

Design of a Proactive Occupational Safety Monitoring System at the Transshipment Point Area

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Keywords:

occupational safety and health, maritime safety, transshipment point, cctv monitoring, root cause analysis

Abstract

Transshipment point maritime coal logistics involves high occupational safety risks due to dynamic sea conditions, continuous operations, and complex vessel-handling activities. Current monitoring practices primarily rely on CCTV systems for security purposes, limiting the real-time detection of unsafe acts and delaying corrective interventions, which contributes to recurring human-factor-related accidents. A gap remains between safety reporting mechanisms and real-time behavioral observation, indicating the need for proactive monitoring integration at the Bulk Sumatra site. This study designed a proactive occupational safety monitoring system to improve the early detection of unsafe acts and support decision-making in complex maritime operational environments. A qualitative case study approach was employed using observations, interviews, and document reviews conducted at a transshipment point. The collected data were analyzed using Root Cause Analysis (RCA), SWOT analysis (Internal Factor Analysis Summary [IFAS]–External Factor Analysis Summary [EFAS]), and Design Thinking to develop a user-centered monitoring framework. The findings revealed discrepancies between reported unsafe conditions and observed unsafe acts, highlighting the limitations of existing monitoring practices. CCTV systems were found to be underutilized for occupational safety purposes. The proposed system integrates risk-based camera placement, digital safety reporting, monitoring dashboards, risk classification, and structured follow-up mechanisms to enhance response effectiveness. The system design emphasizes early warning capabilities, faster supervisory intervention, and improved accountability across operational areas. The proposed model enhances safety visibility, accelerates risk mitigation, strengthens occupational safety controls, and supports improved safety performance in transshipment operations. This study contributes to the transition from reactive safety management toward proactive, risk-based decision-making within maritime coal logistics operations.

INTRODUCTION

Transshipment activities are among the most challenging aspects of maritime coal logistics because material transfer occurs at sea under constantly changing operational conditions. Vessel movements, weather fluctuations, wave conditions, limited workspace, simultaneous loading activities, and 24-hour operations all influence work performance and increase the likelihood of human error (Engelbrecht, 2023; Evangelos, 2018; Salimi et al., 2026). Under these conditions, occupational safety and health cannot rely solely on written procedures and regulations. Safety performance depends greatly on an organization's ability to observe critical

tasks, interpret operational conditions, and intervene before deviations develop into incidents (Hopkins, 2014; Crawford, 2014).

The thesis material summarized and expanded upon in this article focuses on the Transshipment Point area, particularly the CTS Floating Crane at Bulk Sumatra. This unit is strategically important because it supports loading continuity and involves various hazards commonly associated with marine operations, including mooring and unmooring activities, crane movements, vessel-to-vessel access, material transfer, work at height, and night-time operations. The thesis identified that unsafe acts contributed to the majority of accident cases; however, existing reporting patterns continued to emphasize unsafe conditions. This discrepancy indicates a weakness in the current approach to observing, analyzing, and responding to unsafe behaviors (Baldissone et al., 2019; Mullins-Jaime et al., 2021; van Haperen et al., 2019).

A major factor contributing to this limitation is the current orientation of monitoring technology. CCTV systems have already been installed; however, their primary functions remain security surveillance and compliance with the International Ship and Port Facility Security (ISPS) Code. Consequently, the visual monitoring system functions mainly as a passive recording tool rather than as an active occupational safety instrument (Cocca et al., 2016; Patel et al., 2022; Schall Jr et al., 2018). Supervisors continue to rely heavily on physical inspections, manual reporting systems, and post-event investigations. As a result, unsafe behaviors during critical operations may not be detected early enough to enable immediate corrective actions. This condition indicates that the existing monitoring system has not yet fully functioned as a safety leading indicator capable of providing timely information to support corrective measures and proactive decision-making (Hopkins, 2014; Crawford, 2014).

The maritime safety literature discussed in the thesis further supports the importance of this issue. Human factors, fatigue, gaps in situational awareness, normalization of deviance, and ineffective communication continue to emerge as significant contributors in marine accident studies (Hasanspahić et al., 2021; Maternová et al., 2023). Meanwhile, research on CCTV-based monitoring, indirect observation systems, digital dashboards, and user-centered design demonstrates that monitoring technologies provide strategic value when integrated with intervention mechanisms, accountability systems, and organizational learning processes. Effective monitoring can function as a leading safety indicator by providing early warnings and supporting more proactive safety decision-making (Hopkins, 2014; Crawford, 2014).

This article extends the previous short journal version by providing more comprehensive explanations of the conceptual foundation, operational context, patterns of unsafe acts and unsafe conditions, Root Cause Analysis (RCA), SWOT-based strategic assessment, and the proposed integrated monitoring architecture. The objective is to demonstrate how the thesis material can be developed into a more detailed journal article while maintaining its central argument: maritime transshipment safety requires a transition from reactive compliance-based management toward proactive monitoring and earlier risk control.

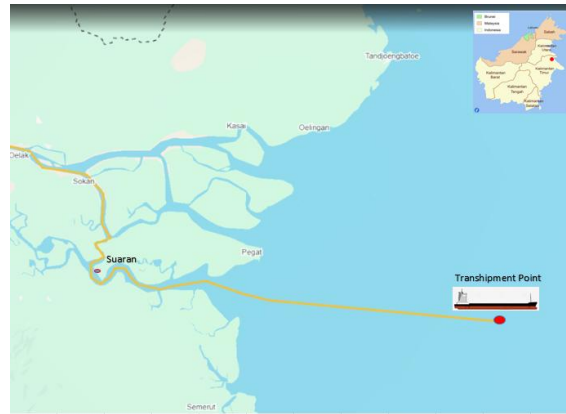


Figure 1. *Transshipment Point*

The operational characteristics of the site served as the basis for the hazard identification process, root cause analysis and the design of the safety monitoring system proposed in this study.

The thesis frames the monitoring problem within the concept of safety culture. Safety is not treated as a narrow technical issue but as a product of organizational values, managerial choices, communication habits, worker behavior, and the consistency of procedural implementation (Guldenmund, 2000; Hopkins, 2014). Literature reviewed in the thesis, such as Guldenmund and Hopkins, suggests that safety performance improves when the organization aligns its underlying assumptions, visible practices, and daily decision-making with the protection of people and assets. In other words, culture matters because it shapes what gets noticed, what gets tolerated, and what gets corrected (Guldenmund, 2000; Crawford, 2014). From the perspective of organizational values, safety behavior is also influenced by the value systems of individuals and work groups. Values such as compliance, responsibility, and concern for safety are factors that influence workers decision making when faced with risky situations (Schwartz, 2012).

In addition to the concept of safety culture, the concept of safety climate is also important for explaining workers perceptions of an organization's commitment to safety. Safety climate can serve as an initial indicator for understanding how workers assess the effectiveness of supervision, communication, and the implementation of safety procedures in high-risk work environments (Flin et al., 2000).

Human factor research gives additional weight to this perspective. In maritime operations, accidents are repeatedly associated with human error, weak situational awareness, incomplete communication, and the tendency to rely on habit under pressure. The thesis uses this body of work to explain why unsafe acts in the Transshipment Point are not random events. They are influenced by fatigue, urgency, imperfect visibility, routine deviation, and the limits of direct supervision in a moving offshore environment. If the system does not help workers and supervisors notice those conditions in time, then risky behavior will continue to recur (Hasanspahić et al., 2021; Dul et al., 2012).

The thesis also reviews the role of monitoring technology in safety-sensitive environments. CCTV can improve discipline, provide visual evidence, and expand observation capacity (Octavianus et al., 2024; Susilo et al., 2024), but only when it is embedded in a broader system of reporting and response. When cameras are installed only to satisfy external compliance

requirements, their contribution to safety remains partial (Octavianus et al., 2024; Susilo et al., 2024). The thesis therefore argues for reinterpreting existing CCTV as a component of occupational-safety management (Hopkins, 2014). This does not require immediate deployment of complex artificial intelligence. It requires a more disciplined connection between visual observation, finding classification, risk prioritization, and corrective action.

To convert diagnosis into system design, the thesis combines SWOT and Design Thinking. SWOT analysis gives a strategic view of what is already strong, what still limits the system, what opportunities can be used, and what external threats need to be managed. Design Thinking then ensures that the solution remains user centered. Managers, supervisors, HSE personnel and crews do not use information in the same way. A meaningful monitoring system must present the right information to the right person at the right time. This combination of strategic analysis and design methodology is one of the thesis's main contributions (Puyt et al., 2023; Tu et al., 2018; Pérez Avella et al., 2024).

The Design Thinking approach is used not only to generate innovative solutions but also to bring about sustainable social and organizational change through a deep understanding of the needs of users and stakeholders (Pieniazek, 2016).

METHOD

The source study was designed as an applied qualitative case study. The research focused on the occupational safety monitoring system in the Transshipment Point operation involving the CTS Floating Crane at Bulk Sumatra as the primary field context. The case study design was selected because it enabled an in-depth exploration of the interactions among crews, supervisors, equipment, procedures, and environmental conditions within an actual maritime workplace. The objective was to develop a practical monitoring system that could support occupational safety improvement in operational settings.

Data were collected through observations, interviews, and document reviews. Field observations examined actual work practices during loading, unloading, vessel access movements, mooring activities, maintenance, and other supporting operations. Interviews were conducted with supervisors, safety officers, crew members, and technical personnel responsible for the monitoring system. The document review included accident investigation reports, unsafe act and unsafe condition records, audit findings, company procedures, and technical information regarding the existing CCTV deployment. These data sources were integrated to capture both operational conditions and the limitations of the existing monitoring system.

Three analytical stages were applied. Root Cause Analysis (RCA) was conducted to identify immediate, underlying, and latent causes contributing to recurring unsafe acts and monitoring deficiencies. SWOT analysis was used to evaluate internal strengths and weaknesses, as well as external opportunities and threats, while IFAS and EFAS matrices were applied to determine the strategic position of the existing monitoring system. Subsequently, Design Thinking was employed to transform user requirements and analytical findings into a practical system concept through the stages of empathize, define, ideate, prototype, and test.

The study applied source triangulation, method triangulation, and theory triangulation to enhance data validity. Interview findings were cross-checked across different organizational roles, field observations were compared with documented records, and interpretations were

supported by relevant literature on safety culture, human factors, strategic management, and user-centered design. This approach strengthened the reliability of the proposed system and supported the development of the thesis findings into a comprehensive journal article.

RESULTS AND DISCUSSION

Existing Conditions and Risk Profile

The Transshipment Point is characterized by continuous material transfer, vessel movement, changing sea conditions, and narrow working spaces. Tasks include barge positioning, line handling, crane operation, coal transfer through hopper and conveyor systems, deck movement, access between vessels and maintenance activity. Each of these activities can expose workers to contact injury, falling material, slips and trips, falling overboard, communication error, or visibility related mistakes. Because the operation continues through shift changes and nighttime conditions, the safety challenge is not static; it changes over time and across work zones.

The characteristics of workspaces in maritime environments are determined not only by technical aspects, but also by how workers interact with limited and constantly changing physical spaces. The concept of body space explains that perceptions of workspace influence workers' behavior, mobility and level of alertness in dynamic operational environments (Neuhaus, 2011).

The thesis identifies a structural monitoring gap. Direct supervision is limited by physical distance and by the impossibility of seeing all critical zones at the same time. CCTV exists, but it is oriented toward security and evidence gathering rather than active behavior based observation. Reporting remains fragmented and frequently delayed. Consequently, the organization often has information about risk but the information is not connected quickly enough to the people who need to respond. This creates a situation in which many deviations become visible only after the most important intervention window has already passed.

Table 1. Dominant Risk Profile of Marine and Floating-Crane Activities

No.	Main Activity	Potential Hazard	Dominant Risk Source	Risk Level
1	Barge maneuvering and berthing	Contact between units and structures	Human error, ineffective communication, changing current and weather	High
2	Crane operation	Uncontrolled load swing and boom movement	Unsafe acts, fatigue, incomplete adherence to procedure	High
3	Coal loading and unloading	Falling material and impact injury	Unsafe positioning and weak exclusion control	High
4	Deck activity	Slip, trip, and fall	Wet surfaces and poor housekeeping	Medium

No.	Main Activity	Potential Hazard	Dominant Risk Source	Risk Level
5	Work near vessel edge	Man overboard	Unsafe acts and limited real-time supervision	High
6	Night operation	Reduced visibility and perception error	Poor lighting and fatigue	High
7	Crew coordination	Communication and execution error	Weak confirmation and procedural misunderstanding	High
8	Activity monitoring	Unsafe acts remain undetected	Manual observation limit and underused CCTV	Med-High
9	Long working hours	Fatigue and alertness decline	Shift pattern and continuous demand	Medium
10	PPE use and positioning	Direct exposure to hazard	Weak enforcement and inconsistent safety discipline	High

The risk profile makes clear that the most serious safety challenges occur in activities that are difficult to supervise continuously through human presence alone. This is why the thesis does not treat technology as a luxury add on. It treats better monitoring as a necessary response to the geometry of risk in the offshore work environment.

Patterns of Unsafe Acts and Unsafe Conditions

A central finding of the thesis is the imbalance between what is recorded and what actually drives accidents. Unsafe conditions are reported more often because they are easier to observe and easier to describe in routine safety documentation. Unsafe acts are more difficult to capture because they are brief, context-dependent and often occur during transitions. Yet those unsafe acts are strongly linked to the majority of accident cases in the marine area. This means that the existing system does not fail because it sees nothing; it fails because it does not see the most critical thing at the right time.

Recurring unsafe acts include releasing lines without adequate verification of current conditions, relying on experience rather than updated situational confirmation, using structures as support points during access movement, and positioning oneself unsafely in relation to moving equipment or material. Recurring unsafe conditions include inadequate lighting, corroded or deformed structures, suboptimal layout of access or mooring points, and blind spots in both direct observation and CCTV coverage. In practice, unsafe acts and unsafe conditions interact with each other rather than appearing as isolated categories.

Incident patterns in the thesis also show clustering in transition phases such as shifting, casting off, berthing and unberthing, and moving between work platforms. Those phases require accurate communication, visual confirmation, and quick adjustment to rapidly changing geometry. The system is particularly weak during these moments because direct supervision is stretched and camera use is not yet optimized for real time safety observation.

Therefore, the redesign of monitoring should focus not only on locations but also on critical moments in the work cycle.

This interpretation is important for system design. If the organization only reacts to completed incidents or to static unsafe conditions, it will continue to miss the window in which risky behavior could have been interrupted. The thesis therefore argues that effective monitoring at the Transshipment Point must be behavior-sensitive, time-sensitive and linked to immediate supervisory response.

Root Cause Analysis and Swot Results

Root Cause Analysis showed that incidents are produced by layers of causes. Immediate causes include specific unsafe acts during line handling, access, and operational decision-making. Basic causes include fatigue, weak situational awareness, inconsistent communication, and limited procedural discipline. Latent causes include the monitoring architecture itself: CCTV is designed around security rather than occupational safety, active real-time monitoring has not yet been institutionalized, and reporting remains separated across multiple channels. This means that unsafe acts persist not only because individuals make poor choices, but because the system does not support fast recognition and intervention.

These findings are consistent with the research by Hasanspahić et al. (2021), which shows that human factors remain the dominant cause of maritime accidents; thus, the strength of the system lies in management commitment, the existence of procedures, a reasonably high level of crew awareness, and the availability of CCTV infrastructure. Weaknesses include the security-only orientation of CCTV, lack of dashboard analytics, fragmented reporting, and the absence of an early-warning mechanism. Opportunities include the growing availability of digital monitoring tools and the possibility of integrating visual data with safety management. Threats include dynamic weather and current, production pressure, continuous operations, and offshore constraints such as limited visibility and infrastructure support.

SWOT analysis has been widely used in the maritime sector to identify internal and external factors that influence the effectiveness of safety and security management systems. This approach helps organizations determine development strategies that are appropriate for complex and dynamic operational conditions (Yudilla & Amri, 2020).

Table 2. Translation of RCA Findings into Monitoring-System Implications

RCA Dimension	Main Finding	SWOT Category	Implication for Design
Human factor	Risky behavior recurs in dynamic conditions	Weakness	Need real-time observation and rapid correction
Human factor	Operational experience exists among crews	Strength	Behavior-based monitoring can build on existing safety awareness
Technology	CCTV infrastructure is already available	Strength	Improvement can focus on function and integration

RCA Dimension	Main Finding	SWOT Category	Implication for Design
Technology	Current CCTV use is dominated by ISPS/security needs	Weakness	Camera use and viewing routines must be redesigned for K3
Monitoring method	Observation is manual and reactive	Weakness	Need dashboard visibility, alerts, and status tracking
External context	Digital monitoring tools are increasingly feasible	Opportunity	System can evolve toward richer analytics over time
External context	Weather, current, and 24-hour operation intensify risk	Threat	Monitoring priorities must be risk-based and continuous
Management system	Monitoring performance is not fully part of leading indicators	Weakness	Outputs should enter management review and accountability cycles

The findings of the Root Cause Analysis can be mapped in the SWOT framework so that each factor contributing to the incident has strategic of development implications for the monitoring system. The main weaknesses, monitoring that remains reactive, the security oriented use of CCTV and the suboptimal use of leading indicators underscore the need to strengthen the system, while the identified strengths, opportunities and threats serve as the basis for developing an integrated and sustainable improvement strategy.

Table 3. IE Matrix (Internal-External)

Matriks	IFAS Weak (1,0–1,99)	IFAS Medium (2,0–2,99)	IFAS Strong (3,0–4,0)
EFAS Strong (3,0–4,0)	I (<i>Grow & Build</i>)	II (<i>Grow & Build</i>)	III (<i>Grow & Build</i>)
EFAS Medium (2,0–2,99)	IV (<i>Hold & Maintain</i>)	V (<i>Hold & Maintain</i>)	VI (<i>Grow & Build</i>)
EFAS Weak (1,0–1,99)	VII (<i>Harvest/Divest</i>)	VIII (<i>Harvest/Divest</i>)	IX (<i>Hold & Maintain</i>)

The IFAS score of 2.632 and EFAS score of 2.325 place the current system in IE Quadrant V or hold and maintain. The significance of that result is practical: the organization already has enough internal strength to improve, but it still faces moderate external constraints. The thesis therefore recommends structured strengthening of the current system rather than complete replacement. Existing assets should be activated and connected more intelligently.

Proposed Monitoring System

The proposed occupational safety monitoring system is designed as an integrated support architecture rather than a single piece of technology. Direct supervision remains necessary, but it is reinforced by risk-based CCTV placement, digital unsafe-act reporting, centralized dashboards, risk classification, and visible follow-up status. The system is intended to improve the speed with which deviations are noticed, the quality with which they are classified, and the clarity with which corrective action is tracked.

A key principle of the design is risk-based camera placement. The thesis highlights vessel access points, mooring winch areas, hopper zones, crane movement areas, sling-wire crossing points, conveyor-adjacent spaces, and working-at-height locations as priority zones for monitoring. These are the areas in which unsafe acts can quickly produce severe consequences. Risk-based placement means the organization does not merely increase visual coverage; it increases useful visual coverage where it matters most.

Table 4. Main Components of the Proposed Integrated Monitoring System

System Component	Description	Primary Function	Expected Output
Risk-based CCTV deployment	Camera placement prioritizes high-risk zones and critical work geometry.	Improve visual access to unsafe acts and hazardous exposure.	Live coverage of critical work
Digital finding input	Unsafe acts, unsafe conditions, and near misses are entered in a structured digital form.	Accelerate reporting and standardize data quality.	Faster and cleaner reporting
Dashboard monitoring	Central dashboard displays finding type, location, status, and risk level.	Support prioritization, supervision, and management review.	Actionable safety information
Risk classification	Findings are tagged as low, medium, or high risk.	Help determine urgency and intervention priority.	Risk-ranked case list
Status tracking	Open, on-progress, and closed conditions are updated visibly.	Strengthen accountability for corrective action.	Transparent follow-up progress
Integrated review cycle	Monitoring data feeds toolbox meetings, inspections, and periodic review.	Turn monitoring output into learning and prevention.	Continuous improvement input

Another principle is information integration. Visual observation only becomes useful when it is connected to reporting and action. The proposed system therefore links camera-based observations, manual hazard reports, follow-up records, and managerial review into one process. This reduces delay between detection and intervention and helps the organization identify repeated patterns instead of treating each event as unrelated.

Design Thinking, Prototype, and Implementation Roadmap

Design Thinking is used in the thesis to keep the solution user-centered. In the empathize stage, the needs of managers, supervisors, HSE personnel, and crews are mapped in relation to the current pain points of the system. In the define stage, the central problem becomes the inability of the current arrangement to detect unsafe acts and support timely response in a single integrated workflow. The ideate stage then generates solution alternatives such as CCTV-based behavior monitoring, centralized dashboards, digital forms and structured notifications. The implementation of Design Thinking in digital system development has proven to improve the alignment between user needs and the features of the developed system, resulting in solutions that are easier to use and more effective in supporting operational processes (Muryanto & Sri Wahyuni, 2023).

The prototype described in the thesis includes several information layers that are directly useful for operational control: the type of non-conformity, the status of follow-up, the assigned risk level, the source of data, and the total number of observations. This is important because supervisors and managers need simplified, decision-ready information rather than large volumes of undifferentiated data. A workable prototype must help users answer immediate questions: what happened, where, how urgent is it, who is responsible, and has anything been done about it.

Because the system is positioned in hold and maintain, implementation is best conducted in phases. The first phase stabilizes camera function, maps risk zones, and standardizes finding categories. The second phase introduces digital reporting and dashboard visibility. The third phase embeds the system into routine toolbox discussion, inspection, and review cycles. Later phases connect monitoring outputs more strongly to leading indicators, coaching and targeted improvement of procedures and engineering controls.

Table 5. Indicative Implementation Roadmap

Phase	Main Focus	Key Activities	Expected Improvement
1	System stabilization	Map high-risk zones, verify CCTV function, standardize observation priorities and reporting categories.	More reliable visibility and cleaner basic data
2	Digital integration	Introduce digital forms, dashboards, risk tags, and status tracking.	Faster escalation and better managerial visibility
3	Operational embedding	Use monitoring outputs in toolbox meetings, inspections, and weekly review.	Monitoring becomes part of daily safety management
4	Behavior strengthening	Analyze repeated unsafe acts and target coaching or procedure refinement.	More focused intervention on root behavioral causes

Phase	Main Focus	Key Activities	Expected Improvement
5	Performance integration	Link outputs with leading indicators and management accountability.	Monitoring gains strategic value
6	Continuous improvement	Review blind spots, user feedback, and usability for future refinement.	Long-term adaptability of the system

The expected effects of the proposed system are broader than incident reduction alone. Better monitoring can improve the visibility of critical work, accelerate intervention, improve reporting quality, and increase traceability of corrective action. It can also strengthen communication between offshore operations and onshore management, improve the targeting of supervisory effort and give the organization a stronger basis for learning from repeated patterns of deviation.

The integration of the results from RCA, SWOT and Design Thinking indicates that the development of the monitoring system should focus on improving early detection, integrating safety information and supporting faster decision making. Based on these findings, design implications for the monitoring system were formulated and subsequently detailed in a phased implementation roadmap to ensure alignment with operational needs and organizational capacity.

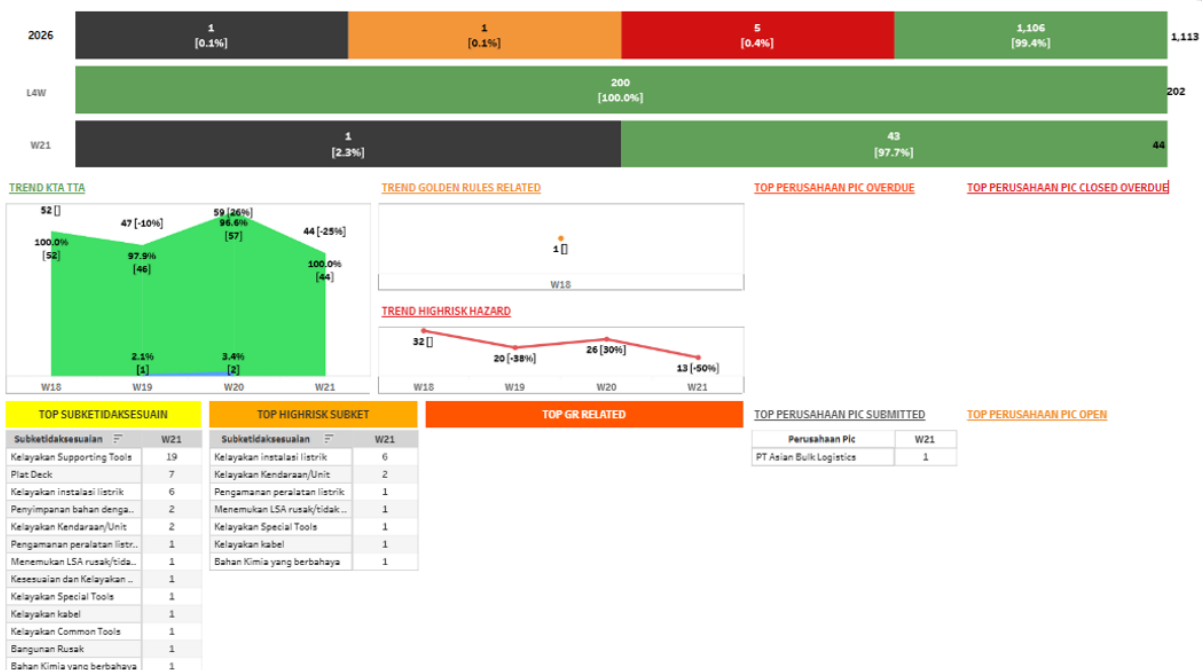


Figure 2. Dashboard monitoring

The monitoring dashboard in figure 2 integrates various safety indicators, corrective action statuses and operational performance trends in real time, thereby facilitating the monitoring process and decision-making. This dashboard supports the implementation of a more proactive

monitoring system by improving data visibility and accelerating the identification of potential deviations.

Managerial Implications and Performance Indicators

One practical implication of the thesis is that monitoring performance itself should become part of management attention. In many operations, safety review still emphasizes lagging outcomes such as accident counts, property damage, or lost time, while the quality of day to day monitoring is treated as background activity. The proposed system challenges that pattern by making monitoring output visible and measurable. If the organization can see how many high risk observations were made, how quickly they were escalated, how long corrective actions remained open, and which work zones repeatedly generated unsafe acts, then monitoring becomes a leading indicator rather than a passive administrative task.

This managerial shift matters because reactive systems often fail through delay rather than through total absence of information. Supervisors may already know that a location is risky, managers may already know that behavior based findings are underreported and crews may already know which tasks are difficult to perform safely. What is missing is a disciplined mechanism that connects those pieces of knowledge fast enough to influence work as it unfolds. By integrating CCTV observation, digital reporting, risk tagging and follow up status, the proposed model creates a chain of visibility that can shorten decision time and reduce the repetition of unmanaged deviations.

Another implication concerns accountability and trust. A monitoring system will not strengthen safety culture if workers perceive it only as a surveillance tool for blame. The thesis therefore implies a balanced governance approach: clear rules on who reviews footage, how findings are classified, how long records are kept, and how the information is used for coaching, reporting, and corrective action. When governance is transparent, the system is more likely to be accepted as a preventive instrument. Acceptance is especially important in maritime operations, where informal routines and practical adaptation often coexist with formal procedure.

The monitoring redesign also has implications for competence development. Recurrent unsafe acts can be used to identify where toolbox meetings, refresher training, procedure review, or engineering improvements are most urgently needed. In this way, the system does not stop at detection and improves the targeting of intervention. Over time, the organization can move from broad and generic safety messaging to more specific learning based on real patterns from the work environment. That shift can improve efficiency because resources are directed toward the behaviors and zones that actually generate the highest exposure.

Table 6. Suggested Leading Indicators for the Proposed Monitoring System

Indicator	Operational Meaning	Why It Matters	Expected Direction
High-risk observations captured	Number of critical unsafe acts or conditions observed in priority zones	Shows whether the system is actually seeing the work that matters most	Increase initially, then stabilize

Indicator	Operational Meaning	Why It Matters	Expected Direction
Average escalation time	Time from observation to reporting or notification	Measures speed of response in high-exposure situations	Decrease
Open finding age	Duration high-priority findings remain unresolved	Shows whether corrective action is moving fast enough	Decrease
Repeat finding frequency	How often the same unsafe act reappears in one work zone	Reveals learning gaps and weak controls	Decrease
Coverage of critical zones	Share of high-risk areas effectively monitored	Measures whether camera placement matches the risk profile	Increase
Closure quality review	Percentage of closed findings that pass follow-up verification	Prevents superficial closure without real improvement	Increase

For journal readers and practitioners, these implications show that the value of the proposed model lies not only in hardware utilization but also in governance and organizational learning. The thesis can therefore be read as a design for stronger safety intelligence in offshore coal logistics: a way to make critical work more visible, intervention more timely and follow up more accountable. This perspective broadens the contribution of the article from a single system proposal into a model for how maritime operations can convert existing monitoring assets into a more preventive occupational safety capability.

CONCLUSION

The expanded article confirmed that occupational safety challenges at the Transshipment Point were fundamentally systemic. Unsafe acts served as immediate triggers for many incidents; however, they were reinforced by limited real-time supervision, fragmented reporting mechanisms, insufficient visibility of critical activities, and a monitoring architecture in which CCTV functions remained closer to security compliance than to occupational safety control. Root Cause Analysis (RCA) revealed these underlying and contributing factors, while SWOT analysis demonstrated that the organization possessed sufficient internal capabilities to improve its monitoring system through a structured approach.

The proposed solution was an integrated monitoring architecture that combined risk-based CCTV placement, digital reporting, dashboard-based visibility, risk scoring, and structured follow-up mechanisms using a Design Thinking approach. Its value extended beyond technological improvement by enhancing the timeliness and quality of supervisory decision-making. By repositioning CCTV as an active occupational safety monitoring tool, the proposed model supported the transition from reactive compliance-based practices toward proactive occupational safety management and a stronger safety culture in maritime transshipment operations.

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