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SWOT and Determinant Factors Approach to Worker Compliance Analysis with Full Body Harness Pass Systems in Construction Projects

R.A. Intan Dwi Saraswati [1], Priyambodo Nur Ardi Nugroho [2], Dewi Kurniasih [3]
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***Abstract*—Since construction sites are dangerous by nature, strict safety precautions are necessary. This study examines the Full Body Harness Pass system compliance of workers and the determinants that affect adherence with the aim of improving compliance and reducing avoidable accidents. A SWOT analysis methodology is utilized in the study to integrate quantitative compliance data with qualitative safety officer observations. Results show that though the FBH Pass system raises safety awareness, a number of issues, including poor training and reluctance to use digital tools, limit its utility. These recommendations go towards promoting an overall safer building environment, coupled with extended training programs and improved monitoring.**

Keywords—Worker Compliance, Full Body Harness Pass System, Construction Safety.

I. Introduction

The construction industry is widely regarded as one of the most hazardous fields [1], with a high prevalence of workplace accidents and significant Occupational Health and Safety (OHS) challenges [2]. Construction projects inherently involve complex and physically demanding tasks that expose workers to various risks [3], particularly when working at heights [4]. Such conditions necessitate a focus on safety practices, not only for the welfare of employees but also to protect the legal, financial, and reputational interests of companies. Maintaining a safe working environment is thus essential for reducing incidents and fostering an atmosphere where health, safety, and productivity are prioritized [5].

Accompanying the many rules and procedures aimed at enhancing the safety of construction sites is the nerve-wracking statistic of workplace injuries and fatalities. According to the report compiled by the BLS in 2017, in the construction industry alone, 16% of workplace fatalities exist, with over 5,000 fatalities registered. Similar trends are mirrored across the globe, as construction has been responsible for 32% of recorded workplace fatal accidents in Indonesia, from its infrastructure projects covering buildings, roads, bridges, and tunnels. Certain projects accounted for the highest incidents; the toll road in Indonesia, for instance, already recorded a staggering 22, among construction projects and light rail transit (LRT) construction, where multiple fatalities occurred, too [6].

In addition to project-specific risks, broader statistics highlight the persistent hazards in construction. The International Labour Organization (ILO) reported that approximately 2.78 million workers die yearly due to occupational accidents [7], Indonesia has seen a marked increase in these occurrences. Data from the Indonesian Social Security Agency revealed a steady rising trend in work-related accidents, with an increase from 221,740 in 2020 to 265,334 in 2023, representing an increase of 11.67% over three years. Notably, the hardest hit are workers between 20 and 25 years old; thus, it reveals the elevating need for comprehensive safety interventions, especially in young and inexperienced workers [8].

B. Problem Definition

Workplace accidents are often caused by unexpected and uncontrolled events related to both the environment and human error [9]. In construction, a large proportion of accidents involve working at heights, a task that presents a high risk of falls, injuries, and fatalities [10]. The Indonesia Occupational Safety and Health (OSH) Law No. 1/1970 makes it clear that accidents can be influenced by two main factors: unsafe actions and unsafe conditions. Unsafe actions encompass behaviors deviating from standards for safety, while unsafe conditions are attributable to environmental factors that lead to potential hazards [11]. Data from Health, Safety, and Environment (HSE) officers show a high level of non-compliance regarding the use of personal protective equipment (PPE). A significant number of these incidents have been reported, in which noncompliance occurred when workers

R.A. Intan Dwi Saraswati is with Safety and Risk Engineering Departement in Politeknik Perkapalan Negeri Surabaya, Surabaya, 60111, Indonesia. E-mail: raintan12@student.ppns.ac.id
Priyambodo Nur Ardi Nugroho is with Ship Design and Construction Engineering Departement in Politeknik Perkapalan Negeri Surabaya, Surabaya, 60111, Indonesia. E-mail: priyambodo@ppns.ac.id
Dewi Kurniasih is with Occupational Health and Safety Engineering Departement, Politeknik Perkapalan Negeri Surabaya, Surabaya, 60111, E-mail: dewi.kurniasih@ppns.ac.id

were not using the Full Body Harness (FBH) that are mentioned as mandatory in the Ministry of Manpower Regulation No. 9/2016 dealing with safety guidelines for high-risk construction work [12].

Such accidents have formidable financial impacts. The mere occurrence of a fatal accident could translate to financial losses approaching Rp. 570,000,000 owing to insurance payments and delay in project works that may extend to even three months in total for investigation and recovery. Uncontrolled risks would further affect the project time and productivity; hence, effective safety management systems are thus mandated. Currently, a lot of companies still rely on manual reporting systems for OHS compliance that need to record workers' data, training records, and incident reports using spreadsheets or paper forms. The shortcomings of such an approach are considerable: error-prone manual data management, data loss, and delays in safety responses.

C. Proposed Solution

This study addresses two major problems: laxity on safety protocols and poor understanding of the factors causing this laxity. Current approaches mostly fail to include data-driven insights, proper analysis, and detailed interventions that promote compliance using systematic approaches [13]. Similarly, workers are given scant training on the use of digital tools, such as FBH Pass, which has limited its acceptance.

To meet these challenges and hurdles, this research proposes to develop a Quality, Health, Safety, and Environment (QHSE) Passport System with an integrated FBH Pass functionality. The QHSE Passport is envisaged as a digital system for centralizing OHS data, tracking worker compliance, and managing safety training, health checks, and incident reports. Concerning the last premise, information transmission is going to be facilitated through a web-based platform via QR code technology to ensure better access and ease of incident reportation by workers, supervisors, and HSE officers.

The primary functionalities of the system will include almost worker registration (for employees and vendors), real-time alerts on HSE induction, QR code generation to facilitate attendance tracking, and a monitoring dashboard. This dashboard would allow the HSE officers to access basic data like total man-hours worked, number of active workers, and how often violations occur. Through this, id cards with QR code can be issued so that attendance and compliance can be easier when checking on site. The system would ensure that the workers were vetted against the assigned risk profile of their job category-subset into high risk and low risk-before entering the work zone.

D. Importance of the Study

This QHSE Passport System has the potential to address many of the limitations of current manual systems. A digital platform not only minimizes human error but also provides HSE officers with real-time data, enabling more responsive and informed safety decisions. By sending automated notifications to supervisors and workers, the system fosters a culture of safety, promoting consistent adherence to compliance requirements. In addition, the platform's compatibility with existing company databases supports seamless integration, facilitating big data analysis for long-term safety improvements.

In addition to immediate compliance tracking, this system is designed to support ongoing safety analysis through features like usability testing and a Benefit-Cost Analysis (BCA) framework. BCA allows the company to assess financial gains associated with the system, comparing reduced accident rates and financial savings to implementation costs. As a result, the system can demonstrate a quantifiable impact on safety performance, presenting a valuable case study for other high-risk industries.

The novelty of this research lies in its comprehensive application of a SWOT analysis framework to bridge these gaps. By combining quantitative compliance data with qualitative observations from safety officers, the study provides a nuanced understanding of compliance determinants [14]. Additionally, it proposes actionable recommendations to enhance the effectiveness of digital safety systems in high-risk environments.

II. METHOD

This study employed a mixed-method approach, integrating quantitative compliance data with qualitative insights from safety personnel and workers. The research was conducted on a construction site using the FBH Pass system, which records worker compliance through checkpoints and QR-based attendance linked to personal protective equipment (PPE) usage.

A. Data Collection

Quantitative Data: Compliance records from the FBH Pass system, including instances of missed compliance checks, were analyzed to identify compliance patterns.

Qualitative Data: Semi-structured interviews were conducted with 20 construction workers and 5 safety officers, focusing on perceived barriers and facilitators of compliance with the FBH Pass system.

B. SWOT Analysis

A SWOT framework was used to organize findings from both data types:

Strengths: Factors within the FBH Pass system that enhance compliance, such as ease of use and digital tracking.

Weaknesses: Limitations, including resistance to digital systems and lack of regular training updates.

Opportunities: External factors, such as technological advancements, that could improve compliance.

Threats: External challenges, like negative worker attitudes and inadequate training resources [15].

C. Statistical Analysis

Correlations between compliance rates and factors like training frequency, worker age, and prior incident history were analyzed using SPSS software to assess the statistical significance of identified determinants.

This research adopts a multi-stage methodology to design and implement a web-based information system

aimed at monitoring worker compliance, training, health data, and violations on high-risk construction projects using the Full Body Harness (FBH) Pass system. The methodology includes system design, problem identification, data collection, data processing, system testing, and analysis using a structured approach.

D. Initial Identification Stage

The initial stage involves identifying specific issues within construction safety management that relate to worker compliance and monitoring. This stage defines the problem based on background analysis, literature review, and field observations. The problem identification phase is crucial in creating a foundation for the study's objectives and goals.

A comprehensive literature review supports the development of the FBH Pass system by examining relevant studies on safety compliance, construction safety statistics, non-conformity violations, and PHP-based web application development with MySQL databases. Key sources include research articles on responsive web design, QR code implementation, and Benefit-Cost Analysis (BCA) in construction safety. This review informs the choice of programming tools, design features, and analytical methods, including the BCA, which assesses the financial and safety benefits of implementing the FBH Pass system versus not using it. Literature is also sourced from local and international safety standards, such as Indonesia's Ministry of Manpower Regulation No. 9/2016 on working at heights, which provides a regulatory framework for compliance requirements [12].

The field study involves direct observations at construction sites, providing insights into current compliance issues and practical challenges. Observations are conducted in high-risk project areas, where violations and compliance gaps are recorded. Field data collection offers real-world context, allowing the study to align system design with actual site conditions and compliance needs.

E. Problem Definition and Research Objectives

This stage refines the research questions and objectives, based on findings from the identification and literature review phases.

The initial examination reveals that construction companies face challenges in manually monitoring worker compliance, training records, health data, and non-conformity (NC) violations. The reliance on manual systems results in inefficiencies and high violation rates due to a lack of effective monitoring. To address these issues, the study proposes a web-based FBH Pass system using PHP, MySQL, responsive web design, and QR code integration.

The objectives focus on designing an integrated and systematic web-based database to monitor worker compliance, training, and health data in real-time. This system aims to streamline the recording and monitoring process, reduce non-compliance incidents, and provide reliable data for decision-making. The anticipated benefits include improved safety and operational efficiency, along with enhanced compliance reporting and analysis capabilities for stakeholders.

F. Data Collection

The data collection phase is split into primary and secondary data sources to build a robust dataset for system design and testing.

Primary data is collected through on-site observations, focusing on risk-prone areas and documenting potential hazards, incidents of non-compliance, and worker behaviors. This information provides a practical foundation for system features, such as real-time health monitoring and compliance tracking.

Secondary data is sourced from company records, including NC violation reports, worker distribution, working hours, training history, and health records for the year 2023. This data offers a basis for analyzing current compliance levels and setting benchmarks within the FBH Pass system for monitoring worker status and predicting areas at higher risk of non-compliance.

G. Data Processing

Data processing transforms collected data into actionable insights, facilitating the creation of an FBH Pass system that tracks compliance effectively.

The system incorporates various forms for data input, covering worker details, training, health, and violation history. The key forms include:

- Personnel Details Form: Contains fields for worker ID, name, identification type, and role, ensuring comprehensive personal information.
- Training and Competency Form: Records training sessions and competencies, supported by relevant certificates or proof of attendance.
- Health Record Form: Documents medical check-ups, including vital signs and fitness recommendations, based on on-site paramedic assessments.

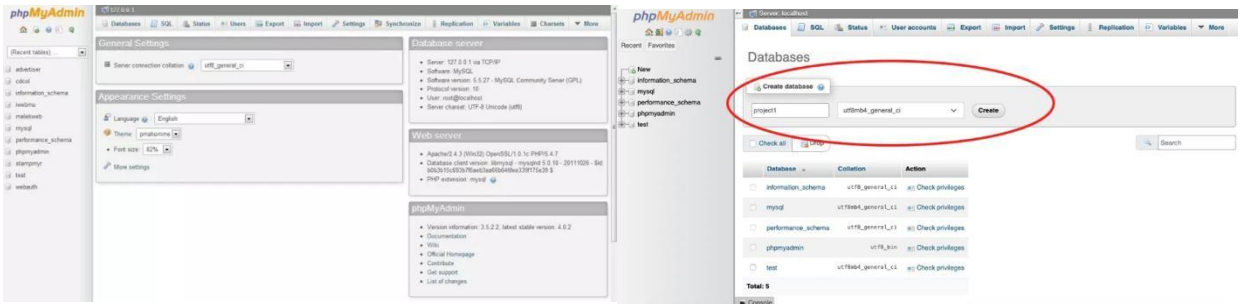

Figure 1. System Interface

- QHSE Violation Form: Logs NC incidents, with fields for type, date, and evidence of violation, enabling supervisors to monitor compliance effectively.

A dashboard interface aggregates real-time data on working hours, user statistics, and violation records, allowing HSE personnel to monitor compliance. The dashboard provides an overview of key metrics, such as:

- Manhours Data: Captures total working hours and lost time due to safety violations, providing a measure of productivity and risk exposure.
- User Statistics: Displays the number of registered users and total system participation, reflecting worker engagement levels.
- Violation Summary: Aggregates reported NC incidents by type and severity, assisting in risk management and trend analysis.

H. Information System Design

The system design phase develops the web-based FBH Pass using PHP for backend functionality, MySQL for database management, and responsive design principles. QR codes enable streamlined user access for tasks such as attendance, personal data access, and compliance tracking. The data collected in real-time is automatically validated by HSE personnel, providing accurate statistics and records of worker compliance and health. System interface could be seen in Figure 1.

I. System Testing and Evaluation

Upon completing the system design, testing and evaluation determine the program's effectiveness and identify necessary adjustments.

Data analysis includes survey-based assessments and BCA calculations to evaluate system impact:

- Questionnaire Analysis: Post-implementation, a Likert scale questionnaire collects user feedback, using the Three-Box Method to interpret responses on system usability and effectiveness.
- Benefit-Cost Analysis (BCA): The BCA assesses financial implications by comparing benefits, such as reduced violation rates, against costs of implementing the FBH Pass system. The process involves:

1. Identifying all benefit and cost variables associated with the system.
2. Analyzing total costs versus projected benefits, including potential reduction in financial losses from safety violations.
3. Evaluating alternative cost scenarios to compare projected benefits with other safety management systems.
4. Calculating a benefit-cost ratio to determine the system's financial viability.
5. Drawing conclusions based on BCA outcomes to decide whether the system should be expanded or adjusted based on cost-effectiveness.

III. Results and Discussion

This section provides an analysis of data gathered and the observed outcomes from the FBH Pass system's implementation. The results are discussed under several headings to capture different perspectives on system performance, compliance, and improvement areas. Additionally, findings related to data collection and system design implementation based on company inputs are presented.

A. Data Collection and System Integration

During the research, comprehensive data collection was conducted, focusing on integrating critical information into the QHSE Passport and FBH Pass systems. This section highlights key categories of data used to structure the system's database and the role of each in promoting compliance and operational efficiency.

1. Non-Conformity (NC) Data

The Non-Conformity (NC) data serves as a core input for the FBH Pass system, allowing for systematic tracking of safety violations. Collected from company records, this data includes incidents of non-compliance categorized by type, severity, and frequency. By integrating NC data into the digital system, the company can monitor trends, identify areas where safety protocols are frequently breached, and prioritize corrective measures. Having this data readily accessible allows supervisors to respond proactively to recurring issues, reducing the likelihood of repeated non-compliance and improving overall safety standards on-site.

2. Worker Distribution Data

The worker distribution data was collected to categorize employees based on their roles and risk levels (high-risk vs. non-high-risk tasks). This dataset includes personal identification details such as personnel numbers, full names, identification types, departments, job levels, education, and contact information. By categorizing workers in the database, the FBH Pass system can ensure that high-risk tasks are allocated to properly qualified and trained personnel. The detailed information also allows for quick verification during site entry checks, ensuring that only authorized workers have access to high-risk areas, thus reinforcing compliance and safety in designated zones.

3. Work Hours Data

Data on total work hours was gathered to support the HSE team in tracking productivity and calculating lost workdays due to safety violations. This data is critical for analyzing the impact of non-compliance on project schedules and operational costs. By integrating work hours into the FBH Pass system, the company can monitor hours spent in high-risk tasks, identify any decrease in productivity due to safety breaches, and calculate lost time accurately. This information provides valuable insights for project managers and helps quantify the indirect costs associated with safety non-compliance.

4. Training and Competency Data

Training and competency data plays a significant role in ensuring that all personnel meet the necessary qualifications for their roles. This data includes details such as the type and field of training, certification dates, and supporting documentation for each worker’s competencies. By centralizing training data within the FBH Pass system, the company can automatically track training expiration dates and identify workers needing

refresher courses. This proactive approach enhances compliance by ensuring that only properly trained personnel are assigned to high-risk tasks. Additionally, the system provides easy access for HSE officers to verify each worker's competency status before they enter restricted work zones.

5. Health Data

Health data, including periodic medical examinations and health histories, was incorporated into the system to ensure that workers are physically fit for high-risk tasks. This dataset covers vital signs, health check results, color blindness tests, and medical certificates. Integrating health data within the FBH Pass system helps supervisors ensure that workers with potential health risks are monitored closely, thereby reducing the chances of health-related incidents on-site. Regular health assessments are especially important in high-risk environments, where physical fitness can significantly impact worker safety.

B. Data Processing and System Development

The collected data was processed and organized to create a structured database for the QHSE Passport system, which integrates seamlessly with the FBH Pass component.

1. Development of the QHSE Passport System

The QHSE Passport system was designed with the purpose of monitoring, managing, and controlling worker readiness before they enter the worksite. The system's main functions include confirming each worker's competency, tracking compliance records, and maintaining health check data. By linking with the company's existing systems, the QHSE Passport supports big data analytics for long-term trend analysis and continuous improvement. This integration allows for a more comprehensive view of worker safety behaviors, enabling data-driven decisions to enhance workplace safety.

2. Roles and Responsibilities within the System

The QHSE Passport outlines specific roles and responsibilities for personnel involved in the safety management process:

Project Managers are responsible for verifying that all personnel in their teams possess a valid QHSE Passport, ensuring compliance.

Safety Officers and Site Managers oversee system implementation and conduct regular training and health checks to keep records up-to-date.

Workers are tasked with keeping their QHSE Passports current, reporting any updates in their training, health, or incident records.

This clear distribution of responsibilities enhances accountability, as each individual's role in maintaining a safe work environment is well-defined.

3. Database Structuring and Interface Design

To optimize usability, the database was structured with class and entity relationship (ER) diagrams to clarify the connections between different data types, such as worker credentials, compliance records, training, and health checks. The interface design was developed to provide each user type—supervisors, project managers, and workers—with access to relevant information. For instance, project managers can view compliance dashboards, while workers have a user-friendly interface for logging in and reporting safety concerns via QR codes.

C. System Testing and Benefit-Cost Analysis (BCA)

Following system development, a system functionality test was conducted to verify that each feature worked as expected. This testing phase assessed the usability, ease of learning, and satisfaction levels through a questionnaire distributed to a sample of 18 users. These users rated the system on aspects such as usefulness, simplicity, and ease of navigation.

In addition, a Benefit-Cost Analysis (BCA) was performed to evaluate the financial implications of the FBH Pass system. The BCA considered the fixed costs of system development against the projected benefits, such as reduced safety violations, lower accident rates, and decreased lost workdays. Preliminary results indicate a favorable benefit-cost ratio, suggesting that the system provides value by improving compliance and reducing safety-related expenses. The BCA findings provide a basis for the company to consider extending the system's application across other high-risk projects, given its potential return on investment (ROI).

The implementation of the Full Body Harness (FBH) Pass system reveals multiple dimensions that influence compliance levels in high-risk construction environments. This section discusses key Strengths, Weaknesses, Opportunities, and Threats (SWOT) associated with the FBH Pass system, identifying areas that contribute to improved safety practices and areas requiring further intervention

Strengths

The FBH Pass system introduces a structured, digital framework for tracking compliance, which significantly enhances both worker awareness and supervisory oversight. One of the main strengths identified is the system's ability to systematically record and monitor worker compliance in real time. This organized approach ensures that both workers and supervisors have clear guidelines regarding the use of safety equipment, which reduces ambiguity around compliance requirements.

The digital nature of the system is particularly beneficial for supervisors, who can access up-to-date records instantly, allowing them to identify and address instances of non-compliance quickly. This feature is critical in high-risk construction environments where safety breaches can lead to severe injuries or fatalities. Supervisors reported that the digital monitoring aspect simplified the compliance process, enabling more efficient inspections and reducing the time needed for manual record-keeping.

Furthermore, workers expressed that being part of a monitored system made them more conscious of their safety obligations. The requirement to use the FBH Pass for entry, equipment checks, and daily compliance tracking encourages a sense of accountability among workers. They reported feeling more responsible for

adhering to safety protocols, as they were aware that their compliance status was continuously monitored and documented. This heightened awareness fosters a proactive approach to safety, as workers become more vigilant about following proper procedures and using safety equipment correctly. Workers reported feeling more aware of their responsibilities when monitored via the FBH Pass system [16], [17].

Finally, the FBH Pass system also contributes to a safety-oriented culture on-site, where compliance is not just a requirement but an integrated part of daily operations. The structured format and digital interface make it easier for new workers to adapt to safety standards, as they have access to clear, documented procedures and resources. By embedding compliance into routine practices, the FBH Pass system helps normalize safety protocols, leading to a collective commitment to reducing incidents and fostering a safer work environment.

Weaknesses

While the FBH Pass system offers numerous benefits, its overall effectiveness is hindered by several key weaknesses that impact worker compliance and system usability. One significant issue is the digital unfamiliarity among many workers, especially those who have limited experience with technology. Workers reported difficulties in navigating the system's digital interface, particularly when using QR codes or digital checkpoints for attendance and compliance logging. This unfamiliarity has led to frequent errors during check-ins, such as failed scans or incorrect data entry, which disrupts the tracking process and diminishes the system's intended accuracy and reliability [18], [19].

Another major weakness is the insufficient training provided for workers to effectively use the FBH Pass system. The initial training sessions on system usage were reported to be brief and lacked depth, leaving many workers without a thorough understanding of how to navigate the digital platform. This gap in training not only leads to errors but also contributes to reluctance among workers to engage with the system. Interviews indicated that some workers avoid using the system whenever possible, citing confusion or frustration due to their limited training. This lack of training is particularly problematic in high-risk construction environments, where consistent and accurate compliance tracking is critical for safety.

Additionally, the time-consuming nature of the FBH Pass system is another point of concern. Workers noted that using the system often requires extra steps, such as waiting for QR code scans to complete or accessing their profiles on mobile devices, which they find restrictive and inconvenient. For workers with low digital literacy, these added steps are even more challenging and perceived as unnecessary obstacles. This perception of the system as a burden rather than a support tool contributes to resistance, especially among workers who prioritize speed and efficiency in their tasks.

Furthermore, the need for regular interaction with digital checkpoints and data input creates frustration among some workers who feel that these steps interrupt their workflow. This sense of restriction is exacerbated in high-pressure environments, where time is critical, and lengthy compliance checks are seen as a hindrance to productivity. Without addressing these usability concerns, the FBH Pass system may face ongoing resistance from workers, ultimately affecting the system's goal of creating a safer, more compliant workplace [20].

Addressing these weaknesses—by providing more comprehensive digital literacy training, simplifying system processes, and making the interface more user-friendly—will be essential to increasing acceptance and compliance with the FBH Pass system.

Opportunities

The rapid evolution of digital technology offers several promising opportunities to improve the functionality, accessibility, and impact of the FBH Pass system. One such opportunity is the integration of mobile alerts and real-time feedback. By incorporating push notifications, text alerts, or app-based reminders, the system could deliver immediate prompts to workers, reminding them of upcoming safety checks or notifying them of incomplete compliance tasks. Real-time feedback could also alert workers instantly to any missed or incorrect check-ins, allowing them to address issues promptly without waiting for supervisor intervention. This instant communication would streamline compliance, making safety checks more intuitive and reducing the likelihood of accidental non-compliance.

Additionally, integrating real-time feedback for supervisors presents a valuable opportunity for on-the-spot management of safety protocols. Supervisors could receive immediate alerts when workers fail to meet compliance standards, enabling them to intervene directly and rectify the situation without delays. This approach would support a more proactive safety culture, as potential risks could be identified and addressed in real-time, minimizing incidents and reinforcing the importance of compliance. Furthermore, automated reporting of compliance data could be generated, providing insights for management and HSE officers to make data-driven decisions and recognize patterns in safety performance.

Collaboration with training providers to develop tailored digital literacy sessions is another key opportunity. Many construction workers, particularly those with limited exposure to digital tools, would benefit from comprehensive training that includes hands-on experience with digital check-ins, QR scanning, and mobile app usage. These sessions could be designed in collaboration with vocational training institutions or digital education providers who specialize in digital literacy for blue-collar workforces. Offering training that is specific to construction environments and the unique requirements of the FBH Pass system would facilitate smoother adaptation among workers, addressing current resistance due to digital unfamiliarity [21], [22]..

Additionally, there is an opportunity to incorporate gamification and incentives within the FBH Pass system to encourage active engagement and increase motivation. Features like compliance scores, achievement badges, or small rewards for consistent adherence to safety protocols could make the system more appealing to workers. Such

incentives could also reinforce a safety-first mindset and improve worker morale, as they feel recognized for their efforts in maintaining safety standards.

Lastly, the FBH Pass system could expand its functionality by integrating with existing company databases and third-party safety management software. This would allow seamless data sharing across platforms, enabling construction companies to leverage big data analytics for long-term safety planning and trend analysis. Integrating data from the FBH Pass system with broader company databases could support predictive analysis, helping companies identify high-risk patterns and prevent potential incidents before they occur.

These opportunities for technological enhancement, targeted training, and incentive-based engagement are crucial for maximizing the system's impact. Leveraging these advancements will not only improve compliance rates but also foster a stronger, digitally proficient workforce that is better equipped to manage safety in high-risk construction settings.

Threats

The effectiveness of the FBH Pass system is subject to various external threats that may undermine its intended safety outcomes. One significant threat is the lack of commitment from some project managers and senior leadership to enforce strict compliance. Effective implementation of the FBH Pass system requires active support from project managers, who play a critical role in setting compliance expectations and promoting a culture of safety. However, if managers do not prioritize or model adherence to safety protocols, workers may perceive compliance as optional rather than essential. This inconsistency in enforcement can lead to gaps in safety practices, ultimately weakening the system's impact and reducing worker buy-in [23], [24]..

Another notable threat is the presence of supervision gaps on construction sites, where safety officers are sometimes unavailable to monitor compliance or provide guidance on using the FBH Pass system. Workers reported instances where they felt uncertain about compliance requirements due to the lack of immediate oversight and support from safety personnel. Without regular supervisory presence, workers may overlook or disregard safety checks, viewing the FBH Pass system as an additional administrative burden rather than a vital safety tool. Supervision gaps are particularly concerning in high-risk environments where prompt intervention from safety officers can be critical in mitigating accidents and ensuring that workers adhere to established safety procedures.

Additionally, the absence of clear communication and consistent reinforcement from supervisors and safety officers regarding the importance of the FBH Pass system can lead to disengagement among workers. When safety protocols are not actively explained or encouraged, workers may lack a complete understanding of the risks associated with non-compliance, leading to complacency. For example, without continuous reminders about the dangers of working without proper safety gear, workers may fail to see the relevance of the FBH Pass system, resulting in lower compliance rates.

High turnover rates in the construction industry further compound these threats, as new workers may not receive adequate onboarding or training in the FBH Pass system, especially if project managers do not fully prioritize safety training for temporary or contract workers. This turnover creates additional challenges in maintaining a consistent standard of compliance, as frequent retraining and oversight become necessary to ensure that all personnel, including new hires, understand and follow safety protocols.

Lastly, operational pressures to meet tight project deadlines pose an ongoing threat to compliance. Under time constraints, workers and managers alike may deprioritize safety checks in favor of expedience, particularly if they perceive compliance as slowing down productivity. In such cases, workers may skip or rush through the FBH Pass procedures, reducing the accuracy and reliability of the compliance tracking system. If safety is sacrificed for speed, the system's capacity to prevent incidents and promote a safer work environment is significantly compromised.

To mitigate these external threats, it is essential for companies to foster a top-down commitment to safety that includes visible support from management and continuous, structured supervision. Regular training sessions, clear communication, and a reinforced emphasis on the necessity of compliance can counteract the influence of these threats, promoting a more consistent and committed approach to safety on high-risk construction sites

Determinant Factors

The study identified training, health status, and organizational safety culture as significant determinants of compliance [25], [26]:

- Training: Effective and ongoing training emerged as one of the strongest determinants of compliance. Workers who received comprehensive training on the FBH Pass system were more likely to understand and consistently adhere to safety protocols. Training provides workers with not only the technical skills needed to use the digital system effectively but also reinforces the importance of compliance for personal and site-wide safety. However, gaps in training—whether in frequency, depth, or accessibility—were correlated with lower compliance rates, as workers without adequate training often felt uncertain about system use and the necessity of adhering to specific safety measures. Regular refresher courses and hands-on training are therefore crucial to maintaining high levels of compliance, especially in environments with rapid technological advancements or evolving safety requirements. Frequent training positively correlated with compliance [27], as workers with recent training sessions were more likely to adhere to FBH Pass requirements ($p < 0.05$).
- Health Status: The physical health of workers is another important factor influencing compliance. Workers who regularly undergo health checks

and maintain a satisfactory level of physical fitness are generally more compliant with safety requirements. Health assessments not only ensure that workers are physically capable of meeting the demands of high-risk tasks but also serve as a reminder of the importance of adhering to safety protocols to prevent injuries. In contrast, workers with untreated health issues may lack the energy, agility, or alertness needed to follow compliance steps reliably, especially when operating in high-risk settings. Ensuring that health checks are integrated into the FBH Pass system supports better compliance by helping workers remain fit and aware of their own safety needs on the job [28], [29].

- Safety Culture: The prevailing safety culture within the organization is perhaps the most influential factor driving compliance [30]. In organizations where safety is deeply embedded in the work culture and visibly prioritized by management, workers tend to view compliance as an integral part of their responsibilities rather than an added task [31]. A strong safety culture is cultivated through consistent messaging from leadership, regular engagement of safety officers with workers, and a framework that rewards adherence to safety protocols. Conversely, in workplaces where safety is not a visible priority, compliance is often lower, as workers may perceive safety requirements as less important or relevant to daily operations. The presence of a committed, safety-oriented organizational culture can therefore reinforce positive compliance behaviors, as workers feel supported and motivated to uphold high safety standards [32].

These determinant factors—training, health status, and safety culture—collectively contribute to shaping a compliance-focused workforce. Addressing each factor through targeted interventions can lead to a more robust and effective implementation of the FBH Pass system, reducing incidents and enhancing overall safety in high-risk construction environments.

IV. Conclusion

This study aims to analyze compliance by construction workers to the Full Body Harness (FBH) Pass system and identify the factors that influence adherence. Using a SWOT analysis framework, the research integrates quantitative compliance data with qualitative insights from safety officers. The findings of this study show that FBH Pass system improves safety awareness, but different challenges such as being poorly trained and resistance against digital tools greatly hinder its effectiveness.

To mitigate this, the recommendations include thorough training on digital systems, an organizational culture oriented towards safety, and compelling monitoring mechanisms that would entice standardized compliance in turn minimizing occurrences of accidents hence a safer construction environment. Future research should further test advanced technologies conserving augmented reality or safety monitoring using AI to enhance compliance further and improve the safety outcome at the workplace.

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