



DEVELOPMENT AND IMPLEMENTATION OF AN ENHANCED OCCUPATIONAL HAZARD MANAGEMENT SYSTEM: CASE STUDY RWANDA SOCIAL SECURITY BOARD

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Abstract

The study's main focus is the establishment of an intelligent software system augmented with Artificial Intelligence for improving occupational hazard management at RSSB, which is crucial in promoting safety and compliance with regulatory frameworks, particularly in risky organizations. The proposed system is intended to facilitate critical processes such as hazard reporting, risk assessment, and safety training, which have been major challenges due to manual handling. By leveraging technologies like data analytics, the system aims to enhance the accuracy, speed, and efficiency of identifying and controlling hazards. Current issues observed, analyzed, and discussed in the study include existing delays and inefficiencies in RSSB's work, data inaccuracies, and low user engagement. The proposed methodology follows a system analysis and design approach, incorporating automation and data integration to streamline processes. Drawing lessons on scaling up best practices in hazard management, the study recommends RSSB adopt a robust Hazard Management System. Such a system would address the current inefficiencies and provide a structured, technology-driven framework to ensure proactive and effective hazard management. The adoption of an HMS would not only improve the accuracy and timeliness of hazard reporting but also foster a culture of safety and compliance within the organization. By integrating advanced AI tools and analytics, RSSB can significantly enhance its capacity to manage occupational risks, ensuring a safer working environment for all stakeholders. This study provides actionable recommendations for policymakers, officials, and safety practitioners to prioritize and implement these improvements for sustainable workplace safety.

Keywords: *Occupational hazards, automation, risk assessment, data analytics, and workplace staff*

1. Introduction

The Rwanda Social Security Board is responsible for guaranteeing Rwandan people' social security and well-being. RSSB was established to provide social protection services in a variety of areas, including health insurance, pension systems, and workplace safety (RSSB, Occupational Hazard, 2024). RSSB's emphasis on occupational safety and health management is critical for protecting workers' rights and maintaining a safe workplace. RSSB, like many other businesses, confronts difficulty in efficiently recognizing, assessing, and minimizing occupational hazards in the workplace (RSSB, Occupational Hazard, 2024). One of the most significant issues is the reliance on traditional hazard management methods, which may fail to fully realize the benefits of sophisticated technologies. Manual systems for risk assessment, incident reporting, and safety audits can be time-consuming and may not give real-time information on new dangers (Rapid & Global, 2024).

Furthermore, maintaining compliance with occupational safety legislation and industry standards is an ongoing problem. Another source of concern is the need for stakeholders to collaborate and exchange data more effectively. Integrating RSSB's occupational health databases with employer portals and current systems is critical for ensuring smooth information flow and effective collaboration in addressing occupational hazards (ILO, How can occupational safety and health be managed? | International Labour Organization, 2024).

2. Problem statement

The current system for managing occupational hazards at the Rwanda Social Security Board (RSSB) faces numerous inefficiencies and operational challenges that undermine its effectiveness. At its core, the system relies heavily on manual reporting and processing mechanisms. Hazard reports are submitted through paper forms, which are then manually entered into the system by staff. This dependence on manual processes introduces significant delays and increases the likelihood of errors in hazard identification, reporting, and analysis. These inefficiencies not only slow down the process but also hinder timely interventions, putting both employees and organizations at risk.

(RSSB, Occupation hazard issues, 2014). One of the critical limitations of the current system is the inconsistency and incompleteness of the data collected. Manual reporting often results in fragmented and inaccurate records, making it difficult for RSSB to comprehensively assess and address workplace risks. Without a streamlined, standardized approach, data discrepancies can emerge,

complicating efforts to analyze trends and identify recurring issues. Additionally, the reliance on both paper-based and digital storage systems creates a dual approach that poses risks of data loss and discrepancies, further complicating hazard management efforts. (Staff,C, 2023, July 26). The high operational costs of the existing system are another concern. Expenses related to printing, storage, and administrative labor strain resources, while employees face personal costs, such as airtime expenses, when reporting hazards. These financial burdens, coupled with cumbersome and non-user-friendly reporting procedures, reduce the motivation and engagement of employees and employers in hazard reporting. This lack of engagement further exacerbates the challenges in maintaining accurate records and implementing effective safety interventions. Moreover, the current system lacks robust oversight and information accessibility. The manual nature of the process makes it difficult for RSSB to maintain visibility and control over reported hazards, compromising record-keeping and traceability. This lack of digitization also limits the organization's ability to analyze data in real time and provide timely, data-driven responses. As a result, RSSB struggles to identify and prioritize emerging hazards, leaving workplaces vulnerable to preventable risks.

3. Objectives

General objective of the study

Develop and implement an intelligent software system that improves the efficiency and effectiveness of occupational hazard management at RSSB. This would improve workplace safety and delivery of service.

Specific objectives

1. To develop and implement an intelligent software solution for the Rwanda Social Security Board (RSSB).
2. To establish a digital system for real-time hazard reporting and risk assessment
3. To demonstrate the improved efficiency and accuracy of risk management.

4. Literature Review

The concept of occupational hazard management

EOHM is defined as the systematic looming, evaluation and control of potential risk factors at workplaces which endanger the health of employees (Kuhn, Müller, Teusch, Tanner, et al, 2021). It encompasses evaluation of risks, control measures and regulations as a way of preventing risks, diseases and injuries related to different workplaces. Good EOHM practices support organizational culture, improve organizational performance and enforce legal and ethical compliance (al T. e., 2023). Thus, constant and systematic approach to the assessment of safety performance indicators will help an organization develop a healthier environment and reduce various losses due to workplace accidents.

Evolution of occupational hazard management

OHM has thus undergone a shift from post-incident measures that would be mainly designed to address injuries that happen in particular workplaces, to pre-emptive measures which mainly seek to avert hazards from turning into incidents. Early in the twentieth century, the rates of injuries started experiencing a rise and organizations realized that there was need for safety standards (al A. e., 2019). OHM development has occurred throughout the decades, in due consideration of technological progress and occupational health research, alongside the formation of the regulatory bodies that govern OHM practice today based on principles including risk assessment, training programs for employees, and the promotion of safety culture. Presently, OHM is a gigantic concept encompassing behavioral safety, ergonomic working principles, and even environmentally safe practices to create a safety martin environment at workplaces. (Tadesse and Admassu, 2006)

Enhanced occupational hazard management system

EOHMS means the systematic identification, risk analysis and control of occupational hazards with the help of extended strategies and technologies. It also combines reflexive monitoring, data analysis, and feedback from staff members in improving the different escrow risk management systems (Team, 2023). Through the integration of technologies like predictive analytical tools and automated reporting; an organization can be in a position to counter act risks that maybe impending and promote safety culture. Programs for safety awareness and compliance training also form part of EOHMS for it is crucial that employees are most aware of these risks. Finally, the objective of an EOHMS is to design safer workplace, obtained fewer levels of incidents and improved organizational health. (Rout, B., & Sikdar, B, 2017)

Effectiveness of digital hazard management systems

Effectiveness of Digital Hazard Management Systems" discuss how the use of digital systems in hazard improving management of hazards in different sectors mainly in disaster and risk management. This article underscores the benefits of surveillance of data in real time, use of anticipation and analysis of occurrence and subsequent automation to minimize response time, entrench improved decision-making, and foster greater cooperation among all actors involved (Umut Lagap, & Saman Ghaffarian, 2024). However, the article also points at some of the problems, for example, regarding the data privacy and ownership, the requirement of having constant updates for the systems as well as having these technologies ease into the current infrastructure. The conclusion stresses that the effective implementation of the discussed principles is only possible when technology development is not at the cost of professionals' experience (Dhirani, Mukhtiar, Chowdhry, and Newe, 2023).

5. Theoretical Review

Systems theory

Systems Theory posits an organization as an open system that is composed of a set of subsystems that depend on each other to provide safety and efficiency. In the management of occupational hazards, this theory maintains that safety management systems need to ensure that approaches like reporting, assessment, and measures are linked among themselves (Academy S. , 2019). These systems only work best if all available components, people, business processes, and technologies are integrated, thereby minimizing the likelihood of failure or gaps in managing workplace safety (Bautista-Bernal, 2024).

Risk management theory

Theory of Risk Management is essential in occupational hazard control. It implies that each and every risk in the workplace has a risk level which has to be evaluated and reduced. It also supports the rigid methodology of searching for hazards and introduction of necessary precautions to avoid them (Bautista-Bernal, Quintana-García, C., & Marchante-Lara, M, 2024). The theory is incorporated into the proposed digital solution for RSSB in that it automates the ways the potential dangers are identified, timeous as well as accurate, and provides the requisite control measures within the specified severity range.

Contingency theory

According to the Contingency Theory, there cannot be one best structure of the organization or the way in which this has to be managed since this depends on specific contingencies within and outside the organization. Such factors may include organization size, level of environmental turbulence, technological integration and leadership (Shala, B., Prebreza, A., & Ramosaj, B, 2021). Theory states that to achieve this optimum performance, the strategies, structures and processes that are used within an organization, need to be responsive to these contextual variables. Finally, Contingency Theory is quite a liberal approach to organization management, opposing the idea of using a single successful method on different organizations (Lawrence, 1922 – 2017)

Safety culture theory

Safety Culture Theory is about the need to achieve a safety conscious culture in any given line of work. This theory is particularly applicable to management of organizations like RSSB since they work on promotion of health and safety of the employees (Bruc, 2011). This favorable safety climate admits the early reporting of hazard factors, adherence to compliance measures, and corporate responsibility for risk management. The proposed system promotes the safety culture because the system provides an easier approach to report hazards and receive feedback, training and safety information to the employees so that they remain alert and responsible towards safe practices (Mesfin Abeje, 2023).

6. Empirical review

The research carried out shows that implementing a computerized reporting system and real-time risk assessment of occupational hazards is critical in enhancing people's safety in the workplace and ensuring functional compliance. Several studies have provided evidence that most industries encounter problems with their manual methods of hazard transmission thereby affecting their effectiveness in handling safety; while industries that implement high technology automatically are accurate and safe in handling safety regulations. For example, (Smith, A., & Doe, J, 2019) recently established that organization's implementing automatic management of hazards recorded a 30% decrease in workplace incidence of accidents, especially due to proper reporting of hazards and subsequent action by the management. Following this, (Johnson, B., & Smith, C., 2021) described those digital applications enhancing the safety audit and inspection produced enhanced data credibility and decreased the inspection time ratio by 25%. Nevertheless, there are still research limitations related to the empirical investigation of digital safety solutions within public organization's including RSSB as a majority of previous studies has provided a focus on the private sphere application of the concept. Further, theoretical and empirical evidence demonstrate the relevance of protective measures and operational rules and regulation as well as employment requirements and standards for organizing safety at workplaces. Organization with improved policies in hazard management is usually associated with improved safety gadgets, improved on the display of hazards, and reduced on collateral mishaps. Nevertheless, research highlight the importance of experience-sharing with staff, and direct executive engagement in promoting safety-focused organizational culture (Gihozo, 2020). They also focus on new issues emerging from the policies of globalization and technology advancement such as telecommuting and contract employees' risks to their safety at workplaces (Zara, 2023). Although the main element of work hazards in organizational safety and health standards has long been physical risks, issues like workplace injury camouflage and failure of compliance with rules in high-emerging industries require better measures to manage the hazards.

7. Conceptual frame work

It is centered on the integration of digital technologies to enhance the management of occupational hazards at the Rwanda Social Security Board (RSSB). It focuses on the interaction of three key variables: hazard reporting, risk assessment, and safety compliance and training (Tuhul, H. S., El-Hamouz, A., Hasan, A. R., & Jafar, H. A, 2021).

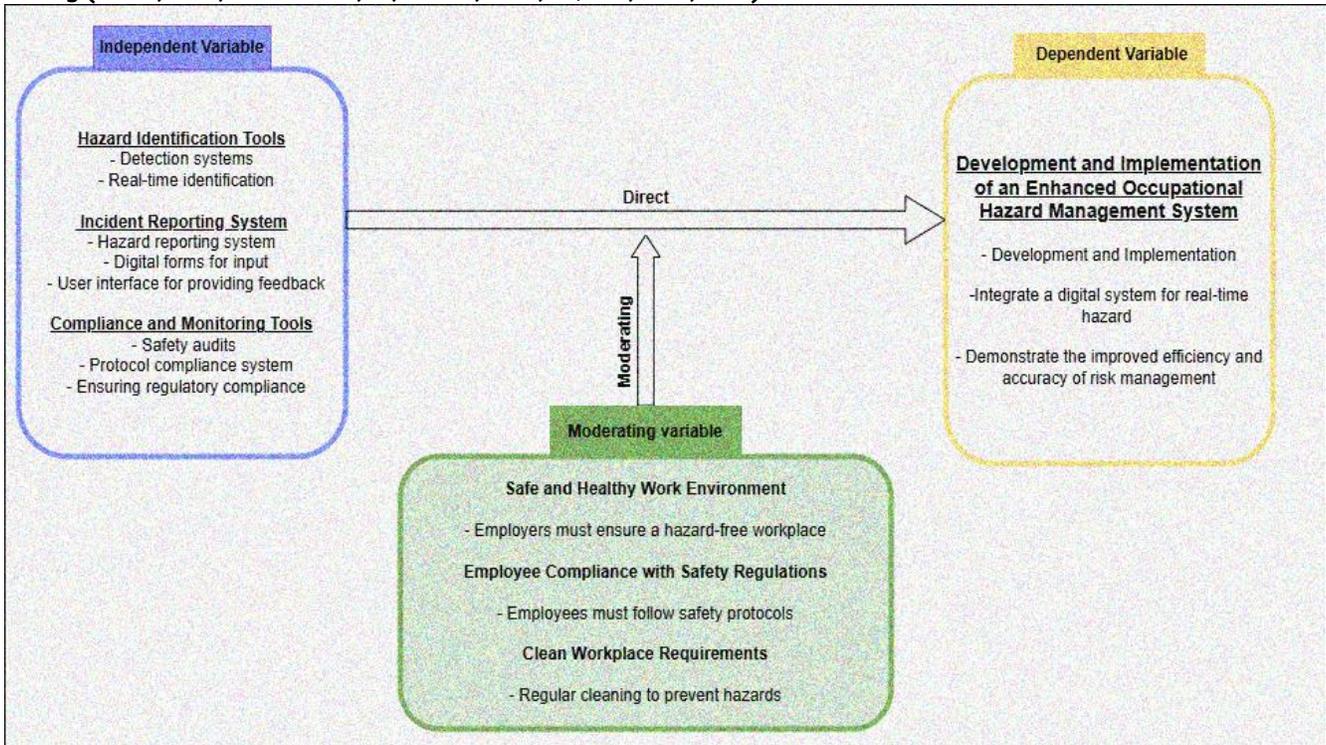


Figure 1: Conceptual Framework

8. Methodology

The stratified sampling approach will be employed to ensure a balanced representation of different disease classes in the dataset (Stratified Random Sampling, n.d.). The sampling strategy will aim to capture the natural variability in disease symptoms and leaf characteristics. This technique will improve the accuracy of our deep learning model (Hayes, How stratified random sampling works, 2024, August 19).

Stratified random sampling Formula:

The sample is a subset of the population under study (Kothari, 2004). The Yamane formula (1967) was used to determine the safety population's sample size.

Where:

n = sample size,

N = population

e = the confidence level $1 =$ constant.

This study assumed the level of precision of 5%

The sample size is:

$$n = \frac{N}{1 + N(e)^2}$$

$$N \text{ of managers} = 20 / 1 + 20(0.1)^2 = 17$$

$$N \text{ of human Resources} = 4 / 1 + 4(0.1)^2 = 4$$

$$N \text{ of employees} = 1732 / 1 + 1732(0.1)^2 = 324$$

Equation 1: Stratified Sampling Formula

However, considering feasibility and resource constraints, a total of 345 respondents were selected using simple random sampling (Kabir, Methods of Data Collection, 2016, July).

SN	Respondents' Category	Population	Sample Size	Sampling Procedure
01	Management	20	17	Simple random sampling
02	Human resources	4	4	Census
03	Employees	1732	324	Simple random sampling
	Total	1756	345	

Table 1: Stratum of Respondents

9. Data analysis:

Thematic Analysis: Thematic analysis will be used to examine qualitative data gathered through observations, interviews, and document analysis. In order to fulfill the research objectives, this entails locating patterns, themes, and linkages within the data.

Descriptive Statistics: Descriptive statistics will be used to assess survey quantitative data. In order to learn more about customer perceptions, levels of trust, and general satisfaction, the survey responses will be compiled and presented using metrics like frequencies, percentages, and averages (Hayes, 2024, August 19).

9.1 Analysis of the existing system

The existing system is hindered by several inefficiencies. It relies on manual paperwork and data entry, which increases the risk of errors and slows down the process. Document verification is time-consuming, and there is no mechanism for real-time updates, leaving workers and employers unaware of the status of their cases.

Modeling of the existing system

The existing system for managing occupational hazards can be modeled as a linear process consisting of sequential steps from hazard identification to resolution. It begins with the identification and reporting of a hazard by the employee or employer, followed by manual documentation and submission to RSSB. The hazard details are then manually entered into a database, after which RSSB officials assess the severity and verify supporting documents, such as police or medical reports.

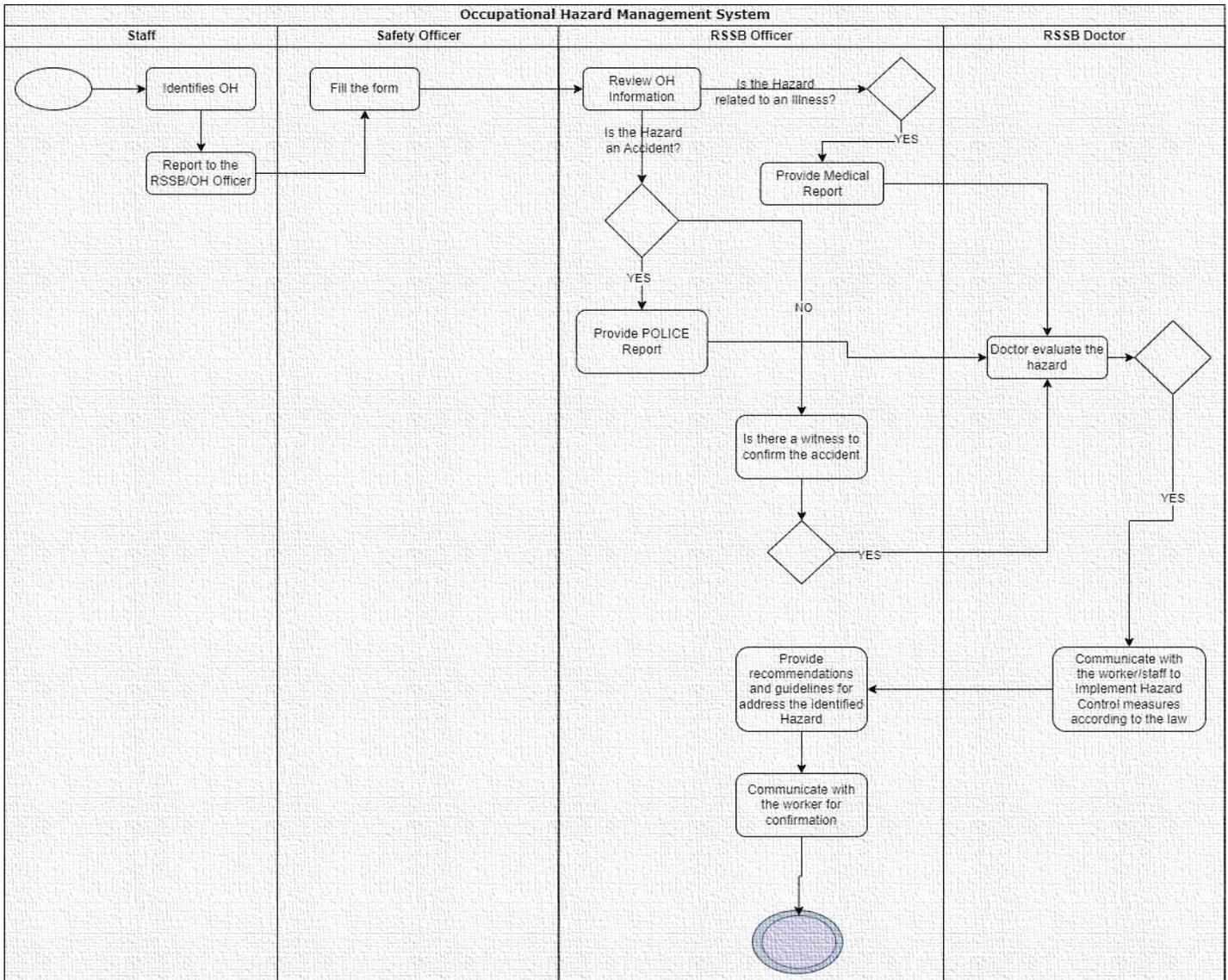


Figure 2: Activity diagram of existing system

The current system to handle the reports of occupational hazards has some inherent problems in terms of performance, especially in terms of capability to scale and response time. Inefficient processing mechanisms ensure that signals are slowed down and do not reach the right individuals or department for processing in time to avoid safety hazard risks to workers or employers. These delays are compounded by manual procedures particularly when handling reports on occupational risks in that; inadequate or ambiguous information prolongs the interruption. This last set of problems cumulatively means that the large flow of reports cannot be processed effectively and

9.2 Unified modeling language

Design of the new system

The design of the Intelligent Software for RSSB Occupational Hazards Management begins the system development lifecycle, fostering collaboration between developers and stakeholders to establish a shared understanding of its functionality. This phase defines the framework, components, connections, and data flows needed to meet the system's objectives.

Use Case Diagram

The symbols below are used in Use Case diagram

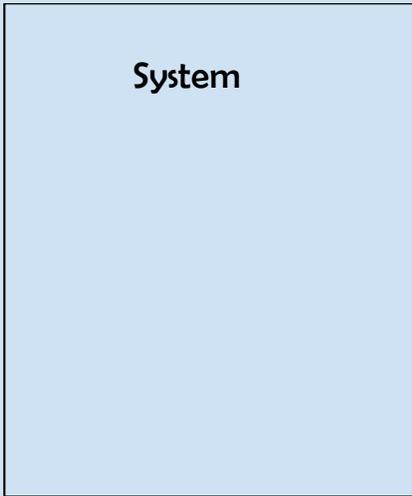
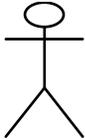
	<p>System</p> <p>The system is the rectangular boundary. Actors will be positioned outside of it, while use cases will fall inside.</p>
	<p>Use Case</p> <p>A use case is represented by an oval shape. Use cases illustrate both the system's functionality and the actor's ultimate objective. Use cases ought to be incorporated into the system.</p>
	<p>Actor</p> <p>A use case is initiated by an actor's interaction with the system. It is best to put actors outside of the system.</p>
	<p>Relationships</p> <p>Line is used to indicate a relationship between an actor and a use case, or between two use cases. An extension indicates that one use case may include the behavior of another use case. An inclusion represents one use case using the functionality of another use case.</p>
	<p>Relationships</p> <p>A relationship between two use cases or between an actor and a use case is indicated by a relationships line. An extension shows that the behavior of one use case may be included in another. One use case utilizing another use case's capability is represented by an inclusion.</p>

Table 2: Element of a Use Case diagram

New system Use case diagram

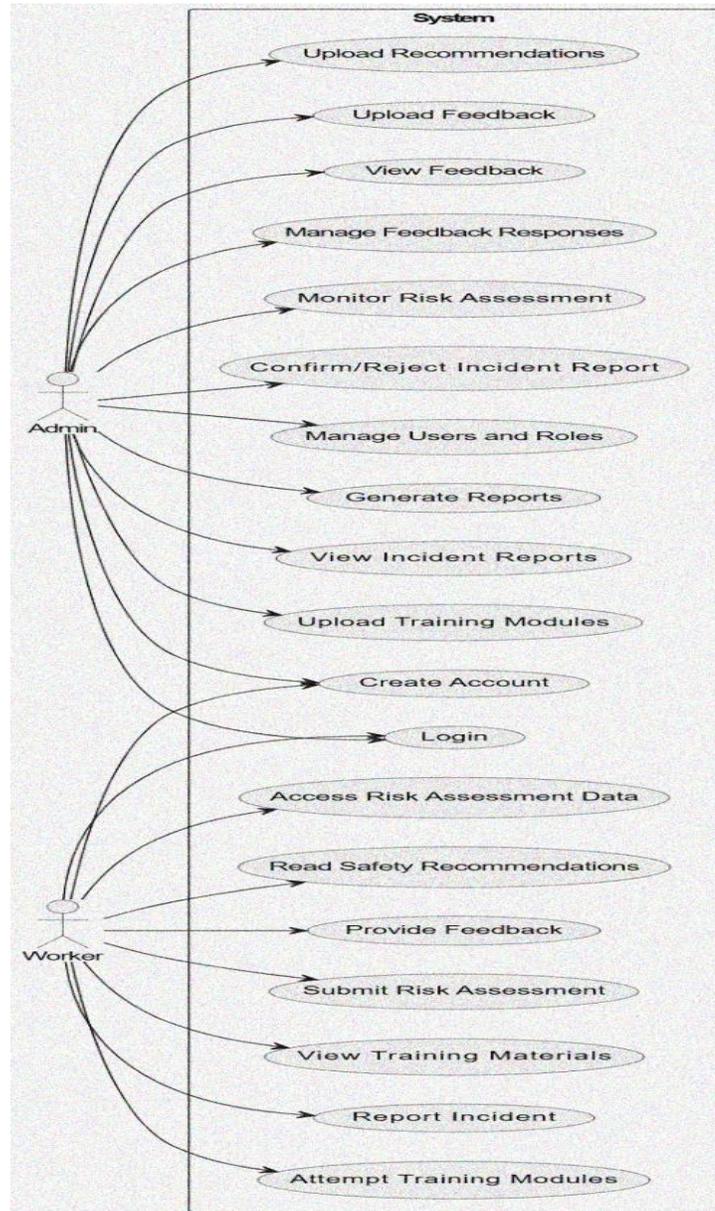


Figure 3: New system use case diagram

Class diagram schema

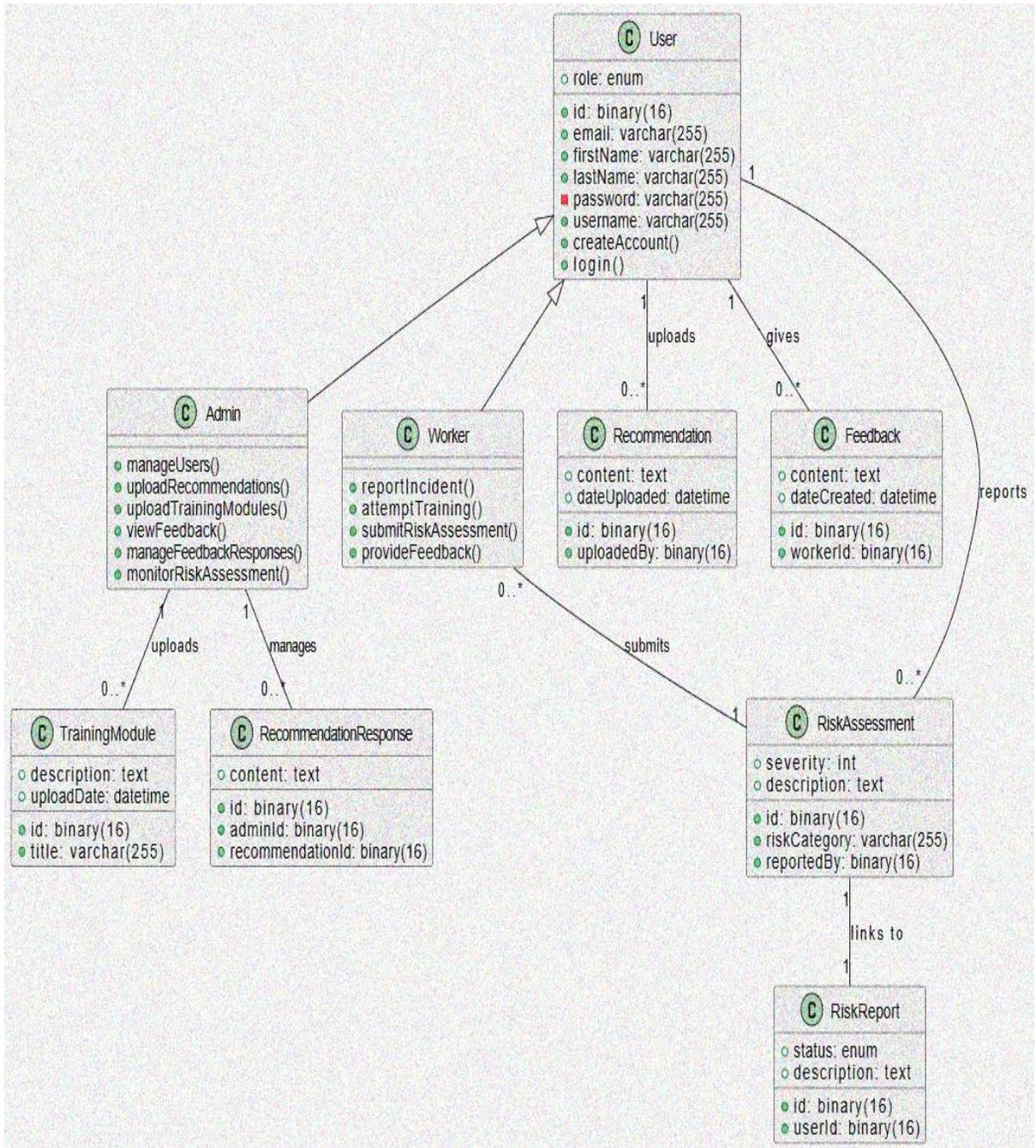


Figure 4: Class diagram

Sequence diagram

A sequence diagram in UML is a behavior diagram that illustrates the interaction between objects or components in a system over time. It shows the sequence of messages exchanged between lifelines, representing the participating objects, and includes activation bars to depict the duration of message processing. Sequence diagrams are valuable for understanding system behavior, identifying flow issues, and communicating scenarios during software development.

The sequence diagram has the following features

The sequence diagram has the following features

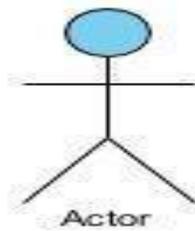
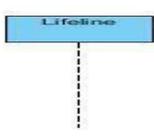
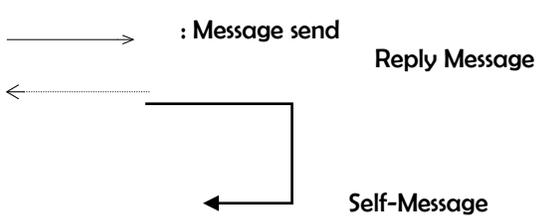
Term and definition	Symbol
<p>An Actor</p> <ul style="list-style-type: none"> • It the internal or external agent that plays role in developed software system • It participates in sequence by sending and retrieving and receiving message • It situated around the top of the diagram 	
<p>An object lifeline: It contributes by sending and receiving the message in given specific order. It located across the top of the diagram.</p>	
<p>Lifelines:</p> <p>It shows the life of the object during sequence from top to the bottom.</p>	
<p>An activation</p> <ul style="list-style-type: none"> ❖ It is vertical narrow rectangle on top of life line ❖ It shows when the object is sending or receiving the messages 	
<p>Messages:</p> <ul style="list-style-type: none"> • It conveys information from one object to another object. • An operation call is named or labeled with message being sent and solid narrow, whereas a return is labeled with the value being returned and shown as dashed arrow 	

Table 3: Sequence Diagram Element

Sequence diagram for Worker Incident Report

This diagram shows the interaction between a worker and the system during the incident reporting process. The worker initiates the report, fills out necessary details, and submits it. The system records the report and updates the database. This flow ensures that incidents are logged systematically.

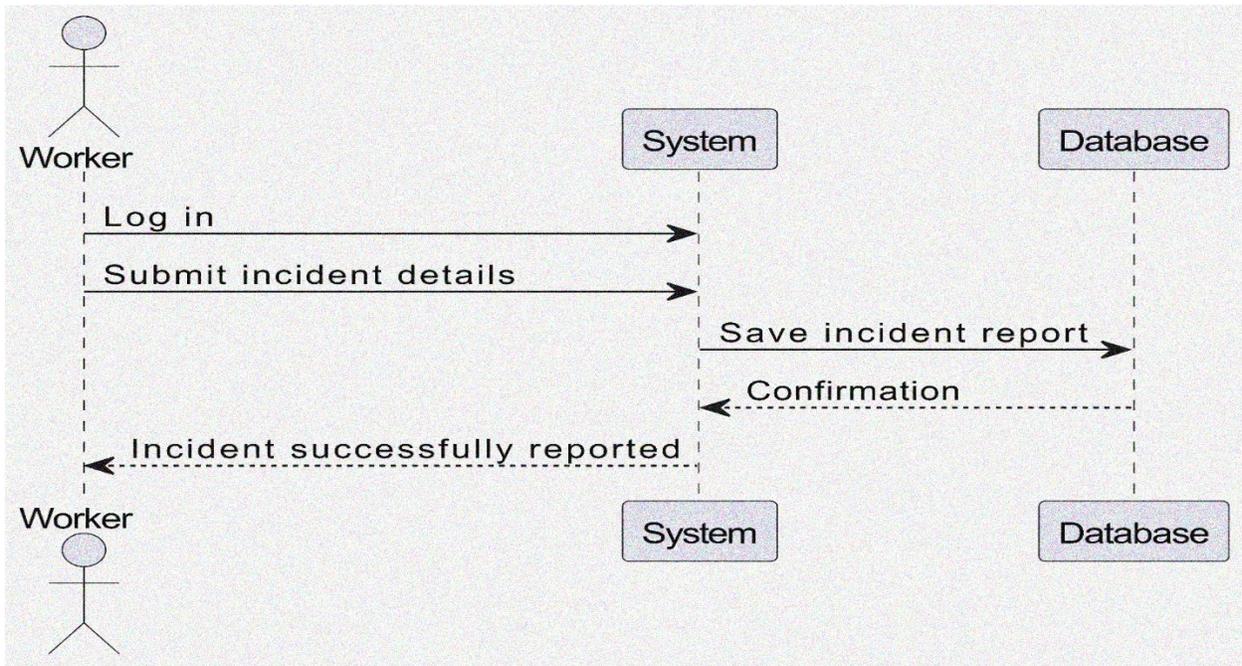


Figure 5: Sequence diagram for Worker Incident Report

Sequence diagram for creating account

This diagram represents the process of a new user registering an account. It illustrates how the user inputs information, submits the form, and the system verifies the details before creating the account. Successful registration results in account creation confirmation.

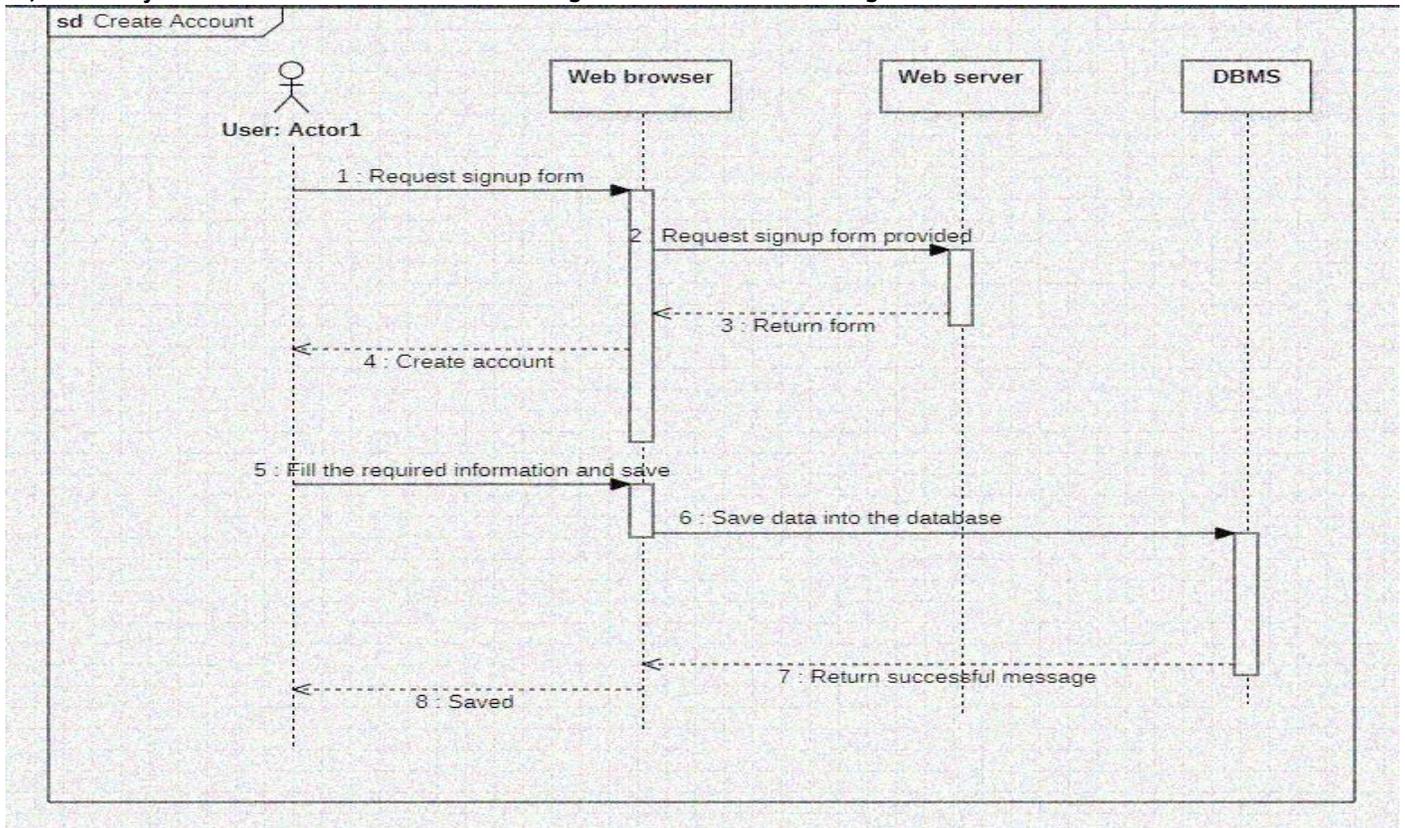


Figure 6: Sequence diagram for creating account

Sequence diagram for login form

The login sequence diagram depicts how a user attempts to access the system. The user inputs credentials, and the system verifies them against stored data. If correct, the user gains access; otherwise, an error message appears.

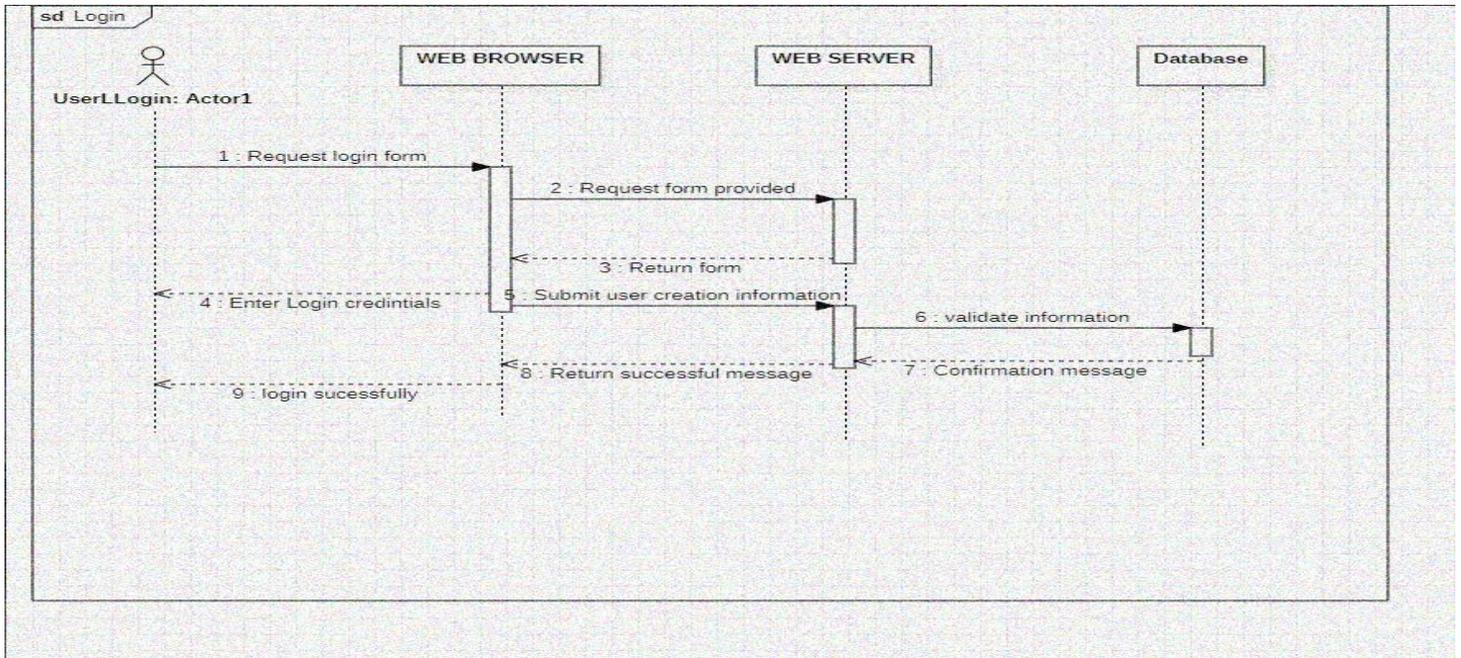


Figure 7: Sequence diagram of login

Sequence diagram for Worker Attempts Training

This diagram outlines how workers engage in training sessions. The worker selects a training module, attempts the training, and submits results. The system records their progress and marks the completion status.

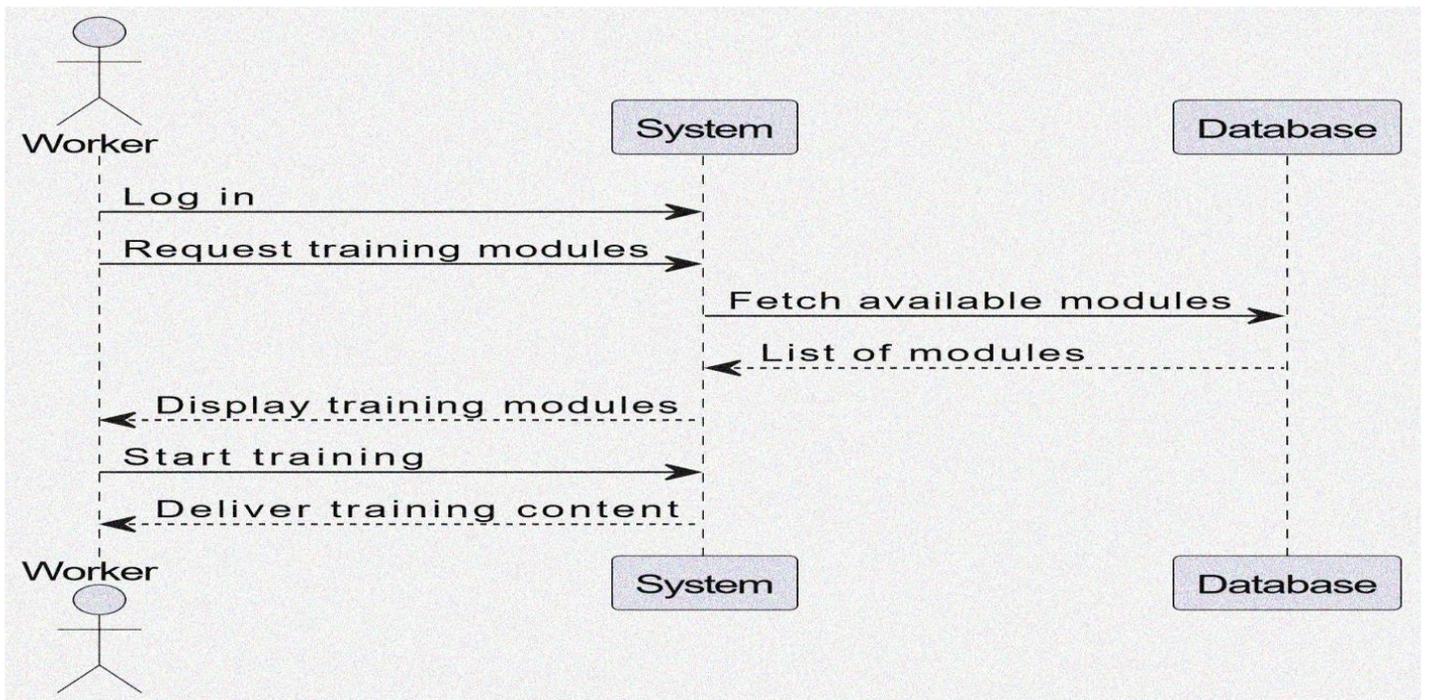


Figure 8: Sequence diagram of attempt training

Sequence diagram for Worker Read; Recommendations;

This diagram illustrates the process of viewing recommendations. The worker selects a section of recommendations, and the system retrieves and displays the relevant information for the worker to review.

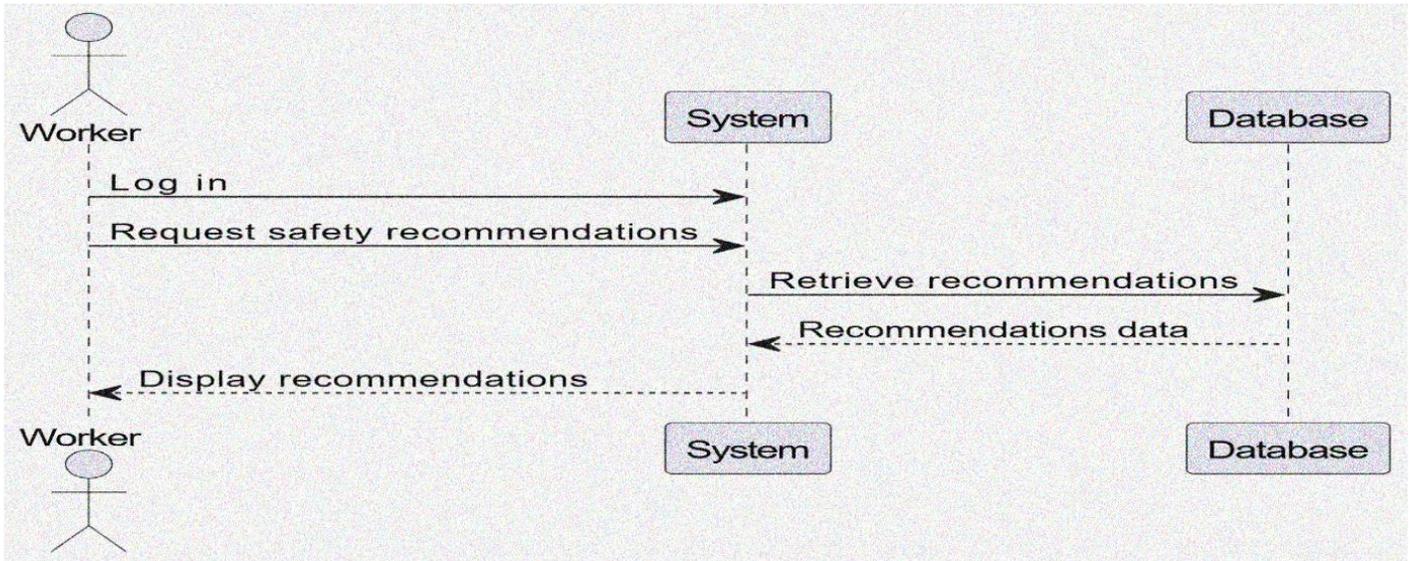


Figure 9: Sequence diagram of read; recommendations;

Sequence diagram for Admin Upload; Training Modules;

This sequence shows how an admin uploads training module to the system. The admin selects files, enters descriptions, and the system stores them for workers to access in the future.

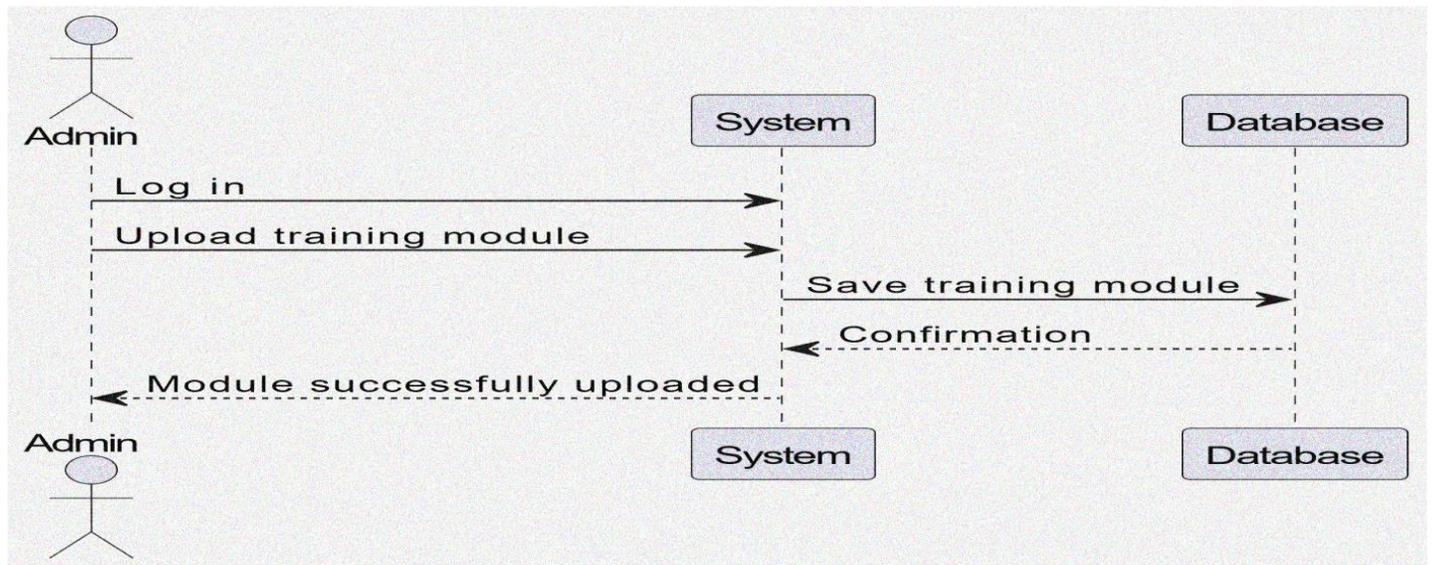


Figure 10: Sequence diagram of upload training modules;

Sequence diagram for Admin Manages Feedback

The admin manages feedback, he can view feedback list and save and delete.

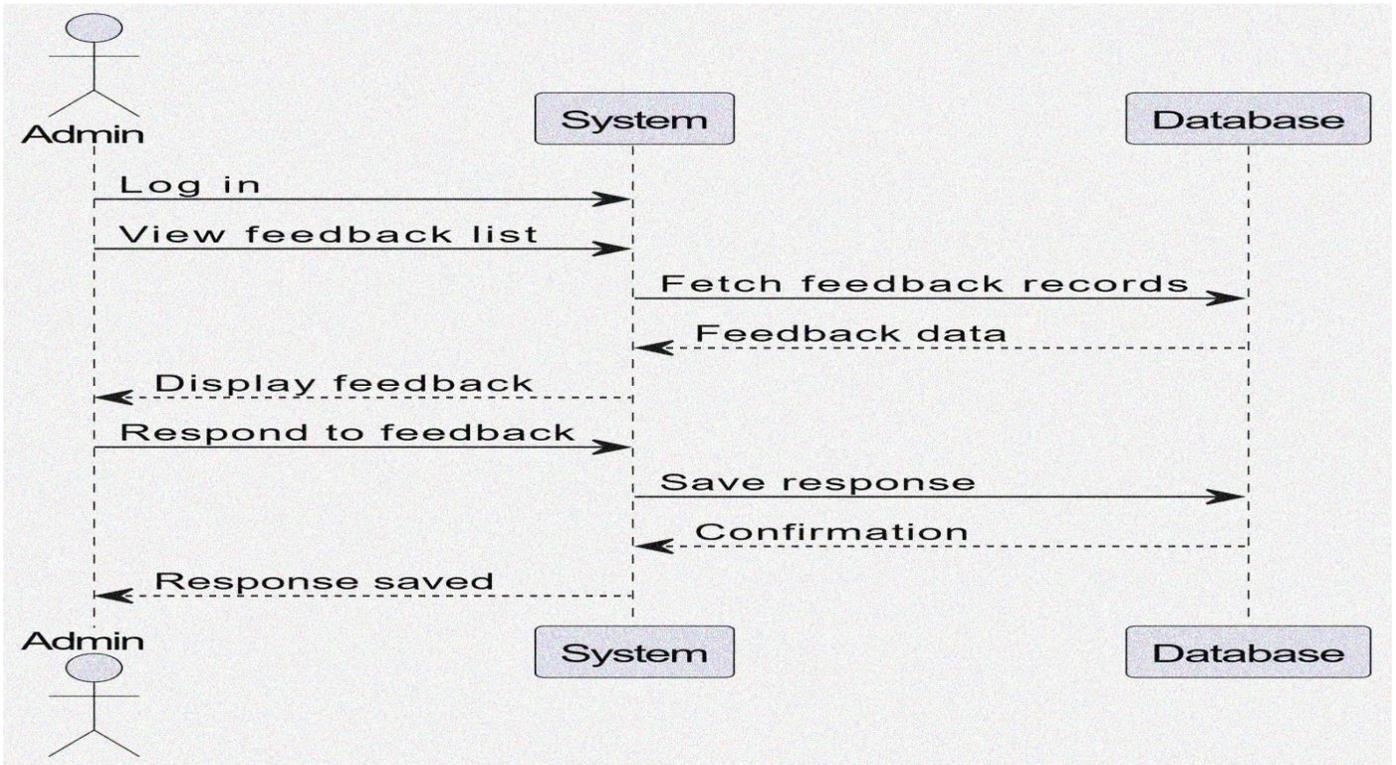


Figure 11: Sequence diagram of admin manages feedback

Sequence diagram for Worker Submit Feedback

The worker submits feedback about training, incidents, or general experiences. The system receives and logs this feedback, ensuring it is available for the admin to review

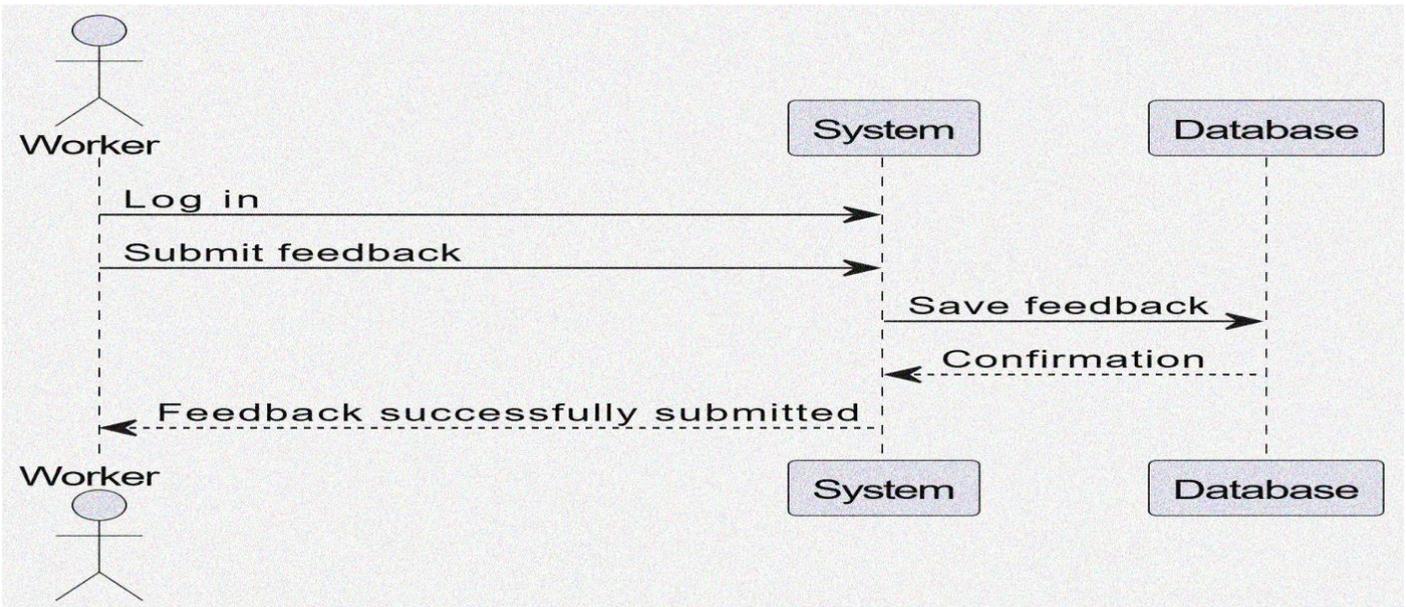


Figure 12: Sequence diagram of worker submit feedback

Sequence diagram for Worker Submits Risk Assessment

This diagram shows the process of a worker conducting and submitting a risk assessment. The system stores the data and provides feedback or recommendations on mitigating identified risks.

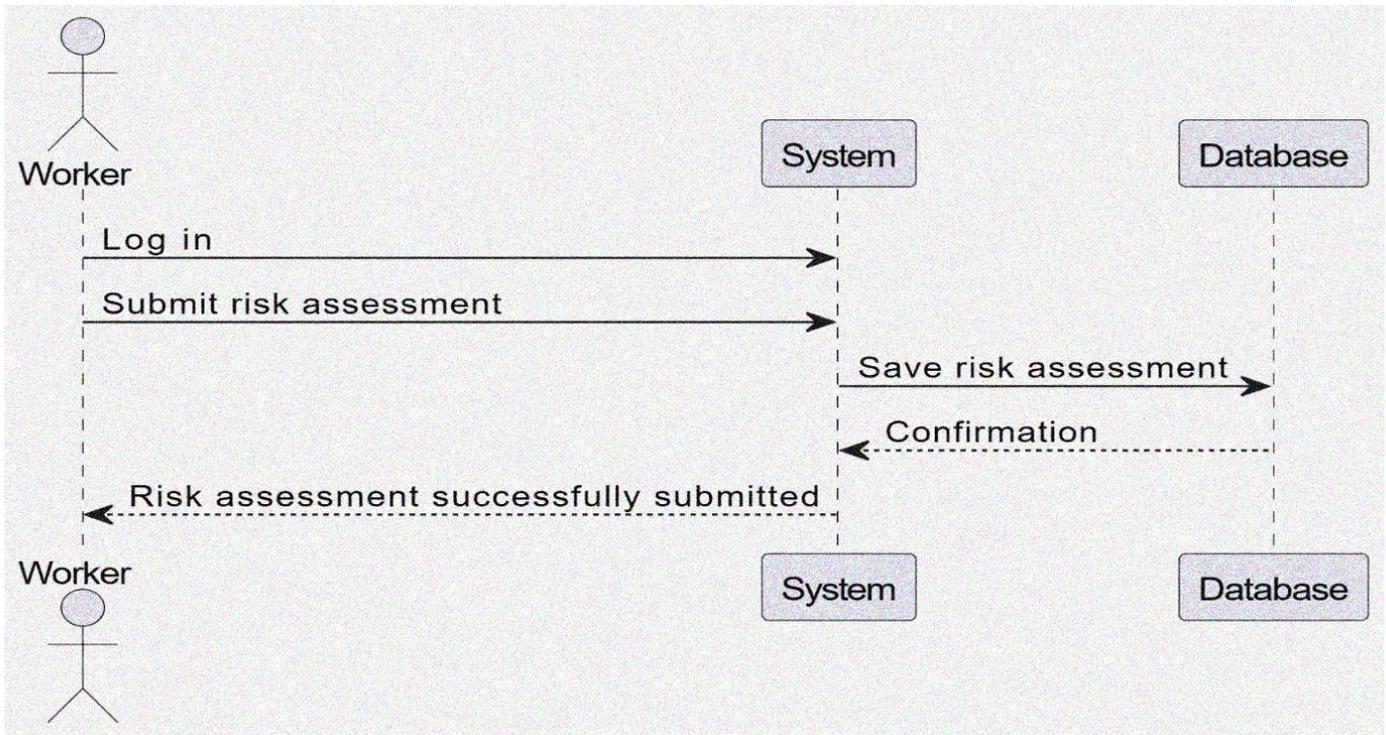


Figure 13: Sequence diagram of worker submits risk assessment

Sequence diagram for Admin Monitor Risk Assessments

This diagram outlines how an admin monitors and manages incoming risk assessments. The admin reviews, approves, or suggests corrective actions for each assessment.

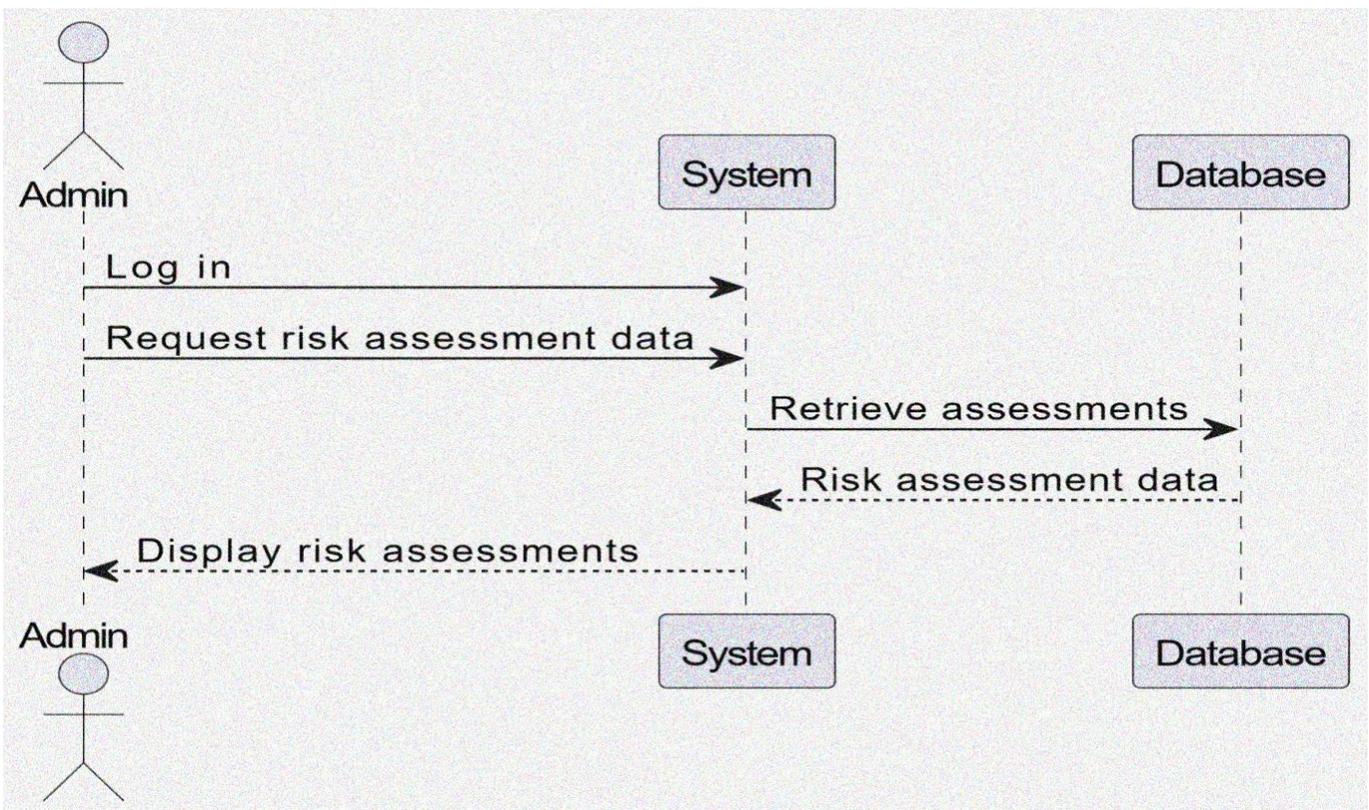


Figure 14: Sequence diagram of admin monitors risk assessments

Activity diagram

An activity diagram is UML diagram that defines the flow of activities and process in a system. It maps concentric activities, choices, and communications and is thereby suitable for simple and compound processes. These diagrams find usefulness when modeling business processes, an algorithmic application or a given system's capabilities. They draw shapes like oval for activity to be done, diamond for decision to be made and lines called arrows for the transition between activities. Stakeholders can easily understand and analyze the system behavior and improved the efficiency of the systems through activity diagrams.

Activity Node: Represents a specific action or activity that occurs in the system. It can be a simple action.

Control Flow Arrow: Represents the sequence of activities and the direction of flow between them. It shows the order in which activities are performed.

Decision Node (Diamond): Represents a decision point where the flow can take different paths based on certain conditions or decisions. Each outgoing branch from the decision node represents a possible outcome.

Initial Node (Filled circle): Represents the starting point of the activity diagram, indicating where the process begins.

Final Node (Bullseye circle): Represents the endpoint of the activity diagram, indicating the completion of the process

Login activity diagram

This activity diagram shows the steps involved in the login process, including data entry, validation, and potential error handling if the credentials are incorrect.

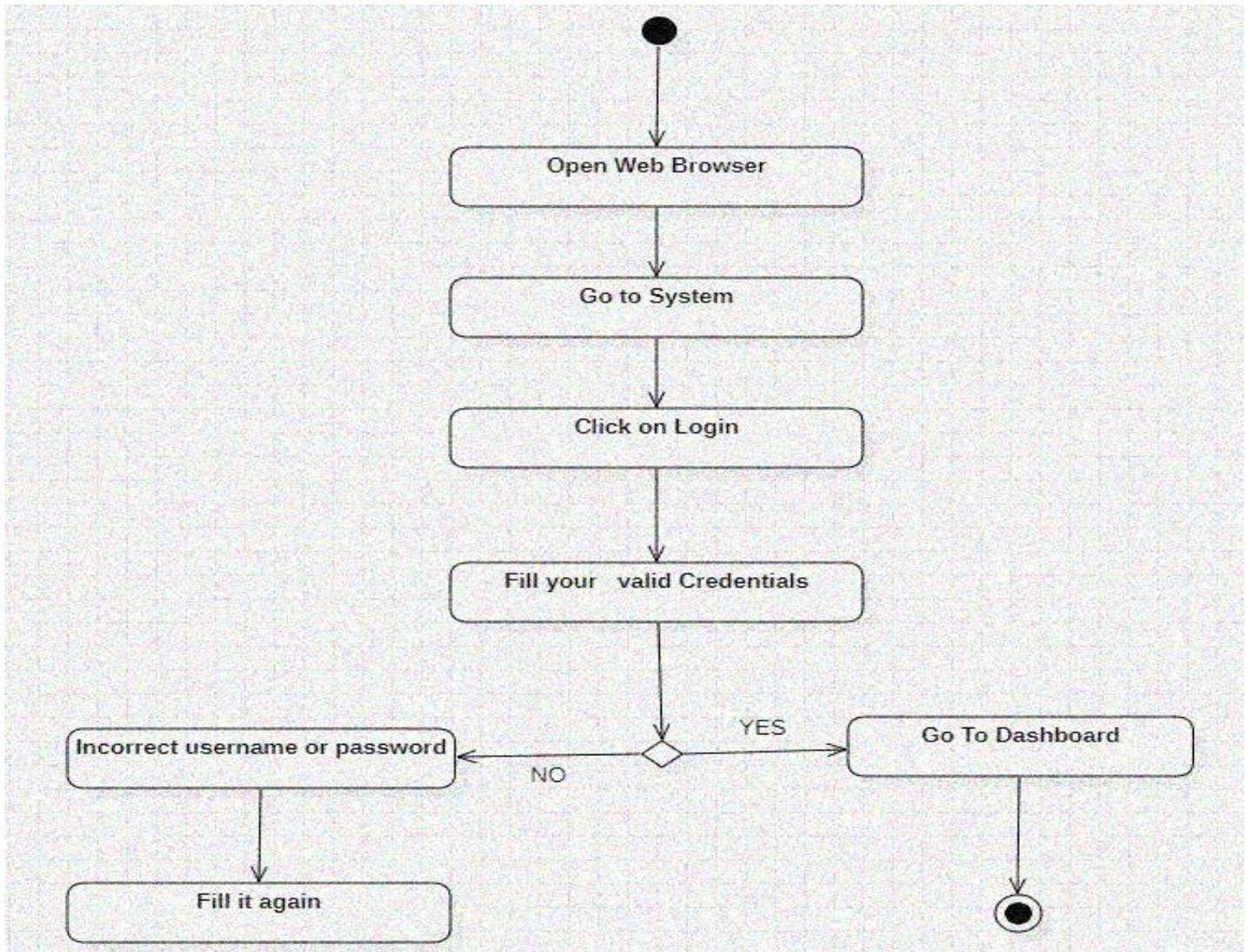


Figure 15: Login activity diagram

Create account activity diagram

This diagram displays the series of actions necessary to create a new account, highlighting user inputs, validations, and system responses.

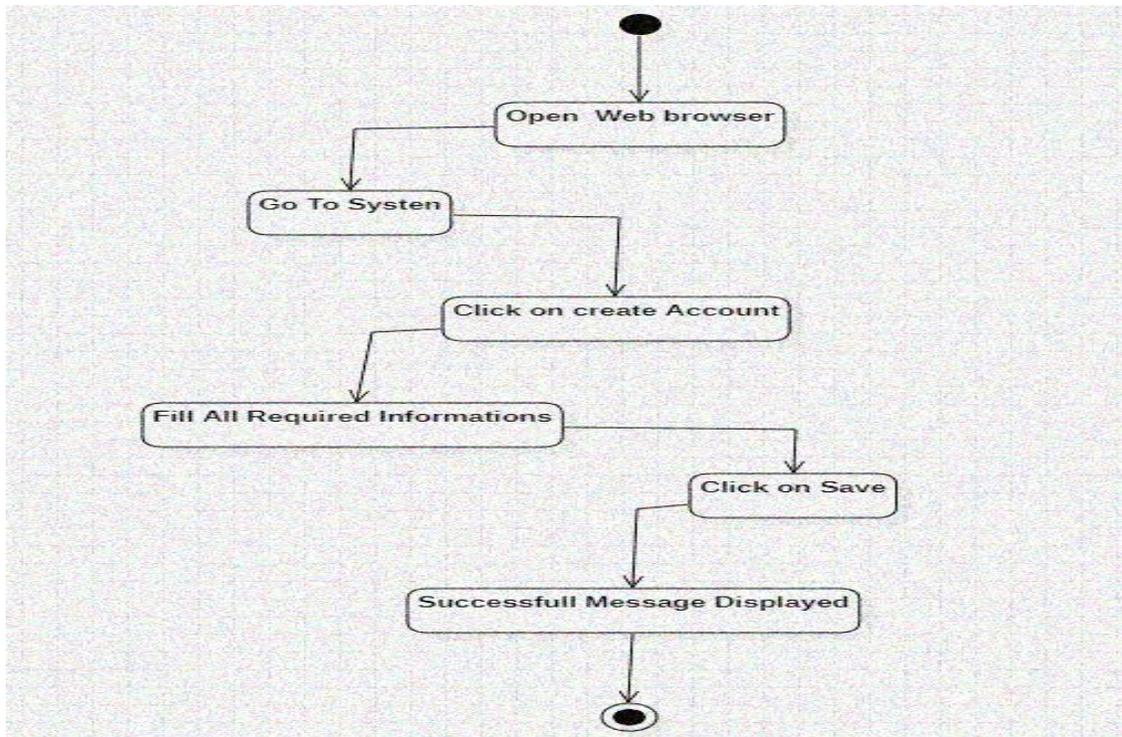


Figure 16: Create account activity diagram

Manage user activity diagram

The admin can manage users by adding, modifying, or deactivating accounts. This flow provides a structured approach to maintaining user data.

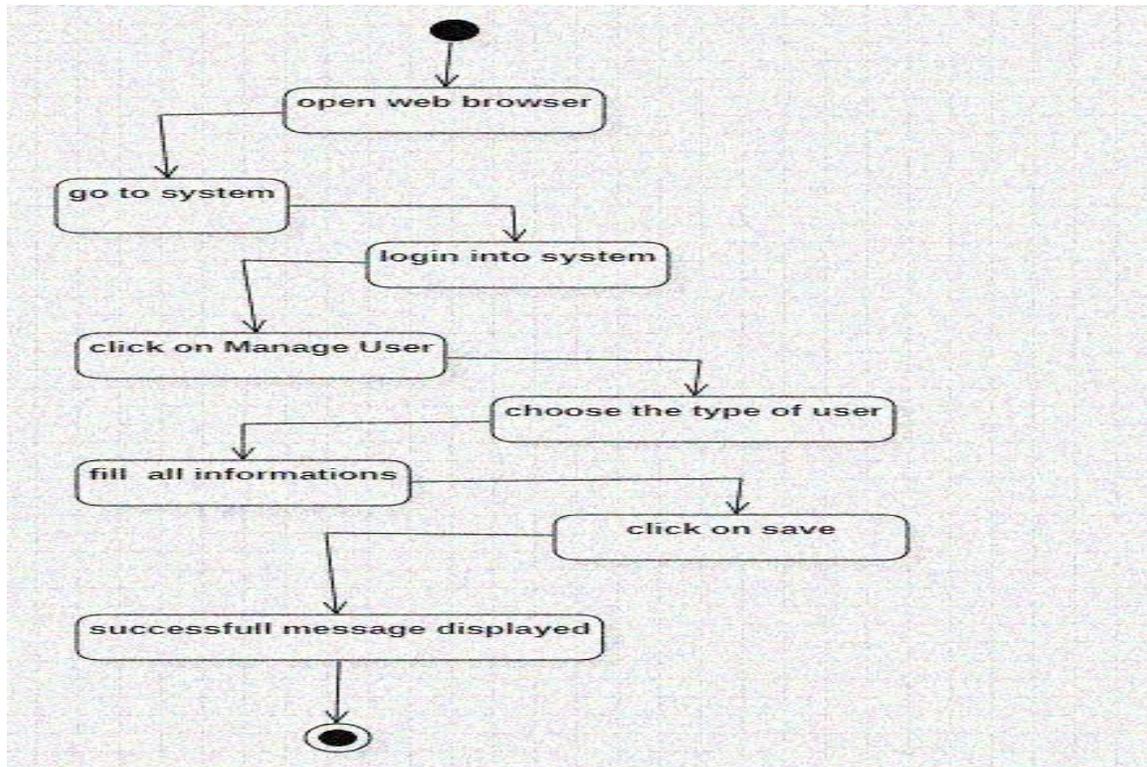


Figure 17: Manage user activity diagram

Database diagram

Database diagram is a visual representation of a database schema, illustrating the structure of a database, its tables, the relationships between the tables, and the constraints imposed on the data. It provides an abstract view of the database, helping database administrators, developers, and stakeholders understand the data model and the organization of data within the database.

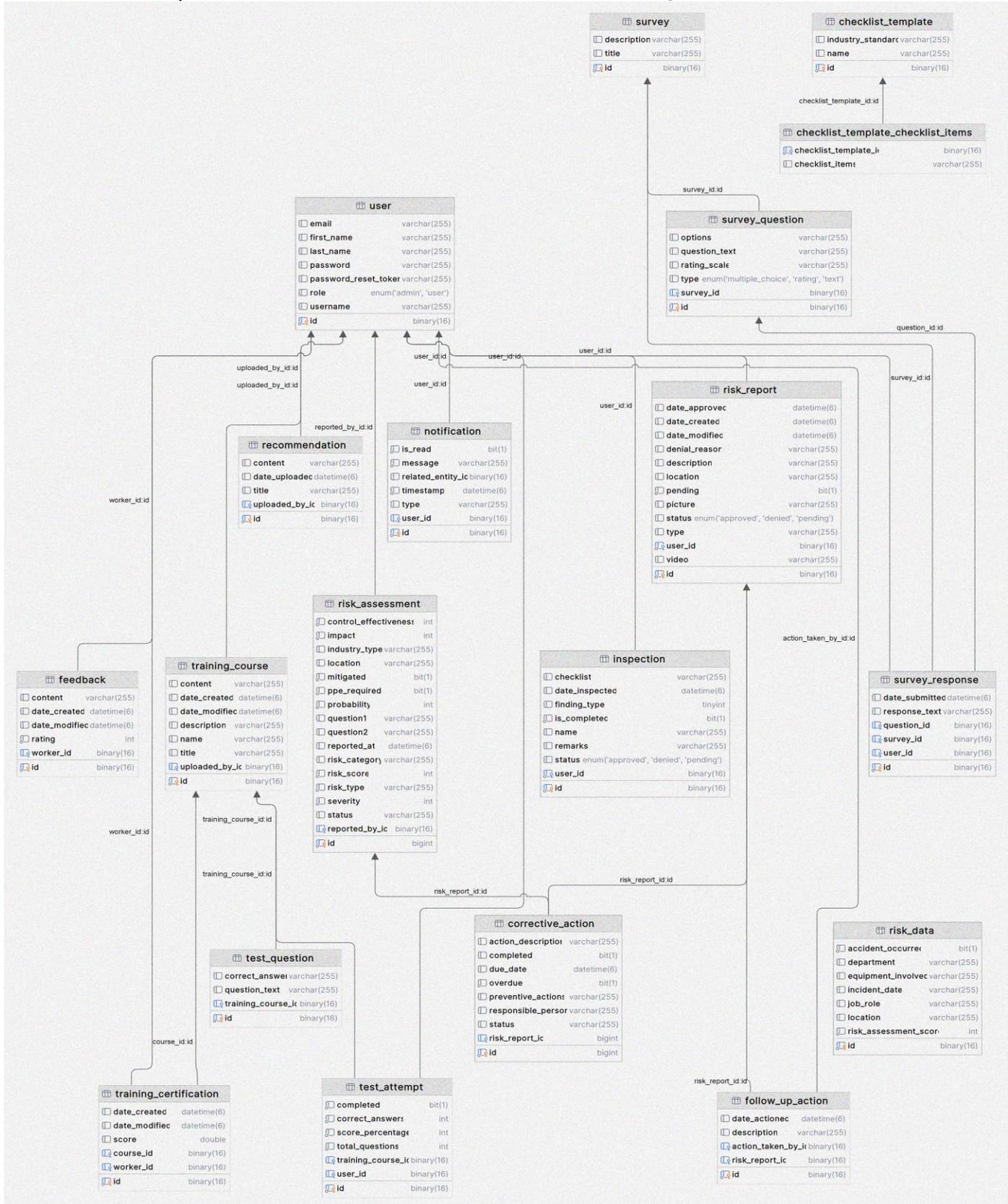


Figure 18: Database diagram

Data Dictionary

A data dictionary is a centralized repository that includes comprehensive metadata and information on the data elements, also referred to as data fields or data attributes that are utilized in an information system or database. It provides a precise and uniform definition of every data element and its properties, acting as a reference manual or documentation for data inside an organization. Making sure that all parties engaged in the development of a database or information system including stakeholders, analysts, developers, and database administrators that has a shared understanding of the data and its meaning is the main goal of a data dictionary.

Key components typically in a Data Dictionary include:

Data Element Name: The name or identifier of the data attribute.

Data Type: The data type of the data element, such as text, numeric, date, Boolean.

Description: A clear and concise description of the data element's purpose, meaning, and usage.

Constraints: Any constraints or validation rules associated with the data element, such as length restrictions, format, or allowed values.

Related Data Elements: Information on any relationships or dependencies between the data element and other data elements in the database.

Data Dictionaries are widely used in database design, data management, and software development processes. They help ensure data consistency, accuracy, and reliability throughout the organization. By providing a clear definition of data elements and their relationships, a Data Dictionary can also aid in data integration, Data migration, and system maintenance activities.

9.3 System architecture design

The process of defining a system's general structure, parts, modules, interfaces, and interactions in order to satisfy particular needs and accomplish intended functionality is known as system architecture design. High-level decisions are taken during this crucial stage of the software development life cycle to guarantee that the system is well-structured, scalable, maintainable, and capable of successfully carrying out its intended function.

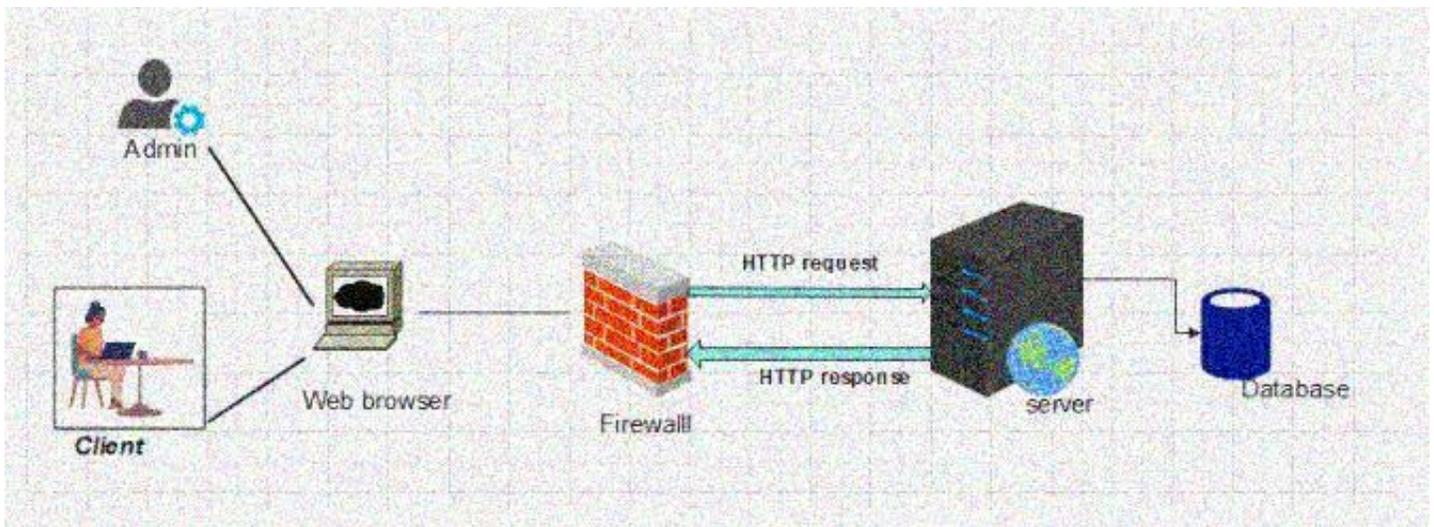


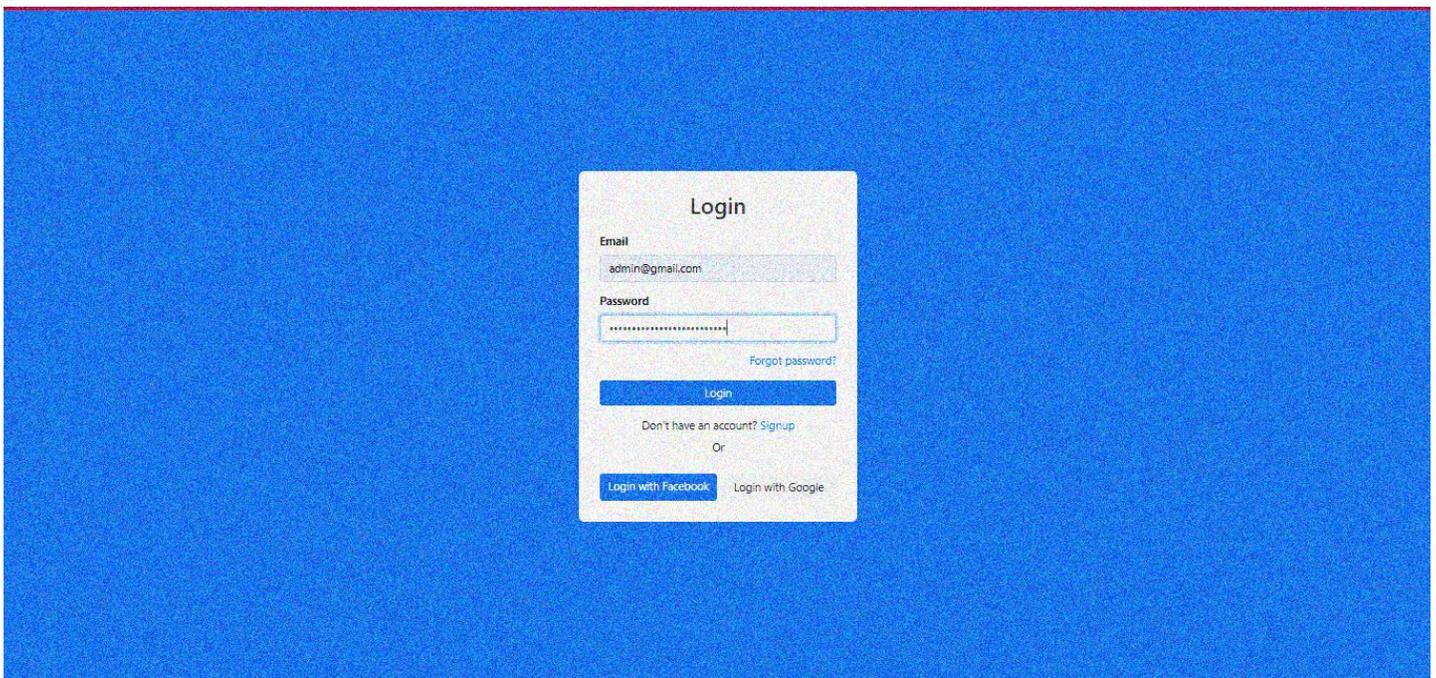
Figure 19: System Architecture Design

Several key components work together in this system architecture design to achieve the system's objectives. Here's a breakdown of each element and their interactions:

9.4 Presentation of the new system

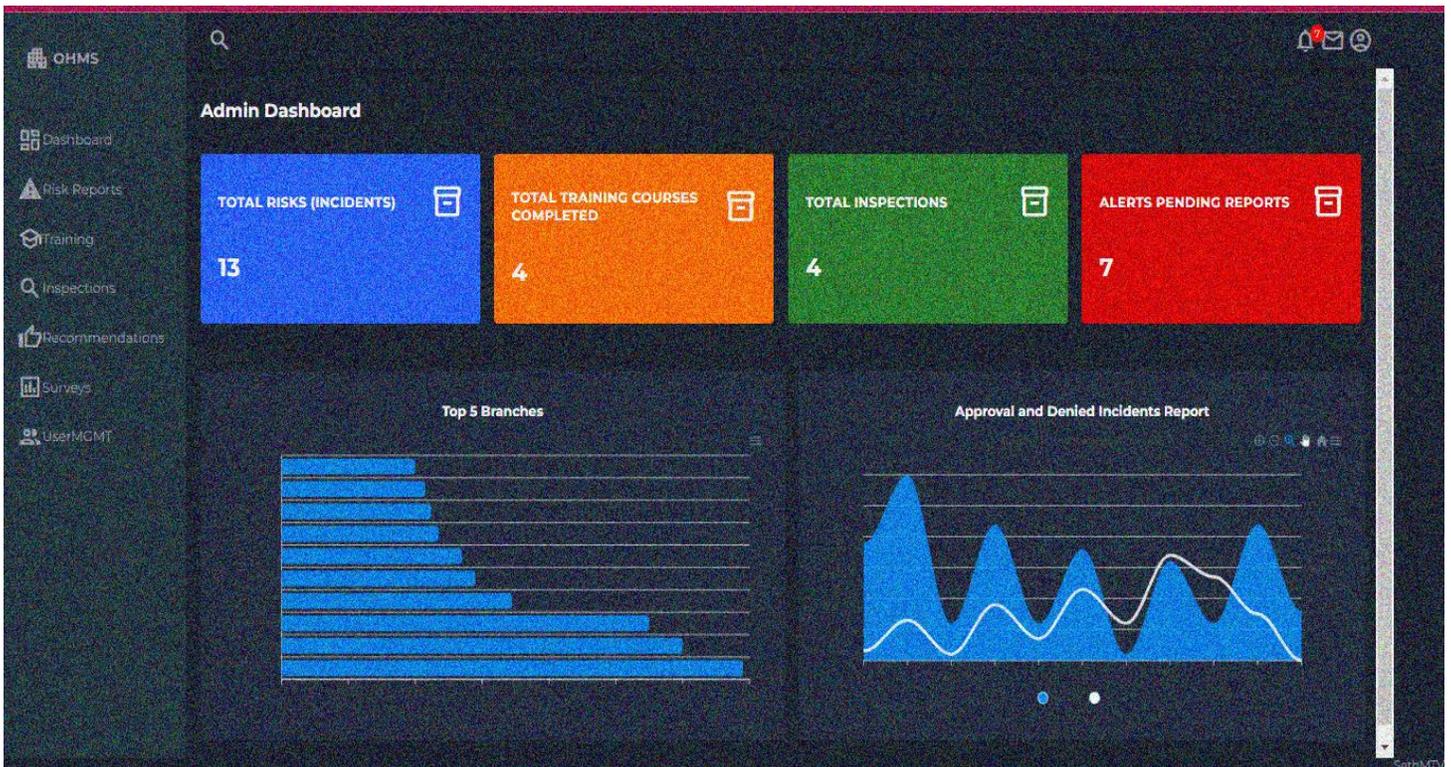
Login

The Login Interface provides a secure and intuitive gateway for users to access the system. This page features input fields for entering credentials, including email and password, along with a "Forgot Password?" link to recover access when needed. The design emphasizes usability, allowing workers, employers, and administrators to log in with ease. The page also includes clear validation messages to guide users in correcting errors. By ensuring robust authentication protocols, this interface safeguards sensitive data while facilitating smooth access to the platform.



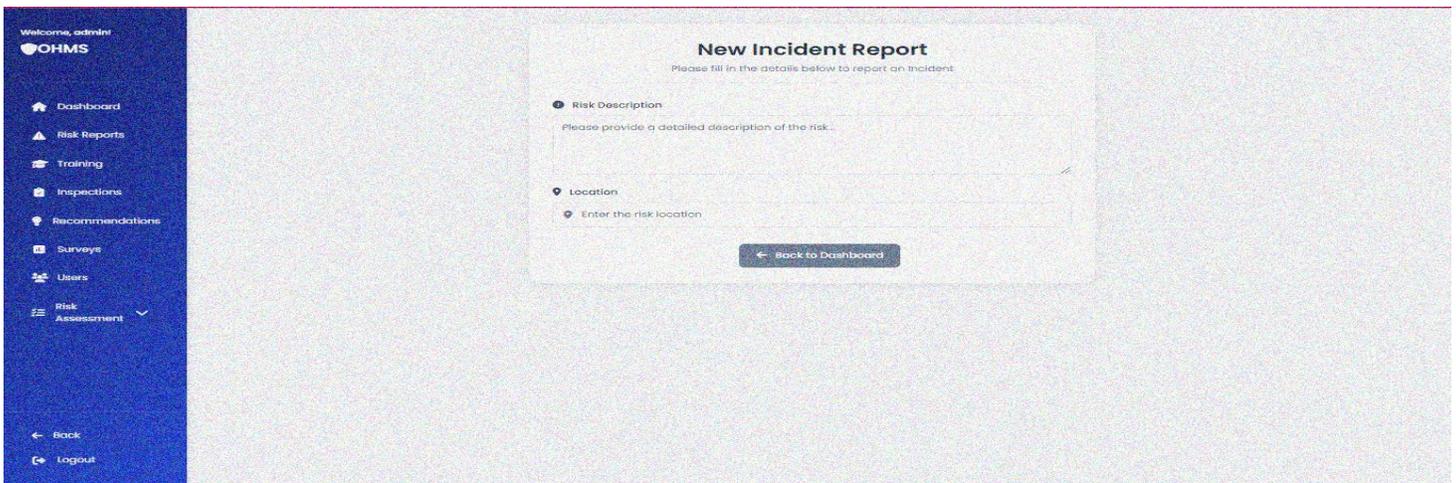
Admin dashboard overview page

The Admin Dashboard serves as the control center for administrators, offering a comprehensive overview of key metrics and tasks. This interface includes visualizations of hazard reports, pending approvals, system notifications, and real-time alerts. Administrators can quickly navigate to detailed modules for reporting, inspections, and compliance management. The dashboard's intuitive layout ensures that critical updates and insights are easily accessible, enabling informed decision-making and efficient system oversight.



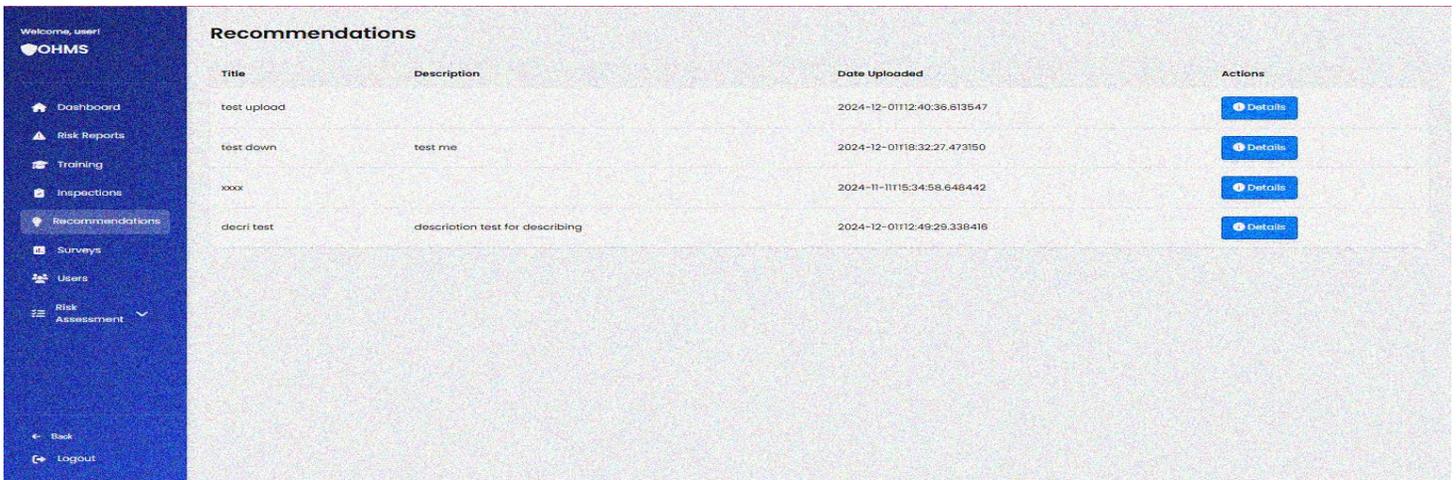
Incident Report Page

The Incident Reporting Interface simplifies the process of reporting occupational hazards Incidents. Employers or Employees can fill in detailed forms, upload supporting documents like photos, and categorize hazards by severity. The system validates the input, ensuring accuracy before submission. This interface also allows Users (Employers or Employees) to track the status of their reports, promoting transparency and accountability in addressing workplace safety concerns. The design ensures that even users with minimal technical expertise can report incidents with ease.



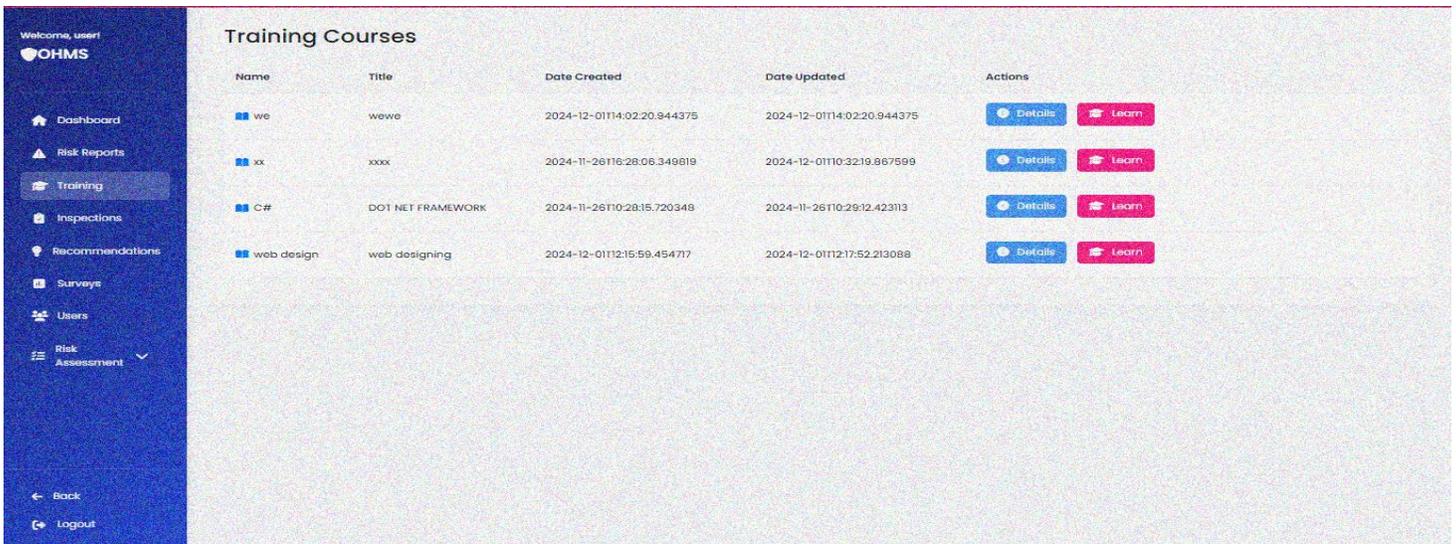
Recommendations and Compliance Page

The Recommendations and Compliance Page provides employers with tailored recommendations for addressing identified hazards. Based on industry standards and regulatory requirements, these guidelines offer step-by-step instructions for implementing safety measures. The interface also displays the organization's compliance status, highlighting overdue actions and upcoming deadlines. This feature ensures actionable support for organizations striving to maintain high safety standards.



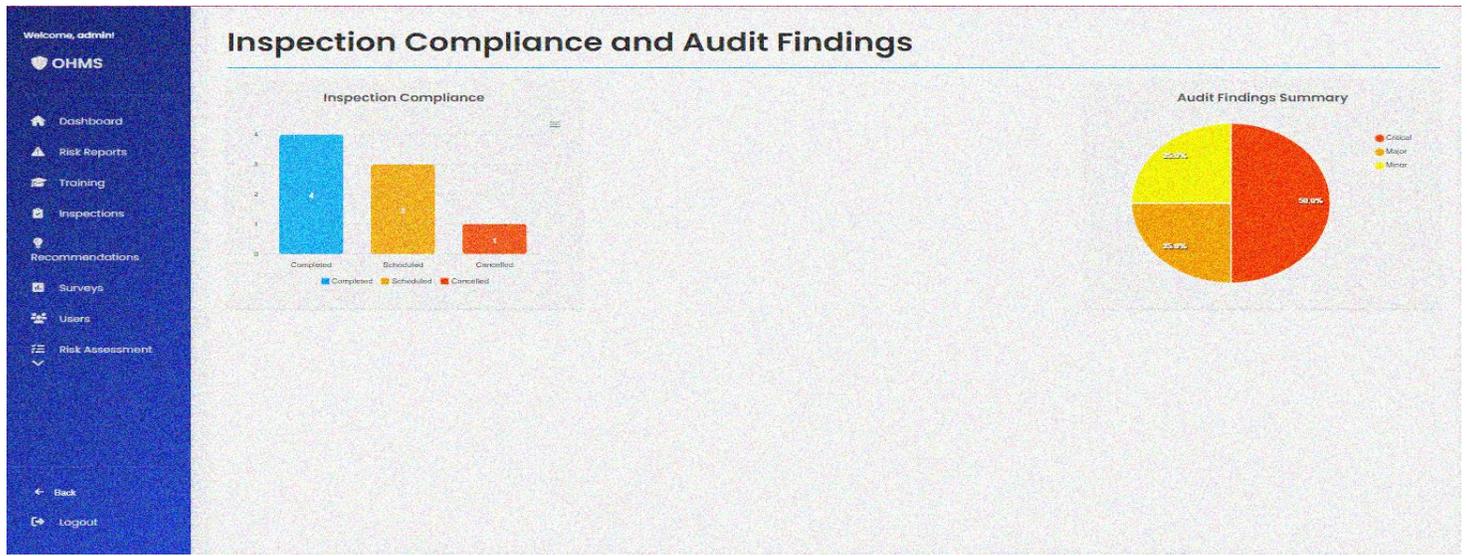
Training and Certification Page

The Training and Certification Module equips employees with essential knowledge through interactive training materials. Workers can access courses on hazard identification, workplace safety, and compliance requirements. The system tracks participation, administers quizzes, and issues digital certificates upon successful completion. This module fosters a culture of safety by empowering employees to enhance their understanding of occupational health practices.



Reports

The Reports and Analytics Dashboard offers dynamic visualizations of workplace safety trends. Charts and graphs display incident frequencies, hazard categories, and risk patterns, providing actionable insights for decision-makers. Administrators and employers can use this module to identify high-risk areas, predict potential hazards, and implement data-driven strategies to improve workplace safety.



9.5 Software testing

Software testing plays a critical role in ensuring the reliability and effectiveness of software applications. Its primary benefit lies in identifying and addressing errors, thereby improving the software's quality.

4.8 Software and hardware compatibility requirements

Client-side software requirements:

You will need a web browser like Google Chrome, Microsoft Edge, Opera, or Mozilla Firefox.
Operating system (Windows 10 or 11, Linux, macOS, iOS)

Client-side hardware requirements:

Microprocessor: Intel Core i3 or higher
Network Card: 2 GHz
A minimum of 8GB RAM for optimal performance.
A minimum of 20GB of available HDD storage space is required for installation and related files

Server-side software requirements:

A web server that can support Apache Tomcat.
Operating System: Windows, Linux
Database: MongoDB ensures efficient data handling and scalability for large datasets.
Python (Flask Framework): Used for backend development
Web Server: Nginx or Apache, required for serving the application to users while ensuring performance and reliability.
Security Tools: Integration of SSL/TLS for secure communication and additional monitoring tools like Fail2ban for security against unauthorized access.

Server-side hardware requirements:

A web server that can support Apache Tomcat.
Network Card: 2 GHz
Hard Disk: 30 GB or more (recommended)
A powerful processor capable of handling the system's computational needs.
A minimum of 16GB RAM is required for optimal server performance.
A minimum of 30GB of available HDD storage space is required for installation and related files.
A high-speed and reliable network connection with sufficient bandwidth.
Memory (RAM): A minimum of 16GB RAM is required to support the server's workload, including database operations and concurrent requests.

10. Conclusion

The development and implementation of an enhanced occupational hazard management system for the Rwanda Social Security Board (RSSB) mark a transformative step toward improving workplace safety and compliance. By integrating artificial intelligence and automation, the proposed system effectively addresses existing inefficiencies in hazard reporting, risk assessment, and safety training. The findings underscore the necessity of shifting from manual, error-prone processes to a streamlined, technology-driven approach that enhances accuracy, efficiency, and responsiveness in managing occupational hazards. This study highlights the critical role of digital solutions in fostering a proactive safety culture and ensuring regulatory adherence. As RSSB embraces this intelligent

system, it stands to significantly reduce workplace risks, improve employee engagement in hazard management, and set a precedent for similar organizations striving to modernize their occupational safety frameworks. The recommendations outlined provide actionable insights for policymakers and industry stakeholders, advocating for continuous advancements in digital occupational health and safety management.

11. Recommendations

I recommend that the implementation of the "Intelligent Software for RSSB Occupational Hazards Management" be carried out with a strong emphasis on user training and onboarding. Comprehensive training programs should be developed to ensure that all members and stakeholders can seamlessly adapt to the new system. Additionally, continuous feedback mechanisms should be established to collect user insights for ongoing improvements. Adequate resources should be allocated for regular system maintenance and updates to ensure data security and system reliability. Furthermore, this project should serve as a catalyst for continued digital transformation within RSSB, encouraging the organization to explore further avenues for innovation and efficiency.

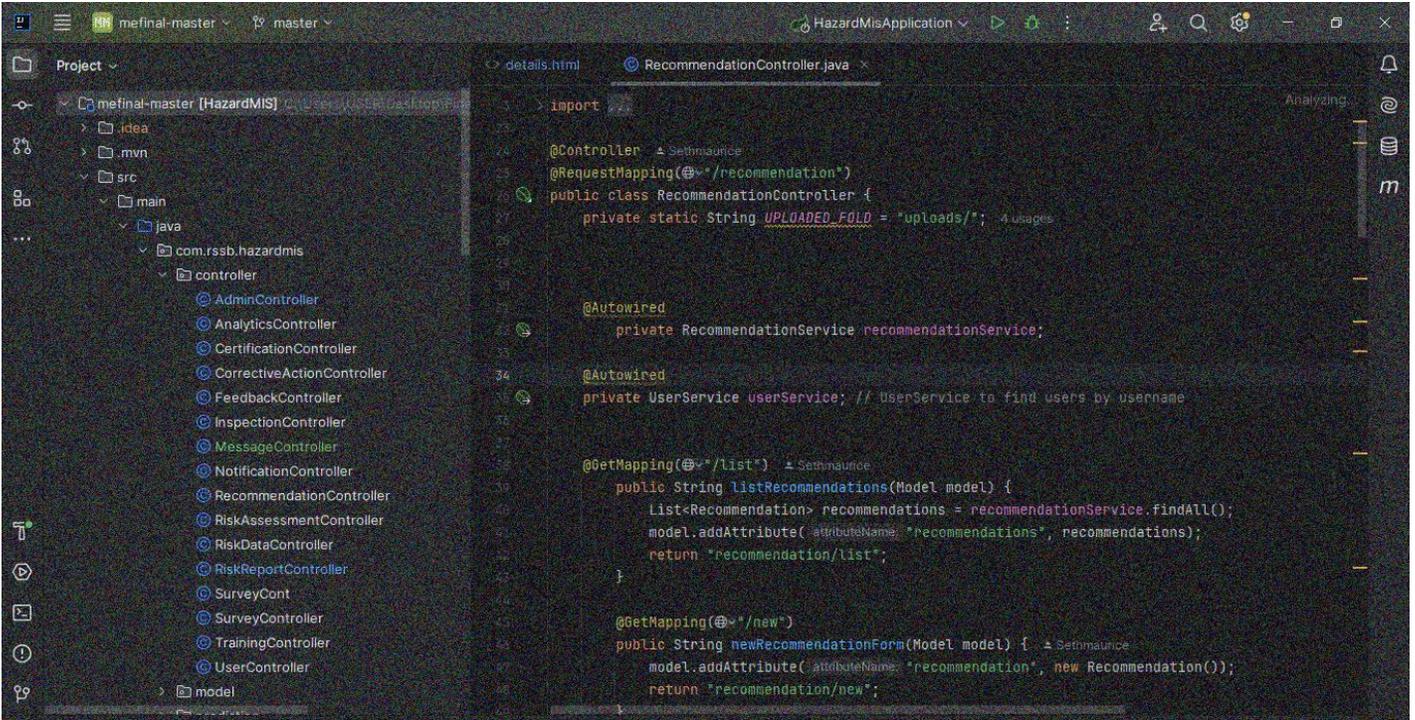
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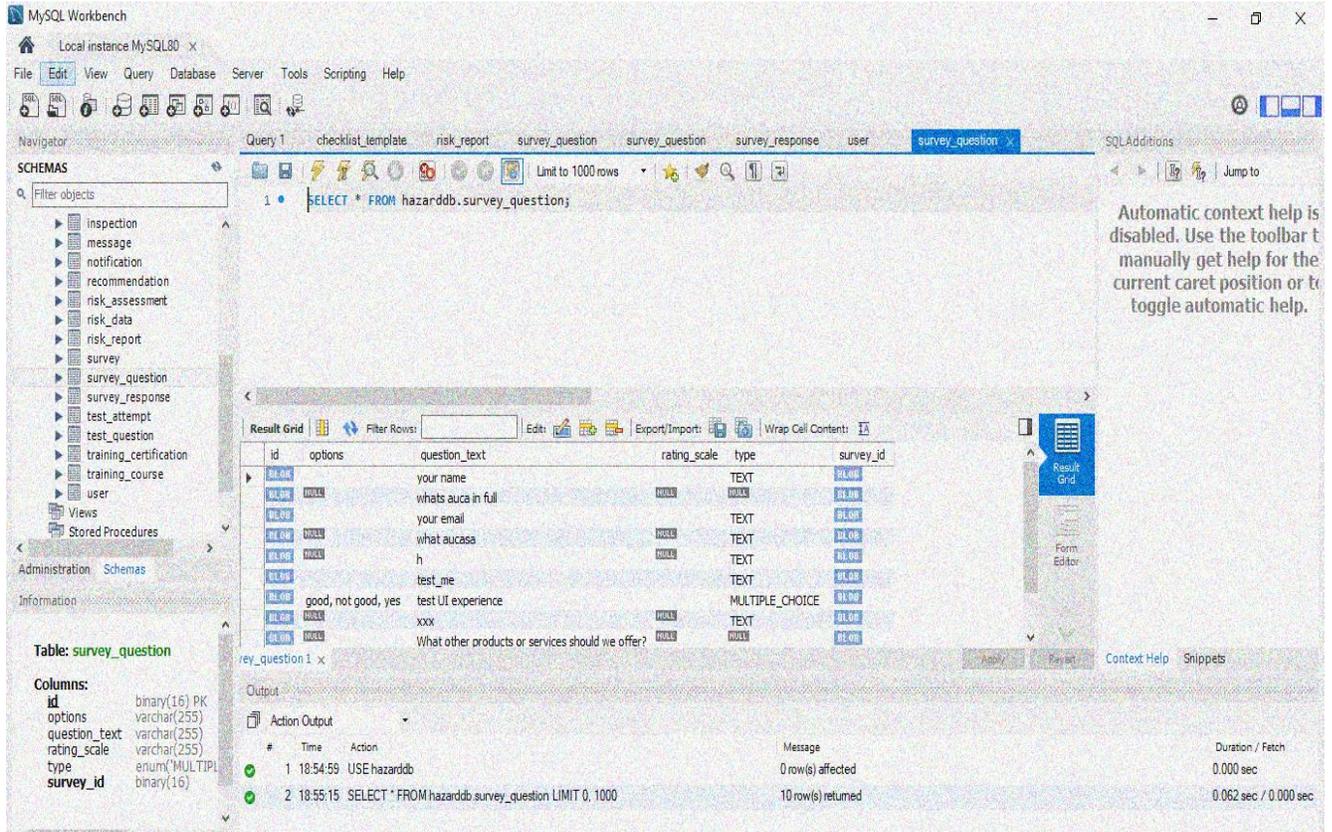
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APPENDICES

IDEA: INTELLIJ ULTIMATE 2024.2.3



DATABASE: SQL SERVER



User Management (Login, Signup, Reset password) Backend Code(Controller)

```
package com.rssb.hazardmis.controller;

import com.rssb.hazardmis.EmailService;
import com.rssb.hazardmis.model.User;
import com.rssb.hazardmis.service.impl.UserService;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.security.access.prepost.PreAuthorize;
import org.springframework.security.authentication.AuthenticationManager;
import org.springframework.security.authentication.UsernamePasswordAuthenticationToken;
import org.springframework.security.core.Authentication;
import org.springframework.security.core.AuthenticationException;
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.*;

import java.util.List;
import java.util.UUID;

@Controller
@RequestMapping("/user")
public class UserController {

    @Autowired
    private AuthenticationManager authenticationManager;

    @Autowired
    private EmailService emailService;

    @Autowired
    private UserService userService;

    @GetMapping("/signup")
    public String signupForm(@ModelAttribute("user") User user ,Model model) {
        model.addAttribute("user", user);
        return "user/signup";
    }

    @GetMapping("/new")
    public String newForm(@ModelAttribute("user") User user ,Model model) {
        model.addAttribute("user", user);
        return "user/newUser";
    }

    @PostMapping("/saveUser")
    public String signup(@ModelAttribute("user") User user) {
        if (user.getId() != null){
            userService.updateUser(user);
        }else {
            userService.addUser(user);
        }
        return "redirect:/user/login";
    }

    @GetMapping("/login")
    public String loginForm(Model model) {
        model.addAttribute("user", new User());
        return "user/login";
    }

    @PostMapping("/login")
    public String login(@ModelAttribute User user, Model model) {
        try {
            // Create an authentication token
            Authentication authentication = new UsernamePasswordAuthenticationToken(user.getUsername(), user.getPassword());
```

```

// Authenticate the user
Authentication authResult = authenticationManager.authenticate(authentication);

// If authentication is successful, redirect to the dashboard
if (authResult.isAuthenticated()) {
    return "redirect:/dashboard";
}

} catch (AuthenticationException e) {
    // Handle authentication failure
    model.addAttribute("error", "Invalid username or password.");
    return "user/login";
}
return "user/login";
}

@GetMapping("/forget-password")
public String showForgetPasswordForm() {
    return "user/forget-password";
}

@PostMapping("/forget-password")
public String processForgetPassword(@RequestParam("email") String email, Model model) {
    String token = userService.createPasswordResetToken(email);
    if (token != null) {
        emailService.sendPasswordResetEmail(email, token);
        model.addAttribute("message", "Password reset link sent to your email.");
    } else {
        model.addAttribute("error", "No account found with that email.");
    }
    return "user/forget-password";
}

@GetMapping("/reset-password")
public String showResetPasswordForm(@RequestParam("token") String token, Model model) {
    User user = userService.findByPasswordResetToken(token);
    if (user == null) {
        model.addAttribute("error", "Invalid or expired token.");
        return "user/reset-password";
    }
    model.addAttribute("token", token);
    return "user/reset-password";
}

@PostMapping("/reset-password")
public String processResetPassword(@RequestParam("token") String token,
    @RequestParam("password") String password,
    Model model) {
    User user = userService.findByPasswordResetToken(token);
    if (user == null) {
        model.addAttribute("error", "Invalid or expired token.");
        return "user/reset-password";
    }
    userService.updatePassword(user, password);
    model.addAttribute("message", "Password successfully reset.");
    return "user/login";
}

@PreAuthorize("hasRole('ADMIN')")
@GetMapping
public String getUser(Model model) {
    List<User> user = userService.findAll();
    model.addAttribute("user", user);
    return "user/list";
}

```

```

}

@PreAuthorize("hasRole('ADMIN')")
@GetMapping("/delete/{id}")
public String deleteUser(@PathVariable("id") UUID id) {
    userService.deleteUser(id);
    return "redirect:/user";
}

@GetMapping("/edit/{id}")
public String editUserForm(@PathVariable("id") UUID id, Model model) {
    User user = userService.findUserById(id);
    if (user != null) {
        model.addAttribute("user", user);
        return "user/form";
    } else {
        return "redirect:/user";
    }
}

@PreAuthorize("hasRole('ADMIN')")
@GetMapping("/profile/{id}")
public String viewProfile(@PathVariable("id") UUID id, Model model) {
    User user = userService.findUserById(id);
    model.addAttribute("user", user);
    return "user/profile";
}

@PostMapping("/profile/update")
public String updateProfile(@ModelAttribute("user") User user) {
    userService.updateUser(user);
    return "redirect:/user/profile/" + user.getId();
}
}

```

User Management (Login, Signup, Reset password) Backend Code(Model)

```

package com.rssb.hazardmis.model;

import jakarta.persistence.*;
import lombok.Data;

import java.util.UUID;

@Entity
@Data
public class User {
    @Id
    @GeneratedValue(strategy = GenerationType.UUID)
    private UUID id;
    private String username;
    private String password;
    private String email;
    private String firstName;
    private String lastName;
    private String passwordResetToken;
    @Enumerated(EnumType.STRING)
    private Role role;

    public enum Role {
        ADMIN, USER;
    }
}

```

```
}
```

User Management (Login, Signup, Reset password) Backend Code(Model)

```
package com.rssb.hazardmis.repository;

import com.rssb.hazardmis.model.User;
import org.springframework.data.jpa.repository.JpaRepository;

import java.util.Optional;
import java.util.UUID;

public interface UserRepository extends JpaRepository<User, UUID> {
    Optional<User> findByUsername(String username);
    User findByEmail(String email);
    User findByPasswordResetToken(String token);
}
```

User Management (Login, Signup, Reset password) Backend Code(Service_Interface)

```
package com.rssb.hazardmis.service.inter;

import com.rssb.hazardmis.model.User;

import java.util.List;
import java.util.UUID;

public interface UserInterface {
    void addUser(User user);
    void deleteUser(UUID id);
    User updateUser(User user);
    List<User> findAll();
    User findUserById(UUID id);
    public User findByUsername(String username);
}
```

User Management (Login, Signup, Reset password) Backend Code(Service_Implementation)

```
package com.rssb.hazardmis.service.impl;

import com.rssb.hazardmis.EmailService;
import com.rssb.hazardmis.model.User;
import com.rssb.hazardmis.repository.UserRepository;
import com.rssb.hazardmis.security.CustomUserDetails;
import com.rssb.hazardmis.service.inter.UserInterface;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.mail.MailException;
import org.springframework.mail.SimpleMailMessage;
import org.springframework.mail.javamail.JavaMailSender;
import org.springframework.security.crypto.bcrypt.BCryptPasswordEncoder;
import org.springframework.stereotype.Service;
import org.springframework.security.core.Authentication;
import org.springframework.security.core.context.SecurityContextHolder;

import java.util.List;
import java.util.UUID;

@Service
public class UserService implements UserInterface {
    @Autowired
    UserRepository userRepository;

    @Autowired
    private EmailService emailService;
```

```

@Autowired
private JavaMailSender mailSender; // Add this field for sending emails

@Override
public void addUser(User user) {
    user.setPassword(new BCryptPasswordEncoder().encode(user.getPassword()));
    userRepository.save(user);
}

@Override
public void deleteUser(UUID id) {
    userRepository.deleteByld(id);
}

@Override
public User updateUser(User user) {
    if (userRepository.existsByld(user.getId())) {
        User existingUser = userRepository.findById(user.getId()).orElseThrow() -> new IllegalArgumentException("User not found");

        if (user.getPassword() != null && !user.getPassword().isEmpty()) {
            if (!new BCryptPasswordEncoder().matches(user.getPassword(), existingUser.getPassword())) {
                // Encrypt the new password
                user.setPassword(new BCryptPasswordEncoder().encode(user.getPassword()));
            } else {
                // Retain the old password if it's the same
                user.setPassword(existingUser.getPassword());
            }
        } else {
            // Retain the existing password if no new password is provided
            user.setPassword(existingUser.getPassword());
        }

        // Other fields can be updated as needed (e.g. name, email, etc.)
        return userRepository.save(user);
    } else {
        throw new IllegalArgumentException("User not found with id: " + user.getId());
    }
}

@Override
public List<User> findAll() {
    return userRepository.findAll();
}

@Override
public User findUserByld(UUID id) {
    return userRepository.findById(id).orElse(null);
}

public User getCurrentUser() {
    Authentication authentication = SecurityContextHolder.getContext().getAuthentication();
    CustomUserDetails userDetails = (CustomUserDetails) authentication.getPrincipal();
    return findByUsername(userDetails.getUsername());
}

public boolean isAdmin(User user) {
    return user.getRole() == User.Role.ADMIN;
}

public boolean isUser(User user) {
    return user.getRole() == User.Role.USER;
}

```

```

}

public User findByEmail(String email) {
    return userRepository.findByEmail(email);
}
@Override
public User findByUsername(String username) {
    return userRepository.findByUsername(username)
        .orElseThrow(() -> new IllegalArgumentException("User not found with username: " + username));
}

public User findByPasswordResetToken(String token) {
    return userRepository.findByPasswordResetToken(token);
}

private void savePasswordResetToken(User user, String token) {
    user.setPasswordResetToken(token); // Set the reset token on the user
    userRepository.save(user); // Save the user with the token
}

public String createPasswordResetToken(String email) {
    User user = findByEmail(email);
    if (user == null) {
        return null;
    }

    String token = UUID.randomUUID().toString();
    savePasswordResetToken(user, token);

    // Send password reset email
    emailService.sendPasswordResetEmail(user.getEmail(), token);

    return token;
}

public void updatePassword(User user, String newPassword) {
    String hashedPassword = new BCryptPasswordEncoder().encode(newPassword);
    user.setPassword(hashedPassword);
    user.setPasswordResetToken(null); // Clear the token after successful password reset
    userRepository.save(user);
}
}
}

```

Login Frontend Code

```

<!DOCTYPE html>
<html xmlns:th="http://www.thymeleaf.org">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Login | Your System</title>
    <link href="https://cdn.jsdelivr.net/npm/font-awesome@6.0.0/css/all.min.css" rel="stylesheet">
    <style>
        * {
            margin: 0;
            padding: 0;
            box-sizing: border-box;
            font-family: 'Segoe UI', Tahoma, Geneva, Verdana, sans-serif;
        }

        :root {
            --primary-color: #2C3E50;
            --accent-color: #E74C3C;
            --gradient-start: #2C3E50;
            --gradient-end: #3498DB;
        }
    </style>

```

```

--success-color: #2ECC71;
--error-color: #E74C3C;
}

body {
  min-height: 100vh;
  display: flex;
  justify-content: center;
  align-items: center;
  background: linear-gradient(135deg, #ECE9E6, #FFFFFF);
  padding: 20px;
  position: relative;
  overflow: hidden;
}

/* Animated background */
.bg-animation {
  position: fixed;
  top: 0;
  left: 0;
  width: 100%;
  height: 100%;
  z-index: -1;
  opacity: 0.7;
}

.bg-animation div {
  position: absolute;
  border-radius: 50%;
  background: linear-gradient(45deg, var(--gradient-start), var(--gradient-end));
  animation: float 15s infinite;
  opacity: 0.3;
}

.bg-animation div:nth-child(1) {
  width: 70px;
  height: 70px;
  left: 10%;
  animation-delay: 0s;
}

.bg-animation div:nth-child(2) {
  width: 100px;
  height: 100px;
  right: 15%;
  animation-delay: 2s;
}

.bg-animation div:nth-child(3) {
  width: 120px;
  height: 120px;
  bottom: 20%;
  left: 20%;
  animation-delay: 4s;
}

@keyframes float {
  0% { transform: translate(0, 0) rotate(0deg); }
  33% { transform: translate(30px, -50px) rotate(120deg); }
  66% { transform: translate(-20px, 20px) rotate(240deg); }
  100% { transform: translate(0, 0) rotate(360deg); }
}

.login-container {
  background: rgba(255, 255, 255, 0.95);
  padding: 2.5rem;
}

```

```
border-radius: 20px;
box-shadow: 0 8px 32px rgba(44, 62, 80, 0.1);
width: 100%;
max-width: 450px;
transform: translateY(0);
transition: all 0.4s cubic-bezier(0.165, 0.84, 0.44, 1);
position: relative;
overflow: hidden;
animation: slideIn 0.6s ease-out;
}
```

```
@keyframes slideIn {
  from {
    opacity: 0;
    transform: translateY(30px);
  }
  to {
    opacity: 1;
    transform: translateY(0);
  }
}
```

```
.login-container:hover {
  transform: translateY(-5px);
  box-shadow: 0 12px 40px rgba(44, 62, 80, 0.2);
}
```

```
.login-header {
  text-align: center;
  margin-bottom: 2rem;
  animation: fadeIn 0.8s ease-out;
}
```

```
@keyframes fadeIn {
  from { opacity: 0; }
  to { opacity: 1; }
}
```

```
.login-header h2 {
  color: var(--primary-color);
  font-size: 2.2rem;
  margin-bottom: 0.5rem;
  font-weight: 700;
}
```

```
.login-header p {
  color: #7F8C8D;
  font-size: 1.1rem;
}
```

```
.form-group {
  margin-bottom: 1.8rem;
  position: relative;
  animation: slideUp 0.6s ease-out;
  animation-fill-mode: both;
}
```

```
.form-group:nth-child(2) {
  animation-delay: 0.1s;
}
```

```
.form-group:nth-child(3) {
  animation-delay: 0.2s;
}
```

```
@keyframes slideUp {
```

```

from {
  opacity: 0;
  transform: translateY(20px);
}
to {
  opacity: 1;
  transform: translateY(0);
}
}

.form-group label {
  display: block;
  margin-bottom: 0.7rem;
  color: var(--primary-color);
  font-weight: 600;
  font-size: 0.95rem;
  transition: all 0.3s ease;
}

.form-group input {
  width: 100%;
  padding: 12px 16px;
  border: 2px solid #E5E7EB;
  border-radius: 12px;
  font-size: 1rem;
  transition: all 0.3s ease;
  background-color: #F8FAFC;
  color: var(--primary-color);
}

.form-group input:focus {
  border-color: var(--accent-color);
  background-color: #FFFFFF;
  outline: none;
  box-shadow: 0 0 0 4px rgba(231, 76, 60, 0.1);
}

.form-group .input-icon {
  position: absolute;
  right: 16px;
  top: 50%;
  transform: translateY(-50%);
  color: #A0AEC0;
  transition: all 0.3s ease;
}

.form-group input:focus + .input-icon {
  color: var(--accent-color);
}

.forgot-password {
  text-align: right;
  margin-top: -1rem;
  margin-bottom: 1.5rem;
}

.forgot-password a {
  color: var(--accent-color);
  text-decoration: none;
  font-size: 0.9rem;
  font-weight: 500;
  transition: all 0.3s ease;
}

.forgot-password a:hover {
  color: #C0392B;
}

```

```

}

.btn {
  width: 100%;
  padding: 14px;
  border: none;
  border-radius: 12px;
  font-size: 1rem;
  font-weight: 600;
  cursor: pointer;
  transition: all 0.3s ease;
  position: relative;
  overflow: hidden;
}

.btn-primary {
  background: linear-gradient(45deg, var(--gradient-start), var(--gradient-end));
  color: white;
  box-shadow: 0 4px 15px rgba(52, 152, 219, 0.2);
}

.btn-primary:hover {
  transform: translateY(-2px);
  box-shadow: 0 6px 20px rgba(52, 152, 219, 0.3);
}

.btn-primary:active {
  transform: translateY(1px);
}

.btn-ripple {
  position: relative;
  overflow: hidden;
}

.btn-ripple:after {
  content: "";
  position: absolute;
  width: 100%;
  height: 100%;
  top: 0;
  left: 0;
  pointer-events: none;
  background-image: radial-gradient(circle, #fff 10%, transparent 10.01%);
  background-repeat: no-repeat;
  background-position: 50%;
  transform: scale(10, 10);
  opacity: 0;
  transition: transform .5s, opacity 1s;
}

.btn-ripple:active:after {
  transform: scale(0, 0);
  opacity: .3;
  transition: 0s;
}

.divider {
  text-align: center;
  margin: 1.5rem 0;
  position: relative;
  color: #7F8C8D;
}

.divider::before,
.divider::after {

```

```

content: "";
position: absolute;
top: 50%;
width: 45%;
height: 1px;
background-color: #E5E7EB;
}

.divider::before { left: 0; }
.divider::after { right: 0; }

.social-login {
display: grid;
grid-gap: 1rem;
margin-top: 1.5rem;
animation: slideUp 0.6s ease-out;
animation-delay: 0.3s;
animation-fill-mode: both;
}

.btn-social {
display: flex;
align-items: center;
justify-content: center;
gap: 10px;
background-color: #F8FAFC;
border: 2px solid #E5E7EB;
color: var(--primary-color);
font-weight: 500;
transition: all 0.3s ease;
}

.btn-social:hover {
background-color: #EDF2F7;
border-color: #CBD5E0;
}

.btn-social i {
font-size: 1.2rem;
}

.register-link {
text-align: center;
margin-top: 2rem;
color: #7F8C8D;
animation: slideUp 0.6s ease-out;
animation-delay: 0.4s;
animation-fill-mode: both;
}

.register-link a {
color: var(--accent-color);
text-decoration: none;
font-weight: 600;
transition: all 0.3s ease;
}

.register-link a:hover {
color: #C0392B;
}

/* Loading animation */
.btn-loading {
position: relative;
color: transparent !important;
}

```

```

.btn-loading::after {
  content: "";
  position: absolute;
  width: 20px;
  height: 20px;
  top: 50%;
  left: 50%;
  margin: -10px 0 0 -10px;
  border: 3px solid rgba(255, 255, 255, 0.3);
  border-radius: 50%;
  border-top-color: white;
  animation: spin 1s ease-in-out infinite;
}

@keyframes spin {
  to { transform: rotate(360deg); }
}

/* Alert styles */
.alert {
  padding: 1rem;
  border-radius: 12px;
  margin-bottom: 1.5rem;
  display: flex;
  align-items: center;
  gap: 10px;
  animation: slideIn 0.5s ease-out;
}

.alert-error {
  background-color: #FEE2E2;
  color: #DC2626;
  border: 1px solid #FCA5A5;
}

.alert i {
  font-size: 1.2rem;
}

@media (max-width: 480px) {
  .login-container {
    padding: 1.5rem;
  }

  .login-header h2 {
    font-size: 1.8rem;
  }

  .form-group input {
    padding: 10px 14px;
  }
}
</style>
</head>
<body>
<!-- Background Animation -->
<div class="bg-animation">
  <div></div>
  <div></div>
  <div></div>
</div>

<div class="login-container">
  <div class="login-header">
    <h2>Welcome Back</h2>

```

```

    <p>Please enter your details to sign in</p>
</div>

<form th:action="@{/user/login}" th:object="${user}" method="post" id="loginForm">
  <div th:if="${error}" class="alert alert-error">
    <i class="fas fa-exclamation-circle"></i>
    <p th:text="${error}">Invalid username or password.</p>
  </div>

  <div class="form-group">
    <label for="email">Username or Email Address</label>
    <input
      type="text"
      id="email"
      name="username"
      th:field="*{username}"
      placeholder="Enter your username or email"
      required >
      <!-- autocomplete="email" -->
    <i class="fas fa-envelope input-icon"></i>
  </div>

  <div class="form-group">
    <label for="password">Password</label>
    <input
      type="password"
      id="password"
      name="password"
      th:field="*{password}"
      placeholder="Enter your password"
      required
      autocomplete="current-password">
    <i class="fas fa-lock input-icon"></i>
  </div>

  <div class="forgot-password">
    <a href="..user/forget-password">Forgot password?</a>
  </div>

  <button type="submit" class="btn btn-primary btn-ripple" id="loginButton">
    Sign In
  </button>

  <div class="divider">Or continue with</div>

  <div class="social-login">
    <button type="button" class="btn btn-social">
      <i class="fab fa-google"></i>
      Continue with Google
    </button>
  </div>

  <div class="register-link">
    Don't have an account? <a href="/user/signup">Sign up</a>
  </div>
</form>
</div>

<script>
  // Form handling
  document.getElementById('loginForm').addEventListener('submit', function(e) {
    const button = document.getElementById('loginButton');
    button.classList.add('btn-loading');
    button.disabled = true;
  });

```

```

// Input focus effects
document.querySelectorAll('.form-group input').forEach(input => {
  input.addEventListener('focus', function() {
    this.parentElement.querySelector('label').style.color = '#E74C3C';
  });

  input.addEventListener('blur', function() {
    this.parentElement.querySelector('label').style.color = '#2C3E50';
  });
});

// Password visibility toggle
const passwordInput = document.getElementById('password');
const togglePassword = document.querySelector('.fa-lock');

if (togglePassword) {
  togglePassword.style.cursor = 'pointer';
  togglePassword.addEventListener('click', function() {
    const type = passwordInput.getAttribute('type') === 'password' ? 'text' : 'password';
    passwordInput.setAttribute('type', type);

    // Toggle icon
    this.classList.toggle('fa-lock');
    this.classList.toggle('fa-lock-open');
  });
}

// Google Sign In handler
document.querySelector('.btn-social').addEventListener('click', function() {
  // Add your Google Sign In logic here
  this.classList.add('btn-loading');
  // window.location.href = '/oauth2/authorization/google'; // Uncomment when implementing OAuth
});
</script>
</body>
</html>

```

IMPORTANT DEPENDENCIES

```

<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 https://maven.apache.org/xsd/maven-4.0.0.xsd">
  <modelVersion>4.0.0</modelVersion>
  <parent>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-parent</artifactId>
    <version>3.3.2</version>
    <relativePath/> <!-- lookup parent from repository -->
  </parent>
  <groupId>com.rssb</groupId>
  <artifactId>HazardMIS</artifactId>
  <version>0.0.1-SNAPSHOT</version>
  <name>HazardMIS</name>
  <description>HazardMIS</description>
  <url/>
  <licenses>
    <license/>
  </licenses>
  <developers>
    <developer/>
  </developers>
  <scm>
    <connection/>
    <developerConnection/>
    <tag/>
    <url/>
  </scm>
  <properties>

```

```

<java.version>17</java.version>
<maven.compiler.source>17</maven.compiler.source>
<maven.compiler.target>17</maven.compiler.target>
</properties>
<dependencies>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-data-jpa</artifactId>
  </dependency>

  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-mail</artifactId>
  </dependency>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-security</artifactId>
  </dependency>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-thymeleaf</artifactId>
  </dependency>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-validation</artifactId>
  </dependency>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-web</artifactId>
  </dependency>
  <dependency>
    <groupId>org.thymeleaf.extras</groupId>
    <artifactId>thymeleaf-extras-springsecurity6</artifactId>
  </dependency>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-devtools</artifactId>
    <scope>runtime</scope>
    <optional>true</optional>
  </dependency>
  <dependency>
    <groupId>com.mysql</groupId>
    <artifactId>mysql-connector-j</artifactId>
    <scope>runtime</scope>
  </dependency>
  <dependency>
    <groupId>org.postgresql</groupId>
    <artifactId>postgresql</artifactId>
    <scope>runtime</scope>
  </dependency>
  <dependency>
    <groupId>org.projectlombok</groupId>
    <artifactId>lombok</artifactId>
    <optional>true</optional>
  </dependency>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-test</artifactId>
    <scope>test</scope>
  </dependency>
  <dependency>
    <groupId>org.springframework.security</groupId>
    <artifactId>spring-security-test</artifactId>
    <scope>test</scope>
  </dependency>
</dependencies>

```

```
<build>
  <plugins>
    <plugin>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-maven-plugin</artifactId>
      <configuration>
        <excludes>
          <exclude>
            <groupId>org.projectlombok</groupId>
            <artifactId>lombok</artifactId>
          </exclude>
        </excludes>
      </configuration>
    </plugin>
  </plugins>
</build>
</project>
```