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Article

Implementation of the Occupational Safety and Health Management System to the Daily Activities of Employees and Visitor Reception at PT X

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A B S T R A C T

Occupational Safety and Health (OSH) management in Liquified Natural Gas (LNG) terminals requires stringent alignment with both general workplace safety and process safety protocols. This study evaluates the implementation of the OSH Management System (SMK3) at PT X, an LNG logistics terminal in Indonesia, focusing on employee Personal Protective Equipment (PPE) compliance and visitor safety controls. Utilizing a qualitative case study design, data were collected through field observations, document reviews, and semi-structured interviews with nine key informants across operational and safety divisions. The data were analyzed using a formal SWOT/TOWS matrix to develop strategic interventions. The findings indicate that while PT X's institutional procedures—such as mandatory safety inductions, daily toolbox meetings, and medical fit-to-work screenings—are consistent with ISO 45001 standards, critical field execution gaps remain. Empirical evidence highlights recurring PPE non-compliance driven by human factors (e.g., thermal discomfort), visitor violations of electronic device restrictions in hazardous explosive zones, and logistical bottlenecks due to insufficient visitor PPE inventory during peak periods. The study concludes that achieving optimal safety compliance requires moving beyond bureaucratic procedures. Practical implications include the necessity for risk-based PPE procurement, the enforcement of a controlled intrinsically-safe device management policy, and enhanced human-centric safety supervision.

1. Introduction

Occupational Safety and Health (OSH) management is a critical pillar of industrial operations, particularly within high-risk environments such as maritime logistics and cryogenic energy distribution. In Indonesia, the systematic application of the Occupational Safety and Health Management System (*Sistem Manajemen Keselamatan dan Kesehatan Kerja* or SMK3) is mandated by Government Regulation No. 50 of 2012, requiring hazardous industries to integrate comprehensive risk control mechanisms into their primary operational frameworks (Government of Indonesia, 2012). The rigorous application of these standards is essential to mitigate workplace hazards that could culminate in human injury, catastrophic asset loss, and severe environmental impact (Asfian et al., 2022).

PT X, a subsidiary of a state-owned enterprise, operates as a vital national object within the energy logistics sector. The facility manages midstream Liquified Natural Gas (LNG) services—including shipping, cryogenic storage, and regasification—alongside onshore marine bunkering operations (PT X, 2024). Handling LNG involves navigating catastrophic risks, specifically explosive atmospheres and cryogenic burns, making stringent process safety and OSH protocols non-negotiable (Nuswantara et al., 2014; CCPS, 2022). To systematically manage these risks, PT X has aligned its internal policies with the ISO 45001:2018 OSH management system framework (ISO, 2018).

However, the existence of Standard Operating Procedures (SOPs) and systemic alignment with ISO 45001 does not inherently guarantee operational compliance (Hale & Borys, 2013). Previous studies highlight that deficient safety culture, inadequate supervision, and human error frequently obstruct the effective application of SMK3 in complex industrial environments (Kurnia, 2020; Zohar, 2010). While the positive correlation between robust OSH systems, employee performance, and organizational resilience is well-documented (Khotami & Bahar, 2022; Geller, 2005), significant gaps often emerge between documented policies and field realities (Reason, 2016).

Preliminary field observations at PT X reveal several critical vulnerabilities. A segment of the workforce exhibits behavioral non-compliance regarding the mandatory use of specialized Personal Protective Equipment (PPE) (e.g., flame-retardant wearpacks, safety helmets). Furthermore, transient populations, specifically external visitors, frequently breach hazardous area regulations. The unauthorized use of non-certified mobile phones within the LNG terminal's classified explosive zones presents a severe ignition hazard, as these devices can generate sparks capable of igniting an invisible gas leak (Kurniawan et al., 2020; Kletz, 2001).

While previous literature extensively covers general OSH compliance (Aini, 2020; Sinaga & Gaol, 2020), there is a distinct research gap regarding the intersection of employee behavioral safety and transient visitor control within high-risk LNG terminal environments. Consequently, this study aims to systematically evaluate OSH implementation at PT X by addressing three research questions: (1) How are OSH procedures practically implemented for daily employee activities and visitor reception? (2) What are the operational and human-factor determinants of safety non-compliance? (3) What data-driven strategic interventions can optimize risk management at the facility?

2. Literature Riview

2.1 Occupational and Process Safety in Hazardous Terminals

The foundation of safety management in LNG facilities requires a dual approach: traditional OSH management and Process Safety Management (PSM). While OSH focuses on preventing personal injuries (e.g., slips, trips, and falls) through mechanisms like SMK3, process safety focuses on preventing catastrophic events such as fires, explosions, and toxic releases (CCPS, 2022; Widodo & Kristiawan, 2020). Previous research by Asfian et al. (2022) at a similar port facility emphasized that continuous monitoring and dynamic risk assessments are fundamental to operational safety. In LNG terminals, the classification of hazardous areas (e.g., ATEX Zones 0, 1, and 2) dictates strict ignition-source controls, requiring specialized intrinsically safe equipment and rendering standard consumer electronics highly dangerous (Kletz, 2001).

2.2 Behavioral Compliance and Human Factors

The disparity between safety procedures ("work-as-imagined") and actual field execution ("work-as-done") is a central theme in human factors engineering (Dekker, 2019). Kurnia (2020) identified that inconsistent enforcement and management commitment are primary barriers to OSH compliance. Furthermore, employee reluctance to utilize PPE is rarely rooted in malicious negligence; rather, it is often a product of human factors such as thermal discomfort, poor ergonomic fit, high workload, and a degraded local safety climate (Reason, 2016; Zohar, 2010). Khotami and Bahar (2022) demonstrated that a well-implemented OSH system actively shapes employee behavior, fostering a mature safety culture that normalizes compliance.

2.3 Visitor Safety Management

Unlike daily employees, external visitors and contractors possess limited site-specific hazard awareness (Hopkins, 2019). Effective visitor control is paramount in high-consequence industries. Institutional procedures typically rely on safety inductions and escorted supervision (Darim, 2020; Hartono et al., 2023). However, as Kurniawan et al. (2020) highlighted regarding the necessity of rigorous equipment readiness, administrative controls (like briefings) are prone to human error and must be supported by physical controls (e.g., equipment confiscation, structural barriers) to ensure complete facility integrity.

2.4 Analytical Framework: SWOT in Safety Strategy

To systematically assess these dynamics, this study utilizes the Strengths, Weaknesses, Opportunities, and Threats (SWOT) framework. Rather than a mere descriptive tool, a formal TOWS matrix allows for the synthesis of internal organizational capabilities (S, W) with external environmental factors (O, T) to generate prioritized, actionable risk-control strategies (Geller, 2005; Hale & Borys, 2013).

3. Research Methodology

3.1 Research Design and Scope

This study employs a qualitative case study design. This methodology was selected because it enables an in-depth, contextual investigation of operational phenomena—specifically behavioral compliance and procedural breakdowns—in their natural industrial setting (Sugiyono, 2022). To ensure analytical precision, the scope of observation was strictly limited to the midstream LNG regasification terminal, excluding the marine bunkering stations, as the LNG sector presents the highest volatility and strictest visitor control requirements. To maintain institutional confidentiality regarding critical national infrastructure, the facility is anonymized as "PT X."

3.2 Data Sources and Participants

Primary data were collected over a six-month period (August 2022 to January 2023). The study utilized purposive sampling to select nine key informants directly responsible for field execution and safety oversight: one Head of HSSQE, two Operations Supervisors, two Maintenance Engineers, one Central Control Room (CCR) Operator, two Security Officers, and one Occupational Health Nurse.

3.3 Data Collection and Ethical Considerations

Data collection involved three triangulated methods:

1. Semi-Structured Interviews: Ranging from 30 to 45 minutes, focusing on daily safety routines, perceived compliance barriers, and visitor management challenges. All participants provided informed consent, and responses were anonymized.
2. Direct Field Observation: Using a structured checklist, researchers observed daily toolbox meetings, PPE utilization rates during field tasks, and visitor induction sessions without interfering in operational duties.
3. Documentary Analysis: Reviewing institutional SOPs, visitor logbooks, Job Safety Analyses (JSAs), and ISO 45001 audit records to corroborate field observations and interview claims.

3.4 Data Analysis Procedure

The data underwent thematic coding to identify patterns of compliance and vulnerability. These themes were subsequently categorized into internal (Strengths and Weaknesses) and external (Opportunities and Threats) factors. A formal SWOT/TOWS matrix was then constructed to derive prioritized strategic interventions linking empirical vulnerabilities to targeted organizational improvements.

4. Results and Discussion

4.1 Overview of the Operational and Hazardous Environment

PT X operates a highly complex midstream LNG terminal. The core operational areas—including the cryogenic storage tanks, the Floating Regasification Unit (FRU), and the metering pipelines—are classified as hazardous zones (e.g., Zone 1 and Zone 2 explosive atmospheres). In these zones, the continuous handling of volatile substances enforces a zero-tolerance policy for uncontrolled ignition sources. Consequently, all electrical equipment, tools, and communications devices entering the field must be ATEX or IECEx certified as "intrinsically safe."

4.2 Empirical Implementation of Daily OSH Activities

Documentary evidence and field observations confirm that PT X has institutionalized three primary OSH mechanisms to control human risk:

1. Mandatory Safety Inductions: Document reviews of the visitor and contractor registry confirmed that entry requires a valid safety induction certificate. Conducted in a multimedia room, the briefing covers evacuation routes, PPE mandates, and strict prohibitions (e.g., no non-certified electronics). The induction is valid for six months, after which institutional policy forces a mandatory renewal.
2. Daily Toolbox Meetings: Observation of the morning shift handovers revealed that the Operations and Maintenance teams systematically conduct Toolbox Meetings. Supported by daily Job Safety Analysis (JSA) documents, these meetings outline specific tasks, assign risk mitigation strategies, and coordinate high-risk activities (e.g., working at heights) with the 24-hour CCR operators.
3. Fit-to-Work (Fitwork) Medical Screenings: To proactively manage occupational health, every field operator undergoes a daily medical triage conducted by the onsite clinic. Clinic logs demonstrate that blood pressure, pulse, and temperature are recorded. Employees failing the medical threshold are temporarily suspended from field duties, demonstrating a tangible commitment to human reliability.

4.3 Risk-Based PPE Standardization and Observed Compliance

Table 1 outlines the required PPE correlated with specific site hazards, alongside compliance levels derived from field observations.

Table 1. Risk-Based PPE Matrix and Field Compliance

Hazard / Risk Factor	Required PPE	Technical Standard / Specification	Observed Compliance / Issues
Falling objects / Structural impact	Safety Helmet	Impact-resistant; equipped with mandatory chin strap.	High availability. Issue: Chin straps frequently observed unfastened during tasks.
Chemical splash / High-velocity dust	Safety Glasses	Wrap-around industrial grade.	Moderate. Issue: Often removed prematurely due to lens fogging in high humidity.
Cryogenic exposure / Flash fire	Flame-Retardant Wearpack	Specialized fabric resisting ignition and direct chemical contact.	High usage. Issue: Causes severe thermal discomfort (heat exhaustion), leading to improper wear.
Heavy machinery / Low visibility	High-Visibility Vest	Reflective striping.	High compliance among visitors and deck crew.
Lacerations / Extreme temperatures	Anti-Slip Safety Gloves	Industrial grade, thermal protection.	High compliance during direct mechanical interaction.
Crush injuries / Punctures	Safety Shoes	Steel-toed, puncture-resistant soles.	Full compliance; strictly enforced at entry gates.

4.4 Operational Constraints: SWOT

Analysis

Based on the triangulated data, a formal SWOT matrix (Table 2) was constructed to map the systemic realities of PT X's safety implementation against external pressures.

Table 2. Formal SWOT Matrix of OSH Implementation at PT X

Internal Strengths (S)	Internal Weaknesses (W)
S1. Comprehensive provisioning of standardized PPE for the workforce.S2. Rigorous daily administrative controls (Fitwork, Toolbox Meetings).S3. Scheduled maintenance and calibration of safety-critical equipment (e.g., gas detectors, harnesses).	W1. Behavioral non-compliance regarding PPE (e.g., unfastened helmets) driven by thermal discomfort and fatigue.W2. Logistical bottleneck in visitor PPE inventory (maximum capacity of 30 sets).W3. Inconsistent enforcement of minor infractions by line supervisors.
External Opportunities (O)	**External Threats (T)**
O1. Availability of advanced, climate-appropriate flame-retardant materials in the market.O2. Industry trend towards digitalization of safety monitoring (e.g., ATEX-certified wearables).	T1. External visitors bypassing safety rules due to low risk perception.T2. Ignition risks from non-intrinsically safe consumer electronics (mobile phones) brought by visitors into classified explosive zones.

Analysis of Vulnerabilities: The data indicates that non-compliance is rarely malicious. Interview excerpts reveal that employees struggle with the *Flame-Retardant Wearpacks* (W1) due to the severe tropical heat, prompting them to unfasten collars or remove helmets to cool down—a classic human-factor failure where comfort competes with safety (Reason, 2016). The most critical threat (T2) stems from visitors. Despite the Safety Induction, visitors frequently attempt to use standard mobile phones for photography in the field. Because the terminal is a classified hazardous area, these non-certified devices can generate electrical arcs, theoretically acting as an ignition source in the presence of an accidental hydrocarbon release. Finally, documentary review of visitor logs revealed group sizes occasionally exceeding 40 individuals, while the facility only holds 30 certified visitor PPE sets (W2). This shortage forces staggered facility tours, disrupting the guiding staff's primary operational schedules.

4.5 Strategic Mitigation Efforts (TOWS Strategies)

To transition from descriptive findings to actionable improvements, the following prioritized strategies are derived directly from the SWOT intersections:

1. (S-T Strategy) Controlled Device Management Policy: To mitigate visitor electronic threats (T1, T2) using existing supervisory strengths (S2), PT X must enforce a strict physical control policy. Visitors must surrender personal mobile devices to secure lockers at the security post prior to entry. To accommodate the need for documentation, the facility leverages its operational staff to provide photography using internally maintained, ATEX-certified (intrinsically safe) cameras.
2. (W-O Strategy) Data-Driven Logistical Upgrades: To resolve the visitor bottleneck (W2), management should utilize historical visitor volume data to justify the procurement of additional PPE sets, ensuring inventory comfortably exceeds peak demand. Furthermore, procuring newer, breathable flame-retardant fabrics (O1) can directly address the thermal discomfort driving employee non-compliance (W1).
3. (S-W Strategy) Human-Centric Supervision and Culture Building: Relying solely on administrative reprimands is insufficient for behavioral change (W3). Leveraging the daily Toolbox Meetings (S2), PT X should transition from punitive enforcement to peer-based safety observations. Supervisors must be trained to recognize fatigue and heat stress, rotating workers effectively so that PPE compliance does not come at the cost of physical exhaustion.

5. Conclusion

Based on the empirical evidence gathered at PT X's LNG terminal, this study concludes that the facility's daily OSH procedures—namely safety inductions, toolbox meetings, and fit-to-work screenings—are robustly structured and consistent with selected core principles of ISO 45001:2018. However, bureaucratic compliance does not fully translate

to field execution. The primary constraints identified are human-factor driven: employee PPE non-compliance resulting from thermal discomfort, visitor violations of intrinsically safe electronic policies due to low hazard awareness, and logistical bottlenecks caused by insufficient visitor PPE inventory during peak demand.

To optimize operational integrity, PT X must implement targeted, risk-based interventions. Strategic recommendations include transitioning from mere administrative warnings to physical controls for visitor electronics (mandating secure lockers and providing ATEX-certified cameras), upgrading PPE inventory based on peak-capacity data, and addressing the root causes of employee non-compliance through climate-appropriate gear and fatigue-aware supervision.

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