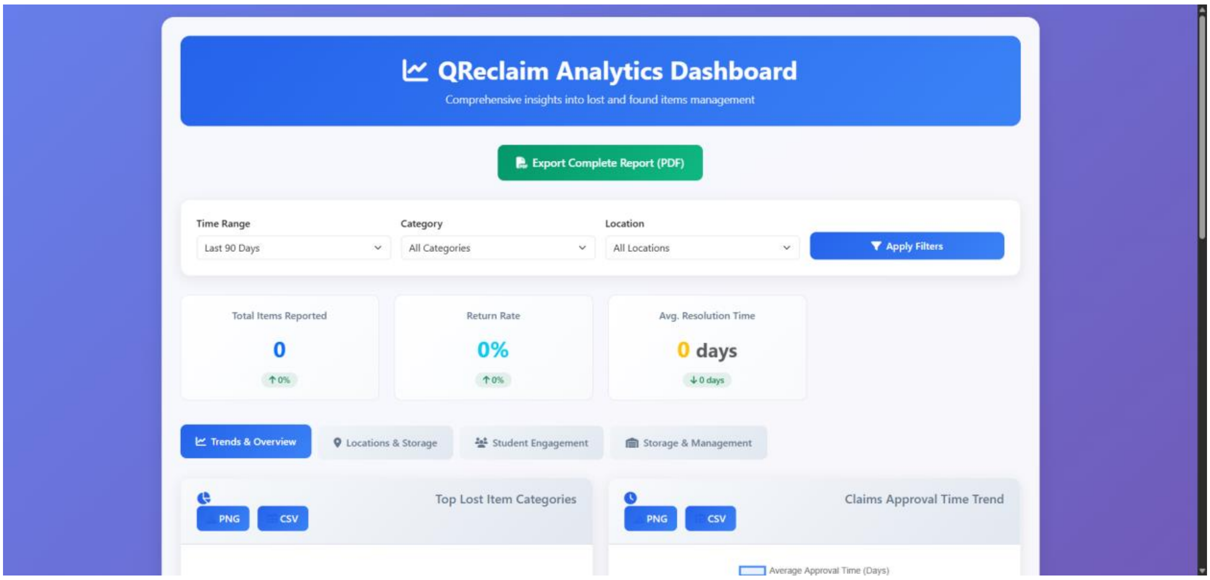


Figure 4.28 Item Analytics Page

This page shows what QR register requested by the user(student) , the admin can decide to approve or reject their request.

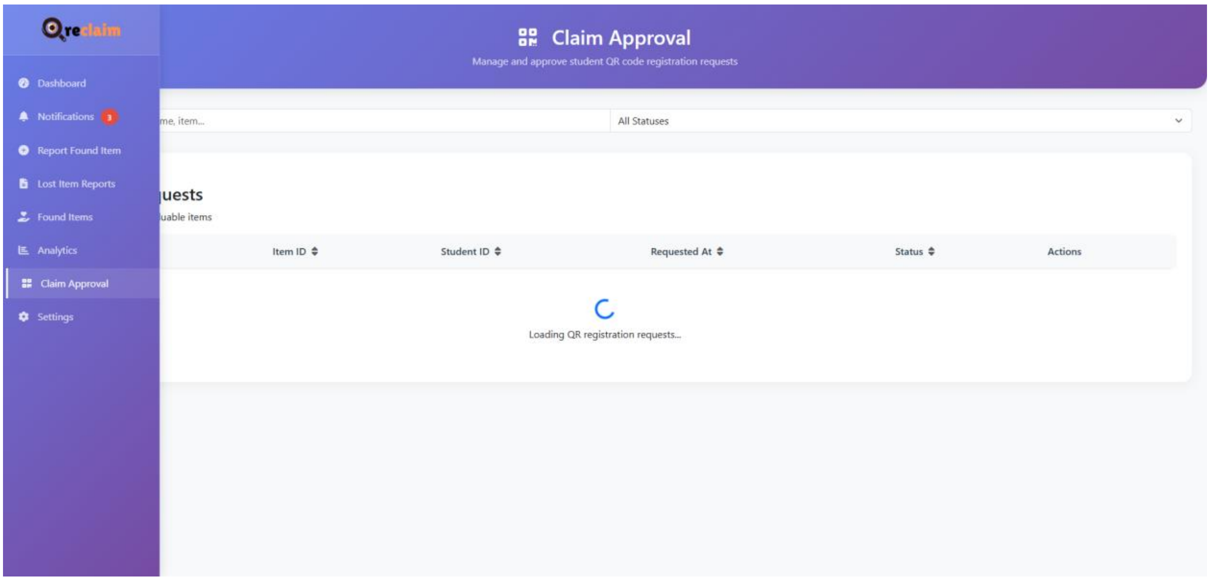


Figure 4.29 QR Request Approval Page

4.7 Chapter Summary and Evaluation

This chapter detailed the system design of Qreclaim, translating the requirements gathered earlier into a comprehensive technical blueprint. In total, six designs were developed: software architecture design, process design, data design, security design, report design, and user interface design. Each of these was carefully planned to ensure that the system is functional, secure, scalable, and user-friendly.

At the architectural level, Qreclaim adopts a layered three-tier design that separates the presentation, application, and data layers. This modular structure enhances scalability and maintainability while securing communication through a Flask RESTful API. The use of Firebase Firestore as the database allows real-time updates and reliable storage, while features such as AI-based tagging, automated item matching, and notifications strengthen the efficiency of the lost-and-found process. The design demonstrates foresight by incorporating features that can support future enhancements, such as mobile integration or expanded verification methods.

The functional aspects of the system were expressed through case diagrams, activity diagrams, and detailed descriptions. These models clearly map how students and administrators will interact with the system, from reporting items to verifying claims using QR codes, RFID, and facial recognition. Together, they ensure that the system addresses the full spectrum of user requirements. While comprehensive, these processes may also introduce a degree of complexity, particularly in the claim verification flow, which could require additional user guidance during deployment.

The data design established a strong foundation by defining the entities, relationships, and attributes required for the system. The inclusion of an ERD, class diagram, and data dictionary ensures consistency and clarity in handling sensitive records such as student details, item reports, and claim information. The choice of a NoSQL database supports flexibility and scalability, though considerations around performance and operational costs will become important as the system grows.

Security design was given significant attention, reflecting the sensitivity of the data being managed. Role-based access control, secure authentication, session management, input validation, and detailed logging were incorporated to protect against unauthorized access or misuse. The multi-layered verification process combining QR codes, RFID, and biometric checks offers a high degree of assurance in claim validation. Nonetheless, issues such as biometric data privacy, hardware reliability at kiosks, and compliance with data protection standards will require ongoing vigilance.

The report design contributes to administrative oversight by providing clear, structured summaries of system activity, while the user interface design focuses on accessibility and ease of use. The interfaces for both students and administrators emphasize clarity, consistency, and intuitive navigation, ensuring that the system remains practical even for users with limited technical background.

Overall, the system design of Qreclaim is thorough, well-structured, and aligned with its intended purpose. It demonstrates a balanced integration of functionality, security, and usability, offering clear improvements over traditional lost-and-found practices. Its modular architecture provides room for growth, while AI-driven features and multi-factor verification improve both efficiency and reliability. The main challenges lie in areas such as safeguarding biometric information, maintaining kiosk hardware, and ensuring smooth performance at scale. These are not weaknesses of the design itself but practical considerations for implementation. With careful attention to these aspects, Qreclaim has the potential to serve as a reliable and user-friendly solution for automating TAR UMT Johor’s lost-and-found process.

Reference

1. Bringula, R. P., & Basa, R. S. (2011). Factors affecting faculty web portal usability. *Educational Technology & Society, 14*(4), 253–265. https://ifets.info/journals/14_4/25.pdf
2. Firebase. (2024). *Firebase documentation*. Google Cloud. https://firebase.google.com/docs
3. Ghazal, M., Alkhalil, Y., Ali, S. S., Haneefa, F., & Rashed, E. (2016). Archival and retrieval of lost objects using multi-feature image matching in mobile applications. *International Journal of Computing and Digital Systems, 5*(1), 129–137. https://doi.org/10.12785/ijcds/050107
4. Ilias, N. F. I. M. (2020). *A web-based lost and found items system using RFID and email notification* [Bachelor's thesis, UiTM]. https://ir.uitm.edu.my/id/eprint/45937/1/FullText%2045937.pdf
5. Ismail, N. K., Wahab, S. A., & Haron, H. (2025). Integrated RFID solution for students entry and exit monitoring system. *International Journal of Synergy in Engineering and Technology, 6*(1), 32–42.
6. Li, J., Li, D., Savarese, S., & Yu, S. (2023). BLIP: Bootstrapping language-image pretraining. *CVPR 2023*. https://arxiv.org/abs/2201.12086
7. Malaysia Digital. (2024). *Malaysia Government Design System (MYDS) – Overview*. https://design.digital.gov.my
8. Moran, K. (2019). Usability testing 101. *Nielsen Norman Group*. https://www.nngroup.com/articles/usability-testing-101/
9. Nielsen, J. (2024). 10 usability heuristics for user interface design. *Nielsen Norman Group*. https://www.nngroup.com/articles/ten-usability-heuristics/
10. OnlyTARCianKnow. (n.d.). *OnlyTARCianKnow Lost and Found* [Facebook group]. https://www.facebook.com/groups/OnlyTARCianKnow.Lost.and.Found/
11. Radford, A., Kim, J. W., Hallacy, C., Ramesh, A., & Sutskever, I. (2021). Learning transferable visual models from natural language supervision. *ICML*. https://arxiv.org/abs/2103.00020
12. Sadiah, S., & Nyambong, A. (2020). *FCSIT Lost and Found Management System* [Unpublished final project, UNIMAS]. https://ir.unimas.my/id/eprint/34661/1/Sylvia%20Sadiah%20ak%20Andrew%20Nyambong%20-%2024%20pgs.pdf
13. Shamshur, A., & Nabilah, T. (2016). *e-Aduan Lost and Found Item System* [Project report, UTeM]. https://digitalcollection.utem.edu.my/32684/2/e-Aduan%20lost%20and%20found%20item.pdf
14. Singh, R., & Sharma, R. (2021). Biometric-based security and authentication system using multimodal biometrics: A review. *Journal of Biometrics and Bioinformatics, 13*(1), 104–112. https://www.omicsonline.org/open-access/biometricbased-security-and-authentication-system-using-multimodal-biometrics-a-review-2155-6180-1000104.pdf

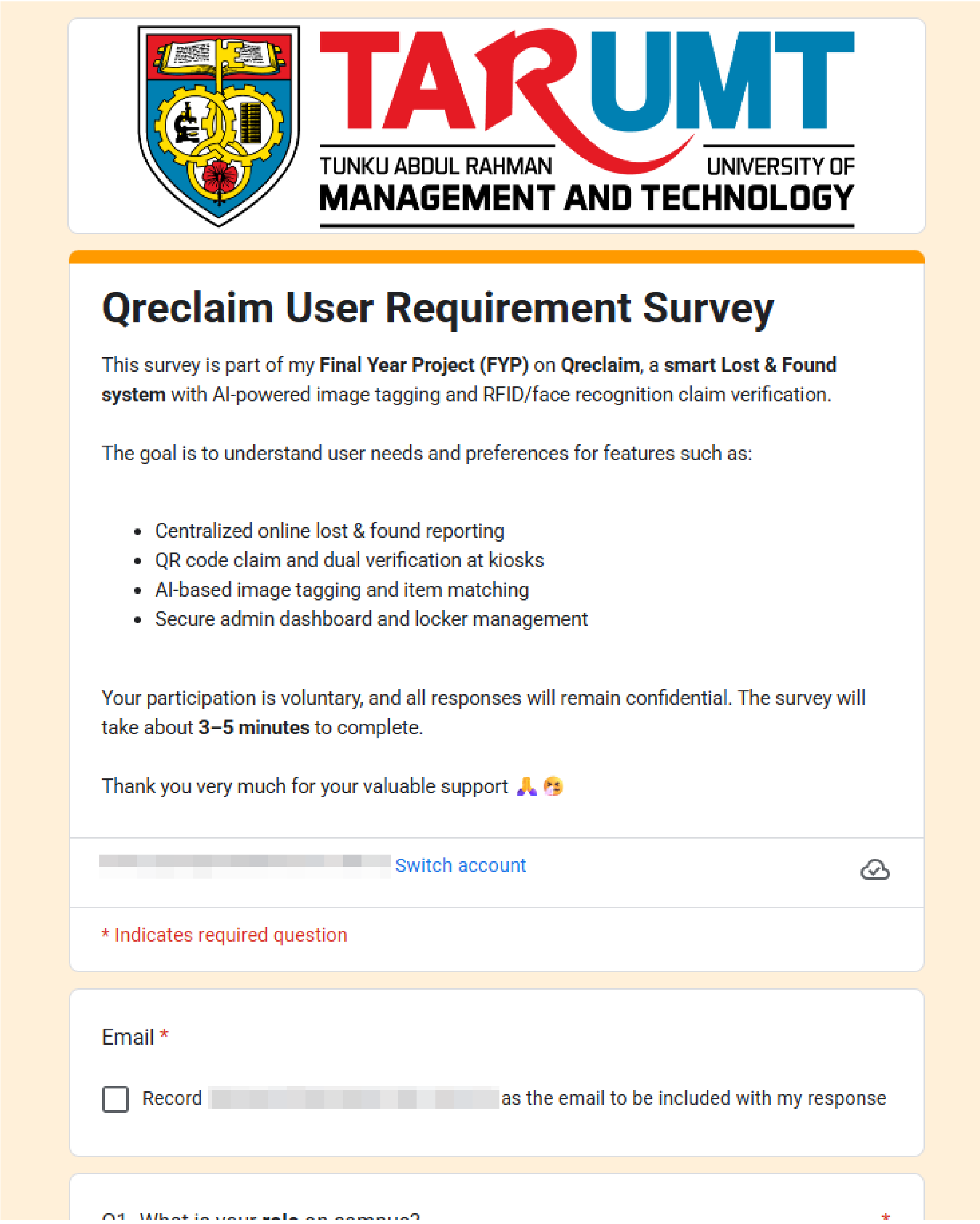
15. Suárez-Armas, J., & Caballero-Gil, P. (2017). Access control system based on Raspberry Pi and Android smartphones. *Computer Science & Information Technology, 7*(16), 25–32. https://doi.org/10.5121/csit.2017.71603
16. Tan, S. Y., & Chong, C. R. (2024). An effective lost and found system in university campus. *Journal of Information System and Technology Management, 8*(32), 99–112. https://gaexcellence.com/jistm/article/view/2714/2381
17. Shivaramakrishnaan, B., & Logesh, B. (2025). Smart campus lost and found portal with IoT sensors. *International Journal of Research Publication and Reviews, 6*(3), 6136–6139. https://ijrpr.com/uploads/V6ISSUE3/IJRPR40493.pdf
18. Umo, S. D. (2023). *Automated campus lost and found management system (Case study of University of Uyo)*. https://nairaproject.com/projects/6177-automated-campus-lost-and-found-management-system-a-case-study-of-university-of-uyo.html
19. Mishra, A., & Alzoubi, Y. I. (2023). Structured software development versus agile software development: A comparative analysis. International Journal of System Assurance Engineering and Management. https://doi.org/10.1007/s13198-023-01958-5
20. Rao, D. B. J., Kalpana, P., Kumar, G. S. N., & Atcha, N. M. (2025). A comparative analysis of software development models: Waterfall, Agile and DevOps. In V. S. Reddy, V. K. Prasad, J. Wang, & N. M. R. Dasari (Eds.), Intelligent Systems and Sustainable Computing (ICISSC 2024) (SIST, Vol. 417, pp. 589–599). Springer. https://doi.org/10.1007/978-981-97-8355-7_51
21. Almorsy, M., Grundy, J., & Müller, I. (2016). An analysis of the cloud computing security problem. *Proceedings of the 2016 Asia-Pacific Software Engineering Conference (APSEC)*, 45–52. IEEE. https://doi.org/10.1109/APSEC.2016.021
22. Avizienis, A., Laprie, J.-C., Randell, B., & Landwehr, C. (2004). Basic concepts and taxonomy of dependable and secure computing. *IEEE Transactions on Dependable and Secure Computing, 1*(1), 11–33. https://doi.org/10.1109/TDSC.2004.2
23. Nielsen, J. (2012). *Usability 101: Introduction to usability*. Nielsen Norman Group. https://www.nngroup.com/articles/usability-101-introduction-to-usability/
24. Shamala, P., Ahmad, R., & Zolait, A. H. (2017). Information security policies compliance: A perspective for higher education institutions. *Journal of Computer Information Systems, 57*(3), 193–203. https://doi.org/10.1080/08874417.2016.1181494
25. Torres, A., Koziolek, A., & Koziolek, H. (2017). Capacity management for availability of distributed software systems. *Journal of Systems and Software, 123,* 96–113. https://doi.org/10.1016/j.jss.2016.03.004
26. GeeksforGeeks. (2024). *Incremental Process Model in Software Engineering*. Retrieved from https://www.geeksforgeeks.org/software-engineering/software-engineering-incremental-process-model

27. Redmon, J., Divvala, S., Girshick, R., & Farhadi, A. (2016). You only look once: Unified, real-time object detection. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 779–788). IEEE. https://doi.org/10.1109/CVPR.2016.91

Appendix

Appendix A - Questionnaire Survey

Questionnaires Survey Google Form Link: https://docs.google.com/forms/d/e/1FAIpQLSdv-tn8HenaDS Fx7KyyZRnsjzY2OJ2VhboP1eVb1eoHGnuGA/viewform



Appendix 1.1 Google Forms

Q1. What is your **role** on campus? *

(This helps us understand your perspective. Different roles may see different sections.)

- Student
- Staff / Admin

After section 1 Continue to next section

Appendix 1.2 Question Template (General) - Q1

Section 2 of 10

Section 2: Student Questions

📌 This section is intended for students. It focuses on your experiences with the current lost and found process and your preferences for features in the proposed system.

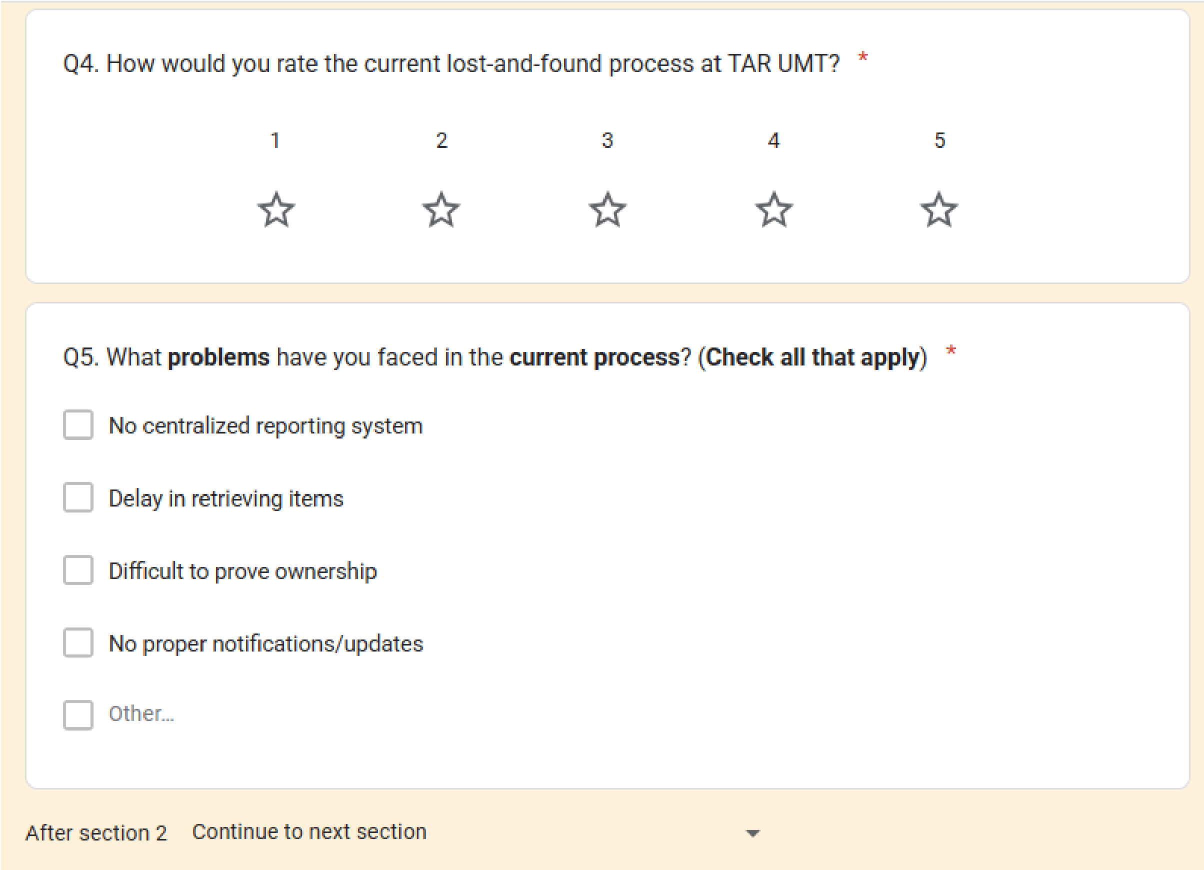
Q2. Which **faculty** are you from? *

- FAFB (DBU, DAC, DEN, RBU, RAF)
- FOCS (DCS, DFT, RSD)
- FOAS (DAQ)
- FSSH (DHM)

Q3. How **often** have you **lost an item** on **campus**? *

- Never
- Rarely
- Sometimes
- Often
- Always

Appendix 1.2 Question Template (Student) - Q2 and Q3


Q4. How would you rate the current lost-and-found process at TAR UMT? *

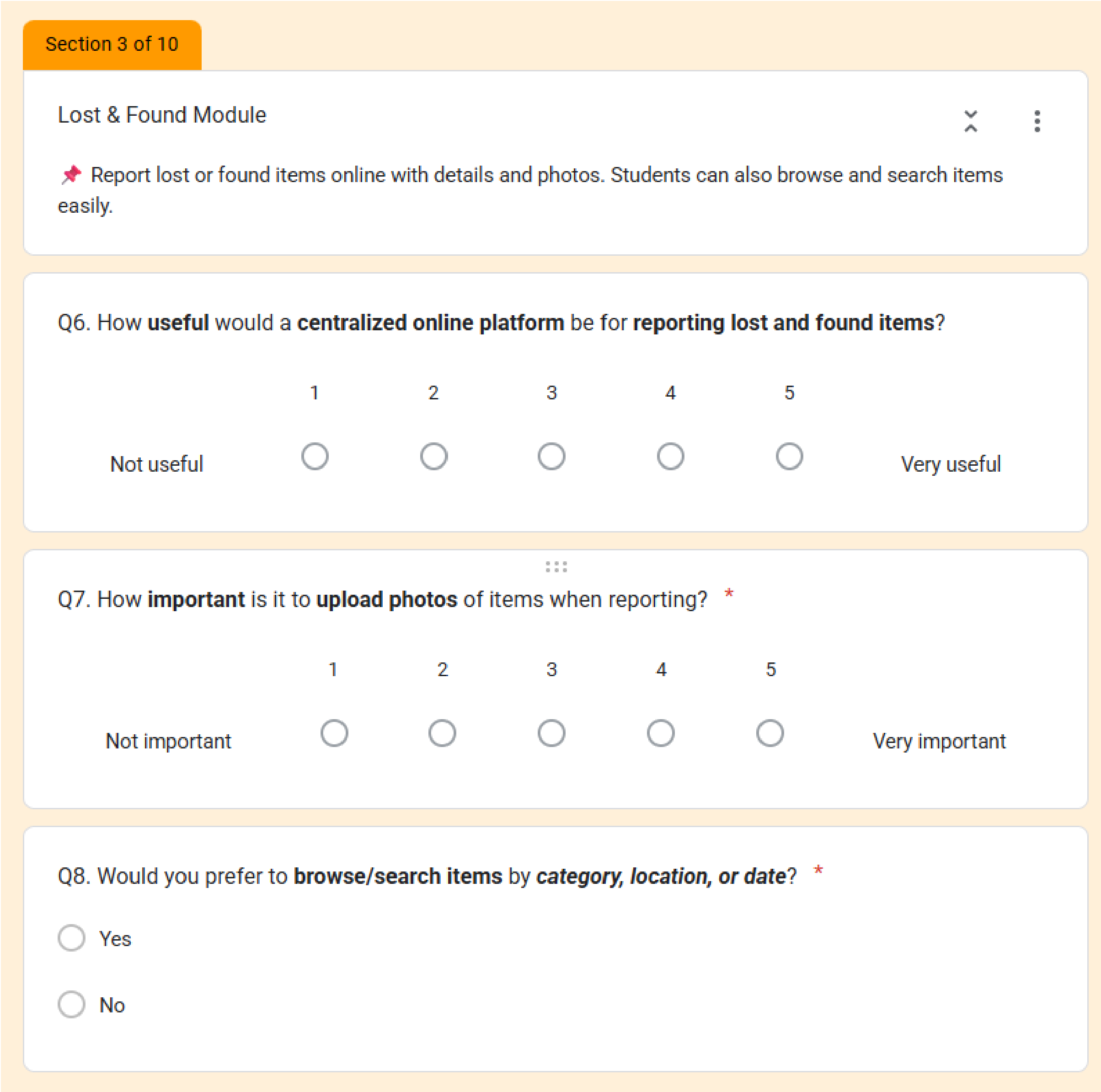
1	2	3	4	5
☆	☆	☆	☆	☆

Q5. What **problems** have you faced in the **current process**? (**Check all that apply**) *

- ☐ No centralized reporting system
- ☐ Delay in retrieving items
- ☐ Difficult to prove ownership
- ☐ No proper notifications/updates
- ☐ Other...

After section 2 Continue to next section

Appendix 1.3 Question Template (Student) – Q4 and Q5


Section 3 of 10

Lost & Found Module

📌 Report lost or found items online with details and photos. Students can also browse and search items easily.

Q6. How **useful** would a **centralized online platform** be for **reporting lost and found items**?

	1	2	3	4	5	
Not useful	○	○	○	○	○	Very useful

Q7. How **important** is it to **upload photos** of items when reporting? *

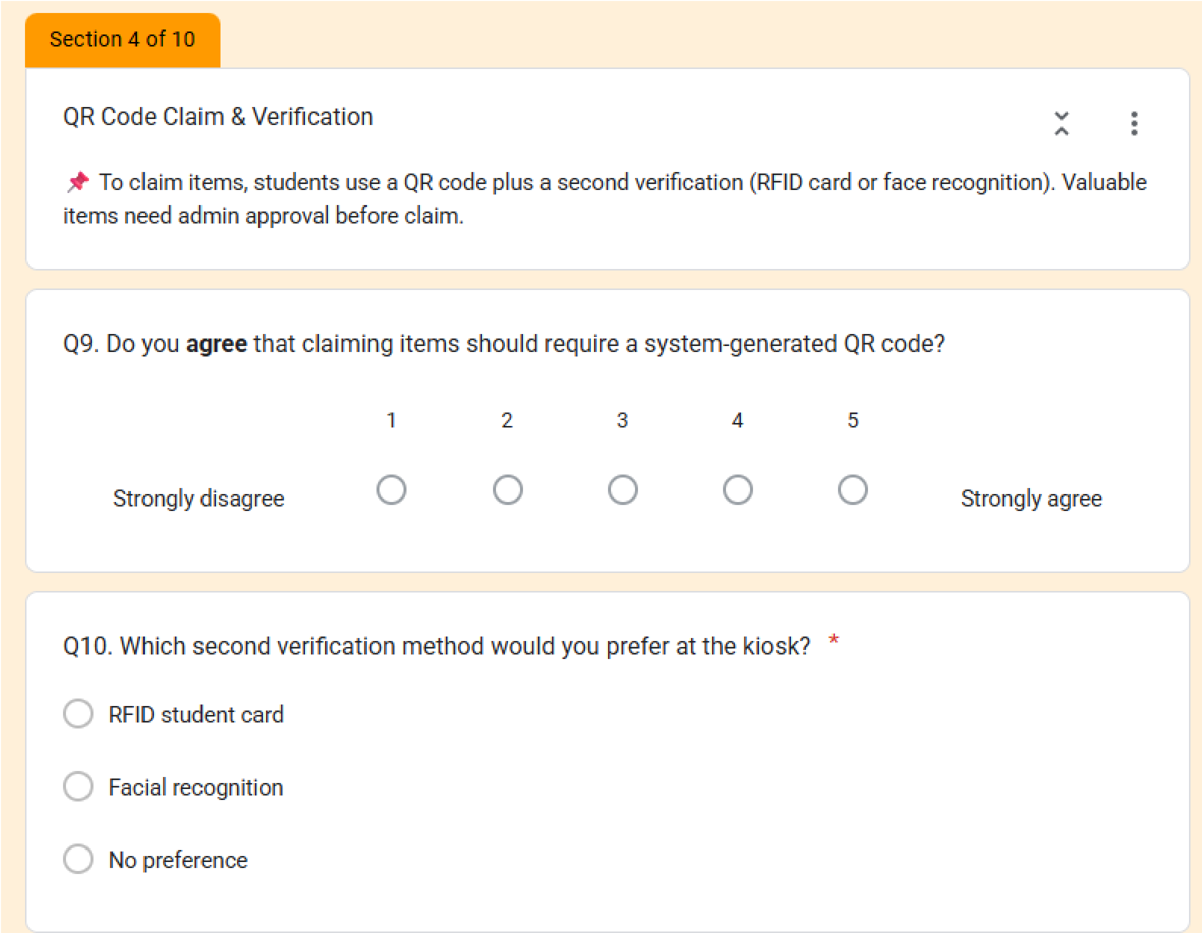
	1	2	3	4	5	
Not important	○	○	○	○	○	Very important

Q8. Would you prefer to **browse/search items** by ***category, location, or date***? *

○ Yes

○ No

Appendix 1.4 Question Template (Student) – Q6, Q7 and Q8



Section 4 of 10

QR Code Claim & Verification

📌 To claim items, students use a QR code plus a second verification (RFID card or face recognition). Valuable items need admin approval before claim.

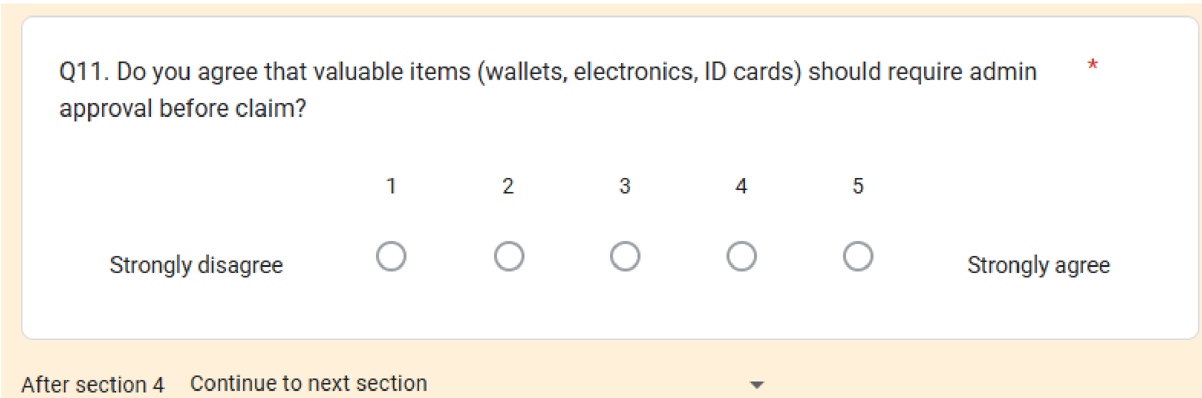
Q9. Do you **agree** that claiming items should require a system-generated QR code?

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Q10. Which second verification method would you prefer at the kiosk? *

- RFID student card
- Facial recognition
- No preference

Appendix 1.5 Question Template (Student) – Q9 and Q10

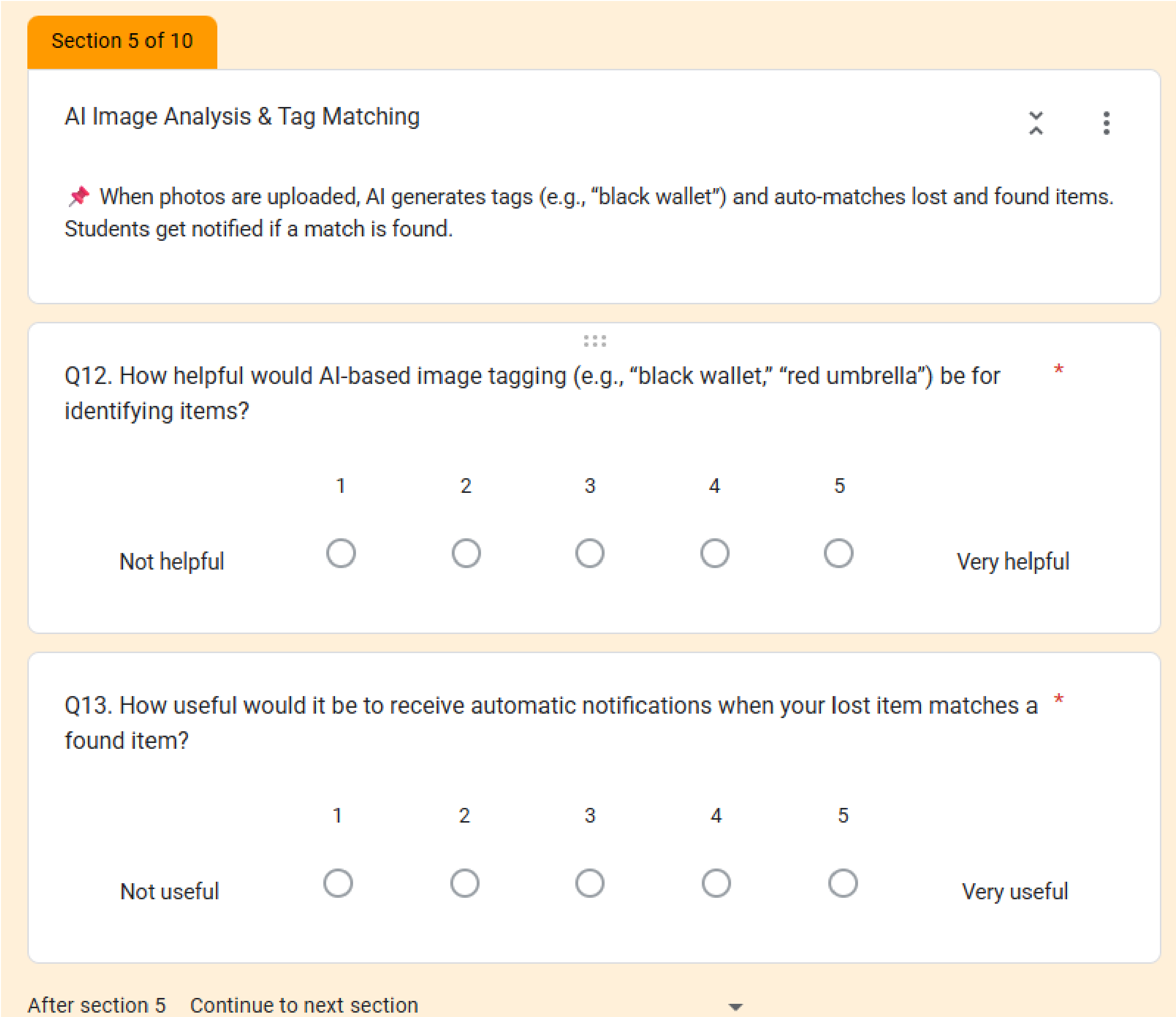


Q11. Do you agree that valuable items (wallets, electronics, ID cards) should require admin approval before claim? *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

After section 4 Continue to next section

Appendix 1.6 Question Template (Student) – Q11



Section 5 of 10

AI Image Analysis & Tag Matching

📌 When photos are uploaded, AI generates tags (e.g., “black wallet”) and auto-matches lost and found items. Students get notified if a match is found.

Q12. How helpful would AI-based image tagging (e.g., “black wallet,” “red umbrella”) be for identifying items? *

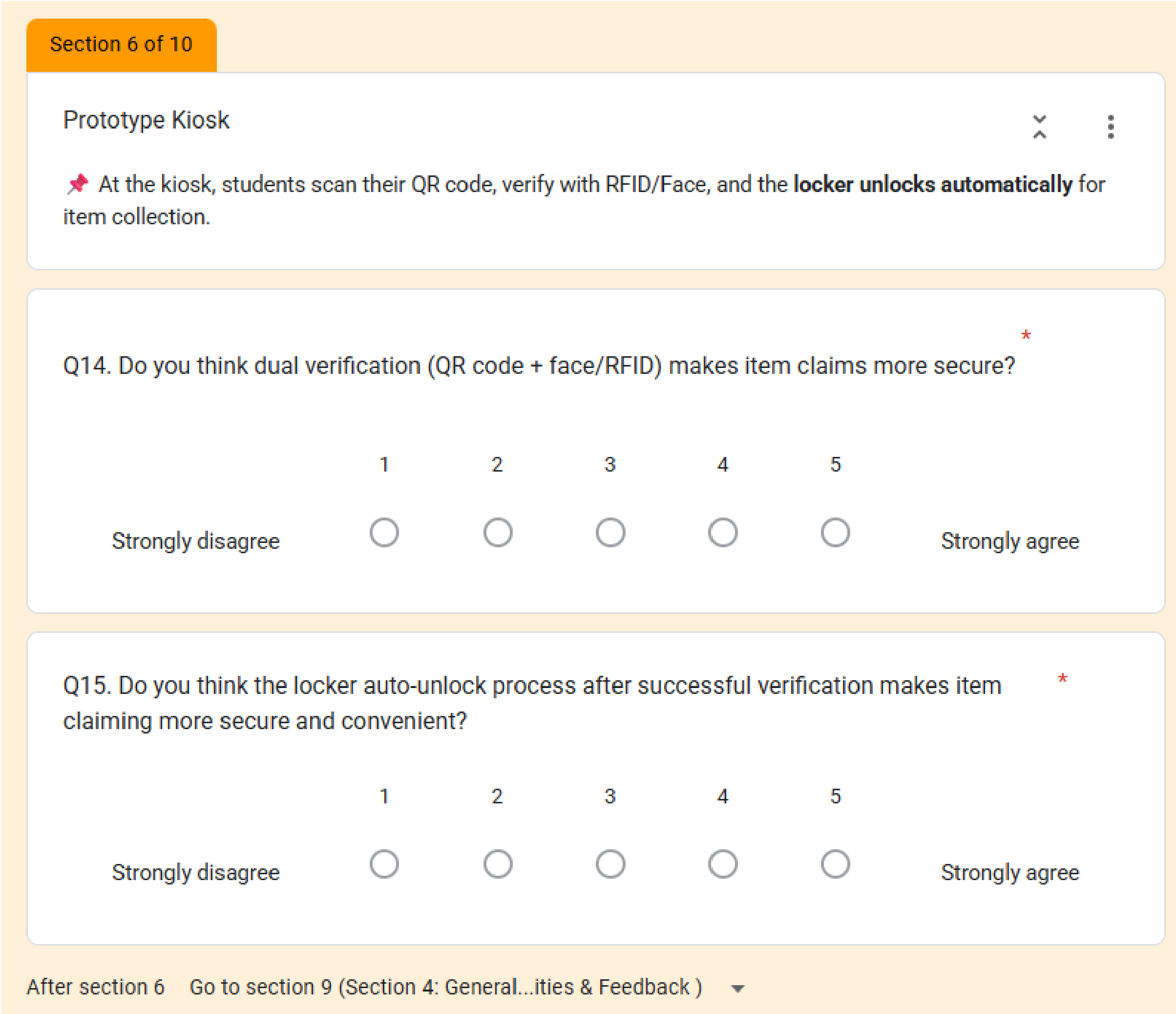
	1	2	3	4	5	
Not helpful	○	○	○	○	○	Very helpful

Q13. How useful would it be to receive automatic notifications when your lost item matches a found item? *

	1	2	3	4	5	
Not useful	○	○	○	○	○	Very useful

After section 5 Continue to next section

Appendix 1.7 Question Template (Student) – Q12 and Q13



Section 6 of 10

Prototype Kiosk

📌 At the kiosk, students scan their QR code, verify with RFID/Face, and the **locker unlocks automatically** for item collection.

Q14. Do you think dual verification (QR code + face/RFID) makes item claims more secure? *

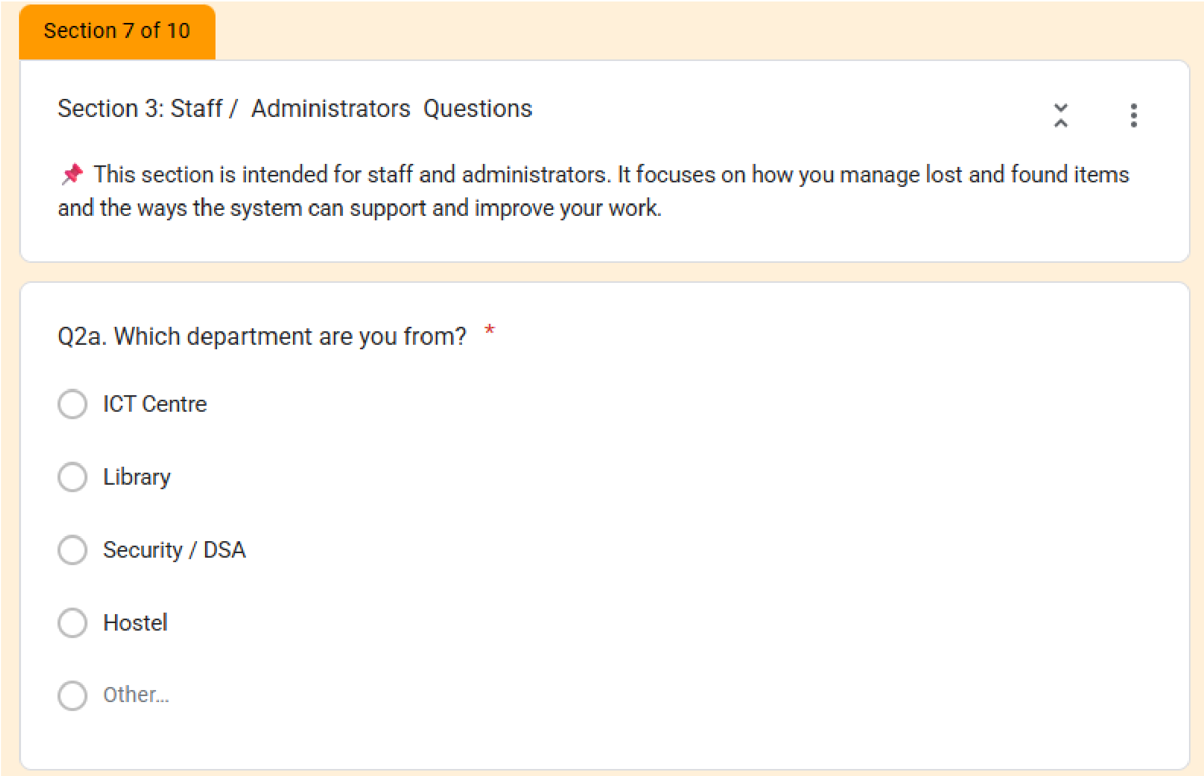
	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Q15. Do you think the locker auto-unlock process after successful verification makes item claiming more secure and convenient? *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

After section 6 Go to section 9 (Section 4: General...ities & Feedback)

Appendix 1.8 Question Template (Student) – Q14 and Q15



Section 7 of 10

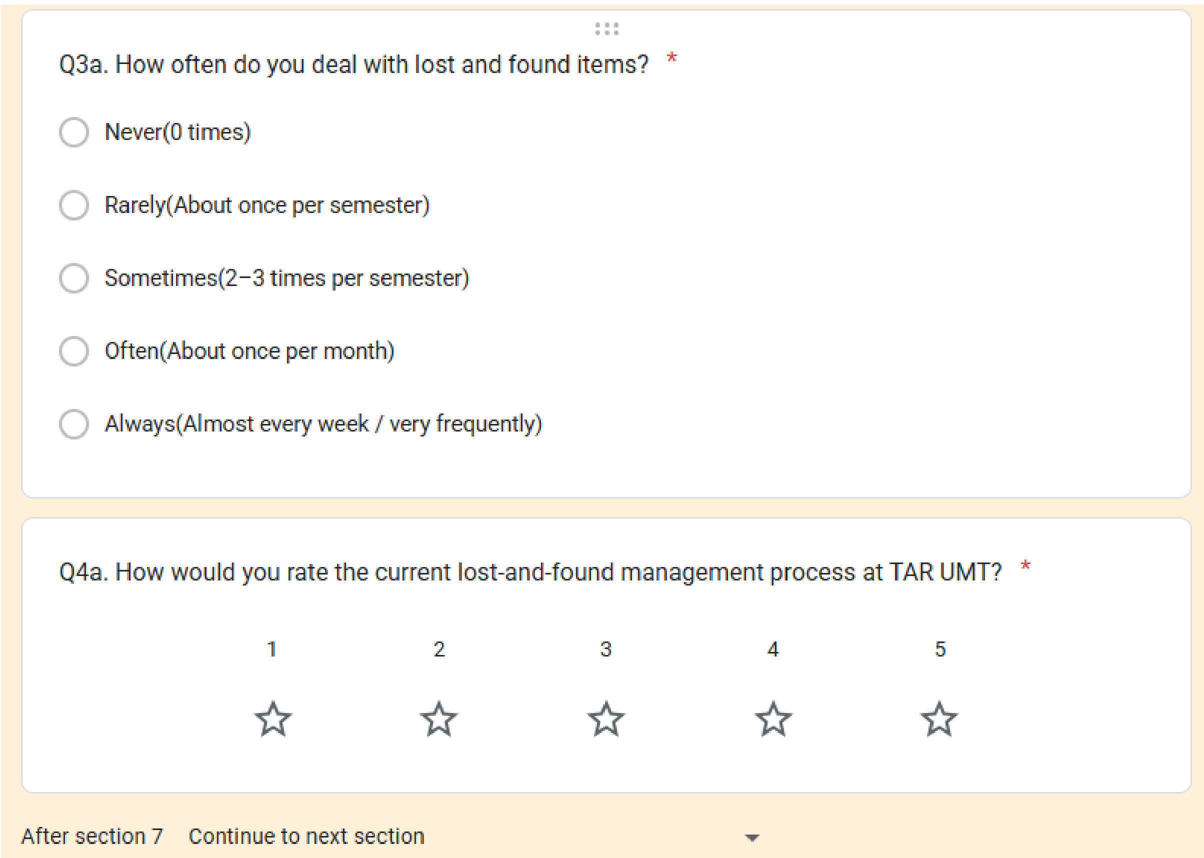
Section 3: Staff / Administrators Questions

📌 This section is intended for staff and administrators. It focuses on how you manage lost and found items and the ways the system can support and improve your work.

Q2a. Which department are you from? *

- ICT Centre
- Library
- Security / DSA
- Hostel
- Other...

Appendix 1.9 Question Template (Admin) – Q2a



Q3a. How often do you deal with lost and found items? *

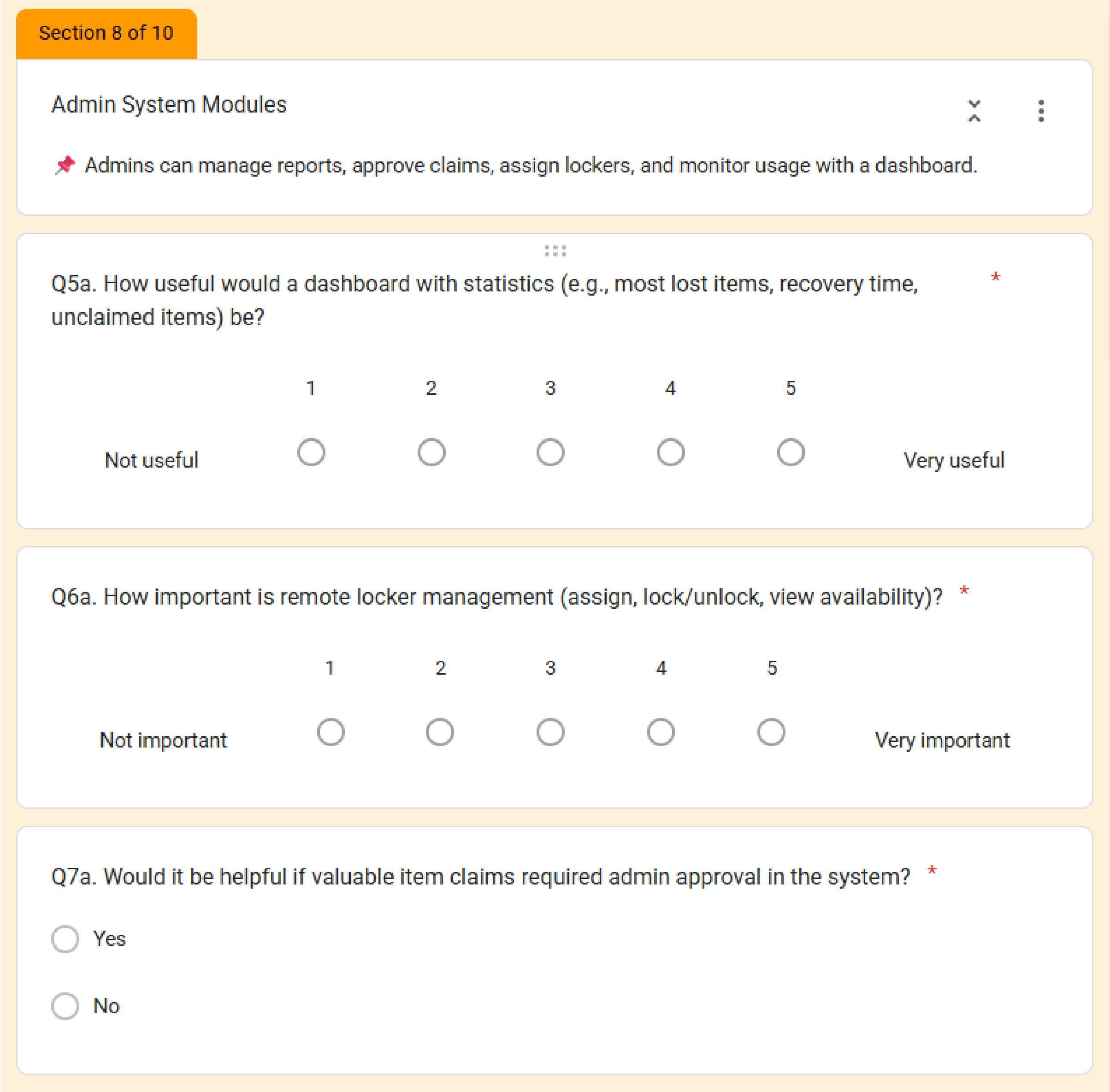
- Never(0 times)
- Rarely(About once per semester)
- Sometimes(2–3 times per semester)
- Often(About once per month)
- Always(Almost every week / very frequently)

Q4a. How would you rate the current lost-and-found management process at TAR UMT? *

1 2 3 4 5

After section 7 Continue to next section

Appendix 1.10 Question Template (Admin) – Q3a and Q4a



Section 8 of 10

Admin System Modules

📌 Admins can manage reports, approve claims, assign lockers, and monitor usage with a dashboard.

Q5a. How useful would a dashboard with statistics (e.g., most lost items, recovery time, unclaimed items) be? *

	1	2	3	4	5	
Not useful	○	○	○	○	○	Very useful

Q6a. How important is remote locker management (assign, lock/unlock, view availability)? *

	1	2	3	4	5	
Not important	○	○	○	○	○	Very important

Q7a. Would it be helpful if valuable item claims required admin approval in the system? *

- ○ Yes
- ○ No

Appendix 1.11 Question Template (Admin) – Q5a, Q6a and Q7a

Section 9 of 10

Section 4: General System Qualities & Feedback

📌 The system should be fast, secure, reliable, and available when needed. Share your thoughts and suggestions here.

Q15. How important is fast system response (e.g., less than 5 seconds for search or tagging)? *

	1	2	3	4	5	
Not important	○	○	○	○	○	Very important

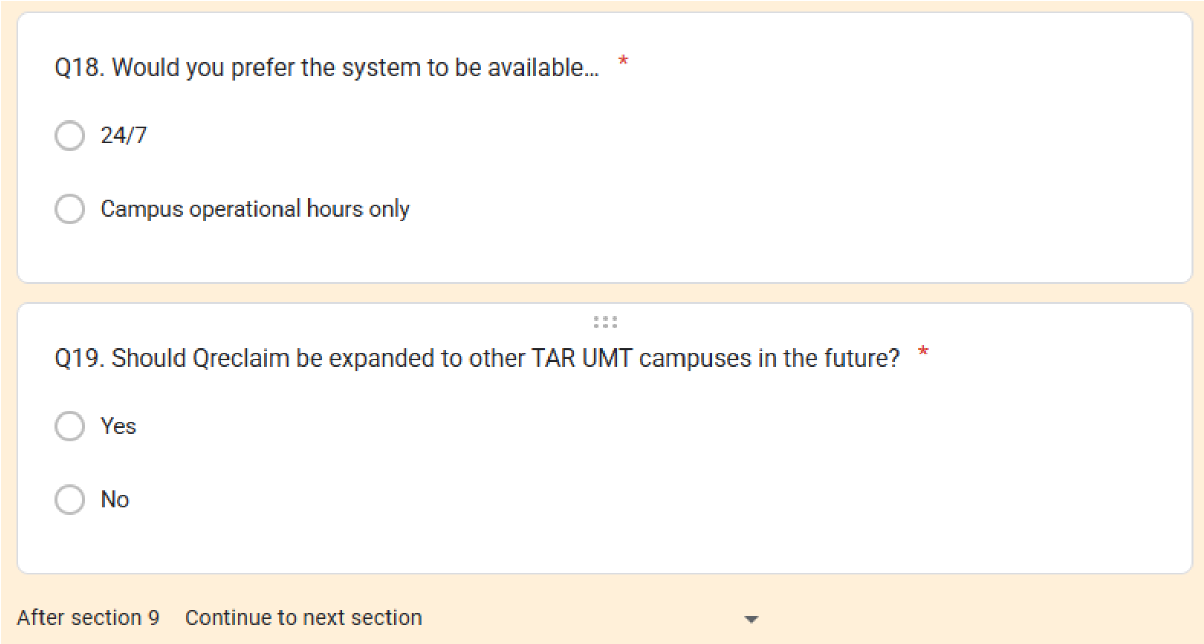
Q16. How important is data security (protection of ID, RFID, and face recognition data)? *

	1	2	3	4	5	
Not important	○	○	○	○	○	Very important

Q17. How important is system reliability (no frequent errors or downtime)? *

	1	2	3	4	5	
Not important	○	○	○	○	○	Very important

Appendix 1.12 Question Template (General) – Q15, Q16 and Q17



Q18. Would you prefer the system to be available... *

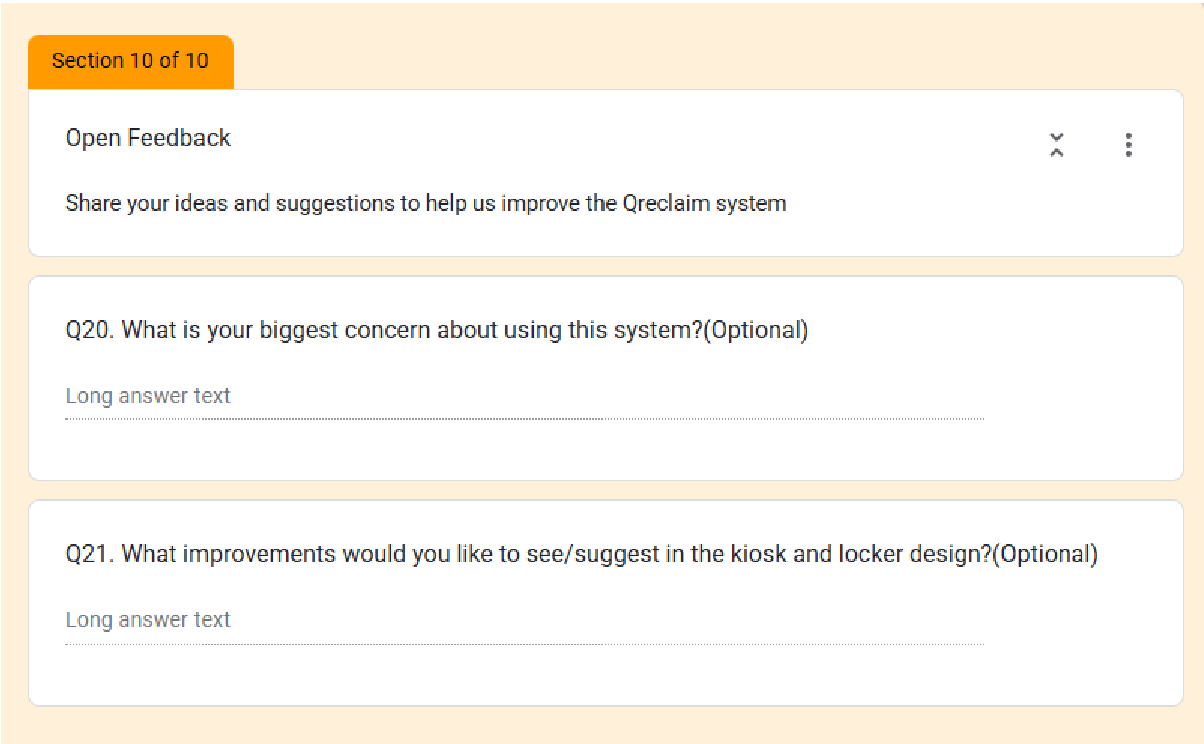
- 24/7
- Campus operational hours only

Q19. Should Qreclaim be expanded to other TAR UMT campuses in the future? *

- Yes
- No

After section 9 Continue to next section

Appendix 1.13 Question Template (General) – Q18 and Q19



Section 10 of 10

Open Feedback

Share your ideas and suggestions to help us improve the Qreclaim system

Q20. What is your biggest concern about using this system?(Optional)

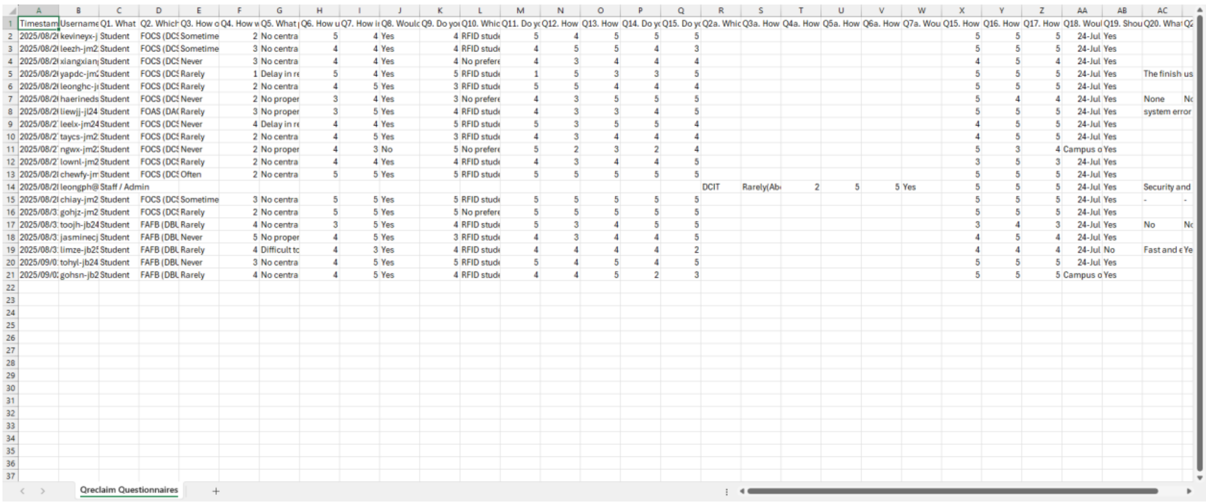
Long answer text

Q21. What improvements would you like to see/suggest in the kiosk and locker design?(Optional)

Long answer text

Appendix 1.14 Question Template (General) – Q20 and Q21

Appendix B - Results of the Questionnaire Survey



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	
1	Timestam	Username	Q1. What	Q2. Which	Q3. How o	Q4. How w	Q5. What	Q6. How u	Q7. How i	Q8. Woulc	Q9. Do yo	Q10. Whic	Q11. Do yc	Q12. How	Q13. How	Q14. Do yc	Q15. Do yc	Q2a. Whic	Q3a. How	Q4a. How	Q5a. How	Q6a. How	Q7a. Wou	Q15. How	Q16. How	Q17. How	Q18. Woul	Q19. Shou	Q20. What	Q2
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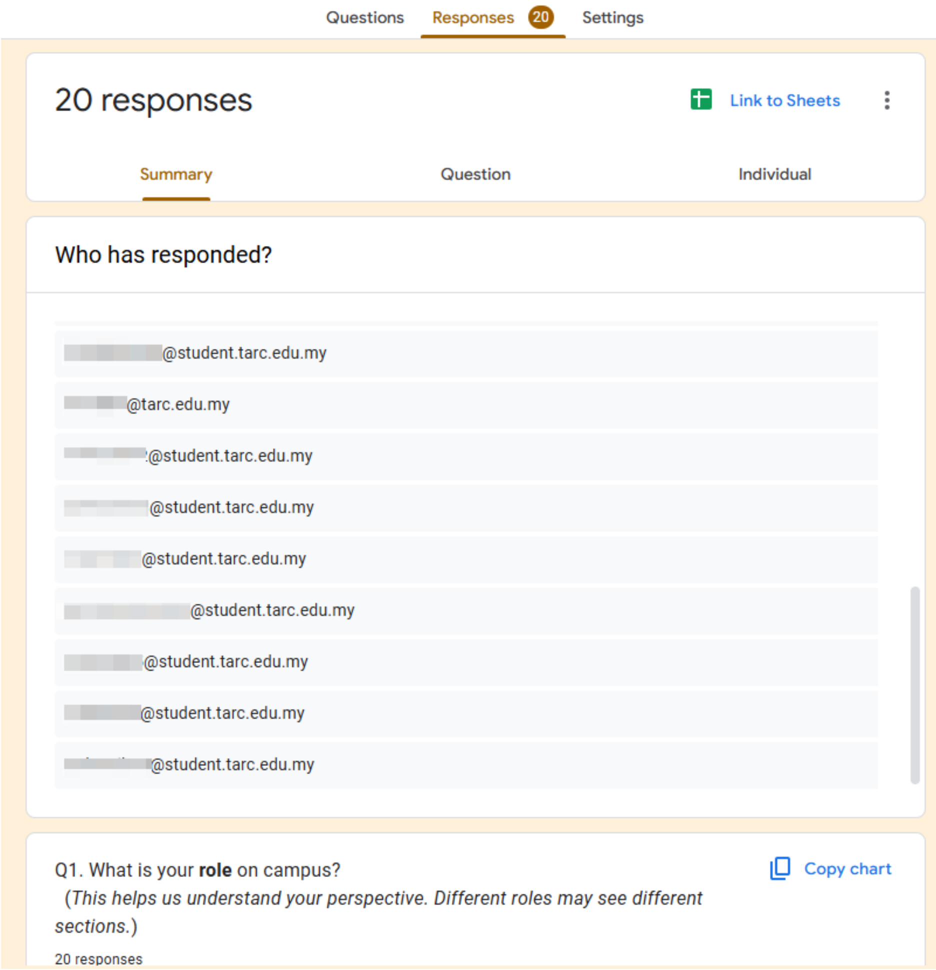
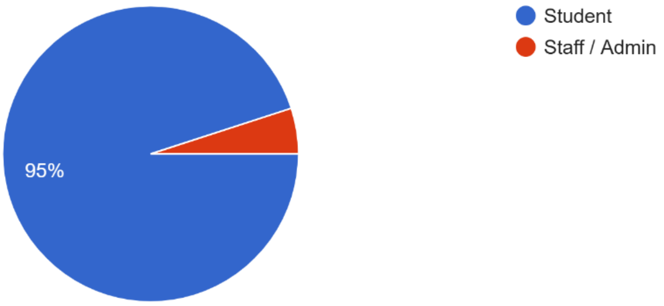
3	2025/08/2(	leezh-jm2	Student	FOCS (DCS	Sometime	3	No centra	4	4	Yes	4	RFID stude	4	5	5	4	3							5	5	5	24-Jul	Yes		
4	2025/08/2(	xiangxian	Student	FOCS (DCS	Never	3	No centra	4	4	Yes	4	No prefere	4	3	4	4	4							4	5	4	24-Jul	Yes		
5	2025/08/2(	yapdc-jm2	Student	FOCS (DCS	Rarely	1	Delay in re	5	4	Yes	5	RFID stude	1	5	3	3	5							5	5	5	24-Jul	Yes	The finish	us
6	2025/08/2(	leonghc-j	Student	FOCS (DCS	Rarely	2	No centra	4	5	Yes	3	RFID stude	5	5	4	4	4							5	5	5	24-Jul	Yes		
7	2025/08/2(	haerineds	Student	FOCS (DCS	Never	2	No proper	3	4	Yes	3	No prefere	4	3	5	5	5							5	4	4	24-Jul	Yes	None	Nc
8	2025/08/2(	liewjj-jl24	Student	FOAS (DAC	Rarely	3	No proper	3	5	Yes	4	RFID stude	4	3	3	4	5							5	5	5	24-Jul	Yes	system error	
9	2025/08/2'	leelx-jm24	Student	FOCS (DCS	Never	4	Delay in re	4	4	Yes	5	RFID stude	5	3	5	5	4							4	5	5	24-Jul	Yes		
10	2025/08/2'	taycs-jm2	Student	FOCS (DCS	Rarely	2	No centra	4	5	Yes	3	RFID stude	4	3	4	4	4							4	5	5	24-Jul	Yes		
11	2025/08/2'	ngwx-jm2	Student	FOCS (DCS	Never	2	No proper	4	3	No	5	No prefere	5	2	3	2	4							5	3	4	Campus o	Yes		
12	2025/08/2'	lownl-jm2	Student	FOCS (DCS	Rarely	2	No centra	4	4	Yes	4	RFID stude	4	3	4	4	5							3	5	3	24-Jul	Yes		
13	2025/08/2(	chewfy-jm	Student	FOCS (DCS	Often	2	No centra	5	5	Yes	5	RFID stude	5	5	5	5	5							5	5	5	24-Jul	Yes		
14	2025/08/2(	leongph@	Staff / Admin															DCIT	Rarely(Ab	2	5	5	Yes	5	5	5	24-Jul	Yes	Security and	
15	2025/08/2(	chiay-jm2	Student	FOCS (DCS	Sometime	3	No centra	5	5	Yes	5	RFID stude	5	5	5	5	5							5	5	5	24-Jul	Yes	-	-
16	2025/08/3:	gohjz-jm2	Student	FOCS (DCS	Rarely	2	No centra	5	5	Yes	5	No prefere	5	5	5	5	5							5	5	5	24-Jul	Yes		
17	2025/08/3:	toojh-jb24	Student	FAFB (DBL	Rarely	4	No centra	3	5	Yes	4	RFID stude	5	3	4	5	5							3	4	3	24-Jul	Yes	No	Nc
18	2025/08/3:	jasminecj	Student	FAFB (DBL	Never	5	No proper	4	5	Yes	3	RFID stude	4	3	4	4	5							4	5	4	24-Jul	Yes		
19	2025/08/3:	limze-jb2	Student	FAFB (DBL	Rarely	4	Difficult to	4	3	Yes	4	RFID stude	4	4	4	4	2							4	4	4	24-Jul	No	Fast and e	Ye
20	2025/09/0:	tohyl-jb24	Student	FAFB (DBL	Never	3	No centra	4	5	Yes	5	RFID stude	5	4	5	4	5							5	5	5	24-Jul	Yes		
21	2025/09/0:	gohsn-jb2	Student	FAFB (DBL	Rarely	4	No centra	4	5	Yes	4	RFID stude	4	4	5	2	3							5	5	5	Campus o	Yes		

Appendix 2.1 Questionnaire Result (CSV)



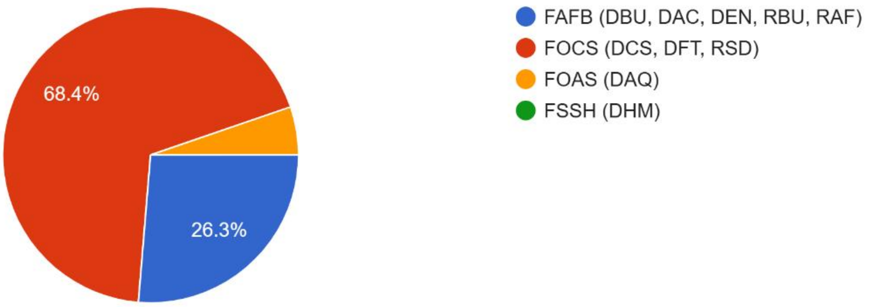
Appendix 2.2 Questionnaire Survey Results

Q1. What is your role on campus? (This helps us understand your perspective. Different roles may see different sections.)
20 responses

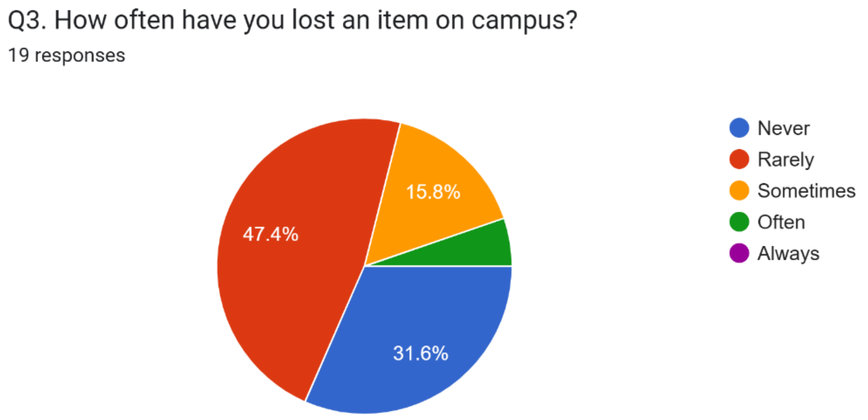


Appendix 2.3 Questionnaire Survey Results – Q1

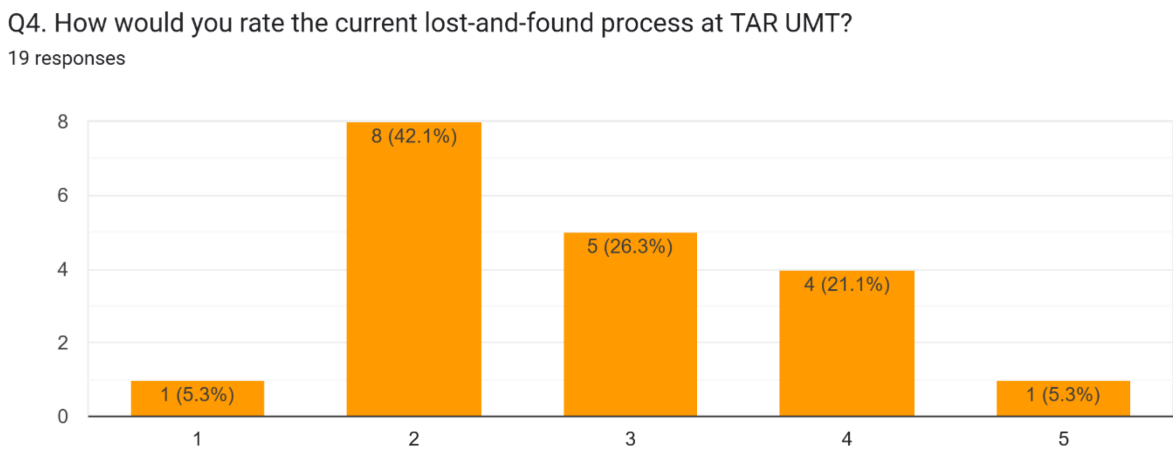
Q2. Which faculty are you from?
19 responses



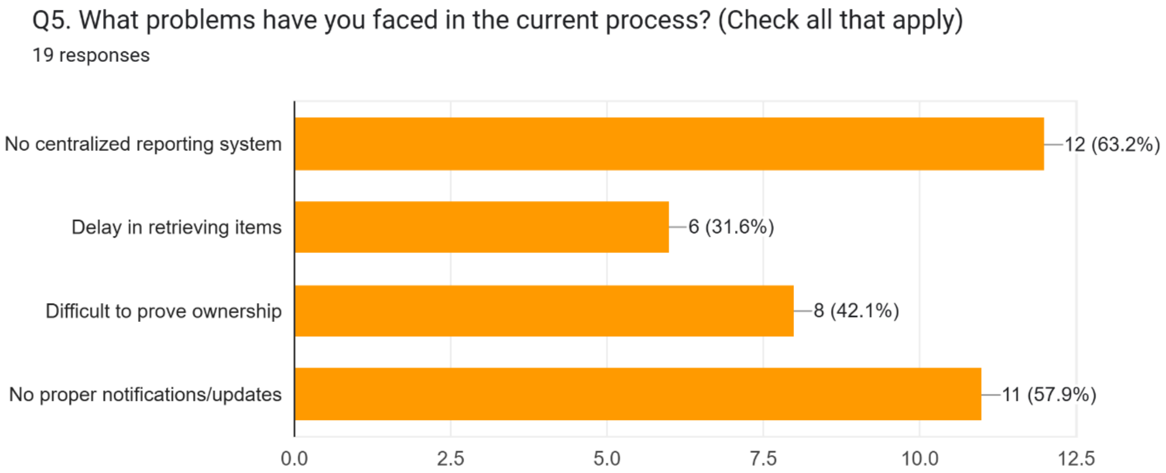
Appendix 2.4 Questionnaire Survey Results (Students) – Q2



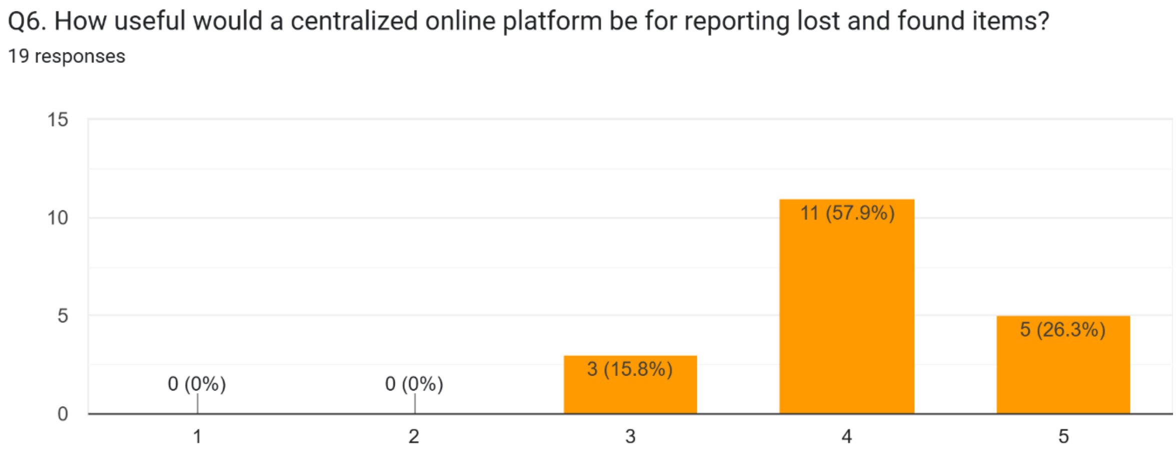
Appendix 2.5 Questionnaire Survey Results (Students) – Q3



Appendix 2.6 Questionnaire Survey Results (Students) – Q4

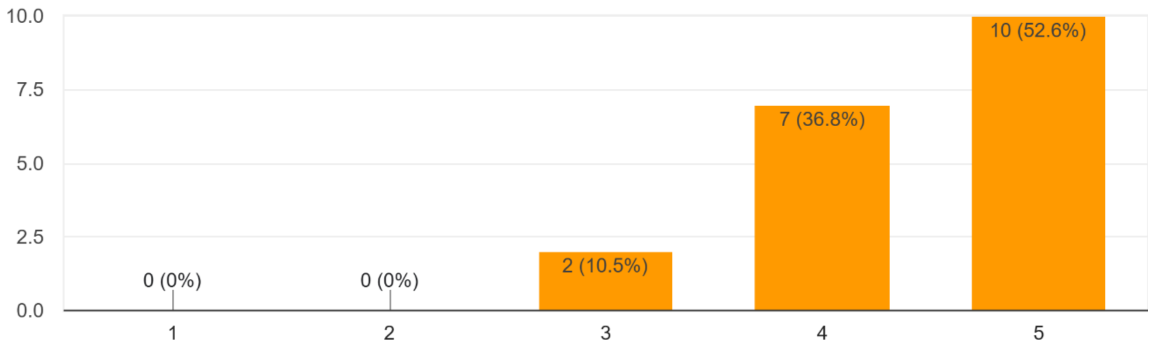


Appendix 2.7 Questionnaire Survey Results (Students) – Q5



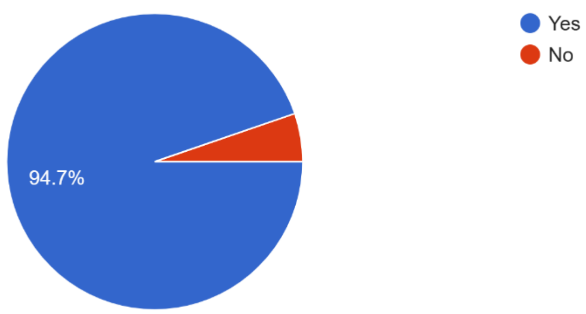
Appendix 2.8 Questionnaire Survey Results (Students) – Q6

Q7. How important is it to upload photos of items when reporting?
19 responses

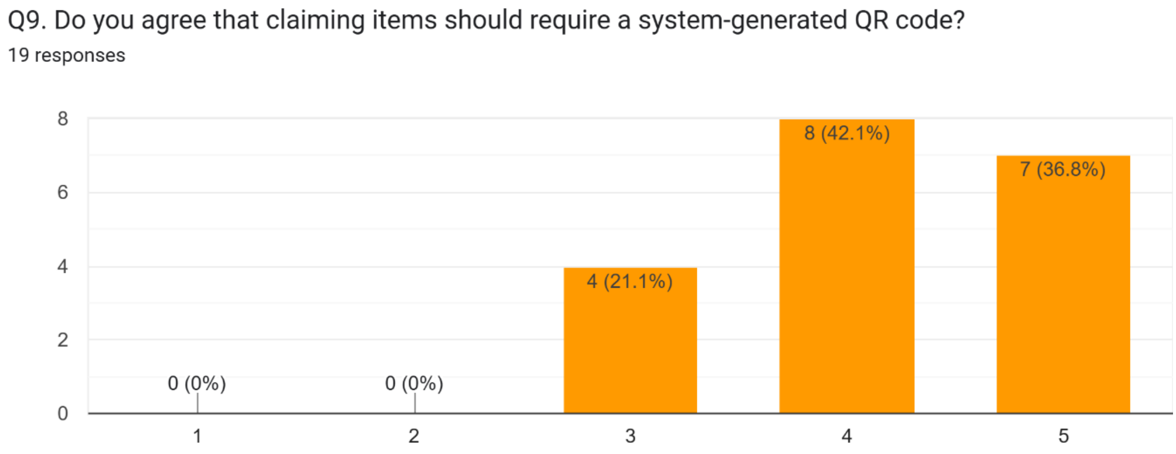


Appendix 2.9 Questionnaire Survey Results (Students) – Q7

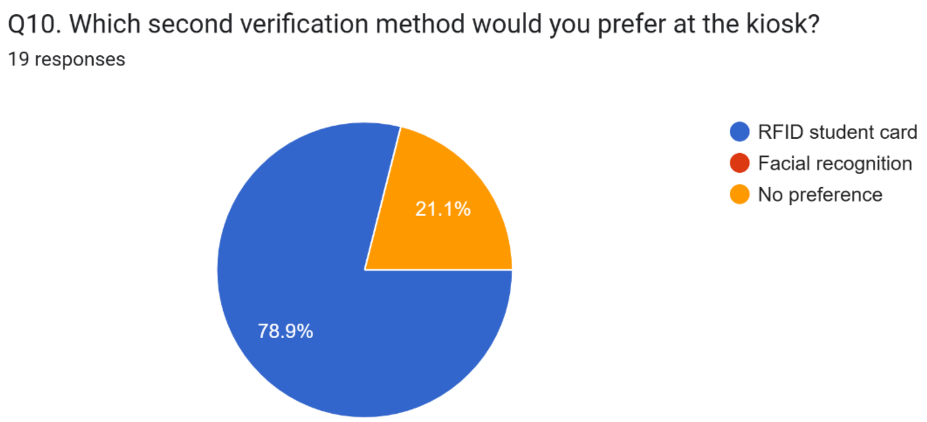
Q8. Would you prefer to browse/search items by category, location, or date?
19 responses



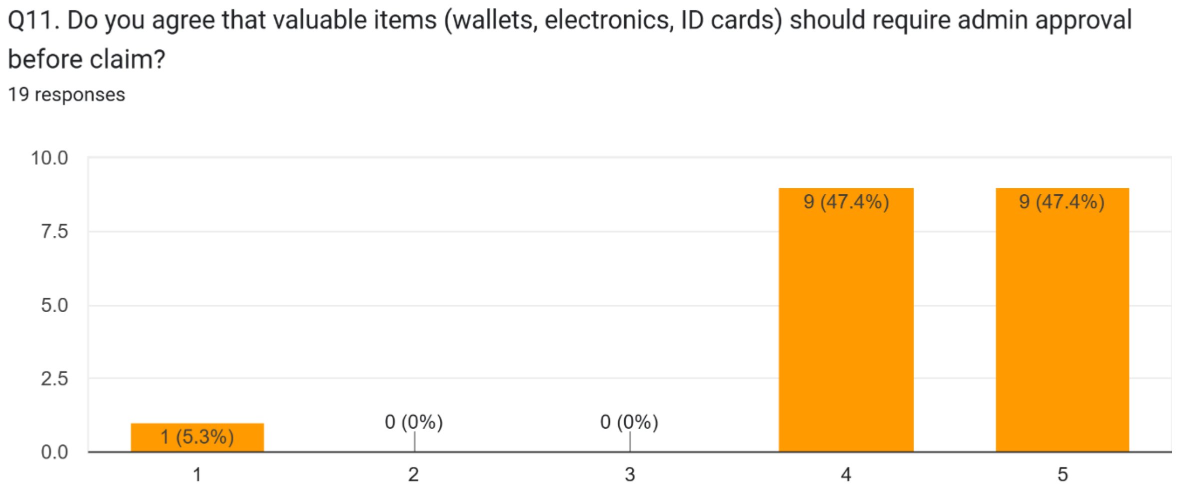
Appendix 2.10 Questionnaire Survey Results (Students) – Q8



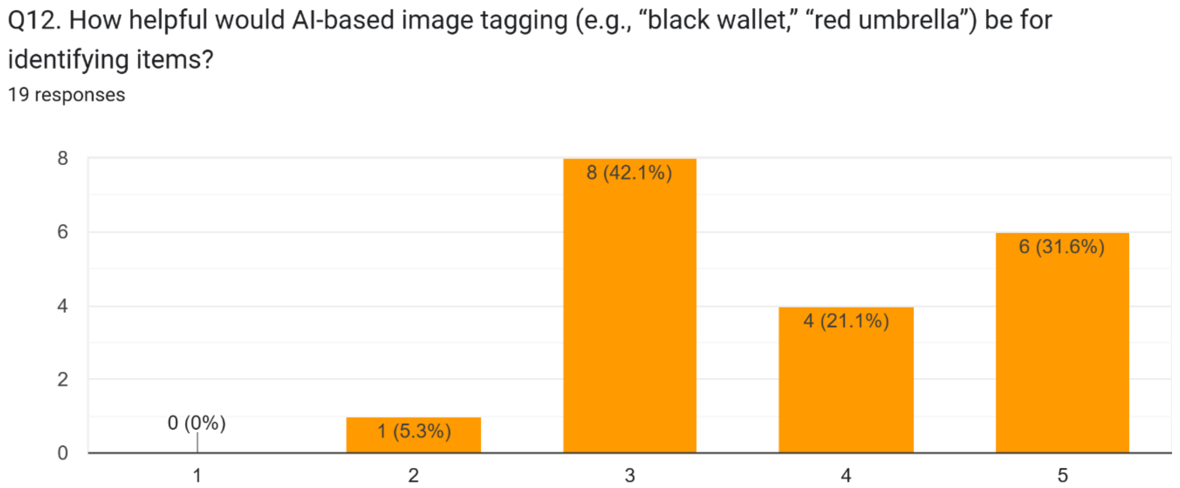
Appendix 2.11 Questionnaire Survey Results (Students) – Q9



Appendix 2.12 Questionnaire Survey Results (Students) – Q10



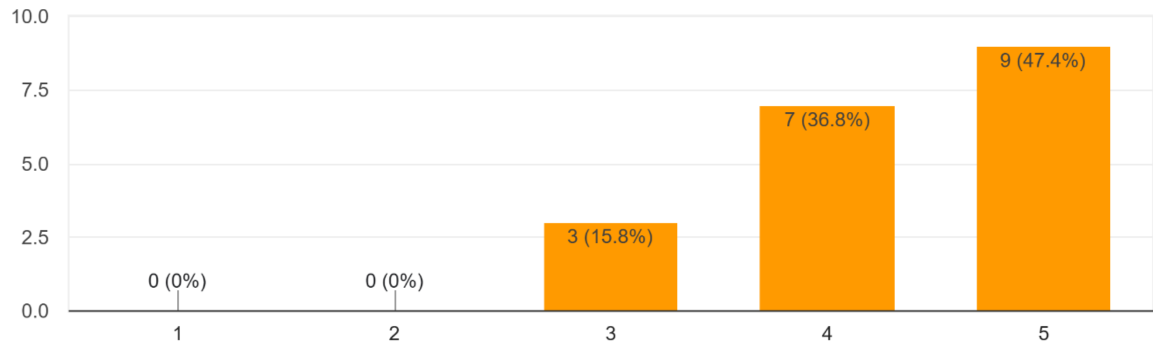
Appendix 2.13 Questionnaire Survey Results (Students) – Q11



Appendix 2.14 Questionnaire Survey Results (Students) – Q12

Q13. How useful would it be to receive automatic notifications when your lost item matches a found item?

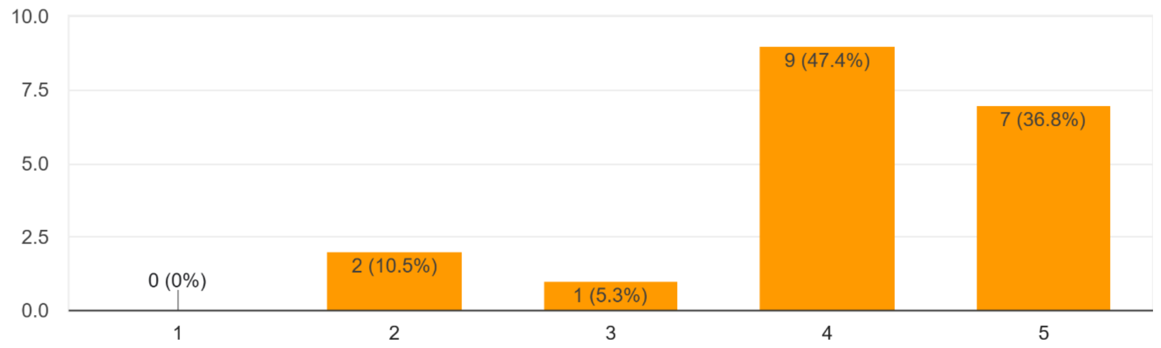
19 responses



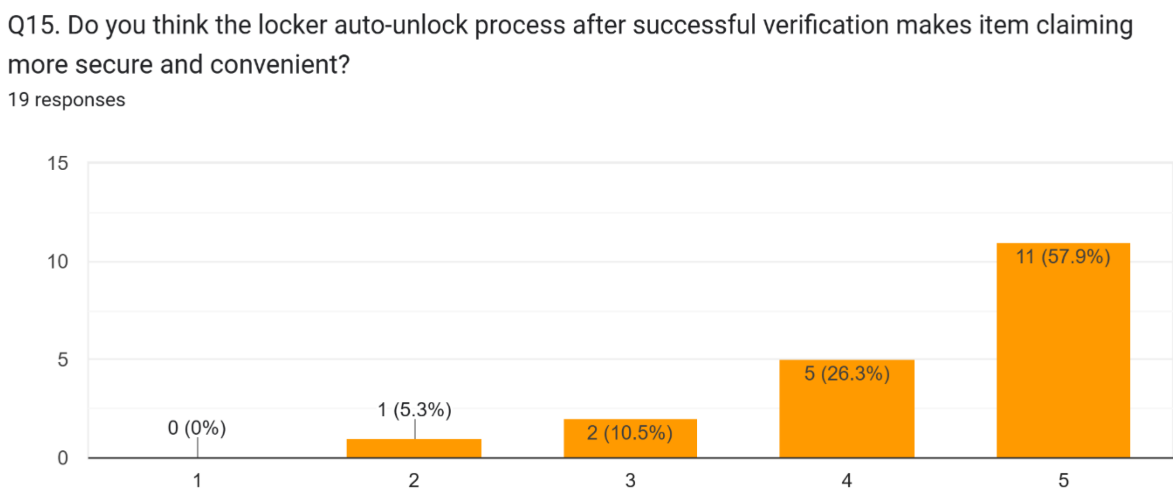
Appendix 2.15 Questionnaire Survey Results (Students) – Q13

Q14. Do you think dual verification (QR code + face/RFID) makes item claims more secure?

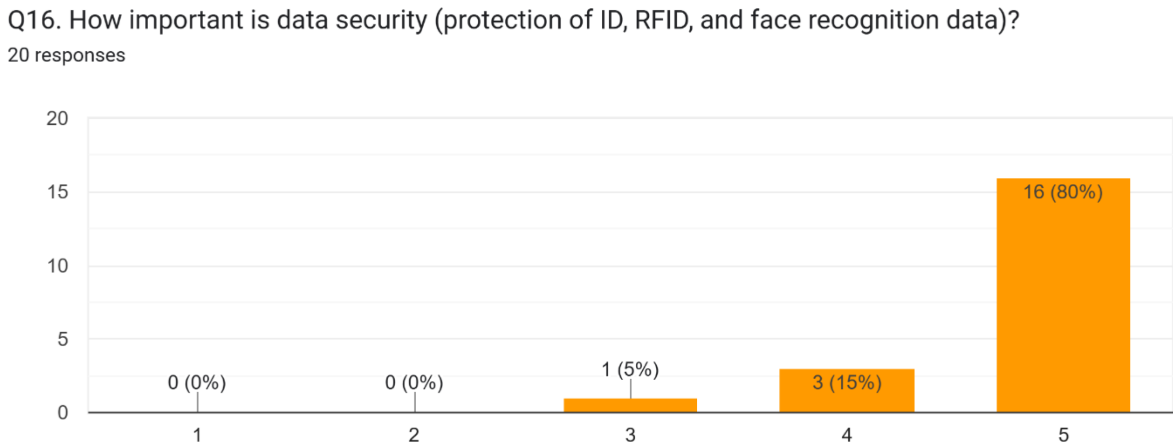
19 responses



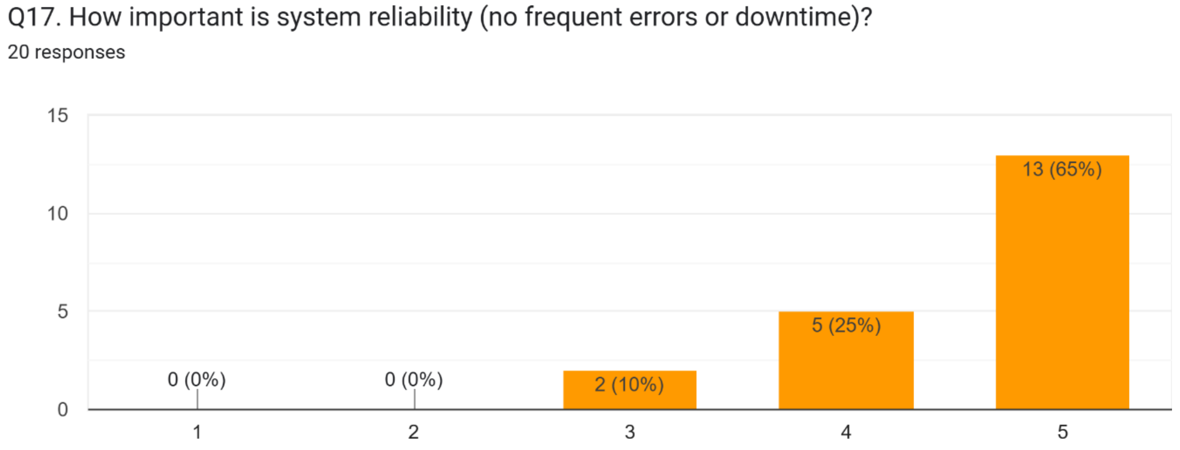
Appendix 2.16 Questionnaire Survey Results (Students) – Q14



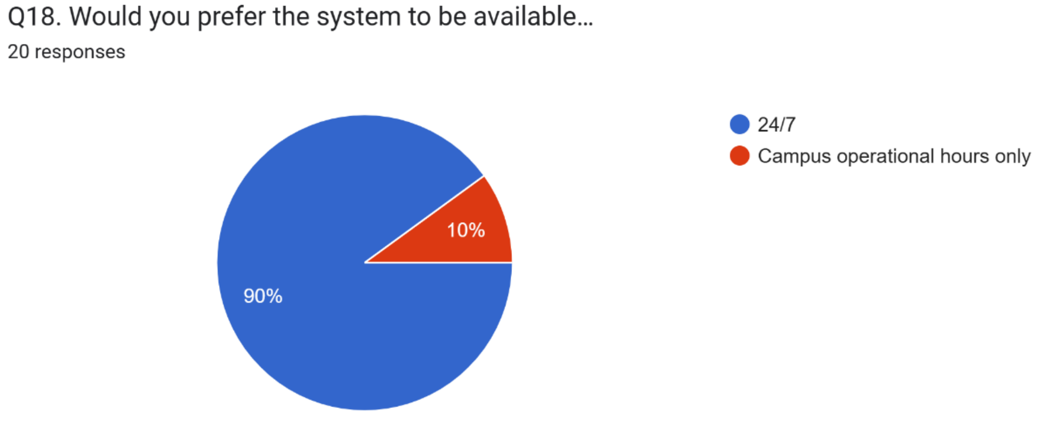
Appendix 2.17 Questionnaire Survey Results – Q15



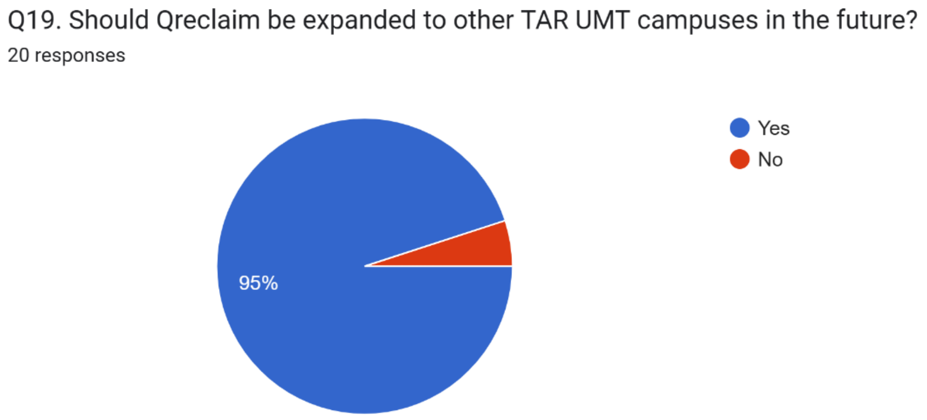
Appendix 2.18 Questionnaire Survey Results – Q16



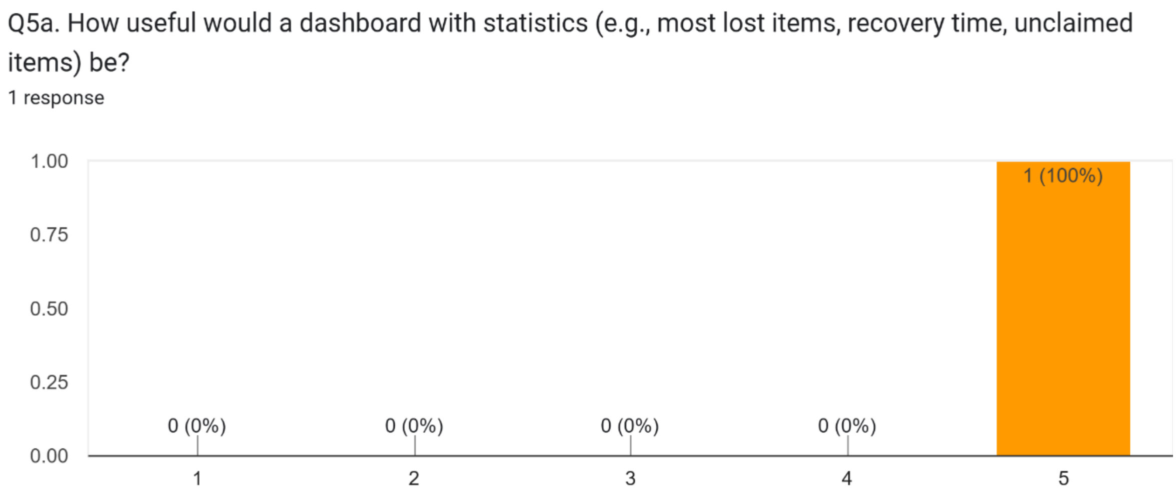
Appendix 2.19 Questionnaire Survey Results – Q17



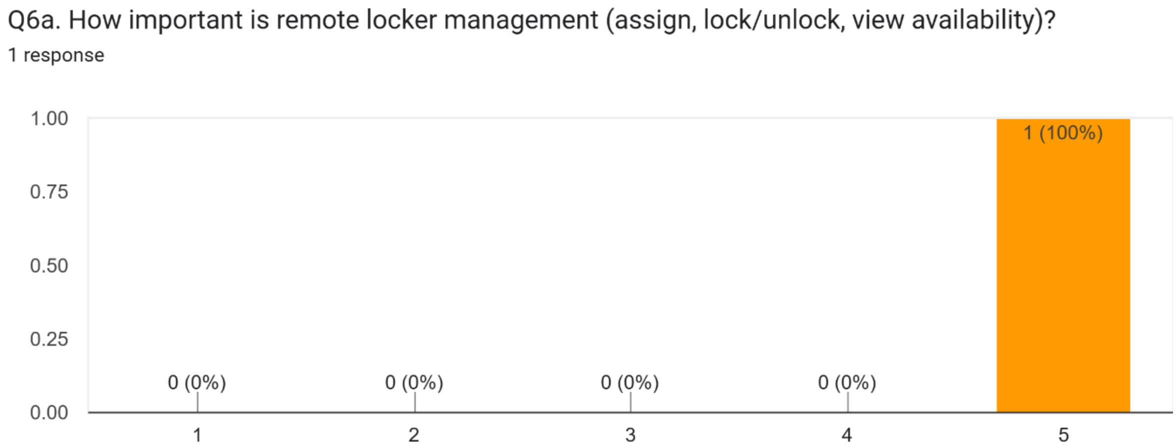
Appendix 2.20 Questionnaire Survey Results (Admins) – Q18



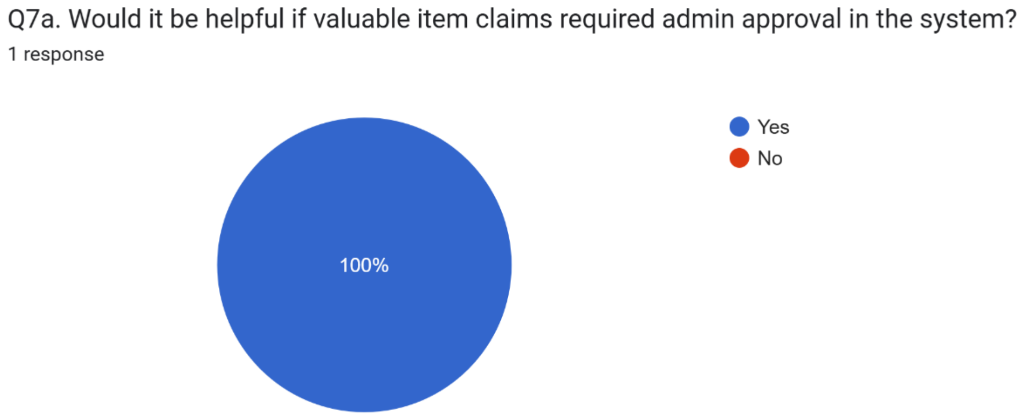
Appendix 2.21 Questionnaire Survey Results (Admins) – Q19



Appendix 2.22 Questionnaire Survey Results (Admins) – Q5a



Appendix 2.23 Questionnaire Survey Results (Admins) – Q6a



Appendix 2.24 Questionnaire Survey Results (Admins) – Q7a