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Development of a Web-Based Contractor Safety Management System (CSMS): A Case Study of PT. Petromine Energi Trading

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Abstract

This study aimed to develop a Contractor Safety Management System (CSMS) to support the program implemented by PT. Petromine Energi Trading, aligning with the company's objectives for managing the CSMS within the framework of the Mining Safety Management System (SMKP). The technical approach focused on creating a web-based application using a user-centered design (USD) methodology. The results showed that the integration of Single Sign-On (SSO) in the web-based platform enhanced user convenience by allowing seamless access and interaction with the CSMS. The backend structure of the system was designed to facilitate efficient data management and ensure secure, real-time information processing. The CSMS was also developed to ensure compliance with national regulations and international standards while improving communication and coordination between PT. Petromine Energi Trading and its contractors, supporting the comprehensive management of Occupational Health and Safety (OHS) risks.

Keywords: Contractor Safety Management System (CSMS), Mining Safety Management System (SMKP), Occupational Health and Safety (OHS), Single Sign-On (SSO), web-based application

1. INTRODUCTION

Mining is an industry known for its high risk of accidents and occupational diseases, primarily due to the complex and hazardous nature of its operations [1]. The involvement of various contractors with different backgrounds in mining activities only adds to the challenge of maintaining a safe and efficient work environment. As a result, effective health, safety, and environmental (HSE) management systems are essential to minimize operational risks, boost productivity, and safeguard the company's reputation. International standards such as ISO 45001:2018 provide a systematic framework for managing Occupational Health and Safety (OHS) risks at all levels of an organization, ensuring that safety protocols are in place and adhered to. Additionally, the Indonesian government has implemented regulations such as the Mining Safety

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Management System (SMKP) through Decree No. 26 of 2018, Decree No. 1827.K/30/MEM/2018, and Decree No. 185.K/37.04/DJB/2019, which specifically focus on enhancing safety management at mine sites, with a clear emphasis on contractor participation [2].

A key aspect of ensuring effective safety in mining operations is the Contractor Safety Management System (CSMS), which is designed to manage HSE aspects within the contractor workforce. The CSMS addresses the organization, planning, responsibilities, procedures, processes, and resources needed to ensure that contractors comply with safety standards. The system's goal is to develop, implement, and maintain an Occupational Health and Safety Management System (OHSMS) that aligns with organizational policies related to contractor activities. The CSMS serves as a comprehensive framework, often adopted by mining companies to ensure the safety of contractors working on-site or at specific projects. It identifies and manages potential risks associated with contractor activities, ensuring a safe working environment for both contractors and permanent employees of the organization [3].

However, despite the existence of these frameworks, gaps remain in the effective implementation and monitoring of contractor safety management systems in mining operations. Inadequate implementation can lead to operational disruptions, safety breaches, and severe financial consequences, including fines, legal liabilities, and reputational damage. The Decree of the Director General of Mineral and Coal No. 185 of 2019 requires mining companies to develop and implement CSMS for contractors to ensure safety throughout their operations. Yet, companies like PT. Petromine Energi Trading, a key player in the mining sector, may still face challenges in ensuring that contractors fully comply with safety regulations, potentially risking business interruptions and losses due to accidents or non-compliance.

To address these issues, PT. Petromine Energi Trading must adopt a robust and integrated approach to managing contractor safety. This includes implementing a comprehensive CSMS that adheres to both local regulations and international standards. Failure to comply with these requirements could result in significant operational disruptions, including halting production and damaging the company's reputation. Moreover, a more modern solution to this problem lies in leveraging technology to support the information management system. Adopting a digital interface or web-based system can provide real-time data that ensures all safety measures are met effectively and continuously monitored. Such a system would streamline communication and documentation, reduce the risk of human error and facilitating more proactive safety management.

The primary aim of this study is to explore how PT. Petromine Energi Trading can enhance its contractor safety management practices through the

implementation of a digital CSMS. This case study will examine the current challenges in contractor safety management, highlight existing gaps in the current systems, and propose a technological solution to address these issues. By leveraging a digital platform, PT. Petromine Energi Trading can improve the accuracy, speed, and efficiency of information processing and distribution to all stakeholders. This system would not only provide a safer working environment for both contractors and permanent employees but also help the company meet regulatory requirements while reducing operational risks and costs associated with safety management.

2. METHOD

The method employed in this study was focused on the technical aspects of managing the performance of the Contractor Safety Management System (CSMS) within PT. Petromine Energi Trading, with an emphasis on integrating a digital platform to enhance system efficiency and effectiveness. This methodology was structured around a systematic, multi-phase approach consisting of planning, designing, developing, and evaluating a web-based application tailored to the specific needs of the company's CSMS. The aim was to create a seamless, user-friendly interface that would streamline contractor safety management processes and improve decision-making through real-time data access and efficient information flow.

The first phase of the methodology involved detailed planning and analysis of the current CSMS practices at PT. Petromine Energi Trading. This step included interviews and consultations with key stakeholders, such as HSE managers, safety officers, and contractor representatives, to identify existing gaps, challenges, and inefficiencies in the current system. An in-depth review of the company's business processes was conducted, focusing on areas such as risk assessment, incident reporting, compliance monitoring, and contractor safety performance. This comprehensive analysis helped in outlining the requirements for the web-based application, ensuring that the system would address the unique needs and regulatory requirements of the mining sector.

Following the planning phase, the design and development of the web-based CSMS application took place. In this phase, the design of the system was crafted with a focus on usability, ensuring that all features were intuitive for both internal employees and contractors. The application incorporated key functionalities such as real-time incident reporting, safety compliance tracking, contractor performance evaluation, and document management. It was built using robust technologies that supported scalability and security, enabling it to handle large volumes of data while ensuring confidentiality and integrity. The system's architecture was designed to integrate seamlessly with existing company infrastructure and was customized to accommodate the specific regulatory

requirements outlined by both local and international standards, including the Indonesian Ministry of Energy and Mineral Resources (MEMR) Decrees and ISO 45001:2018.

Once the web-based application was developed, it was subjected to a series of rigorous evaluations and testing. The system was implemented in a controlled environment within the business process units at PT. Petromine Energi Trading to ensure that it met the desired performance criteria. Various scenarios and real-world use cases were tested to assess the system's ability to manage data flow efficiently, support safety monitoring, and facilitate compliance tracking in dynamic, high-risk environments like mining operations. The feedback from stakeholders during this phase was crucial in refining the system. Adjustments were made based on real-time feedback to enhance the user experience and improve system performance, ensuring that it was not only functional but also aligned with the company's safety and operational goals.

The final phase involved assessing the limitations and providing practical recommendations for future improvements. During this phase, the system's impact on CSMS performance was critically analyzed, and any operational or technical limitations were identified. Areas for enhancement were outlined based on user feedback and observed system performance in real-world mining conditions. Recommendations were made regarding further system optimization, additional features for improved safety tracking, and potential integration with other operational management tools used by PT. Petromine Energi Trading. Additionally, the study considered the potential scalability of the web-based system, suggesting ways it could be expanded to other business units or incorporated into broader safety management strategies across the company. This iterative review process ensured that the final product not only addressed current issues but also laid the groundwork for continuous improvement and adaptability in the future. By combining technical development with stakeholder engagement and iterative evaluation, this methodology ensured a comprehensive approach to managing CSMS performance. The integration of a digital solution in managing contractor safety was not only aligned with regulatory compliance but also positioned PT. Petromine Energi Trading to benefit from enhanced efficiency, risk mitigation, and real-time decision-making capabilities.

3. RESULT AND DISCUSSION

3.1. Objective and Policy Foundation

Contractors play a critical role in mining operations, especially in the exploration, mining, and processing stages, where their involvement often spans various specialized activities. However, the varying safety cultures, procedures, and understanding of safety among contractors can create significant gaps in risk

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management, leading to potential safety hazards. To address these challenges, organizations have sought to integrate Contractor Safety Management Systems (CSMS) with existing Mining Safety Management Systems (SMKP). The CSMS was conceptualized to overcome persistent challenges such as contractor prequalification and compliance management. Specifically, the system aims to ensure that contractors meet all regulatory, technical, and safety requirements before being engaged in high-risk operational environments like mining. This approach is crucial for sectors such as construction, mining, energy, and industrial operations, where contractor activities can substantially influence project safety and regulatory outcomes.

The primary strategic goal of the CSMS is to digitize, centralize, and standardize the management of contractor documentation and compliance verification processes. Unlike traditional ad-hoc methods, such as email-based submissions, which are prone to delays, miscommunication, and data loss, the CSMS offers a structured workflow where contractors can submit required documentation digitally. This system not only ensures that submissions are timely but also provides clear feedback to contractors, allowing them to track the history of their participation in tenders and projects. Such transparency and accountability help reduce administrative burdens and promote early compliance verification, which aligns with broader organizational goals of improving safety management and regulatory adherence.

From a policy perspective, the CSMS supports organizations in their commitment to proactive safety governance and continuous improvement. Designed in accordance with international management standards, particularly ISO 45001 :2018, the system incorporates systematic planning, performance evaluation, and documented information control. Clause 7.5 of ISO 45001 emphasizes the need for organizations to retain documented information as evidence of compliance with safety management protocols, while Clause 8.1 underscores the importance of establishing operational controls to ensure consistency with environmental and safety objectives. The CSMS effectively satisfies these clauses by integrating document control mechanisms and automated feedback channels directly into its workflow, ensuring that all necessary documentation is readily available for internal audits and compliance checks [4].

The CSMS also strengthens organizational processes by providing a robust traceability feature. Contractors are required to submit mandatory documents in three core categories: legal, technical, and HSE/OHS (Health, Safety, and Environment/Occupational Health and Safety). These documents are reviewed by designated internal stakeholders, and each verification action—whether approval, rejection, or resubmission request—is recorded with justifications. This detailed tracking enables the system to function as a compliance tool and as a valuable resource for data-driven decision-making. By consolidating historical

participation and verification records, the CSMS helps management make informed judgments regarding contractor eligibility, project matching, and futurs engagements. Previous studies, such as that by G.S. Reddy et al. (2009), show that effective information management systems significantly improve decision quality, particularly in contexts requiring regulatory oversight and multi-stakeholder coordination [5].

The CSMS also acts as a key enabler for policy internalization across the organization. For example, policies such as "only contractors with a valid Occupational Health and Safety Management System (OHSMS) certification may engage in high-risk operations" are seamlessly integrated into the system. Contractors are prevented from progressing in the application or bidding process without uploading and verifying the required certifications. This alignment between policy objectives and system implementation ensures that safety policies are not only conceptualized but also effectively operationalized. Earl (1989) highlighted the importance of digital tools in translating abstract organizational objectives into enforceable practices through automation and monitoring, a feature well embodied in the CSMS [6]. Moreover, by clarifying the roles and responsibilities of various departments, the system reduces overlap, increases accountability, and fosters a shared responsibility for contractor compliance across the organization.

3.2. System Design and Architecture

The CSMS was designed using a modular, scalable, web-based architecture to meet organizational needs for flexibility, traceability, and cross-functional collaboration. This architecture was built around a secure digital environment that facilitates real-time data exchange, structured document submissions, and multi-level verifications, all in alignment with safety governance principles. A user-centered design approach was adopted, prioritizing user roles, task sequences, and system goals to create a cohesive, minimal interface that simplifies the user experience and supports efficients system operation [7].

1) Web-based Platform and Single Sign-On (SSO)

The foundation of the CSMS is a web-based platform that integrates Single Sign-On (SSO) functionality, enhancing access management and secure authentication (Figure 1). This feature enables contractors and internal stakeholders—including legal officers, technical reviewers, and HSE/OHS personnel—to securely access the system with role-based permissions. Each user is authenticated through unique credentials, and their access privileges are determined by their respective roles. This approach reduces the administrative burden of managing multiple login accounts and enhances system usability and security. Additionally, the integration of SSO strengthens system auditability by tracking and timestamping all user

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activities, including document submissions, verifications, comments, and approvals. This feature is vital for establishing accountability and enabling retrospective reviews in case of disputes or incidents.

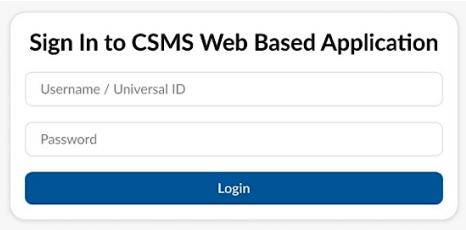

Figure. 1. The single sign on (SSO) page.

2) Structured Workflow for Document Submission and Verification

A core element of the CSMS architecture is the structured workflow for document submission and verification, designed to align with the internal division of responsibilities within the organization (Figure 2). The process begins when contractors submit an initial application form containing basic corporate and contact information. Following this, they upload required documentation in three key categories: legal, technical, and HSE/OHS. Each document is routed to the appropriate verification team—legal, technical, or HSE/OHS—for review. Verifiers can approve, reject, or request resubmission of documents, with feedback provided to the contractor. This automated feedback mechanism improves communication efficiency and supports continuous improvement, a principle emphasized by ISO standards. The system also allows contractors to track their compliance status and address deficiencies through an intuitive dashboard (Figure 3).

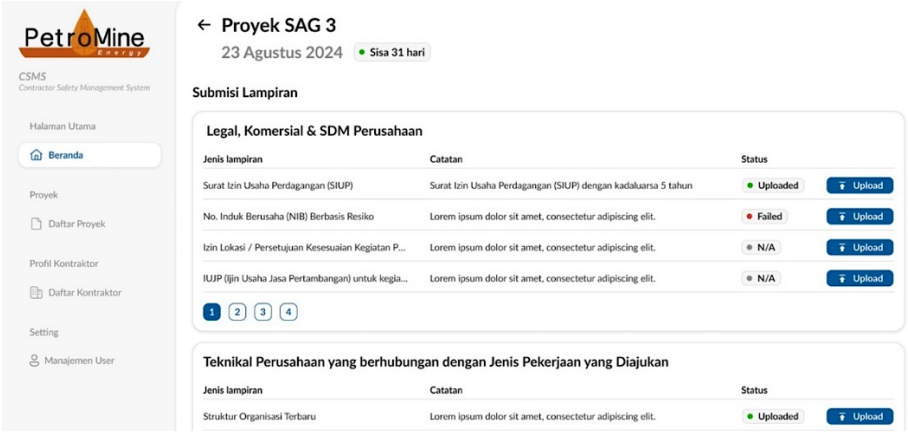

Figure2. Submission Document

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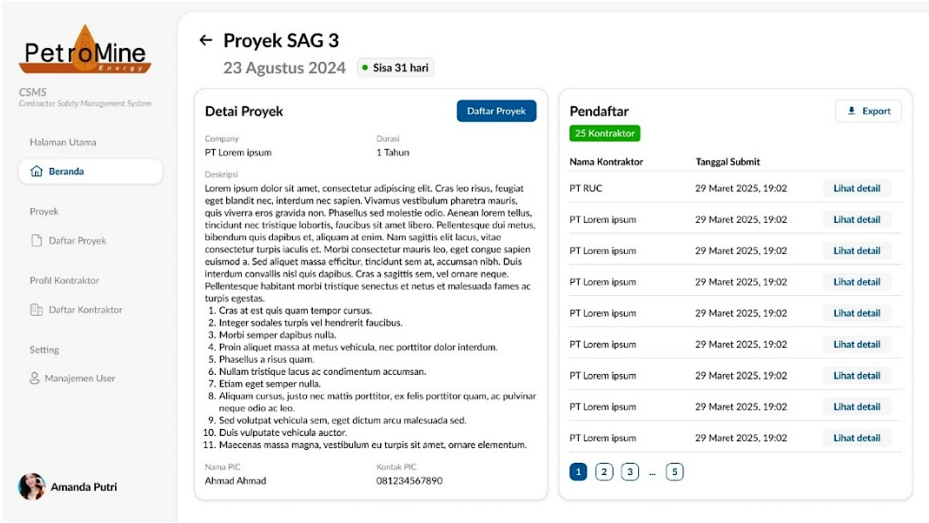

Figure 3. Project page and details

3) Contractor History and Participation Tracking

Another critical feature of the CSMS is the contractor history log, which records all interactions with the system (Figure 4). This log captures key information such as the contractor's participation in tenders, document submission status (approved, rejected, pending), feedback history, and project outcomes (completed, ongoing, delayed). By consolidating this data, the CSMS enables the organization to evaluate contractor reliability over time and incorporate historical performance into future selection criteria. This feature serves as both a compliance tool and a performance intelligence resource, allowing management to make informed decisions based on past contractor behavior and outcomes.

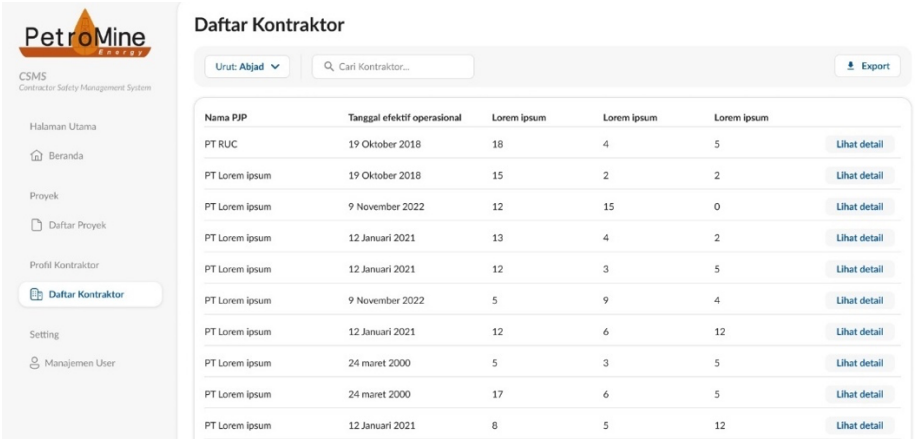

Figure 4. Contractor history page

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4) Tender and Project Lifecycle Management

The system supports the tracking of tenders and projects, ensuring that verified contractors are matched to relevant projects based on their areas of expertise. The platform categorizes tenders by domain (e.g., electrical works, mechanical fabrication, safety consulting), making it easier for internal administrators to align contractor profiles with project requirements. Contractors who win tenders are invited to confirm or decline participation, after which the system tracks the project through various milestones : initiated, ongoing, completed, or delayed. This project lifecycle management feature ensures that safety and compliance efforts extend beyond documentation, continuing throughout project execution to mitigate risks and ensure adherence to safety standards.

5) Backend Structure and Data Integrity

The CSMS backend is powered by a relational database schema, visualized using Entity Relationship Diagrams (ERD), which maps the relationships between contractors, documents, verification records, tenders, and projects. The database enforces data integrity through validation checks at both the input and storage levels, ensuring that only complete and accurate data is recorded. This design facilitates efficient querying and reporting, enabling internal users to generate summaries, export compliance reports, and conduct audits with ease. The ERD schema provides a solid foundation for future system enhancements, such as contractor performance scoring and integration with incident reporting systems.

6) Interoperability and Future Scalability

The CSMS is designed with future scalability and interoperability in mind, allowing for integration with other enterprise systems such as Emergency Response and Preparedness (ERP), procurement platforms, or Environmental Health and Safety (EHS) dashboards. The modular architecture supports the addition of new features, including contractor performance scoring, incident reporting integration, safety training certification modules, and real-time KPI dashboards. These extensions will further enhance the system's role as a strategic asset in contractor management and organizational safety performance.

3.3. System Benefits and Operational Improvements

The implementation of the CSMS delivers significant operational improvements. One key benefit is the reduction in processing times, as automation of verification and document management streamlines the workflow and reduces administrative burdens. Safety and compliance teams can now focus on higher-value activities rather than manual document tracking and verification. Furthermore, the system enhances contractor readiness by providing structured checklists and iterative

feedback to guide contractors through compliance steps before project engagement. This proactive approach helps ensure that contractors are well-prepared and meet all regulatory and organizational standards before commencing work, thus reducing delays and compliance risks. The CSMS also facilitates data-driven decision-making by maintaining a comprehensive database of contractor performance and compliance records. This repository enables internal teams to make informed decisions, conduct risk assessments, and audit project performance with greater accuracy. The system's flexibility allows for easy integration with other enterprise systems, ensuring that it can evolve alongside organizational needs and regulatory changes, thereby ensuring its long-term relevance and effectiveness.

3.4. Strategic and Operational Impact

The CSMS not only offers operational efficiencies but also serves as a strategic tool for improving safety governance within PT. Petromine Energi Trading. By digitizing and centralizing the contractor safety management process, the system enhances accountability and ensures that safety and compliance are consistently prioritized across all levels of the organization. One of the key strategic advantages is the integration of real-time monitoring and feedback, which allows for proactive identification of safety concerns before they escalate into incidents. With the historical data captured in the CSMS, decision-makers can quickly assess contractor reliability, predict potential safety risks, and make informed decisions on contractor selection for high-risk projects. This data-driven approach supports continuous improvement by identifying patterns in contractor performance and helping to refine selection criteria, ultimately leading to better project outcomes and reduced operational risks.

The integration of the CSMS also promotes interdepartmental coordination, ensuring that all relevant stakeholders—from legal and technical departments to HSE teams—are aligned in their efforts to maintain safety standards. By clarifying the roles and responsibilities within the system, the CSMS helps avoid duplication of efforts, reduces inefficiencies, and enables more accurate performance evaluations. This collaborative framework is essential for fostering a resilient safety culture where contractor compliance is viewed as a collective responsibility, rather than an isolated task. In doing so, the system aligns internal operations with safety policies, helping to institutionalize safety and compliance as core values that are consistently enforced at all stages of contractor engagement.

Furthermore, the system's flexibility and scalability provide PT. Petromine Energi Trading with the tools necessary to adapt to changing regulatory environments and expanding operational demands. As new safety standards and industry regulations evolve, the CSMS can be updated and enhanced to integrate these changes, ensuring ongoing compliance and minimizing legal risks. This

adaptability is critical in an industry like mining, where safety regulations are frequently updated to address emerging risks and technologies. The CSMS's modular structure enables PT. Petromine Energi Trading to incorporate new features and capabilities, such as performance scoring, safety training certification modules, and advanced KPI dashboards, which will further improve its contractor management and safety performance over time.

3.5. Discussion

The implementation of the Contractor Safety Management System (CSMS) at PT. Petromine Energi Trading has had a significant impact on contractor safety management, addressing key challenges faced in the mining sector. One of the most notable improvements is the enhanced ability to bridge gaps in safety cultures and practices among contractors. Prior to the CSMS, contractors' varying levels of understanding and adherence to safety protocols often led to inconsistencies and safety risks. With the CSMS, all contractors are held to the same standards, as the system centralizes documentation and compliance verification processes. This standardized approach promotes uniformity and ensures that safety regulations are uniformly upheld, reducing the risk of incidents.

In addition to bridging gaps in safety practices, the system has streamlined the process of contractor verification, ensuring that all contractors meet the necessary legal, technical, and HSE (Health, Safety, and Environment) requirements before they are allowed to engage in high-risk operations. This structured, digital workflow replaces ad-hoc email submissions that were prone to delays and miscommunication. The CSMS provides real-time feedback to contractors, allowing them to track the status of their submissions and compliance. This level of transparency and accountability promotes early identification of compliance issues, reducing the administrative burden and allowing for a more efficient verification process. By automating feedback and approval processes, the system minimizes the risk of delays and errors, which could otherwise lead to project delays or safety incidents.

The CSMS also significantly enhances the organization's ability to make data-driven decisions. By consolidating contractor history and compliance data into a single platform, the system provides management with a comprehensive view of contractor performance over time. This historical data enables more informed decision-making when selecting contractors for future projects. By assessing past performance, including feedback on prior projects, management can identify the most reliable and compliant contractors, ultimately improving safety outcomes and reducing operational risks. The system's traceability feature also ensures that all verification actions, whether approvals or rejections, are recorded with clear justifications, making it easier for the organization to respond to audits, safety investigations, or non-compliance incidents.

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Beyond improving contractor management and safety outcomes, the CSMS fosters greater interdepartmental coordination. By clearly defining roles and responsibilities within the system, the platform reduces duplication of efforts and ensures that each department—legal, technical, and HSE—can efficiently carry out its specific verification tasks. This improves the overall efficiency of the verification process and promotes a collaborative approach to safety management, where compliance is seen as a collective responsibility rather than the sole duty of any one department. The transparency and clear assignment of responsibilities help reinforce a culture of accountability throughout the organization, ensuring that all stakeholders are aligned in their efforts to maintain high safety standards.

The system's flexibility is another key benefit, allowing it to adapt to future needs and regulatory changes. As safety regulations and industry standards evolve, the CSMS can be updated and modified to remain compliant with new requirements. This modularity ensures that the system will continue to meet the organization's needs as the business grows and as the regulatory landscape shifts. Furthermore, the ability to integrate the CSMS with other enterprise systems, such as Emergency Response and Preparedness (ERP) and Environmental Health and Safety (EHS) platforms, enhances its scalability. The addition of new features, such as contractor performance scoring and incident reporting, can further strengthen the system's role in improving contractor safety and performance management.

Ultimately, the CSMS is more than just a tool for managing contractor safety; it has become a strategic asset that strengthens the overall safety governance framework at PT. Petromine Energi Trading. By automating key processes, improving data accuracy, and enhancing communication, the CSMS enables safety teams to focus on higher-value activities, such as proactive risk management and continuous improvement. The system supports decision-making with comprehensive data on contractor performance, improving contractor selection and risk assessments, which leads to better project outcomes. Moreover, the ability to track and analyze safety performance in real time ensures that the organization can identify and address safety issues before they escalate, further minimizing operational risks. Through this digital transformation, PT. Petromine Energi Trading has built a more resilient safety culture that integrates compliance, risk management, and continuous improvement, positioning the organization for long-term success in contractor safety management.

4. CONCLUSION

Contractor Safety Management System (CSMS) significantly enhanced transparency and traceability within PT. Petromine Energi Trading by maintaining a comprehensive audit trail of all submissions, verifications, and decision-making processes. This meticulous record-keeping not only ensured compliance with ISO 45001:2018 but also aligned with internal audit requirements, reinforcing the

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company's commitment to systematic safety management. The system's design contributed to increased accountability at every stage of contractor engagement, giving stakeholders confidence in the integrity of safety and compliance protocols. The CSMS went beyond merely facilitating contractor registration; it evolved into a strategic tool that bolstered safety outcomes and mitigated risks associated with the tendering process. By streamlining the contractor verification and compliance workflows, the system helped strengthen the organization's compliance culture, ensuring that safety standards were consistently met throughout the contractor lifecycle.

Furthermore, the robust design of the system, with its focus on data integrity and real-time feedback mechanisms, positioned the CSMS as a crucial enabler of sustainable safety governance. Its ability to consolidate, analyze, and act upon critical contractor data empowers PT. Petromine Energi Trading to make informed, data-driven decisions that enhance overall safety performance. As such, the CSMS represents a key step forward in integrating technology with safety management practices, ensuring long-term operational efficiency, compliance, and risk reduction.

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