ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

The Impact of Facility Modernization on Personal Protective Equipment (PPE) Compliance among Workers

Dukor Anderline[1*], Ukamaka Okafor[2], Emeje Simon[3]

[1]Research Scholar, Department of Public Health, Ballsbridge University, CWD, Roseau, Nigeria

[2]Faculty Member Department of Public Health Ballsbridge University, CWD, Roseau, Nigeria

[3]Distinguished Professor Ballsbridge University, Commonwealth of Dominica, Roseau, Nigeria

[*]Corresponding Author

DOI: https://doi.org/10.51244/IJRSI.2025.120800155

Received: 05 Aug 2025; Accepted: 14 Aug 2025; Published: 16 September 2025

ABSTRACT

Background: In various industries like healthcare, pharmaceuticals, construction, agriculture, food and beverage, the use of Personal Protective Equipment (PPE) is essential. The primary reason for the use of PPE is to safeguard workers from potential risks, protect them from workplace hazards that could lead to injuries or health issues.

Objective: This research investigated the impact of facility modernization on compliance with PPE use among workers within a manufacturing setting. The study aimed to determine how changes in infrastructure, training programs, management support, and the availability of PPE affected workers' behaviour towards safety practices.

Method: A mixed-methods approach was used for the study. Qualitative and quantitative data were collected from 2023(pre-upgrade) and 2024(post-upgrade). The data collected was to evaluate changes in behaviour, effectiveness of training, the level of management support, and the availability of PPE. Both correlation and regression analyses were conducted to determine the relationships between these variables and compliance with PPE uses.

Result: The results obtained showed that despite improvements in infrastructure, training, and supply, non-compliance rose from 70.14% to 73.96%. Correlation and regression analyses showed that increased availability and training alone did not lead to behaviour change, as weakened management enforcement and reduced risk perception played larger roles. Regression results ($R^2 = 0.88$) confirmed that perceived risk and management support explained a significant portion of compliance variability. Thematic analysis of open-ended responses identified comfort concerns, inconsistent PPE distribution, and weak supervisory oversight.

Conclusion: Findings highlighted that upgrades to physical infrastructure must be coupled with behavioural strategies, strong leadership commitment and targeted training programs in order to achieve lasting improvements in PPE compliance.

Key words: Behavioural Change, Facility Modernization, Management Enforcement, Risk Perception, PPE Compliance

INTRODUCTION

The use of Personal Protective Equipment (PPE) plays a crucial role in safeguarding worker health and ensuring product safety across industries such as healthcare, pharmaceuticals, construction, agriculture, and food and beverage manufacturing. PPE serves as the final barrier between workers and hazards, particularly

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

where engineering or administrative controls are insufficient. Despite its importance, challenges with PPE compliance persist, often resulting in preventable injuries, illness, or product contamination.

Studies have shown that poor adherence to PPE protocols significantly increased the risk of work-related accidents, some of which can be catastrophic [1]. While PPE reduces exposure to hazards when other controls are not feasible, it does not eliminate the risks themselves, making consistent and proper usage critical [1, 2].

PPE includes items such as gloves, safety glasses, respirators, hard hats, and coveralls [3]. Usage is influenced by individual factors like risk perception, knowledge, and attitude, and by organizational factors such as management commitment, training, and safety culture [4, 5].

While factory upgrades are often pursued to enhance safety and operations, there is limited empirical evidence on whether such modernization efforts actually influenced workers' behaviour towards PPE compliance. It had remained unclear whether physical improvements lead to better risk perception, stronger enforcement, or sustained behavioural change [6, 7].

This study addressed that gap by evaluating PPE compliance levels before and after a factory modernization carried out between 2023 and 2024. A mixed-methods approach was used to analyze quantitative and qualitative data on changes in compliance behaviour, training effectiveness, perceived risk, and management support.

Given the post-pandemic emphasis on health and safety, this research was timely and relevant. It examined whether structural upgrades alone can shift safety behaviours or whether a more integrated approach was needed. The study aimed to provide practical insights for aligning infrastructural improvements with behavioural strategies to promote sustainable PPE compliance and a stronger safety culture.

Problem Statement

Personal Protective Equipment (PPE) is of great importance in protecting the health of personnel and reducing job-related injuries in industrial spaces. Regardless of its widely accepted importance, non-compliance remained a notable concern among factory workers [8]. Contributing factors include poor risk perception, inadequate training, lack of availability, discomfort, and weak enforcement [5, 9].

In many industrial settings, infrastructure upgrades such as transitioning to a Current Good Manufacturing Practice (cGMP) compliant facility was expected to strengthen safety culture and improve compliance behaviours. These upgrades often involve enhanced facility layout, controlled environments, improved workflows, and stricter hygiene and safety standards. However, there was limited empirical evidence on whether such environmental improvements alone were effective in driving behavioural change, particularly regarding PPE usage [6, 7].

To address this gap, the study evaluated PPE compliance before and after a cGMP-compliant factory upgrade to determine whether physical modernization improved compliance or if behavioural factors such as perceived risk and supervisory enforcement played a greater role. The findings aimed to inform how structural enhancements can be integrated with targeted behavioural strategies to support sustained PPE adherence and a stronger safety culture

Research Questions

This study aimed to examine the levels of PPE compliance among factory workers before and after the upgrade; investigate how the factory upgrade affected workers' PPE compliance behaviour; identify the factors contributing to PPE non-compliance before and after the upgrade; and explore how workers perceive the upgrade's impact on PPE accessibility, usage, and safety culture.

Objectives

This study aimed to compare PPE compliance levels among factory workers before and after the factory upgrade; assess

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

the extent to which the factory upgrade influenced workers' PPE compliance behaviour; identify and compare the key factors contributing to PPE non-compliance, before and after the factory upgrade; and explore workers' perceptions of the effectiveness of the factory upgrade in enhancing PPE accessibility, usage, and overall safety culture.

Null Hypotheses (H_0)

H_{01}: There is no significant difference in PPE compliance among factory workers before and after the factory upgrade.

H_{02}: Factory upgrade has no significant impact on workers' PPE compliance behaviour.

H_{03}: There is no significant difference in the factors contributing to PPE non-compliance before and after the factory upgrade.

H_{04}: There is no significant change in perceptions of the upgrade's effectiveness on PPE use and safety culture

LITERATURE REVIEW

Personal Protective Equipment – PPE

Personal protective equipment (PPE) is crucial in the workplace to minimize exposure to hazards that can lead to serious injuries and illnesses. To ensure effectiveness, PPE should be properly designed, constructed, fitted, and regularly maintained. Employers have a legal and ethical responsibility to provide appropriate PPE when engineering, administrative, and work practice controls are insufficient to eliminate workplace hazards. Moreover, they must train employees on the selection, use, limitations, maintenance, and disposal of PPE [3].

A well-designed PPE program goes beyond mere distribution of equipment; it involves systematic hazard assessments, proper selection, fit testing, maintenance protocols, employee training, and continuous monitoring for effectiveness. Regulatory agencies such as the Occupational Safety and Health Administration (OSHA) provide standards addressing PPE use across industries, including general industry, construction, and maritime [3]. Outside of industrial contexts, PPE is also part of daily life, including motorcycle helmets, sunglasses, and safety boots, which provide protection in both occupational and non-occupational environments.

Factors Affecting Non-Compliance with PPE Use

Several studies have explored why workers fail to comply with PPE guidelines, identifying a combination of individual, organizational, and environmental factors.

A study by Rafindadi et al., (2022), investigating PPE use on construction sites found that factors such as risk perception, safety training, on-site supervision, and employment status significantly influenced PPE adherence, explaining 45% of the variance in PPE use. Poor awareness, especially regarding specific items like earplugs and safety nets, contributed to non-use, highlighting the need for targeted training programs and awareness campaigns [10].

Galanis et al., in their research on healthcare workers during the COVID-19 pandemic, reported high rates of adverse physical outcomes associated with PPE use, driven by sociodemographic, clinical, and job-related risk factors. They recommended that organizations publish clear PPE guidelines, especially in low-resource settings, and implement operational adjustments such as regular breaks, shorter shifts, and adequate PPE supply to improve worker wellbeing and compliance [11].

Baye et al., in 2022, upon studying factory workers in Debre Berhan, Ethiopia, found that only 34.5% of workers consistently used PPE. Key barriers included non-availability, discomfort, the desire to save time, and negligence. On-the-job training, history of workplace injury, supervisory enforcement, and the presence of clear safety guidelines were found to positively influence compliance [12].

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

Role of Safety Culture and Management Commitment

Safety culture refers to the shared beliefs, practices, and attitudes within an organization regarding safety. A strong safety culture marked by visible management commitment, effective communication, and active workers' involvement is a critical determinant of PPE compliance. According to Empactivo, organizations with robust safety cultures typically experience lower accident rates and higher adherence to safety protocols [13]. Faqir, highlighted that management commitment is fundamental to building a strong health, safety, and environmental (HSE) culture and requires the active participation of all employees [14]. However, a growing lack of practical, genuine efforts has contributed to a decline in meaningful commitment. To foster a positive safety culture, management must set clear expectations, model safe behaviours, and provide consistent feedback, recognizing their leadership as the driving force behind sustained safety engagement.

Influence of Training and Risk Perception

Effective safety training is crucial for enhancing PPE compliance, as it not only imparts knowledge, but also positively influence workers' perceptions of risk. A study by Priolo et al., (2025), highlighted that workers with higher risk perception were more likely to engage in safety behaviours, including consistent PPE use. The study emphasized the importance of addressing both the cognitive and emotional aspects of risk perception in training programs to improve safety outcomes [15]. Furthermore, a 2025 study by Febriyanti and Widajati found that factors such as PPE comfort, availability, and workplace safety culture significantly influence PPE usage among manufacturing workers. The study advocated for a holistic approach that combined ergonomic workplace design with behavioural interventions to foster a safer working environment [16]. These findings underscore the necessity for comprehensive training programs that enhance safety knowledge and address workers' risk perceptions, thereby promoting consistent PPE usage and improving occupational safety.

Impact of Workplace Design and Environmental Factors

Workplace design and environmental conditions significantly influence PPE compliance. Poor ventilation, overcrowding, and physically demanding layouts can deter PPE use, especially when equipment is uncomfortable or restricts movement. Conversely, infrastructure enhancements such as improved lighting, ventilation, workflow optimization, and spatial organization can indirectly boost PPE adherence by reducing physical strain and enhancing workers' perceptions of safety and managerial commitment. The study by Febriyanti and Widajati, (2025), emphasized that factors like PPE comfort, availability, and workplace safety culture are pivotal in reinforcing PPE usage. The study advocates for a holistic approach that combined ergonomic workplace design with behavioural interventions to foster a safer working environment [16].

Behavioural and Psychological Dimensions

Effective workplace safety programs must go beyond simply providing knowledge; they should also address the psychological and behavioural factors that shape workers' actions. Research by Tessema and Sema, (2022), showed that PPE use among large-scale factory workers was strongly influenced by perceived susceptibility to risks, perceived severity of hazards, perceived barriers to PPE use, and self-efficacy, or the confidence to use PPE correctly [17]. These findings emphasized that improving compliance required more than just supplying equipment or issuing rules. Instead, health education programs should focus on enhancing workers' understanding of risks, reducing practical and psychological barriers, and building their confidence and motivation to consistently use PPE. By integrating these behavioural dimensions, organizations can strengthen both compliance and overall occupational safety outcomes.

Literature Gaps

Numerous studies have explored factors influencing PPE use, but relatively few have investigated the specific role of environmental improvements, such as factory upgrades, in shaping PPE compliance. Most research has focused on individual-level or organizational predictors, overlooking how physical upgrades to the work environment may interact with behavioural and cultural factors to influence safety practices. This study seeks to fill this gap by examining both the quantitative changes in compliance levels and the qualitative perceptions of workers following a factory upgrade.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

Theoretical Review

The Health Belief Model (HBM) is frequently seen as a significant theoretical framework for explaining personal health conduct, which encompasses the decision to use or forgo personal protective equipment (PPE) in construction and industrial workplaces. It was originally developed in the 1950s by social psychologists Hochbaum, Rosenstock, and Kegels in collaboration with the U.S. Public Health Service to explain preventive health behaviours [18]. The study revealed that one's health decisions are affected by their perceptions of potential risks, benefits, impediments, and motivational cues [19]. This makes it highly relevant for explaining why workers often fail to use PPE consistently, even when the risks are well known, safety protocols are in place, and PPE is both available and essential.

Perceived Susceptibility and Severity

Many workers do not perceive themselves to be at serious risk of injury or illness, especially when they have not previously been affected. The HBM posits that unless individuals feel personally vulnerable (susceptibility) and view the consequences of injury as serious (severity), they are unlikely to engage in protective behaviour like wearing PPE [20]. This perception gap is particularly evident in high-risk sectors like construction, where overfamiliarity with hazards leads to normalization of unsafe conditions [21].

Perceived Benefits

The effectiveness of personal protective equipment in lowering workplace threats may not be clear to workers, particularly if they have not encountered any accidents or injuries. The HBM indicates that individuals are more motivated to take health-related actions if they are convinced that these actions will alleviate their risks or reduce the severity of potential outcomes [18]. However, a lack of safety training or previous exposure to incidents may limit this belief. Studies have shown that when workers understand the practical benefits of PPE, compliance rates improve significantly [22]. When workers do not clearly see the protective value of PPE, perhaps due to lack of education or prior experience, they are less likely to comply with its use [23].

Perceived Barriers

Discomfort, heat, movement restriction, and perceived reduction in productivity are common barriers reported in studies of PPE use [24]. According to the HBM, even when risk perception is high, perceived barriers can prevent compliance. Interventions should aim to reduce these barriers by improving PPE design and increasing access to more ergonomic options [25].

Cues to Action

The presence of reminders, such as supervisor encouragement, signage, safety meetings, or peer modeling, can significantly enhance PPE compliance [26]. Cues to action help bridge the gap between awareness and actual behaviour. The HBM identifies such external cues as essential for triggering protective actions, especially in dynamic or high-pressure environments.

The Health Belief Model is highly relevant for analyzing PPE noncompliance in construction and industrial contexts. Its components align closely with the psychological and practical factors influencing workers' safety behaviours, making it a valuable tool for designing effective interventions and safety training programs.

Factors Influencing PPE Non-Compliance

Setyawan et al., (2020), found that only 43.7% of Indonesian cement workers adhered to PPE use, with punitive policies as a significant factor [8]. The study underscored the importance of supportive regulations and management enforcement for enhancing compliance. Rayyan and others in 2022 noted that the supply of PPE and the implementation of regulations resulted in improved compliance for industrial workers in Kano, Nigeria, although training by itself was not sufficient [7]. In their 2023 study, George and team confirmed that for Indian tertiary hospitals, adherence to institutional policies, sufficient PPE quality, and a stable supply chain were imperative for compliance [27].

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

Elshaer and Agage, (2022), reported an 81.9% compliance rate among Egyptian nurses during the COVID-19 pandemic, linking adherence to strong risk perception and knowledge [9]. Kim et al., (2024), reported a comparable trend in South Korea, revealing that the compliance of nurses with PPE (rated 4.28/5) was driven by their awareness, clinical experience, and previous COVID-19 exposure [28]. Maglio et al., (2016) found that behavioural determinants of PPE use among firefighters include identity, peer influence, and situational pressure [29]. In their 2023 study, Jalil et al., emphasized the worrisome rates of noncompliance within the construction industry, mostly arising from a lack of risk perception and poor enforcement of safety regulations [6].

Wotherspoon and Conroy, (2021), highlighted low PPE compliance among Australian medical officers, 58.61% for donning and 68.84% for doffing, emphasizing the need for structured training [30]. Elshaer and Agage, (2022), associated high compliance among nurses in Egypt with comprehensive PPE training [9]. Harrod et al., (2020), discovered that irregularities in institutional policies negatively impacted PPE usage in hospitals throughout the United States [31], while Alakhras et al., (2020), pointed out a 12.6% compliance rate among dental radiographers, which highlights the pressing need for ongoing education on infection control [32].

Manookian et al., (2022), examined the physical impacts of prolonged PPE use, linking it to health issues contributing to non-compliance among healthcare workers [5]. Aljaffary et al., (2024), identified shift length, comfort, and PPE availability as critical compliance factors among Saudi nurses [33]. George et al., (2023), pointed out that inappropriate PPE sizing represented a major barrier in India, exhibiting a statistically significant effect ($p=0.042$) [27]. Schlünssen and Jones, (2023), pointed out that poor PPE fit for women despite higher compliance and called for gender-specific PPE initiatives [34].

In their study, Maglio et al., (2016), revealed that psychosocial factors and the influence of peers played a role in the use of personal protective equipment by firefighters [29], whereas Jalil and associates in 2023 associated it to poor climate adaptation and insufficient training within the construction sector [6]. Alakhras et al., (2020), highlighted high workload and patient load as barriers in dental radiography, where PPE use was particularly low [32]. The study by Kim et al., (2024), illustrated that higher compliance rates were observed in Korean hospitals, which were due to institutional support, staff experience and workload [28].

In summary, PPE compliance is influenced by management policy, risk perception, training, equipment comfort, and specific sector challenges. Evidence indicated that targeted strategies including standardized education, ergonomic PPE design, and sector-specific policies are vital for enhancing PPE adherence across various work environments. There is still an obvious gap in literatures on the role of infrastructure on PPE compliance.

METHODOLOGY

This study adopted a mixed-method approach combining quantitative and qualitative data to evaluate changes in PPE compliance before and after a factory upgrade. The approach enabled both statistical analysis and thematic interpretation of workers' experiences.

Study Design

A comparative cross-sectional design was employed, collecting data in two phases: pre-upgrade (November 2023) and post-upgrade (November 2024). This design allowed for the assessment of changes in PPE adherence and the influence of infrastructural changes.

Population and Sample Size

The study population comprised workers of Spring-Deal Ltd (actual company name withheld), a Lagos and Nigeria-based pharmaceutical company. The research focused specifically on factory workers whose duties required the use of PPE. Prior to the facility upgrade, the population included 230 workers, which increased to 300 post-upgrade. Based on the Krejcie and Morgan Table [35], sample sizes of 144 (in 2023) and 169 (in

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

2024) were selected. Convenience sampling was used to encourage voluntary participation across various departments and job roles.

Data Collection

Data were collected using structured online questionnaires (Google Forms), distributed through email and WhatsApp. To accommodate workers with limited literacy, semi-structured interviews were conducted by trained officers who assisted in transcribing responses into the digital forms. All participation was voluntary and anonymous to encourage honest feedback.

Inclusion criteria were based on job roles that involved mandatory PPE use.

Data Analysis

Quantitative Analysis

Descriptive statistics (frequencies, percentages) summarized demographic characteristics and compliance rates. PPE compliance was coded based on four criteria: received PPE training, availability, accessibility, and comfort. Workers missing any of these were classified as non-compliant. Correlation analysis examined relationships between compliance and variables such as training, PPE availability, management support, and risk perception. Regression analysis was used to determine the predictive power of these factors on PPE adherence.

Qualitative Analysis

Open-ended responses were thematically analyzed to identify recurring concerns related to comfort, fit, management support, and PPE distribution. A manual coding process was used, and themes were validated through independent review and cross-checking. Word clouds were generated to visualize key topics raised by participants across both years. This integrated methodology enabled a holistic assessment of PPE compliance trends and the multifactorial influences affecting worker safety behaviour.

Ethical Consideration

Permission was obtained from the Management of Spring-Deal Ltd (actual company name withheld) to administer questionnaires to its workers. It is a Pharmaceutical Manufacturing Company located in Lagos Nigeria.

The identity of the company and all personal data collected were treated with strict confidentiality and used solely for academic purposes. Informed consent was also obtained from all respondents prior to their participation in the study.

RESULTS

Demographics Analysis

The dataset comprised of responses from two time periods: Pre-Upgrade (2023) and Post- Upgrade (2024). The table below provided a summary of key demographic details for both years.

Table 1. Demographic details for the Years 2023 and 2024

Feature	2023 (Pre-Upgrade)	2024 (Post-Upgrade)
Total Sample Size	144	169
Age Distribution	26-40: 84	18-25: 79

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

	18-25: 54 41-55: 6	26-40: 75 41-55: 14 56-65: 1
Gender Representation	Female: 95 Male: 49	Female: 123 Male: 46
Years of Experience	<1 year: 43 1-5 years: 70 6-10 years: 20 >10 years: 10 15 years: 1	<1 year: 82 1-5 years: 67 6-10 years: 15 >10 years: 5

From the demographic analysis, it was observed that the post-upgrade sample (2024) had younger workers (18–25 years) and fewer experienced workers (6+ years of experience). The percentage of female employees who participated in this survey increased from 66 percent (2023) to 73 percent (2024). The number of workers with less than one year experience grew significantly from 43 (in 2023) to 82 (in 2024).

Quantitative PPE Compliance Analysis

Table 2. PPE Compliance Analysis

Metric	**2023 (Pre-upgrade)**	**2024 (post-upgrade)**
PPE Non-Compliance Rate	**70.14%** (101)	**73.96%** (125)
Training Coverage	**58.30%** (84)	**68.60%** (116)
PPE Availability	**69.40%** (83)	**74.60%** (105)
High Risk Perception	**75.00%** (108)	**48.50%** (82)
Management Support	**86.80%** (125)	**79.90%** (135)
Comfortable PPE (%)	Neutral (%)	Uncomfortable PPE (%)
Comfort and Fit Issues		
Year	Comfortable PPE (%)	Neutral (%)	Uncomfortable PPE (%)
2023	**71.5%** (103)	**15.3%** (22)	**13.2%** (19)
2024	**71.0%** (120)	**15.4%** (26)	**13.6%** (23)

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

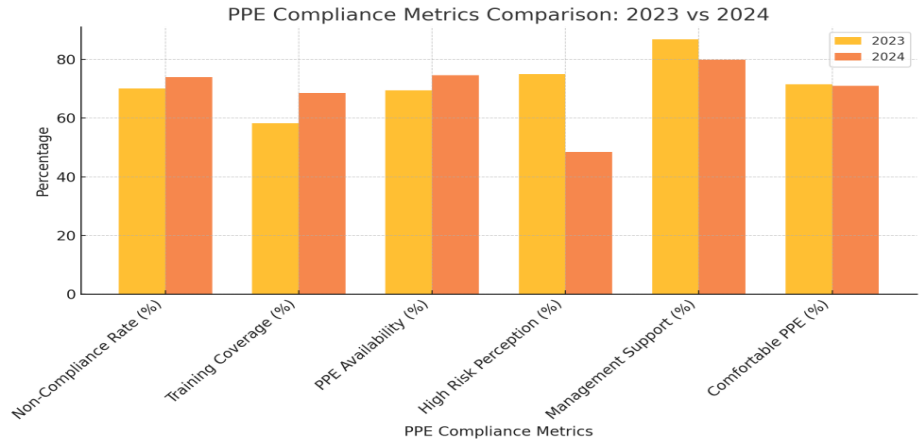

Fig.1 PPE compliance metric comparison

Interpretation of Results

PPE non-compliance increased after the factory upgrade, rising from 70.14% in 2023 to 73.96% in 2024. Despite improvements, workers continued to ignore PPE safety regulations. Training on PPE use improved by 10.3%, yet compliance worsened, showing that training alone is insufficient. PPE availability increased by 5.2%, but non-compliance still rose. A 26.5% drop in workers perceiving PPE non-use as high risk likely led to more non-compliance. Management support fell by 6.9%, suggesting reduced enforcement. PPE discomfort persisted, with comfort levels changing minimally: 71.5% (2023) to 71.0% (2024), and discomfort rising from 13.2% to 13.6%. These findings indicate that comfort issues remained but were not the main cause of non-compliance. Behavioural and enforcement-related factors played a larger role.

Correlation Analysis Results (2023 VS. 2024)

This analysis showed how different factors relate to PPE compliance:

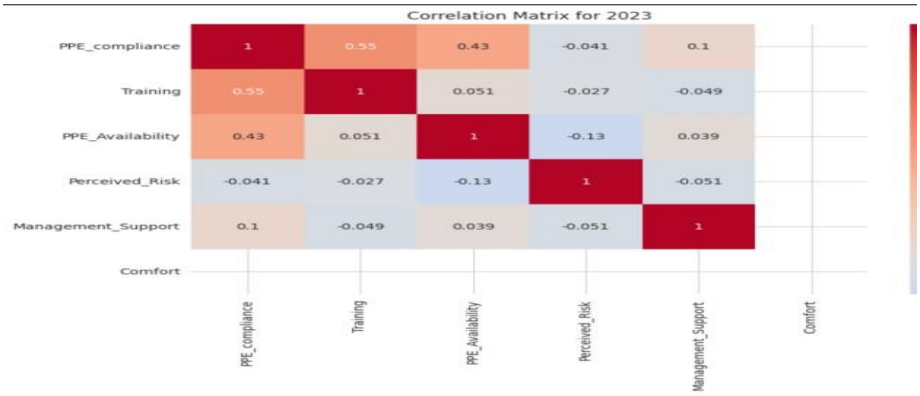

Fig. 2 Correlation for 2023

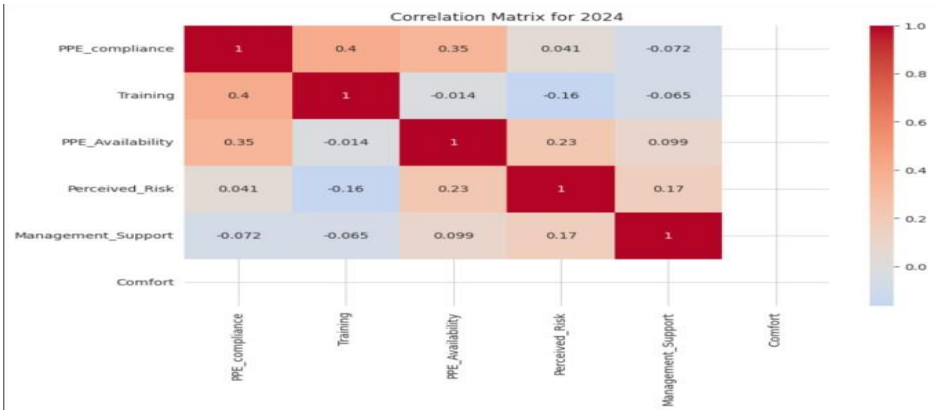

Fig. 3 Correlation for 2024

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

Table 3. Correlation between factors and PPE compliance

Factors	2023 Correlation	2024 Correlation	P-Value/Interpretation
Training & PPE Compliance	0.55 (Strong)	0.40 (Moderate)	**(P = < 0.001)** - Training remained a key factor in compliance, though its impact slightly decreased in 2024.
PPE Availability & PPE Compliance	0.43 (Moderate)	0.35 (Moderate)	**(P = < 0.001)** - Readily available PPE improved compliance in both years, with a slightly weaker effect in 2024.
Perceived Risk & PPE Compliance	-0.04 (Weak Negative)	0.04 (Weak Positive)	**(P = 0.6341)** - In 2023, lower risk perception slightly reduced compliance, while in 2024, risk perception had minimal influence.
Management Support & PPE Compliance	0.10 (Weak Positive)	-0.07 (Weak Negative)	**(p = > 0.23)** - Management support had a small positive effect in 2023 but showed a weak negative relationship in 2024.
Other Correlations	Mostly weak or insignificant	Mostly weak or insignificant	No strong additional relationships were observed.

Correlation Matrix for Non-Compliant Cases

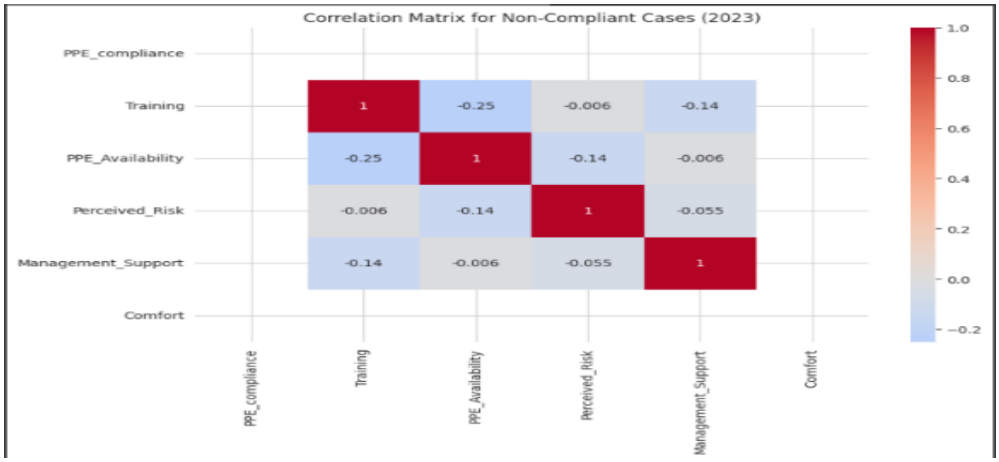

Fig. 4 Correlation Matrix for Noncompliant Cases (2023)

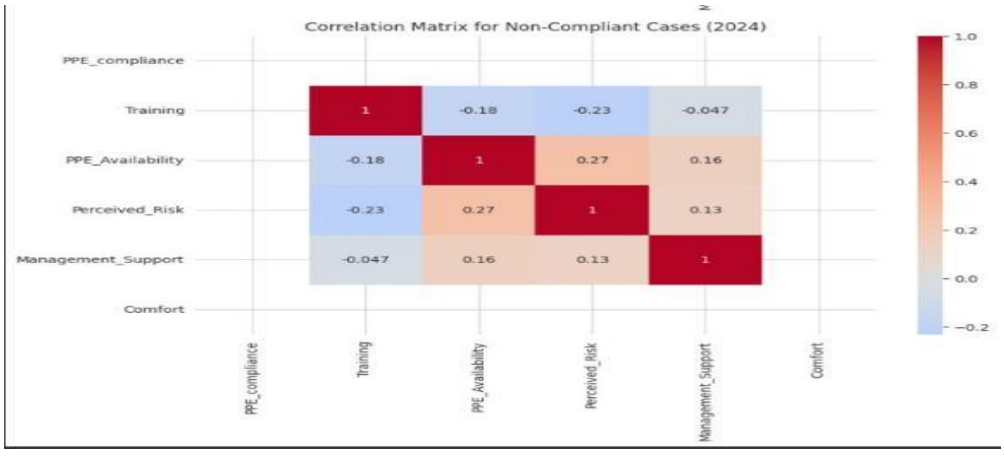

Fig. 5 Correlation Matrix for Noncompliant Cases (2024)

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

Findings from the Correlation Matrix for Non-Compliant Cases showed that training and PPE availability had a weak negative correlation, suggesting lower training rates when PPE is readily available. In 2024, PPE availability was moderately linked to higher perceived risk of non-compliance, possibly due to increased awareness. Most other relationships were weak or not statistically significant, indicating other unmeasured factors may influence non-compliance. These findings highlight the need to balance PPE availability and training to improve compliance rates.

Key Factors Influencing PPE Non-Compliance (2023 vs. 2024)

Table 4. Key Factors Influencing PPE Non-Compliance

Factor	2023 Findings	2024 Findings	Impact on Non-Compliance
Reduced Perceived Risk	75% perceived non-use as high risk; correlation: -0.04	48.5% perceived non-use as high risk; correlation: +0.04	Lower risk perception post-upgrade contributed to increased non-compliance.
Weak Enforcement & Management Support	86.8% reported management support; correlation: +0.10	79.9% reported management support; correlation: -0.07	Decline in enforcement and oversight increased non-compliance after the upgrade.
Training Effectiveness	Training coverage 58.3%; correlation with compliance: 0.55	Training coverage 68.6%; correlation: 0.40	Training improvements did not translate into behaviour change; reinforcement was lacking.
PPE Availability	Availability rate 69.4%	Availability rate 74.6%	Higher availability alone was insufficient; behavioural and enforcement gaps persisted.
Comfort & Fit Issues	71.5% found PPE comfortable	71.0% found PPE comfortable	Comfort remained stable and was not a primary factor influencing non-compliance.

Regression Analysis

Simple linear observations include the following: Training coverage increased but non-compliance also increased slightly, suggesting training alone was not sufficient. PPE availability increased, yet non-compliance still rose, indicating availability alone didn't reduce non-compliance. High risk perception dropped significantly while non-compliance worsened, confirming a strong negative influence. Management support dropped, and non-compliance worsened, confirming the effect.

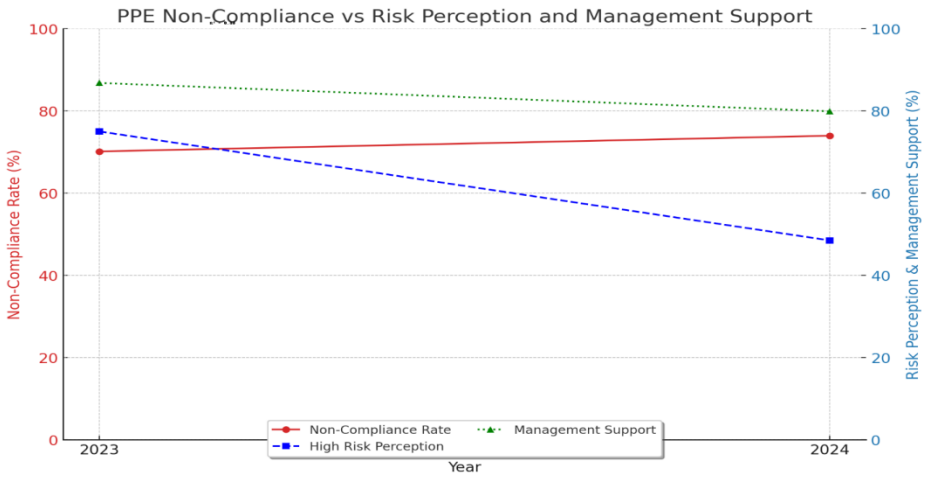

Fig. 6 Simple Regression Plot

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

From the regression analysis, it was observed that High Risk Perception and Management Support are the strongest predictors of compliance behaviour. Regression Coefficient of **$R^2 \approx 0.88$** means that 88% of the changes in PPE non-compliance could be explained by changes in risk perception and management support. While the other dependent variables like comfort and fit, availability and training accounted for the remaining 12% changes.

Analysis of Open-ended Responses

The 2023 and 2024 responses were analyzed, removing inconsistencies and irrelevant text. Word clouds visualized key concerns, while thematic analysis categorized responses into three areas: Management support for PPE usage, Comfort and fit issues and PPE availability. A comparative analysis was used to identify trends and to highlight improvements and ongoing challenges.

Results from Open-ended Response Analysis

Comfort and Fit Issues with PPE

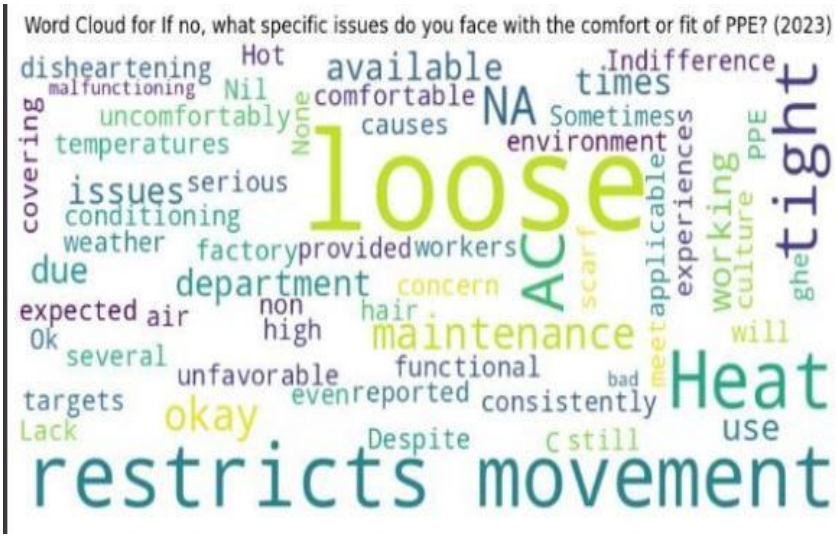

Fig. 7 – 2023 Open-ended Responses

Fig. 8 – 2024 Open-ended Responses

PPE fit issues such as looseness, tightness, and restricted movement remained concerns in both years, along with heat discomfort. While some workers in 2024 reported no significant complaints, suggesting minor improvements, but overall usability challenges persisted.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

Management Support for PPE Usage

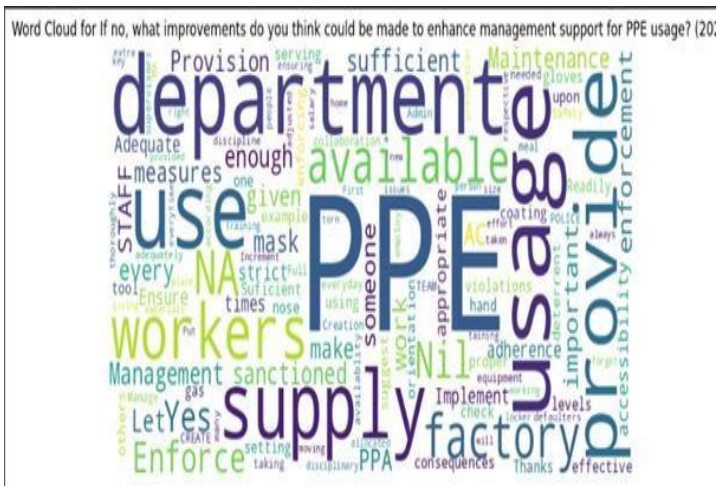

Fig. 9 – 2023 Responses for Management Support

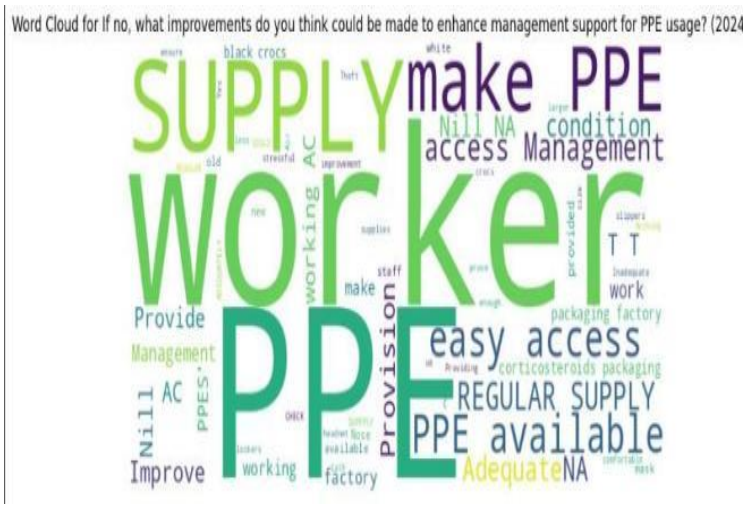

Fig. 10 – 2024 Responses for Management Support

Workers in 2023 highlighted the need for better PPE distribution, oversight, and training. By 2024, accessibility had improved, but concerns about consistent supply and availability remained, suggesting ongoing distribution challenges.

Additional Comments on PPE Availability and Suggestions

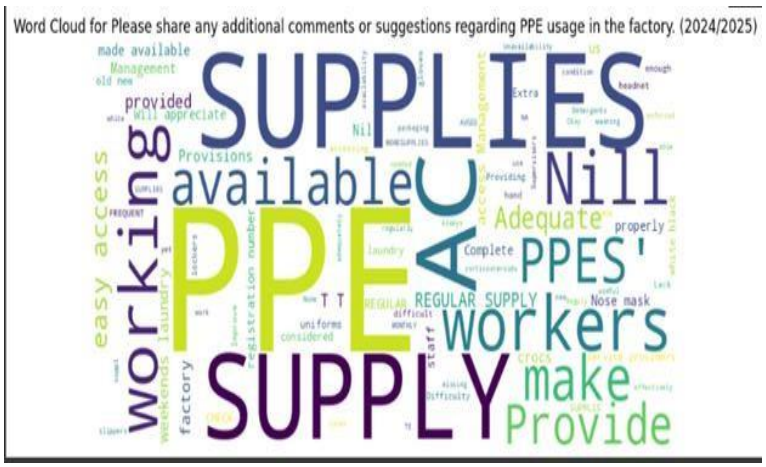

Fig. 11 – 2023 Comments on PPE Availability and Suggestions

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

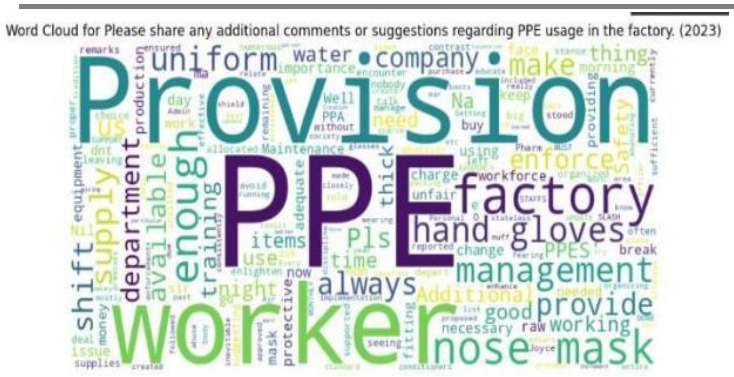

Fig 12 – 2024 Comments on PPE Availability and Suggestions

In 2023, workers focused on specific PPE shortages, particularly gloves and masks, calling for more uniform provisions. By 2024, concerns shifted toward overall supply consistency, with improvements noted, though issues of adequacy and proper use persisted.

Summary of Open ended Responses

For open ended responses, persistent issues like movement restriction, heat and discomfort remained major concerns in both years. PPE availability improved, with more workers in 2024 reporting adequate supply. However, better-fitting PPE and stronger management oversight are still needed for effective distribution and compliance.

Hypothesis Testing

Based on the findings of this study, the following conclusions were drawn regarding the null hypotheses:

Hypothesis (H_0)	**Decision**	**Justification**
H_{01}: No significant difference in PPE compliance among factory workers before and after the factory upgrade.	Rejected	Non-compliance increased from 70.14% (2023) to 73.96% (2024), indicating a significant change.
H_{02}: Factory upgrade has no significant impact on workers' PPE compliance behaviour.	Rejected	Risk perception declined from 75% to 48.5% and management support dropped from 86.8% to 79.9%.
H_{03}: There is no significant difference in the factors contributing to PPE non-compliance before and after the factory upgrade.	Rejected	Post-upgrade, perceived risk declined, enforcement weakened, training impact reduced, and PPE availability increased.
H_{04}: There is no significant change in perceptions of upgrade's effectiveness on PPE use and safety culture	Accepted	Despite structural improvements, workers' perceptions and behaviours did not improve; declining risk perception and increased non-compliance suggested that the upgrade had little effect on PPE use or safety culture. Training and availability remained significant ($p < 0.001$), but risk perception and management support were not ($p > 0.23$), indicating minimal improvement in perceived upgrade's effectiveness on PPE use and safety culture.

DISCUSSION

This study examined the impact of a factory upgrade on PPE compliance among workers, exploring the relationship between infrastructure improvements and behavioural outcomes. Despite expectations of

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

improved adherence following environmental upgrades, findings indicated that PPE non-compliance increased post-upgrade; challenging the assumption that facility upgrade alone is sufficient to improve worker safety practices.

Compliance Before and After the Upgrade: Quantitative analysis revealed that PPE non-compliance rose from 70.14% (2023) to 73.96% (2024), despite improvements in training coverage (+10.3%) and PPE availability (+5.2%). These results rejected the null hypotheses (H_{01} and H_{02}), indicating a significant difference in compliance levels post-upgrade and suggesting that the upgrade may not have effectively addressed underlying behavioural determinants. This is consistent with literatures asserting that physical environment improvements alone are insufficient without corresponding changes in safety culture and behavioural reinforcement [36, 37].

Factors Contributing to Non-Compliance

Several factors emerged as key drivers of non-compliance:

Reduced Risk Perception: The proportion of workers perceiving non-use of PPE as high risk fell significantly from 75.0% to 48.5% post-upgrade. This shift may reflect a false sense of security resulting from perceived environmental safety improvements. The review by Priolo et al., (2025), found that there is a significant positive association between risk perception and safety behaviours, indicating that workers who perceive higher risks are more likely to engage in safety behaviours [15]. This supports the notion that reduced risk perception can lead to decreased compliance with safety measures such as PPE usage. According to Ahmadi Marzaleh et al., (2025), enhancing risk perception is crucial for improving PPE compliance [38]. This shows that risk perception is a strong predictor of safety behaviour

Weakened Management Enforcement: Support from management dropped by 6.9%, with correlation to compliance shifting from +0.10 to -0.07, indicating reduced supervisory involvement post-upgrade. Studies have shown that consistent supervision and enforcement including penalties for non-compliance, significantly improved PPE usage among workers, indicating that management's active role in enforcement is crucial for maintaining safety behaviours [39, 40].

Training Limitations: Although training coverage increased, its correlation with compliance declined from 0.55 to 0.40, suggesting diminishing returns. This reinforces findings that training must be practical, interactive, and continuous to effect long-term behaviour change [41, 42].

PPE Availability and Behaviour Gap: Availability improved slightly, yet usage did not follow. Regression analysis confirmed that increased PPE availability without behavioural re-enforcement was insufficient (R^2 = 0.88). This aligns with findings that providing PPE alone is not predictive of behaviour, rather factors such as knowledge, attitudes, and motivation, as well as external factors like training and supervision, played crucial roles in compliance [43]

Comparison of Pre- and Post-Upgrade Barriers While comfort and fit issues remained stable and were frequently mentioned in open-ended responses, correlation analysis showed that they were not a major driver of non-compliance. This suggested that behavioural and systemic factors, rather than equipment design, remained the primary obstacles. This however is contrary to the outcome of a study in selected public hospitals in eastern Ethiopia which indicated that improper PPE practices among workers were widespread, largely due to inadequate PPE availability, discomfort, carelessness, and neglect [44].

Open-text data and thematic analysis revealed recurring concerns around PPE distribution oversight, inconsistent supply, and management engagement, which persisted despite reported improvements in physical infrastructure. Workers' perceptions reflect a mismatch between facility improvements and enforcement or training quality.

Implications in Relation to Research Objectives

The study's findings align with the research objectives. It identified organizational and behavioural factors, not infrastructure, as key influencers of PPE compliance. It demonstrated that factory upgrades alone did not

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

improve compliance; thereby refuting the assumption that factory upgrade leads directly to safer behaviour. It emphasized the importance of risk perception, enforcement, and practical training, reinforcing the need for integrated, multi-level safety strategies.

Relevance to Existing Literature

The results support existing research emphasizing that workplace safety is not solely a function of infrastructure but is shaped by perceived risk, organizational climate, and individual motivation [37, 44]. These findings underscore the need for behavioural interventions, clear policy enforcement, and leadership involvement alongside physical improvements.

Limitations of the Study

This study had several limitations. It relied on self-reported data, which may be influenced by social desirability bias. The findings were derived from a single factory setting, which may limit their applicability to other industrial environments. Being a single-site study in a pharmaceutical manufacturing facility in Lagos may not reflect other industrial or geographic settings. The cross-sectional design at two time point restricted causal interpretation and long-term trend analysis.

Measures to Mitigate the Impact of Limitations

Multiple data sources, such as supervisor reports, PPE distribution records, and incident logs, were used to validate workers' survey responses. Though based on a single factory, describing its cGMP upgrade helps others assess relevance to similar settings. A mixed methods design combining quantitative data and qualitative feedback provided deeper insights. Standardized compliance metrics were used across the two time points to ensure fair comparison. Recommendations were based on observed trends and contextual limitations, avoiding overgeneralization.

Suggestions for Further Research

Future studies should adopt a longitudinal design to track PPE compliance behaviour over an extended period beyond immediate pre- and post-upgrade comparisons. This would help identify trends, sustainability of behaviour change, and delayed effects of interventions.

Future research could compare PPE compliance across different industries (e.g., healthcare vs. manufacturing vs. construction) to identify sector-specific challenges and best practices.

Research could also explore the use of digital tracking systems to monitor PPE use objectively, reducing the biases associated with self-reported compliance data.

Observed PPE compliance rate research should be adopted in order to reduce the risk of over- or under-reporting that might be associated with self-reported study.

CONCLUSION

This study revealed that infrastructure improvements alone did not result in enhanced PPE compliance. While there was an increase in PPE availability and training efforts, non-compliance worsened due to factors such as a decline in workers' risk perception, weakened enforcement of PPE policies, and the limited effectiveness of training. The analysis indicated that compliance was largely influenced by workers' perceived risk and the level of management support, highlighting that improvements in PPE use cannot be solely attributed to physical upgrades. The findings underscore the critical role that a combination of factors, including strong leadership, effective training, and consistent reinforcement of safety behaviours, plays in ensuring long-term PPE compliance. This suggests that focusing only on structural upgrades and modernization without addressing underlying behavioural and cultural aspects may not lead to the desired improvements in safety outcomes.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VIII August 2025

RECOMMENDATIONS

To improve PPE compliance and workplace safety, risk awareness should be increased by using real-life injury cases and launching PPE awareness campaigns, especially after factory upgrades, to reinforce consistent usage. PPE enforcement and accountability should be strengthened through random checks, penalties for non-compliance, incentives for adherence, and active supervisor monitoring.

Training should be enhanced with hands-on, scenario-based sessions and practical PPE drills to improve learning and retention. Management involvement must be increased by ensuring leadership actively engages in policy implementation and leads by example.

Comfort and fit issues should be addressed through regular feedback sessions on PPE usability and by improving ventilation and climate control systems to enhance worker comfort.

REFERENCES

1. Ayikoru, M., Ddamulira, C., & Mutekanga, D. R. (2019). Determinants of employee use of personal protective equipment: The case of Spedag Interfreight Uganda Limited, Kampala. Journal of Environmental Science and Public Health, 3, 419-434. https://doi.org/10.26502/jesph.96120073
2. Safety+Health Magazine. (2024). Workplace hand injuries: Did you know PPE is the last line of defense? Safety+Health. https://www.safetyandhealthmagazine.com/articles/25393-workplace-hand-injuries-did-you-know-ppe-is-the-last-line-of-defense
3. U.S. Department of Labor. (2025). Personal protective equipment. Occupational Safety and Health Administration. https://www.osha.gov/personal-protective-equipment
4. Khoshakhlagh, A. H., Malakoutikhah, M., Park, J., Dehghani Kodnoueieh, M., Rafieian Boroujeni, Z., Bahrami, M., & Ramezani, F. (2024). Assessing personal protective equipment usage and its correlation with knowledge, attitudes, performance, and safety culture among workers in small and medium-sized enterprises. BMC Public Health, 24, 1987. https://doi.org/10.1186/s12889-024-19517-3
5. Manookian, A., Dehghan Nayeri, N., & Shahmari, M. (2022). Physical problems of prolonged use of personal protective equipment during the COVID-19 pandemic: A scoping review. Nursing forum, 57(5), 874–884. https://doi.org/10.1111/nuf.12735
6. Jalil Al-Bayati, A., Rener, A. T., Listello, M. P., & Mohamed, M. (2023). PPE non-compliance among construction workers: An assessment of contributing factors utilizing fuzzy theory. Journal of safety research, 85, 242–253. https://doi.org/10.1016/j.jsr.2023.02.008
7. Rayyan, M. G., Ibrahim, U. M., Usman, U. S., & Muhammad, K. I. (2022). Non-COVID-19 uptake of personal protective equipment and rules compliance amongst industrial workers in Kano, Nigeria. The Nigerian postgraduate medical journal, 29(4), 303–309. https://doi.org/10.4103/npmj.npmj_214_22
8. Setyawan, F. E. B., Supriyanto, S., Ernawaty, E., & Lestari, R. (2020). Developing a Holistic-Comprehensive Assessment Model: Factors Contributing to Personal Protective Equipment Compliance among Indonesian Cement Workers. Indian journal of occupational and environmental medicine, 24(1), 19–24. https://doi.org/10.4103/ijoem.IJOEM_115_19
9. Elshaer, N., & Agage, H. (2022). Nurses' perception and compliance with personal protective equipment and hand hygiene during the third wave of COVID-19 pandemic. The Journal of the Egyptian Public Health Association, 97(1), 14. https://doi.org/10.1186/s42506-022-00109-1
10. Rafindadi, A. D. U., Napiah, M., Othman, I., Alarifi, H., Musa, U., & Muhammad, M. (2022). Significant factors that influence the use and non-use of personal protective equipment (PPE) on construction sites—Supervisors' perspective. Ain Shams Engineering Journal, 13(3), 101619.
11. Galanis, P., Vraka, I., Fragkou, D., Bilali, A., & Kaitelidou, D. (2021). Impact of personal protective equipment use on health care workers' physical health during the COVID-19 pandemic: a systematic review and meta-analysis. American Journal of Infection Control, 49(10), 1305-1315.
12. Baye, B. F., Baye, M. F., Teym, A., & Derseh, B. T. (2022). Utilization of personal protective equipment and its associated factors among large scale factory workers in Debre Berhan Town, Ethiopia. Environmental Health Insights, 16, 11786302221102324.

13. Empactivo. (2024). Companies with strong safety cultures usually have lower accident rates. https://empactivo.com/2024/04/22/companies-with-strong-safety-cultures-usually-have-lower-accident-rates/
14. Faqir, Z. (2024). Management commitment in safety. https://doi.org/10.13140/RG.2.2.22999.07846
15. Priolo, G., Vignoli, M., & Nielsen, K. (2025). Risk perception and safety behaviours in high-risk workers: A systematic literature review. Safety Science, 186, 106811. https://doi.org/10.1016/j.ssci.2025.106811
16. Febriyanti, R. S., & Widajati, N. (2025). Factors influencing compliance with personal protective equipment use among manufacturing workers: A literature review. World Journal of Advanced Research and Reviews, 25(3), 1334–1338. https://doi.org/10.30574/wjarr.2025.25.3.0874
17. Tessema, M., & Sema, W. (2022). Utilization of Personal Protective Equipment and Associated Factors among Large-Scale Factory Workers in Debre-Berhan Town, Amhara Region, Ethiopia, 2021. Journal of environmental and public health, 2022, 8439076. https://doi.org/10.1155/2022/8439076
18. Rosenstock, I. M. (1974). Historical origins of the Health Belief Model. Health Education Monographs, 2(4), 328–335. https://doi.org/10.1177/109019817400200403
19. Jones, C. L., Jensen, J. D., Scherr, C. L., Brown, N. R., Christy, K., & Weaver, J. (2015). The Health Belief Model as an explanatory framework in communication research: Exploring parallel, serial, and moderated mediation. Health Communication, 30(6), 566–576. https://doi.org/10.1080/10410236.2013.873363
20. Shahraki, A., Sepehri, M. M., & Alizadeh, S. M. (2022). PPE use and occupational injuries: Applying the Health Belief Model in small-scale industries. Journal of Safety Research, 80, 251–258. https://doi.org/10.1016/j.jsr.2021.10.003
21. Noori, H., Asilian-Mahabadi, H., & Hajizadeh, R. (2020). Factors affecting the use of personal protective equipment (PPE) among Iranian construction workers: A qualitative study. BMC Public Health, 20, 1258. https://doi.org/10.1186/s12889-020-09349-1
22. Liao, C. M., Fu, C. M., & Wang, M. Y. (2020). Behavioural intention of PPE usage among construction workers: A theory-based structural equation modeling study. Safety Science, 123, 104573. https://doi.org/10.1016/j.ssci.2019.104573
23. Laird, I. S., Lamm, F., & White, H. (2010). Integrating health and safety into workplace management systems. International Journal of Health Services, 40(3), 495–510. https://doi.org/10.2190/HS.40.3.f
24. Okpala, I., Mannan, M. S., & Al-Sharif, F. (2022). Assessment of barriers to the use of PPE among construction workers in developing countries: A system-based approach. Safety, 8(2), 33. https://doi.org/10.3390/safety8020033
25. Zhou, Q., Fang, D., & Wang, X. (2022). Ergonomic redesign of personal protective equipment to increase compliance in construction. Automation in Construction, 135, 104124. https://doi.org/10.1016/j.autcon.2021.104124
26. Alrawadieh, Z., Alrawadieh, H., & Cetin, G. (2021). Occupational health and safety in the construction industry: A review of the influence of human factors. International Journal of Environmental Research and Public Health, 18(3), 1154. https://doi.org/10.3390/ijerph18031154
27. George, J., Shafqat, N., Verma, R., & Patidar, A. B. (2023). Factors Influencing Compliance with Personal Protective Equipment (PPE) Use among Healthcare Workers. Cureus, 15(2), e35269. https://doi.org/10.7759/cureus.35269
28. Kim, E. J., Park, Y. H., & Choi, H. R. (2024). Factors influencing nurses' compliance related to the use of personal protective equipment during the COVID-19 pandemic: A descriptive cross-sectional study. Nursing open, 11(7), e2235. https://doi.org/10.1002/nop2.2235
29. Maglio, M. A., Scott, C., Davis, A. L., Allen, J., & Taylor, J. A. (2016). Situational Pressures that Influence Firefighters' Decision Making about Personal Protective Equipment: A Qualitative Analysis. American journal of health behaviour, 40(5), 555–567. https://doi.org/10.5993/AJHB.40.5.2
30. Wotherspoon, S., & Conroy, S. (2021). COVID-19 personal protective equipment protocol compliance audit. Infection, disease & health, 26(4), 273–275. https://doi.org/10.1016/j.idh.2021.06.002
31. Harrod, M., Weston, L. E., Gregory, L., Petersen, L., Mayer, J., Drews, F. A., & Krein, S. L. (2020). A qualitative study of factors affecting personal protective equipment use among health care personnel. American journal of infection control, 48(4), 410–415. https://doi.org/10.1016/j.ajic.2019.08.031

32. Alakhras, M., Al-Mousa, D. S., Mahasneh, A., & AlSa'di, A. G. (2020). Factors Affecting Compliance of Infection Control Measures among Dental Radiographers. International journal of dentistry, 2020, 8834854. https://doi.org/10.1155/2020/8834854
33. Aljaffary, A., Al Elaiwi, T., AlOtaibi, N., AlAnsari, F., Alumran, A., & Salama, K. F. (2024). Determining the nurses' perception regarding the effectiveness of COVID-19 protocols implemented in Eastern Province: Saudi Arabia. Frontiers in public health, 11, 1291261. https://doi.org/10.3389/fpubh.2023.1291261
34. Schlünssen, V., & Jones, R. M. (2023). Gender aspects in occupational exposure and health studies. Annals of work exposures and health, 67(9), 1023–1026. https://doi.org/10.1093/annweh/wxad063
35. Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. Educational and psychological measurement, 30(3), 607-610. https://www.kenpro.org/sample-size-determination-using-krejcie-and-morgan-table/
36. Dyreborg, J., Lipscomb, H. J., Nielsen, K., Törner, M., Rasmussen, K., Frydendall, K. B., Bay, H., Gensby, U., Bengtsen, E., Guldenmund, F., & Kines, P. (2022). Safety interventions for the prevention of accidents at work: A systematic review. Campbell systematic reviews, 18(2), e1234. https://doi.org/10.1002/cl2.12
37. Shen, Y., Li, Y., Ju, C., Ashraf, H., Hu, Z., He, C., & Memon, S. A. (2023). Foundational Effects of Organizational Climate on Perceived Safety Climate: A Multiple Mediation Model. Sustainability, 15(22), 15759. https://doi.org/10.3390/su152215759
38. Ahmadi Marzaleh, M., Bastani, P., Raeyat Mohtashami, A., Farhadi, P., Ghanbari, S., & Ravangard, R. (2025). Predicting Factors Affecting the Behaviour of Healthcare Employees in the Use of Personal Protective Equipment during Epidemics Based on Godin et al's Model: A Study in Iran. Health services insights, 18, 11786329251316668. https://doi.org/10.1177/11786329251316668
39. Syed-Yahya, S. N. N., Noblet, A. J., Idris, M. A., & Lee, M. C. C. (2022). Examining the role of supervisory and co-worker safety support in mediating the relationship between safety climate and safety performance. Safety Science, 155, 105880. https://doi.org/10.1016/j.ssci.2022.105880
40. Lee, B., & Kim, H. (2024). Evaluating the effects of safety incentives on worker safety behaviour control through image-based activity classification. Frontiers in Public Health, 12, Article 1430697. https://doi.org/10.3389/fpubh.2024.1430697
41. Bęś, P., & Strzałkowski, P. (2024). Analysis of the effectiveness of safety training methods. Sustainability, 16(7), 2732. https://doi.org/10.3390/su16072732
42. Lakeland Industries. (2025). Risk tolerance and behavioural science in the management of PPE. Retrieved from https://www.lakeland.com/risk-tolerance-and-behavioural-science-in-the-management-of-ppe/
43. Ningsih, A., & Suryani, D. (2024). Factors influencing adherence to the utilization of personal protective equipment among healthcare workers: A systematic review. Epidemiology and Society Health Review (ESHR), 6(1), 13–23. https://doi.org/10.26555/eshr.v6i1.8972
44. Tolera, S. T., Gobena, T., Geremew, A., Toseva, E., & Assefa, N. (2024). Compliance and associated factors of personal protective equipment among sanitary workers in selected public hospitals, Eastern Ethiopia: A cross-sectional study design. SAGE open medicine, 12, 20503121241308303. https://doi.org/10.1177/20503121241308303