

IMPLEMENTATION OF CLOUD-BASED DIGITAL OCCUPATIONAL HEALTH AND SAFETY INSPECTION CHECKLIST FOR WORKPLACE SAFETY MONITORING AT PT X

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Abstract

Effective Occupational Health and Safety (OHS) supervision in the industrial sector demands rapid, accurate, and real-time actionable inspection mechanisms. PT X, a steam power generation company, previously relied on a conventional paper-based inspection system, susceptible to reporting delays of 24–48 hours, document loss, and delayed hazard corrective action responses. This community service program aimed to implement a Cloud-Based Digital OHS Inspection Checklist to enhance workplace safety supervision effectiveness and strengthen OHS personnel capacity at PT X. Participatory Action Research (PAR) was employed alongside a One-Group Pretest-Posttest quasi-experimental design. Activities encompassed inspection form redesign, cloud platform development (AppSheet/Google Workspace), intensive training, and field mentoring involving 30 OHS supervisors and auditors. Effectiveness was evaluated through Normalized Gain (N-Gain) and Wilcoxon Signed-Rank Test analysis, supplemented by inspection time efficiency metrics. Results indicated a significant improvement in participants' knowledge, with mean scores rising from 52.33 to 88.67 (N-Gain = 0.76, high category; $p < 0.001$). Operational efficiency improved by 74.2%, reducing processing time from 180 to 46 minutes per session. The cloud-based system proved effective in accelerating real-time hazard coordination and reinforcing safety culture at PT X.

Keywords: Cloud Computing, Digital Inspection Checklist, N-Gain, Occupational Health and Safety, Real-Time Supervision.

INTRODUCTION

Occupational Health and Safety (OHS) constitutes a fundamental pillar in sustaining productivity and operational continuity across modern industries (ILO, 2023). According to data published by the Ministry of Manpower of the Republic of Indonesia, workplace accident rates continue to exhibit an upward trend, with the majority of incidents attributed to undetected unsafe conditions and unsafe acts (Kemenaker, 2023). In accordance with Government Regulation No. 50 of 2012 concerning the Implementation of the OHS Management System (SMK3) and ISO 45001:2018 Clause 9.1.1 on Monitoring and Measurement, organizations are mandated to conduct systematic workplace inspections to proactively identify hazards (BSI, 2018; Government of the Republic of Indonesia, 2012).

In practice at PT X, a steam power generation company, daily and weekly OHS inspections were predominantly conducted using conventional paper-based inspection checklists. Based on preliminary investigations and field observations, this manual system presented several critical operational barriers:

- **Reporting Lag:** Field inspection data required manual re-entry into computer spreadsheets at the HSE office, consuming 24–48 hours before corrective recommendations could be issued.
- **Risk of Data Loss and Damage:** Physical inspection forms were susceptible to water damage, tearing, or loss within plant operational areas.
- **Lack of Real-Time Accessibility:** Senior management and persons-in-charge (PICs) did not receive immediate notifications regarding high-risk hazard conditions.
- **Difficulty in Hazard Trend Analysis:** Manual processing of historical inspection data impeded the identification of recurrent hazard patterns.

Advancements in cloud computing and mobile application technologies offer transformative solutions to these OHS monitoring challenges (Chari et al., 2020; Markowski et al., 2021). Digital OHS inspections enable onsite data

collection via smartphones, including photographic evidence capture, automatic GPS coordinate recording, and direct synchronization to cloud databases integrated with real-time monitoring dashboards (SafetyCulture, 2022; Utomo et al., 2022). Research by Rahardjo and Haryanto (2021) confirmed that cloud-based OHS form digitalization can accelerate corrective action response by up to 65% and increase inspection compliance rates among supervisors to 90%. Despite these evident advantages, transitions from manual to digital systems in industrial settings frequently encounter technological resistance from workers and inspection teams (Venkatesh et al., 2012). Without structured facilitation, comprehensive socialization, and training, digital platform implementations risk failing to achieve optimal effectiveness. Accordingly, this community service program was designed to bridge the gap between modern OHS supervision requirements and the human resource readiness at PT X, with three specific objectives: (1) to design and implement a Cloud-Based Digital OHS Inspection Checklist tailored to PT X hazard characteristics; (2) to enhance knowledge and technical skills of supervisors, auditors, and HSE staff; and (3) to analyze the effectiveness of the digital system on inspection reporting time efficiency and corrective action management.

LITERATURE REVIEW

Cloud-based occupational safety inspection systems represent an emerging paradigm in industrial safety management. Markowski et al. (2021) demonstrated that cloud-integrated safety management frameworks in smart manufacturing environments significantly reduce hazard response latency and improve traceability of corrective actions. Similarly, Chari et al. (2020) conducted a systematic literature review on OHS system digitalization in manufacturing, concluding that digital inspection platforms enhance data accuracy, audit trail integrity, and cross-functional communication.

The Technology Acceptance Model (TAM), extended by Venkatesh et al. (2012) into the Unified Theory of Acceptance and Use of Technology (UTAUT2), provides the theoretical lens for examining user adoption of digital OHS tools. TAM posits that Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) are the primary determinants of technology acceptance behavior—particularly relevant when assessing voluntary adoption of cloud-based tools among OHS inspection personnel.

The Normalized Gain (N-Gain) methodology introduced by Hake (1998) serves as a standardized metric for evaluating learning effectiveness. N-Gain values ≥ 0.70 indicate high effectiveness, 0.30–0.70 indicate moderate effectiveness, and < 0.30 indicate low effectiveness. Participatory Action Research (PAR), as outlined by Stringer (2014), integrates stakeholder participation at every phase of the research cycle, ensuring contextually relevant and practically implementable solutions—aligned with ISO 45001:2018's emphasis on worker participation in OHS management system development.

The literature collectively indicates that successful OHS digitalization requires not merely technological deployment, but a comprehensive change management approach encompassing needs analysis, system customization, capacity building, and continuous mentoring—gaps that this study specifically addresses.

METHOD

A. Activity Design and Approach

This community service program was designed using a Participatory Action Research (PAR) approach, integrating active participation from PT X management and workers across all implementation phases (Stringer, 2014). A One-Group Pretest-Posttest quasi-experimental design was employed to measure intervention effectiveness (Sugiyono, 2021):

$$O_1 \text{ ——— } X \text{ ——— } O_2$$

where O_1 = initial Pre-Test; X = Training and Cloud Application Intervention; O_2 = Post-Test conducted four weeks after intervention.

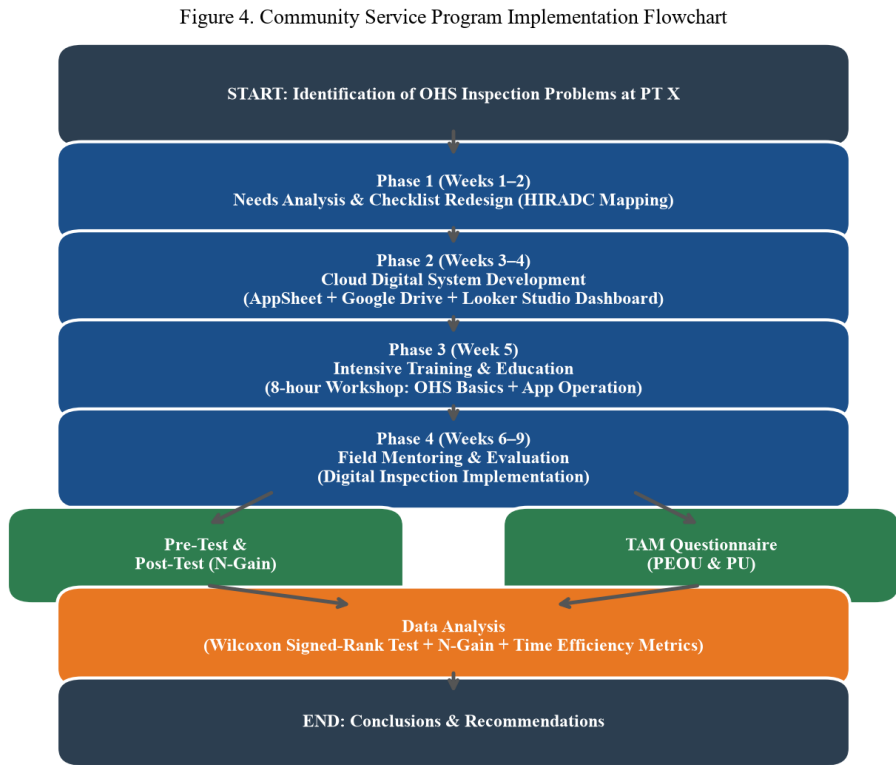


Figure 4. Community Service Program Implementation Flowchart

B. Location and Participants

The program was conducted at the operational area of the steam power generation plant of PT X during the period of September 23, 2026. A total of 30 participants (N = 30) were selected through purposive sampling, comprising 10 Area Operations Supervisors, 8 OHS/HSE Officers, and 12 Internal OHS Management System (SMK3) Auditors.

C. Implementation Procedure

The program was executed in four sequential phases:

- Phase 1 – Needs Analysis and Checklist Redesign (Weeks 1–2): HIRADC mapping to convert eight manual inspection forms into structured digital formats.
- Phase 2 – Cloud Digital System Development (Weeks 3–4): AppSheet mobile application connected to Google Drive/Cloud Database and Looker Studio Dashboard, with photo evidence, GPS geotagging, digital signatures, automated email notifications, and instant PDF generation.
- Phase 3 – Intensive Training and Education (Week 5): A one-day workshop (8 hours) covering fundamental OHS inspection principles, cloud application operation, and digital supervision techniques.
- Phase 4 – Field Mentoring and Evaluation (Weeks 6–9): Direct field mentoring during daily and weekly digital inspections across production, warehouse, and workshop areas of PT X.

D. Data Collection Instruments

Data were collected using three primary instruments: (1) a Pre-Test and Post-Test instrument comprising 10 multiple-choice items; (2) a Technology Acceptance Model (TAM) questionnaire using a 5-point Likert scale; and (3) an Inspection Time Log Worksheet.

E. Data Analysis Technique

Intervention effectiveness was quantified using the Normalized Gain (N-Gain) formula (Hake, 1998):

$$g = \frac{\text{Post-Test Score} - \text{Pre-Test Score}}{\text{Maximum Score} - \text{Pre-Test Score}}$$

Statistical significance was assessed using the Wilcoxon Signed-Rank Test (SPSS v26) at a 95% confidence level (p < 0.05), given the non-parametric nature of the data distribution.

RESULTS AND DISCUSSION

A. Participant Demographic Characteristics

The demographic profile of the 30 participants ($N = 30$) is presented in Table 1. The majority of participants were aged 31–40 years (46.7%) and held a Bachelor's degree (S1, 50.0%), with 53.3% having 2–5 years of tenure—reflecting a workforce with moderate experience and foundational educational competency to engage with digital systems.

Table 1. Demographic Characteristics of Participants ($N = 30$)

Demographic Variable	Category	N	Percentage (%)
Age	20–30 Years	11	36.7%
	31–40 Years	14	46.7%
	> 40 Years	5	16.6%
Education	High School (SMA/SMK)	8	26.7%
	Diploma (D3)	7	23.3%
	Bachelor's (S1)	15	50.0%
Tenure	< 2 Years	6	20.0%
	2–5 Years	16	53.3%
	> 5 Years	8	26.7%

B. Knowledge and Skills Improvement (Pre-Test vs. Post-Test)

Table 2 presents the descriptive statistics for Pre-Test and Post-Test performance. Figure 1 provides a visual comparison of mean scores across participant groups, while Figure 2 illustrates the N-Gain score distribution. The mean score increased substantially from 52.33 to 88.67, representing a gain of 36.34 points.

Table 2. Pre-Test, Post-Test, and N-Gain Results

Statistical Parameter	Pre-Test	Post-Test	Increase (Δ)	N-Gain
Mean	52.33	88.67	+36.34	0.76 (High)
Minimum Score	30.00	75.00	+45.00	—
Maximum Score	70.00	100.00	+30.00	—
Standard Deviation	10.40	6.81	—	—

Figure 1. Comparison of Pre-Test and Post-Test Mean Scores by Participant Group

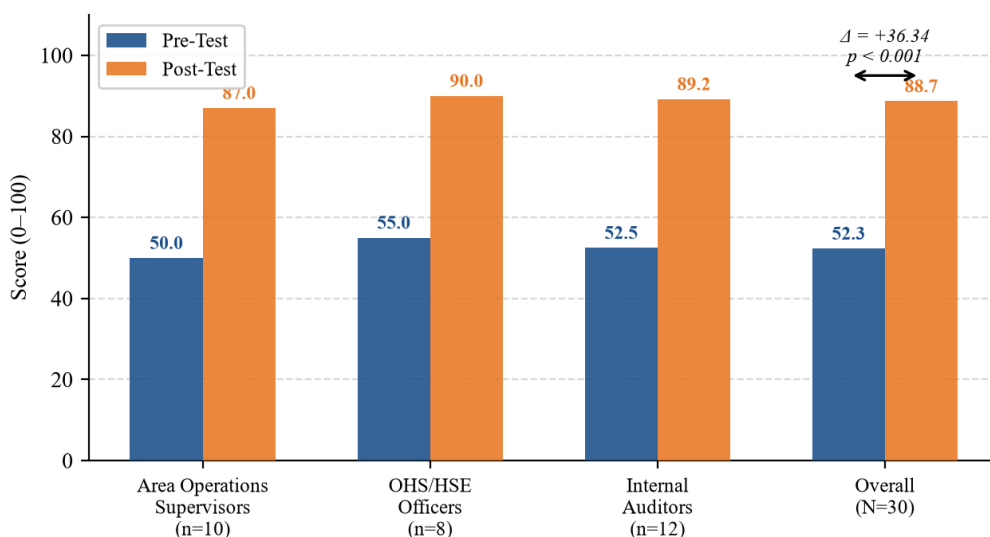


Figure 1. Comparison of Pre-Test and Post-Test Mean Scores by Participant Group

Figure 2. N-Gain Score Analysis of Training Effectiveness

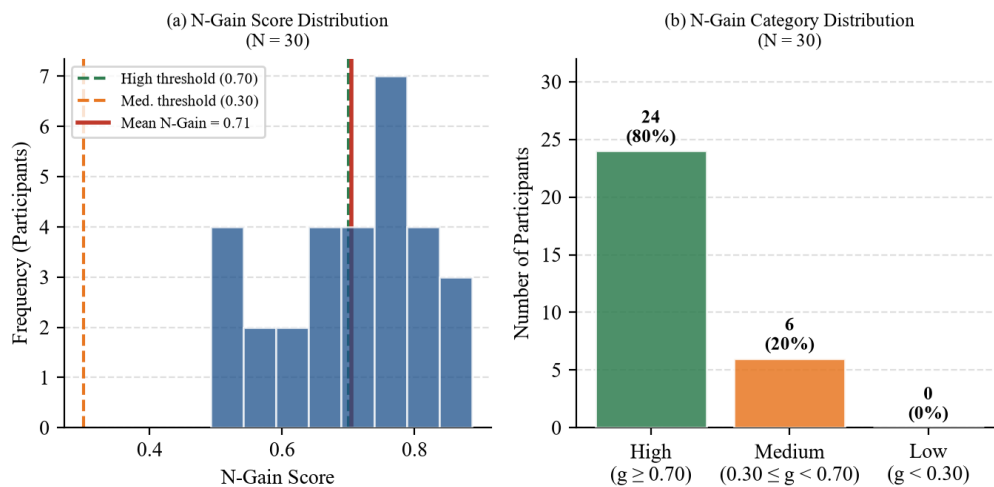


Figure 2. N-Gain Score Analysis of Training Effectiveness

Figure 6. Statistical Evaluation: Wilcoxon Test and Progressive Score Improvement

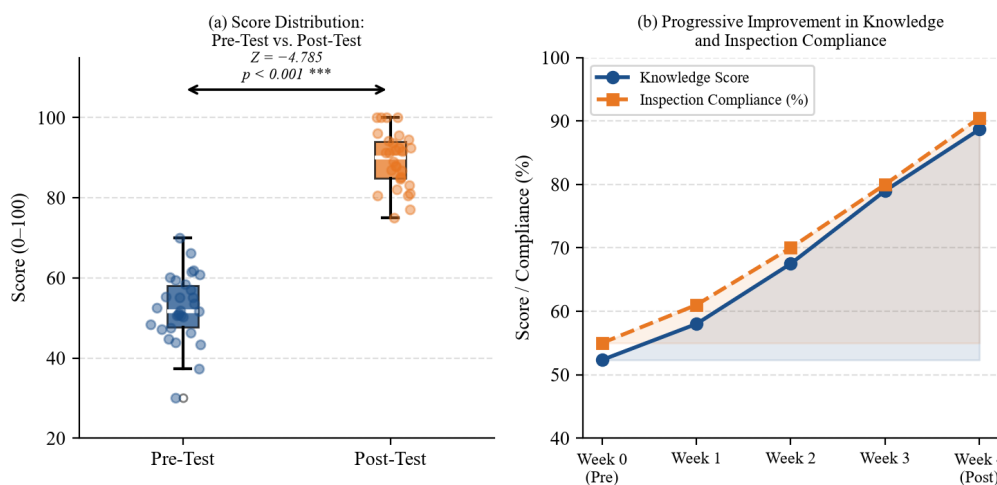


Figure 6. Statistical Evaluation: Wilcoxon Test Result and Progressive Score Improvement

The Wilcoxon Signed-Rank Test yielded $Z = -4.785$ with $p\text{-value} < 0.001$, confirming a highly significant difference in participants' knowledge and competencies before and after the intervention. These results are consistent with findings by Rahardjo and Haryanto (2021) and corroborate the effectiveness of structured training combined with digital tool deployment in OHS capacity enhancement.

C. Operational Efficiency of OHS Inspection Time

Table 3 presents a comparative analysis of inspection processing time before and after digitalization, and Figure 3 provides a visual representation of time reduction across all operational parameters.

Table 3. OHS Inspection Time Efficiency Before and After Digitalization

Efficiency Parameter	Before Intervention (Manual)	After Intervention (Digital)	Time Efficiency (%)
Field Form Completion	35 minutes	15 minutes	57.1% faster
Data Re-entry to Spreadsheet	45 minutes	0 minutes (Automated)	100.0% eliminated
PDF Report Generation	60 minutes	1 minute (Automated)	98.3% faster
Hazard Notification to PIC	24–48 hours	Real-time (< 5 min)	99.6% faster
Total Processing Time	180 minutes	46 minutes	74.2% reduction

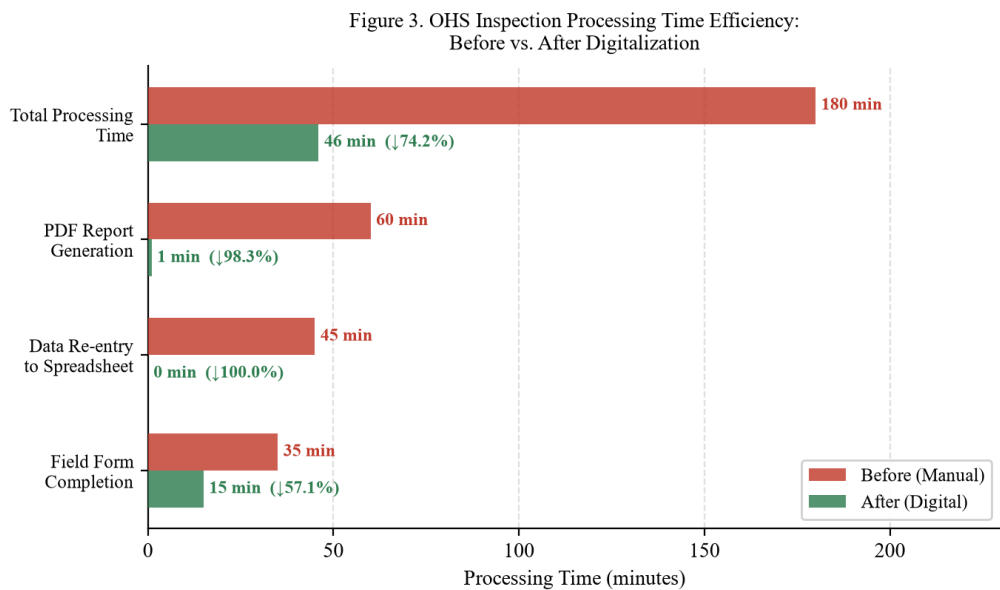


Figure 3. OHS Inspection Processing Time Efficiency: Before vs. After Digitalization

D. Technology Acceptance Evaluation (TAM)

Figure 5 presents the TAM radar chart illustrating user acceptance scores across five dimensions. Perceived Usefulness (PU) scored highest at 4.78/5.00, followed by Overall Satisfaction (4.70) and Perceived Ease of Use (PEOU) at 4.62, indicating that participants perceived the digital system as both instrumentally valuable and user-friendly. Behavioral Intention to continue using the system scored 4.55, further confirming strong adoption intent.

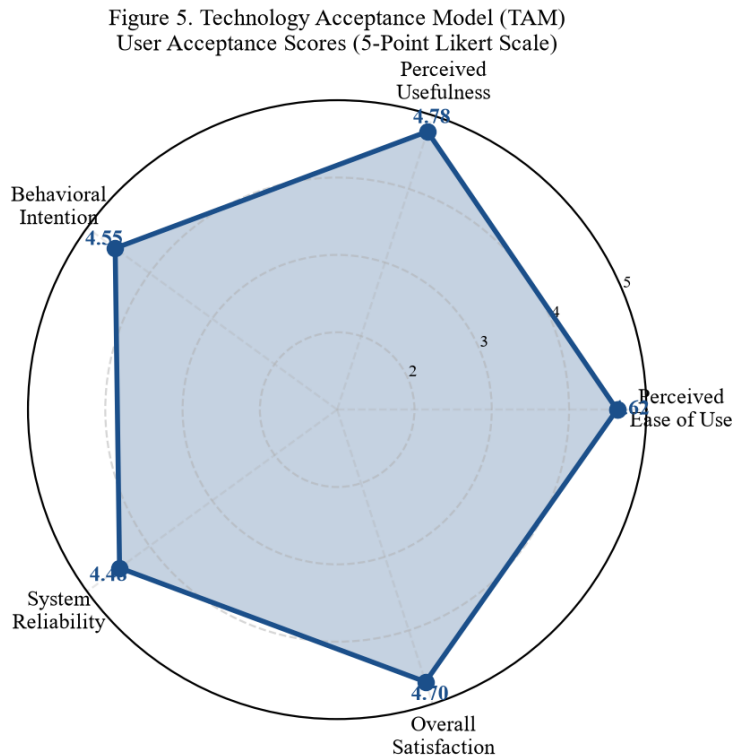


Figure 5. Technology Acceptance Model (TAM) User Acceptance Scores (5-Point Likert Scale)

The findings demonstrate that the transition from paper-based to cloud-based OHS inspection at PT X fundamentally transformed the safety supervision paradigm. The N-Gain value of 0.76 (high category) and Wilcoxon test result ($p < 0.001$) confirm that the structured intervention—combining form redesign, practical training, and field mentoring—successfully enhanced digital literacy and technical competencies among safety supervisors.

Operationally, the 74.2% reduction in processing time carries substantial productivity implications for PT X. The instant notification system eliminated the reporting lag that had historically constituted the primary driver of recurring incidents. Cloud storage with automatic timestamps and GPS geotagging fulfills the documentation requirements stipulated in ISO 45001:2018 Clauses 9.1.2 and 10.2.

Notwithstanding positive outcomes, this program acknowledges limitations regarding internet connectivity dependency in enclosed areas (signal dead zones) within the plant. Future development is recommended to optimize an offline-first system architecture and to explore IoT sensor integration and artificial intelligence (AI) for predictive hazard trend analysis.

CONCLUSION

This community service program successfully implemented a Cloud-Based Digital OHS Inspection Checklist at PT X, yielding three principal conclusions:

1. The implementation significantly enhanced participants' OHS knowledge and skills, with mean scores increasing from 52.33 to 88.67 (N-Gain = 0.76, high category; $p < 0.001$), confirming the effectiveness of the structured training and mentoring intervention.
2. The digital system reduced inspection processing time by 74.2% (from 180 to 46 minutes per session), enabled real-time hazard reporting, and eliminated manual data re-entry procedures entirely.
3. Technology acceptance among users was very high, with Perceived Ease of Use scoring 4.62 and Perceived Usefulness scoring 4.78 on a 5-point Likert scale, indicating strong system–user alignment.

The following recommendations are proposed: (1) PT X management should establish mandatory standard operating procedures for digital inspection use and integrate compliance metrics into Safety KPIs; (2) the HSE team should conduct regular cloud database maintenance and expand the system to include a Work Permit module; and (3) future research should investigate system reliability under offline-first conditions and explore AI-driven hazard prediction capabilities.

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