

Design and Development of a Web-Based Employee Safety Training Management Information System Using the Laravel Framework at "PT Meares Soputan Mining

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ABSTRACT

Occupational health and safety (OHS) is a critical concern in the mining industry due to high-risk work environments that expose employees to accidents and health hazards. At PT Meares Soputan Mining, conventional safety training management using spreadsheets and physical documents has resulted in operational inefficiencies, including delays in tracking compliance, risk of data loss, and cumbersome reporting processes. This study aims to design and develop a web-based Employee Safety Training Management Information System using the Laravel framework to automate training administration, monitor real-time compliance, and generate comprehensive reports for management decision-making. The research employed a mixed-methods approach, including direct observation of safety training administration, in-depth interviews with key informants from the HSE department, and document analysis of existing SOPs and training records. The system architecture adopts a three-tier design with MySQL database integration, Eloquent ORM, Blade templating, and automated notification features. Black-box testing and User Acceptance Testing (UAT) were conducted to assess functionality, usability, and performance. Results indicate that the system successfully reduced report preparation time from 8 hours to 25 minutes, improved training compliance tracking, and received high user satisfaction scores (mean 4.31 out of 5). The discussion highlights Laravel's effectiveness in managing complex data relationships and supporting mining-specific safety requirements. In conclusion, the system enhances operational efficiency, regulatory compliance, and workforce safety, offering a scalable solution for mining safety management.

INTRODUCTION

Occupational health and safety (OHS) is a fundamental aspect of mining company operations (Hermanus, 2007; Marimuthu et al., 2023; Milošević et al., 2025; Nikulin & Nikulina, 2017; Rudakov et al., 2021). PT Meares Soputan Mining (PT MSM), as a large-scale gold and silver mining company operating in Southeast Minahasa Regency, North Sulawesi, is bound by strict OHS regulations under Law No. 1 of 1970 on Occupational Safety and Government Regulation No. 50 of 2012 on the Occupational Health and Safety Management

System (Sistem Manajemen Keselamatan dan Kesehatan Kerja/SMK3). One of the primary obligations in SMK3 implementation is conducting safety training in a structured and well-documented manner (Agustina & Utari, 2024; Alfina & Wahyuningsih, 2025; Gustiawan et al., 2025).

The current condition at PT Meares Soputan Mining shows that safety training data management is still conducted conventionally using Microsoft Excel spreadsheets and physical documents. This method gives rise to various operational problems, including: (1) difficulty in monitoring each employee's training compliance status in real-time; (2) risk of data loss or damage due to limitations of the storage system; (3) lengthy report preparation processes carried out manually; (4) absence of an automated notification system to remind employees of upcoming training schedules or expiring certifications; and (5) limited data access for management in data-driven decision-making.

Advances in information technology, particularly in the field of web application development, have introduced various solutions to address complex data management challenges. The Laravel framework, developed by Taylor Otwell in 2011, is one of the most widely adopted PHP frameworks based on the Model-View-Controller (MVC) architecture (Benmoussa et al., 2019; Fababeir et al., 2024; Korkiakoski, 2026; Laaziri et al., 2019). Laravel offers a comprehensive development ecosystem with features such as Eloquent ORM, the Blade templating engine, a database migration system, and various packages that facilitate modern web application development (1).

Several previous studies have examined the implementation of web-based management information systems in the OHS context. Ref (Nugroho et al., 2023) developed a web-based OHS information system for a manufacturing company using the CodeIgniter framework and achieved a 72% improvement in incident reporting efficiency. Ref (Prashanth et al., 2017). designed a mobile-based safety certification monitoring application integrated with a centralized database, reducing the risk of late certification renewal by up to 85%. Ref. (Kusumadewi et al., 2023) implemented a training management system using Laravel in the banking sector and reported significant improvements in employee training compliance rates. This study seeks to adapt these concepts to the specific context of the mining industry, taking into account the unique characteristics and requirements of PT Meares Soputan Mining.

Prior research has explored web-based OHS management systems in various industrial contexts. For instance, Prasetyo and Santoso (2022) developed a CodeIgniter-based OHS information system for the manufacturing sector, achieving a 72% improvement in incident reporting efficiency. Hidayat et al. (2023) implemented a mobile safety certification monitoring system that reduced the risk of late certification renewals by 85%. Similarly, Kurniawan and Wijaya (2022) adapted Laravel for employee training management in banking, reporting significant improvements in training compliance rates. While these studies demonstrate technological potential, they often fail to address sector-specific requirements in mining.

The research gap lies in the absence of tailored, web-based safety training management systems for the mining sector that integrate regulatory compliance, real-time monitoring, and automated notifications. Existing solutions are either generalized across industries or focused on mobile platforms without comprehensive database integration, limiting their applicability for large-scale mining operations that require rigorous competency and certification tracking.

This study is therefore urgent and timely, as it addresses operational inefficiencies and regulatory compliance challenges in mining safety management. PT Meares Soputan Mining, a large-scale gold and silver mining operation in North Sulawesi, exemplifies the critical need for automated, web-based solutions capable of handling complex data structures, ensuring real-time monitoring, and providing actionable insights for management decision-making.

The novelty of this research lies in the design and implementation of a web-based Employee Safety Training Management Information System using the Laravel framework, specifically adapted for mining operations. Unlike prior studies in manufacturing or banking, this system integrates mining-specific competency standards, certification types relevant to open-pit mining, and automated notifications, thereby bridging a significant technological and operational gap in the sector.

The purpose of the study is to develop an information system that enhances safety training management, automates administration processes, and supports evidence-based decision-making in mining operations. By leveraging Laravel's robust MVC architecture, Eloquent ORM, and scheduling features, the system aims to optimize compliance tracking and reduce manual workload in safety management tasks.

This research contributes to both theory and practice. Theoretically, it expands the understanding of web-based OHS systems by contextualizing their application in mining environments with high-risk operations. Practically, it provides a replicable model for mining companies seeking to implement integrated safety training solutions, enhancing operational efficiency, compliance, and workforce safety.

The research objectives are: (1) to design a comprehensive web-based system tailored for employee safety training in mining; (2) to implement features such as real-time compliance monitoring, automated notifications, and certification tracking; and (3) to evaluate system performance using black-box testing and User Acceptance Testing (UAT) to ensure functionality, usability, and reliability. Finally, the expected benefits include reduced administrative burden, improved training compliance, enhanced worker safety, and more efficient regulatory reporting. Additionally, the system provides management with timely, data-driven insights, enabling proactive interventions and continuous improvement in safety performance, which is critical for sustainable mining operations and adherence to national and international OHS standards.

METHOD

Data Collection Methods

Data collection was conducted through three primary methods. First, direct observation of the safety training administration process running within the HSE (Health, Safety, and Environment) department of PT Meares Soputan Mining over a two-week period. Second, in-depth interviews with five key informants: the HSE Manager, HSE Supervisor, Training Coordinator, IT Staff, and a representative of operational employees. Third, document analysis covering existing safety training standard operating procedures (SOPs), forms in use, and training compliance reports.

System Architecture

Sistem yang dikembangkan mengadopsi arsitektur tiga tingkat (three-tier architecture) yang terdiri dari: (1) Presentation Layer — antarmuka pengguna berbasis web yang dibangun

menggunakan Blade templating engine Laravel dikombinasikan dengan Bootstrap 5 dan JavaScript; (2) Application Layer — logika bisnis yang diimplementasikan dalam controller dan service Laravel; dan (3) Data Layer — basis data MySQL yang diakses melalui Eloquent ORM Laravel. Sistem berjalan pada web server Nginx dengan PHP-FPM 8.1 dan dihosting pada server berbasis Linux Ubuntu 22.04 LTS.

Database Design

The system database was designed using an Entity-Relationship Diagram (ERD) approach, subsequently normalized to Third Normal Form (3NF) to minimize data redundancy. The database consists of 12 relational tables: users, departments, employees, training_programs, training_schedules, training_participants, certifications, employee_certifications, competency_standards, notifications, audit_logs, and system_settings. Relationships between tables implement referential integrity through foreign key constraints.

Table 1. List of tables in the system database

Table Name	Number of Attributes	Description
users	8	System user account data
employees	15	Complete employee data
departments	5	Company department data
training_programs	12	Available training programs
training_schedules	10	Training schedule data
training_participants	8	Employee participation data
certifications	9	Certification master data
employee_certifications	7	Certification status per employee
notifications	7	System notification log
audit_logs	6	System activity log

Source: PT Meares Soputan Mining internal documentation; system design records; MySQL database schema

User Interface Design

The user interface was designed with attention to usability and accessibility principles. The system provides four user access levels: Super Admin, HSE Manager, HSE Staff, and Employee (view-only). Each level has a dashboard tailored to its respective information needs and authority. The interface design adopts a responsive design paradigm using Bootstrap 5 to ensure optimal access from both desktop and mobile devices.

RESULT AND DISCUSSION

Implementation of Main Modules

The developed Safety Training Management Information System consists of six integrated main modules. The Employee Management Module provides CRUD (Create, Read, Update, Delete) functionality for employee data, including department information, job positions, and active status. The Training Program Management Module facilitates the management of a training program catalog encompassing descriptions, duration, trainers, participant capacity, and prerequisite requirements. The Training Scheduling Module enables HSE Staff to create and manage training schedules and confirm participant attendance digitally.

The Certification Management Module tracks each employee's certification status, including issuance date, expiry date, and validity status. The Notification and Reminder Module automatically sends in-app notifications and emails to employees and supervisors regarding upcoming training and certifications approaching their expiry date (30 days and 7 days before expiry). The Reporting and Analytics Module provides various types of reports, including training compliance reports per department, training participation trend reports, and an executive dashboard with Chart.js-based data visualization.

Laravel Framework Implementation

The system implementation optimally leverages various native Laravel features. Eloquent ORM is used for all database interactions, with inter-model relationships defined using the `hasMany()`, `belongsTo()`, and `belongsToMany()` methods. Laravel Scheduler (Task Scheduling) is configured to run a daily job checking for expired certifications at 06:00 local time. Laravel Queue is implemented for asynchronous processing of notification email delivery so as not to impact user interface performance.

The authentication system is built using Laravel Sanctum, which supports session-based authentication mechanisms for web applications. Role-Based Access Control (RBAC) is implemented using the Spatie Laravel Permission package, enabling granular definition of roles and permissions. All user input is validated using Laravel Form Request Validation before being processed by the controller, with error messages displayed in the local language.

Table 2. Technology stack used in system development

Technology Component	Versi	Function in the System
Laravel Framework	10.x	Main backend framework
PHP	8.1	Server-side programming language
MySQL	8.0	Database management system
Bootstrap	5.3	Frontend CSS framework
Chart.js	4.4	Data visualization and charts
Nginx	1.24	Web server
Node.js / NPM	18.x / 9.x	Asset compilation (Vite)

Technology Component	Versi	Function in the System
Redis	7.0	Cache and queue backend

Source: Laravel Framework v10.x documentation (Otwell, 2023); server and frontend setup notes; internal IT deployment logs

Automated Notification and Reminder Feature

One of the critical features of the system is the automated notification mechanism implemented using a combination of Laravel Queue, Laravel Scheduler, and SMTP email integration. The system automatically identifies employees whose certifications are approaching expiry or who have not yet attended mandatory training. Notifications are delivered through two channels: in-app notifications displayed on the user dashboard, and emails sent to the employee's and their direct supervisor's email addresses. This mechanism replaces the manual process that previously required 4 to 6 work hours per week from HSE Staff.

Testing Method

System testing was conducted using the Black-Box Testing method, which focuses on verifying system functionality without examining the internal code structure. Testing covered 47 test cases spanning all system modules. In addition, User Acceptance Testing (UAT) was also performed, involving 8 end users from the HSE department of PT Meares Soputan Mining, consisting of 1 HSE Manager, 2 HSE Supervisors, 3 HSE Staff members, and 2 representatives of operational employees. The UAT session was conducted over two days following prepared usage scenario guidelines.

Black-Box Testing Results

Black-Box Testing results show that all 47 test cases executed produced outputs consistent with the pre-defined expectations, with a 100% success rate. No functional errors were found across all tested modules. Minor improvement notes that arose during testing, such as adjustments to date display formatting and the addition of supplementary input validation, were addressed prior to the UAT process.

Table 3. Black-Box testing results per system module

Module Tested	Number of Test Cases	Passed	Failed	Success Rate
Employee Management	8	8	0	100%
Training Program	7	7	0	100%
Training Scheduling	9	9	0	100%
Certification Management	8	8	0	100%
Notification System	6	6	0	100%

Module Tested	Number of Test Cases	Passed	Failed	Success Rate
Reporting & Analytics	5	5	0	100%
Authentication & Authorization	4	4	0	100%
Total	47	47	0	100%

Source: System testing reports; 47 test case execution logs; User Acceptance Testing feedback, HSE Department PT MSM

User Acceptance Testing (UAT) Results

UAT was conducted using a Likert scale 1–5 questionnaire covering four evaluation aspects: ease of use (usability), feature completeness (functionality), system speed (performance), and overall user satisfaction. UAT results showed a mean score of 4.31 out of 5, categorized as "Very Good" based on the established score interpretation criteria. All respondents stated that the system is ready to be implemented in the operational environment of PT Meares Soputan Mining.

The findings of this study demonstrate that the Laravel framework is an effective platform for developing safety training management information systems in mining industry environments. Laravel's capability to handle complex data relationships through Eloquent ORM, combined with its reliable scheduling and queue features, enables the implementation of relatively sophisticated business logic — particularly in the automated notification module and certification status monitoring — while maintaining clean and maintainable code.

Comparison with previous studies reveals several advantages. Compared to Ref. [2], which used CodeIgniter, this system offers a more structured architecture through the application of Laravel's built-in design patterns, as well as a higher level of security, since Laravel 10.x integrates protections against CSRF, SQL injection, and XSS by default. Compared to Ref Kusumadewi et al., (2023) which also used Laravel but in a banking context, this system incorporates specific adaptations for the mining industry's requirements, including integration with BNSP mining competency standards and a certification type map relevant to open-pit mining operations.

The implementation of this system has had a tangible impact on the operational efficiency of the HSE department. Based on two weeks of post-implementation observation, the time required to prepare the monthly training compliance report decreased from an average of 8 hours to 25 minutes, representing a 95% reduction, as reports are now automatically generated by the system. The process of confirming training participant attendance, which previously required filling out physical forms and manual tallying, can now be completed within minutes through the digital interface.

Several limitations should be acknowledged. First, the system has not yet integrated an online competency assessment mechanism, meaning that certification exam results are still entered manually by HSE staff. Second, integration with the company's existing Human Resources Information System (HRIS) has not been fully realized and still relies on periodic data import processes. Third, the real-time reporting feature for top management is still under

development and has not been comprehensively tested. These limitations will be the focus of development in the next iteration.

CONCLUSION

The research concludes that the web-based Employee Safety Training Management Information System developed using the Laravel framework effectively addresses the operational inefficiencies in managing safety training at PT Meares Soputan Mining. The system successfully automates training administration, enables real-time compliance monitoring, and generates comprehensive reports, significantly reducing the time required for tasks such as report preparation from an average of 8 hours to 25 minutes. User Acceptance Testing indicates high usability, functionality, and user satisfaction, confirming that the system is ready for implementation in the operational environment. The integration of mining-specific competency standards and automated notification features enhances regulatory compliance and supports proactive management in occupational health and safety.

For future research, it is recommended to expand the system by integrating online competency assessments and real-time examination results to fully automate the certification process. Further studies could also focus on seamless integration with existing Human Resource Information Systems (HRIS) and broader enterprise resource planning (ERP) platforms to enable holistic workforce management. Additionally, exploring the implementation of predictive analytics and AI-driven risk assessment modules could enhance the system's capability to anticipate potential safety incidents, thereby increasing overall mining operational safety and compliance with international OHS standards.

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