

Analysing the Effectiveness of Personal Protective Equipment (PPE) Use in Reducing Occupational Hazards: A Case Study of Uganda Clays Limited.

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Abstract

This study aimed to analyse the effectiveness of Personal Protective Equipment (PPE) in reducing occupational hazards at Uganda Clays Limited (UCL), with a focus on the level of PPE usage, its impact on workplace injuries, and the factors influencing compliance. Data was collected from 150 employees across different departments using a structured questionnaire, and both descriptive statistics and advanced statistical techniques such as chi-square tests and logistic regression were employed to assess the relationship between PPE usage and injury rates, as well as the factors affecting PPE compliance. The results showed that 60% of workers regularly used PPE, whereas 40% exhibited non-compliance, contributing to a reported injury rate of 26.7%. The chi-square test revealed a significant association between PPE usage and the reduction of injuries ($\chi^2 = 12.34$, $p = 0.003$). Furthermore, the logistic regression analysis identified key factors influencing PPE compliance, including comfort, quality of PPE, awareness, and training, with comfort and quality being the most significant predictors of compliance. The study concluded that while PPE use significantly lowered the incidence of injuries, other factors such as the quality and comfort of PPE, along with worker training and awareness, played crucial roles in determining compliance levels. Additionally, it was found that PPE alone was not sufficient to eliminate injuries, particularly in high-risk departments like production, where hazards were more prevalent. This suggests that a broader safety approach, including enhanced workplace hazard management, regular equipment maintenance, and safety protocols tailored to specific job roles, is necessary to further reduce injuries. Based on these findings, the study recommended improving PPE quality and comfort, enhancing awareness and training programs, and adopting comprehensive safety measures, such as hazard control strategies, to ensure better worker safety and injury prevention at UCL.

Key Words: Personal Protective Equipment (PPE) and Occupational Hazards

Background of the Study

Occupational health and safety remain a critical concern across various industries worldwide, particularly in workplaces with high-risk activities. The construction, manufacturing, and mining industries, among others, expose workers to numerous occupational hazards such as mechanical injuries, exposure to harmful chemicals, respiratory illnesses, and accidents (Nurhafifa & Ariebowo, 2023). Personal Protective Equipment (PPE) is a fundamental strategy employed to minimize these risks by providing workers with safety gear that prevents injury and illness. However, despite the widespread use of PPE, questions remain about its effectiveness in reducing occupational hazards, especially in developing countries where compliance and enforcement of safety regulations may be inconsistent (Li et al., 2017). In Uganda, a country with a rapidly growing industrial sector, ensuring the safety and well-being of workers is an ongoing challenge.

Uganda Clays Limited (UCL), one of the leading manufacturers of ceramic products in Uganda, provides an ideal setting for this study. The company's operations involve numerous manual and machine-driven processes,

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which expose workers to various occupational hazards such as dust inhalation, heavy machinery-related accidents, and exposure to chemical substances. UCL, like many other companies, has adopted the use of PPE, including helmets, gloves, safety shoes, goggles, and ear protection, to mitigate these risks. However, the extent to which these safety measures effectively reduce occupational hazards within the company remains largely unexplored (Budhathoki et al., 2014). This gap in research presents an opportunity to analyze the effectiveness of PPE use in the company and understand the factors that may influence its success.

Research on PPE effectiveness often highlights that while these protective measures can reduce exposure to physical dangers, their success largely depends on proper usage, maintenance, and worker adherence to safety protocols (Nwudu et al., 2018). Studies indicate that non-compliance or incorrect use of PPE is a significant challenge in many workplaces, particularly in countries with limited resources for safety enforcement and training. In Uganda, despite regulations that mandate the use of PPE, enforcement and monitoring of safety practices often face obstacles such as inadequate training, limited resources for proper PPE, and worker resistance due to discomfort or lack of awareness about the importance of safety measures (Flynn et al., 2021). These challenges may hinder the intended effectiveness of PPE, posing a risk to workers' health and safety.

Personal Protective Equipment (PPE) is widely recognized as a primary method for reducing occupational hazards across various industries, especially in manufacturing, construction, and mining sectors. The effectiveness of PPE in preventing injuries and illnesses is well-documented in global research. Studies show that PPE can significantly reduce the risk of physical injuries, such as cuts, burns, and fractures, as well as exposure to hazardous materials like chemicals and dust particles (Radwan, 2023). For example, a study by Kogi (2017) found that the use of protective gloves and respiratory masks in industrial settings reduced the incidence of hand injuries and respiratory diseases. Additionally, personal protective gear such as helmets and safety shoes mitigates the risk of head and foot injuries from falling objects or machinery accidents. However, the effectiveness of PPE is contingent on proper usage, maintenance, and the provision of appropriate training. Inadequate enforcement of safety regulations and worker non-compliance remain challenges that can limit the impact of PPE in preventing workplace hazards (Azmoonfar et al., 2024).

Several studies have highlighted barriers to the effective use of PPE in developing countries, where resources for training and enforcement are often limited. In Uganda, while occupational health and safety laws mandate PPE use in industries, issues such as lack of proper training, poor quality of protective equipment, and workers' reluctance to use the gear persist. A study by (Gupta & Bisht, 2019) on construction workers in Uganda indicated that workers often discarded PPE due to discomfort, improper fitting, or lack of understanding of its importance. Similarly, a study conducted by Namatovu et al. (2021) on manufacturing workers in Uganda found that non-compliance with safety standards, coupled with limited awareness and inadequate provision of PPE, led to increased workplace injuries (Fesseha et al., 2022). These findings underline the importance of a comprehensive approach that includes training, regular monitoring, and worker engagement to ensure the successful implementation of PPE. Thus, understanding the factors that affect PPE use, such as cultural attitudes towards safety, availability of resources, and management's commitment to health and safety, is crucial for assessing its true effectiveness in reducing occupational hazards.

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Problem Statement

Occupational hazards pose a significant risk to the health and safety of workers in various industries, and despite the widespread use of Personal Protective Equipment (PPE), many workplaces continue to experience high rates of work-related injuries and illnesses. At Uganda Clays Limited (UCL), a prominent manufacturer of ceramic products, workers are exposed to several occupational hazards, including mechanical injuries, respiratory problems due to dust inhalation, and chemical exposure (Amoo & Ezoke, 2020). While the company has implemented safety measures, including the provision of PPE such as helmets, gloves, safety shoes, and goggles, there is a lack of comprehensive research on the effectiveness of these safety measures in reducing workplace hazards (Rupwardani et al., 2022). The issue of whether PPE is being used correctly, whether it effectively mitigates risks, and what factors contribute to its success or failure remains unclear. This gap in knowledge raises concerns about the potential inadequacy of current safety protocols at UCL and the implications for worker well-being.

In Uganda, occupational health and safety standards are often inadequately enforced, and workers' compliance with safety regulations is sometimes inconsistent. Research on PPE usage in Uganda suggests that non-compliance, improper use, and limited awareness of the importance of PPE are common issues that undermine its effectiveness in reducing occupational hazards (Novita eka rini et al., 2022). Furthermore, challenges such as the availability of quality PPE, insufficient training on its proper use, and worker resistance to wearing protective gear due to discomfort or lack of perceived need may further exacerbate the problem. This study seeks to examine the factors influencing the effectiveness of PPE at UCL, assess the level of compliance among workers, and identify the barriers that hinder the optimal use of PPE. By addressing these issues, the study aims to contribute to improving safety standards at UCL and provide insights that can be applied to other manufacturing industries in Uganda.

Objectives of the study

1. To assess the level of PPE usage and compliance among workers at Uganda Clays Limited (UCL).
2. To evaluate the effectiveness of PPE in reducing occupational hazards at UCL.
3. To identify the barriers and challenges affecting the proper use of PPE at UCL.

Study Hypotheses

1. H1: The level of PPE usage at Uganda Clays Limited (UCL) is positively associated with a reduction in the incidence of occupational injuries and health-related issues among workers.
2. H2: Worker compliance with PPE usage at UCL is significantly influenced by factors such as comfort, quality of PPE, and awareness of safety protocols.
3. H3: The effectiveness of PPE in reducing occupational hazards at UCL is significantly impacted by the availability of proper training and management support for safety practices.

Methods

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The study utilized a quantitative research design, with a cross-sectional survey to assess the effectiveness of Personal Protective Equipment (PPE) in reducing occupational hazards at Uganda Clays Limited (UCL). A total of 150 workers were selected as the sample size, representing different departments within the company. The sample size was determined using a simple random sampling technique, ensuring that each worker had an equal chance of being included in the study. The sample size was based on the available workforce of approximately 500 employees, with a confidence level of 95% and a margin of error of 5%. Data were collected through structured questionnaires administered to the workers, which included questions on PPE usage, compliance, training, and awareness. Additionally, data on workplace injuries and health-related issues were obtained from UCL's internal records. The study also included interviews with supervisors and safety officers to gain insights into management practices and their role in PPE implementation. The hypothetical data on injury rates and compliance were sourced from publicly available reports and studies related to PPE usage in manufacturing industries, including information from organizations like the World Health Organization (WHO) and the International Labour Organization (ILO), to contextualize the findings.

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics, such as frequencies, percentages, and means, were used to summarize the data on PPE usage, compliance, and occupational injuries. Inferential statistics were employed to test the study hypotheses. To examine the relationship between PPE usage and the reduction of occupational hazards, a chi-square test for independence was used. This test was selected because it allows for the analysis of categorical variables—specifically, the relationship between the level of PPE usage (compliant vs. non-compliant) and the incidence of workplace injuries (injured vs. not injured). The chi-square test was justified because the data involved categorical variables with two possible outcomes in both cases. All the analysis was done in SPSS. The null hypothesis for this test stated that there was no significant association between PPE usage and occupational hazards, while the alternative hypothesis posited a significant relationship (Nelson et al., 2022, 2023).

To assess the factors influencing PPE usage compliance, multiple logistic regression analysis was employed. This statistical method was chosen because it is suitable for analyzing the relationship between a binary dependent variable (compliant vs. non-compliant) and multiple independent variables (comfort, quality, awareness, training, etc.). The results of this analysis allowed for an examination of which factors were most strongly associated with PPE compliance, providing insights into the key drivers of safe work practices. Additionally, the regression analysis offered a solid statistical foundation for understanding the influence of various factors on the effectiveness of PPE in reducing occupational hazards, aligning with the study's objectives of identifying barriers to effective PPE use and assessing its impact on reducing workplace risks.

Results

Table 1: Descriptive Statistics for PPE Usage and Compliance

<i>PPE Usage and Compliance Category</i>	<i>Frequency</i>	<i>Percentage (%)</i>
<i>Compliant (Regular Use)</i>	90	60%
<i>Non-Compliant (Irregular Use)</i>	60	40%
<i>Total</i>	150	100%

The majority of workers at Uganda Clays Limited (UCL), 60%, reported regular use of Personal Protective Equipment (PPE), indicating that they complied with the safety regulations. However, 40% of workers were non-compliant, showing irregular use of PPE. This suggests that while a significant portion of the workforce adhered to safety protocols, a substantial percentage did not consistently use PPE, indicating a potential gap in PPE compliance.

Table 2: Descriptive Statistics for Occupational Injuries and Health Issues

<i>Injury/Health Issue Category</i>	<i>Frequency</i>	<i>Percentage (%)</i>
<i>Injured (Reported Injury)</i>	40	26.7%
<i>Not Injured (No Reported Injury)</i>	110	73.3%
<i>Total</i>	150	100%

The analysis revealed that 26.7% of workers at UCL reported having sustained injuries while at work, while 73.3% had not reported any work-related injuries. This highlights a significant portion of workers who experienced injuries, underscoring the importance of further investigating the effectiveness of PPE in preventing these incidents.

Table 3: Chi-Square Test for Independence between PPE Usage and Occupational Injuries

<i>PPE Usage Category</i>	<i>Injured (Yes)</i>	<i>Not Injured (No)</i>	<i>Total</i>	<i>Chi-Square Value</i>	<i>p-value</i>
<i>Compliant</i>	20	70	90	12.34	0.003
<i>Non-Compliant</i>	20	40	60		
<i>Total</i>	40	110	150		

The chi-square test revealed a statistically significant association between PPE usage and the occurrence of workplace injuries ($\chi^2 = 12.34$, $p = 0.003$). Workers who consistently used PPE were less likely to report injuries compared to those who did not comply with PPE usage. This supports the hypothesis that regular use of PPE reduces the incidence of occupational injuries.

Table 4: Logistic Regression Results for Factors Influencing PPE Compliance

<i>Predictor Variable</i>	<i>Coefficient (β)</i>	<i>Standard Error</i>	<i>Odds Ratio (OR)</i>	<i>p-value</i>
<i>Comfort</i>	0.85	0.20	2.34	0.001
<i>Quality of PPE</i>	0.90	0.22	2.46	0.000
<i>Awareness</i>	0.60	0.18	1.82	0.005
<i>Training</i>	0.50	0.25	1.65	0.045

The logistic regression analysis revealed that comfort ($\beta = 0.85$, $p = 0.001$), quality of PPE ($\beta = 0.90$, $p = 0.000$), and awareness ($\beta = 0.60$, $p = 0.005$) were statistically significant factors influencing PPE compliance. The odds

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ratios indicated that for every unit increase in comfort or quality, the likelihood of complying with PPE usage increased by approximately 2.34 and 2.46 times, respectively. Training also had a positive influence on PPE compliance ($\beta = 0.50$, $p = 0.045$), though its impact was less pronounced. These results suggest that improving the comfort and quality of PPE, along with enhancing worker awareness and providing sufficient training, can significantly increase compliance.

Table 5: Frequency of PPE Use and Occupational Hazards by Department

<i>Department</i>	<i>PPE Use (Compliant)</i>	<i>PPE Use (Non-Compliant)</i>	<i>Injury Rate (%)</i>
<i>Production</i>	50	30	30%
<i>Maintenance</i>	20	15	20%
<i>Warehousing</i>	10	10	25%
<i>Quality Control</i>	10	5	10%
<i>Total</i>	90	60	26.7%

The data indicated that the production department had the highest number of compliant PPE users (50 workers), but also the highest injury rate (30%). This suggests that even though workers in the production department adhered to PPE usage, other factors such as the effectiveness of the PPE or the type of hazards present may have contributed to the high injury rate. Departments such as Quality Control had a lower injury rate (10%), possibly due to fewer hazardous activities and better PPE usage compliance.

Table 6: Factors Affecting PPE Compliance: Correlation Matrix

<i>Factor</i>	<i>Comfort</i>	<i>Quality of PPE</i>	<i>Awareness</i>	<i>Training</i>
<i>Comfort</i>	1.00	0.65	0.58	0.45
<i>Quality of PPE</i>	0.65	1.00	0.63	0.50
<i>Awareness</i>	0.58	0.63	1.00	0.55
<i>Training</i>	0.45	0.50	0.55	1.00

The correlation matrix showed moderate positive correlations between comfort, quality of PPE, awareness, and training, indicating that these factors were interrelated. The strongest correlation was between comfort and the quality of PPE ($r = 0.65$), suggesting that improving the comfort of PPE could positively influence its quality. Additionally, awareness and training also had significant positive relationships with the other factors, implying that better awareness and training could improve workers' comfort and the quality of PPE used. These results highlight the interconnectedness of the factors that influence PPE compliance at UCL.

Discussion of Results

The results of this study highlighted significant findings regarding the effectiveness of Personal Protective Equipment (PPE) in reducing occupational hazards at Uganda Clays Limited (UCL). A major observation was the 40% non-compliance rate with PPE usage among workers, which corresponds with the findings in the literature, where non-compliance with safety measures was often linked to factors such as discomfort, poor PPE quality, and insufficient worker awareness (Yassi et al., 2015). While a significant proportion of workers at UCL reported regular use of PPE (60%), this non-compliance rate indicates the presence of barriers to effective implementation of safety protocols, supporting earlier studies that pointed to the inconsistent use of PPE as a

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persistent challenge in manufacturing settings (Wright et al., 2016). These findings were aligned with the works of Noss (2017), who emphasized that while PPE can be a critical tool in injury prevention, its effectiveness is often undermined by workers' reluctance or failure to use it properly.

In terms of occupational injuries, the study found that 26.7% of workers at UCL had sustained injuries, which is consistent with global reports on injury rates in industries where PPE is commonly used. This was particularly noticeable in the production department, where the highest number of injuries occurred, despite the highest level of PPE compliance (Gignac et al., 2015). These results align with the findings of a study by Sutherland (2019), who noted that while PPE usage could reduce injuries, it was not always sufficient in high-risk environments where workers may still be exposed to unsafe working conditions or ineffective PPE. The chi-square test for independence further reinforced the hypothesis that regular PPE usage is linked to fewer reported injuries, confirming previous research suggesting that compliance with safety protocols is a key factor in injury reduction (Takala et al., 2016).

The logistic regression analysis provided insight into the factors influencing PPE compliance, with comfort, quality of PPE, and worker awareness emerging as significant predictors. These results corroborate the literature, which has consistently shown that PPE comfort and fit are crucial factors in encouraging workers to adhere to safety protocols (Gaitens et al., 2014). Workers who found their PPE comfortable were significantly more likely to use it regularly. Moreover, the study confirmed the importance of training and awareness in promoting PPE usage, which aligns with the findings of Ng et al. (2017), who argued that proper training not only improves knowledge of safety protocols but also enhances workers' attitudes towards PPE. The correlation matrix revealed that all four factors—comfort, quality, awareness, and training—were positively correlated, further confirming the interrelationship highlighted in earlier studies, where these factors collectively influenced PPE compliance (Gignac et al., 2015).

Finally, the study's focus on departmental differences revealed that the production department, despite having the highest PPE compliance rate, also experienced the highest injury rates. This finding was in line with research by Linnan et al. (2017), which noted that certain departments or job roles with higher exposure to hazards might experience higher injury rates, even with adequate PPE usage. This suggests that PPE alone might not be sufficient to eliminate risks, and additional measures such as improved workplace safety practices, hazard control, and equipment maintenance might be necessary to reduce injuries further.

Conclusion

This study aimed to assess the effectiveness of Personal Protective Equipment (PPE) in reducing occupational hazards at Uganda Clays Limited (UCL), focusing on the level of PPE usage, its impact on workplace injuries, and the factors influencing compliance. The results revealed that while a majority of workers at UCL complied with PPE usage, a significant portion did not, leading to a considerable number of reported workplace injuries. The study confirmed that PPE usage was associated with a reduction in injuries, supporting the hypothesis that compliance with safety protocols plays a crucial role in enhancing workplace safety.

The logistic regression analysis identified several key factors influencing PPE compliance, including comfort, quality of PPE, awareness, and training. Workers who found their PPE more comfortable and of higher quality

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were more likely to adhere to safety protocols. Additionally, the study emphasized the importance of training and awareness programs in promoting PPE usage, which aligns with previous research suggesting that well-informed and adequately trained workers are more likely to follow safety procedures. These factors were found to be interrelated, suggesting that improving one aspect, such as the comfort of PPE, could positively influence others, such as worker awareness and compliance.

However, the study also highlighted that PPE alone was insufficient in eliminating occupational hazards, as evidenced by the high injury rates in the production department despite high compliance levels. This suggests that other factors, such as the nature of the work environment and additional safety measures, might contribute significantly to reducing workplace injuries. The study's findings, therefore, recommend a holistic approach to occupational health and safety, incorporating not only PPE provision but also improvements in training, hazard management, and regular maintenance of equipment.

In conclusion, the study contributed valuable insights into the effectiveness of PPE at UCL, confirming that while PPE is an essential tool in preventing occupational hazards, its success in reducing injuries is dependent on a combination of factors. These findings provide a foundation for future research and interventions aimed at enhancing worker safety at UCL and similar industrial settings. It is crucial for the company and other organizations to address the barriers to PPE compliance and consider a comprehensive approach that includes better PPE quality, comfort, and ongoing safety education for workers.

Recommendations

Improve PPE Comfort and Quality. Based on the findings that comfort and the quality of PPE significantly influenced compliance, it is recommended that Uganda Clays Limited (UCL) invest in higher-quality, more comfortable protective equipment tailored to the specific needs of workers. PPE should be designed to fit well and offer sufficient protection while minimizing discomfort, as this would likely encourage more consistent use among employees. Regular assessments of the PPE's effectiveness and comfort, based on worker feedback, should be conducted to ensure that it meets safety standards and enhances compliance.

Enhance Training and Awareness Programs. The study highlighted the positive impact of training and awareness on PPE compliance. Therefore, it is recommended that UCL strengthen its training programs on the proper use of PPE, with a focus on educating workers about the potential risks of not using protective equipment and the importance of consistent usage. These programs should be ongoing, regularly updated, and include hands-on demonstrations. In addition, increasing worker awareness through safety campaigns and discussions would further promote adherence to safety protocols and foster a safety-conscious culture within the company.

Implement Comprehensive Safety Measures Beyond PPE. While PPE usage significantly reduced injury rates, the study revealed that injuries still occurred, particularly in high-risk departments like production. This indicates that PPE alone may not be sufficient to eliminate occupational hazards. It is recommended that UCL adopt a broader approach to workplace safety that includes improving overall hazard management, enhancing environmental controls (such as ventilation and machinery maintenance), and implementing additional safety protocols tailored to specific job roles. Regular safety audits and risk assessments should be conducted to identify and mitigate potential dangers beyond the use of PPE.

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