

(RESEARCH ARTICLE)



Enhancing safety in zimbabwean manufacturing industry: The role of human factors engineering in reducing workplace accidents

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Abstract

Workplace accidents continue to be major problem in Zimbabwean manufacturing enterprises impacting productivity, employee well-being and operational efficiency. The study sought to explore the extent to which Human Factors Engineering (HFE) can be utilised as a safety intervention in Zimbabwean manufacturing industries. Using a mixed-method approach, including qualitative data on key human factors in accidents and quantitative data on the effectiveness of HFE interventions to mitigate these risks. By demonstrating that ergonomic design was significant in influencing operator training accidents, the results were used to show how safety culture can also mitigate such incidences at national level and hence enhance workplace general safety of Zimbabwean manufacturing operations.

Keywords: Safety; Manufacturing Industry; Human Factors Engineering; Ergonomic Design

1. Introduction

Zimbabwe's manufacturing sector has for time immemorial been a cornerstone of the economy of the nation, playing a vital role in its development as well as its efforts towards improved industrialisation. In the traditional sense, the sector has rather been diverse encompassing industries producing textiles, food and beverages, clothing, machinery, to name but a few. However, the manufacturing sector has over the last decades faced significant challenges due to political as well as economic instability. In spite of these significant hurdles, the manufacturing sector remains a vital component of the Zimbabwean economic structure, contributing to employment, the nation's Gross Domestic Product (GDP) as well as export earnings [1].

1.1. The State of Workplace Safety

Workplace safety is a critical issue within the Zimbabwean Manufacturing landscape, with factors such as lack of proper training, outdated technologies and inadequate safety regulations contributing to a high incidence of workplace accidents. The manufacturing industry has over the years recorded one of the highest accidents at work cases annually and this is according to a Zimbabwe national social security Authority (NSSA) report. Such accidents are not only detrimental to the health and welfare of workers, but they are also economically expensive due to loss in production scheduled; medical costs incurred include compensation claims [2].

1.2. Contributory Factors to Workplace Accidents

1.2.1. Outdated Machinery and Equipment:

The majority of manufacturing firms in Zimbabwe are making use of outdated equipment that inherently lack advanced safety features, thus increasing the risk of accidents during the execution of day to day tasks [3].

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1.2.2. Lack of Proper Training

The failure by organisations to train the workforce on safety measures, precautions as well as the proper handling of tools is also one of the main causes of the accidents [1]. More often, workers lack the adequate training on how to go about their duties in a safe manner that does not put them at risk of getting into more adverse circumstances that may trigger off more life threatening situations.

1.2.3. Inadequate Safety Regulations

While the nation of Zimbabwe may have occupational safety and health laws, the levels of implementation have been noticed to be inconsistent, thus culminating in insecure workplace environments [2].

1.2.4. Ergonomic Challenges

Poor ergonomic design within the workspaces tends to increase the risk of musculoskeletal disorders as well as a myriad of other injuries, particularly in the case of workers who are employed to perform repetitive tasks or those who lift heavy items [4].

1.3. Economic and Social Impacts of Workplace Accidents

Widespread workplace accidents in Zimbabwe manufacturing firms pose a considerable economic and social effect. From an organizational perspective as well as from an economic point of view, accidents tend to reduce productivity as employees are unable to work due to injury and those that can work may be less skilled than the employees who were injured. Furthermore, there are also a plethora of expenses that companies face within the medical treatment, compensations and legal implications. In the social perspective, workplace accidents are disastrous for workers and their dependants probably through the loss of wages, disabilities or in the worst-case scenario death. These outcomes call for the necessity of the enhancement of the safety of the sector [3].

1.4. The Need for Improved Workplace Safety

Since manufacturing is a key sector in Zimbabwe's economy the promotion of workplace safety is a necessity for the growth and development of the sector. Hence, people factors like lack of training, poor working environment, and outdated tools employed by Zimbabwean manufacturers increase the likelihood of occurrence of accidents in the workplace thus would be useful in reducing such an occurrence. This, of course, would result in an enhanced manufacturing sector to help it be better positioned to support the nation's economic rebuild and progress [1].

2. Literature Review

2.1. Workplace Accidents in Manufacturing

Manufacturing sector workplace accidents are a global issue of concern as millions of employees get injured every year. The International Labour Organization (ILO) has reported that the manufacturing sector reported high levels of workplace injuries and fatalities in many countries [5]. While advancements in erecting safety legislation have significantly reduced accident rates in some regions, the manufacturing sector due to the nature of its processes, remains a high-risk industry.

2.2. Consequences of Workplace Accidents

2.2.1. Health and Safety Impacts

Workplace injuries have a tendency to lead to physical disabilities, chronic pain as well as mental stress, which can have a bearing on the long term health of the workforce [6].

2.2.2. Economic Costs

Accidents within the workplace tend to result in significant costs for the employers, taking into consideration factors such as medical expenses, reduced productivity as well as worker compensation [7].

2.2.3. Legal and Regulatory Implications

Therefore, if safety standards are not accomplished, then the companies are liable to suffer in terms of penalties that are in the form of fines or legal suits or even come under additional scrutiny from the regulating authorities [8].

2.3. Human Factors Engineering (HFE)

HFE, also called ergonomics is primarily the scientific discipline that covers interactions of persons with systems [9]. HFE's main thrust is to enhance the influence of systems, products and environment so as to improve performance, safety and comfort of the user. The Principles of Human Factors Engineering are given as follows;

2.3.1. User-Centred Design

As indicated earlier on in the research, HFE is founded on the principle of User-Centred Design (UCD). This entails the development and design of systems based primarily on the capabilities and limitations of the user, thus ensuring that they meet the needs as well as expectations of the user [10].

2.3.2. Ergonomic Fit

Ergonomic fit focuses on the adaption of equipment, tools as well as workspaces in order to fit human cognitive and physical capabilities, so as to reduce injury and discomfort risks [11].

2.3.3. Human-Computer Interaction

Human-Computer Interaction (HCI) is a field that studies the relationship between the user and the computer system as well as the interfaces on them [12]. It seeks to create interfaces which are user friendly and minimise errors, so as to improve efficiency within the manufacturing process [13].

2.3.4. Safety and Error Prevention

HFE incorporates within itself, methods such as mistake proofing (poka-yoke) [14] and error resilient design so as to reduce human errors and prevent workplace accidents.

2.4. Application of HFE in Manufacturing

2.4.1. Ergonomic Design of Workstations

In manufacturing, HFE principles have a significant impact on workstation design so as to boost comfort and productivity. This involves creating adjustable work surfaces, comfortable chairs, and tools to cut down on repetitive strain as well as to help maintain good posture. Workstations that follow these guidelines help stop muscle and bone problems and make workers more productive [11].

2.4.2. Human-Machine Interface Design

Human-Machine Interface (HMI) design aims to create effective ways for operators to interact with machines. HFE principles help design control panels, displays, and interfaces that people find easy to understand and use. Good HMI design lowers the chance of operator mistakes and has a positive impact on the safety and productivity of manufacturing processes [15].

2.4.3. Training and Skill Development

HFE stresses how crucial and imperative it is, to have training programs that tackle what humans can and cannot do [16]. In the manufacturing environment, this entails creating training sessions so as to help workers better grasp equipment, steps, and safety rules.

2.4.4. Safety Systems and Protocols

HFE principles play a crucial role in the development of safety systems and protocols for manufacturing settings. This typically involves designing easy-to-understand safety warnings, emergency steps, as well as safety gear. By ensuring that safety is an integral part of system design, the design team can lower accident risks and boost workplace safety in the overall sense [17].

2.5. Safety Culture

Safety culture refers to the shared values, beliefs, and practices in an organisation which prioritise safety [18]. It takes into consideration how employees and bosses think and act when it comes to safety as well as the management of risks. When a workplace has a strong safety culture, it means safety is typically embossed into everything they do, from day to day tasks up to the handling emergencies. This thus creates a work environment where safety is always a priority.

2.5.1. Design and Systems Thinking

By integrating human factors into system design, an organisation can enhance its safety culture by developing work environments which account for the capabilities as well as limitations of its workforce [19].

2.5.2. Training and Awareness

Training programs focusing on human factors and safety principles play a key role in developing a safety-first mind-set within an individual. To strengthen safety practices and boost readiness within the employee base, companies need to offer regular refresher courses and training based on real-life scenarios [20].

2.5.3. Leadership and Management Commitment

Leadership commitment plays a key role in the building of an organisation's safety culture [21]. The organisation's leadership structures must model safe behaviours and support safety initiatives across the breadth of the organisation.

3. Research Methodology

3.1. Purpose of the Study

The study sought to investigate how Human Factors Engineering can reduce workplace accidents in Zimbabwe's Manufacturing Industry.

3.2. Research Questions

- What human factors contribute to workplace accidents in Zimbabwe's manufacturing industry?
- How effective are HFE Interventions in reducing workplace accidents?
- What strategies can be used to integrate HFE into Zimbabwean Manufacturing processes?

3.3. Research Objectives

- To identify key human factors contributing to workplace accidents in Zimbabwe's Manufacturing Sector.
- To evaluate the effectiveness of HFE interventions in reducing workplace accidents.
- To propose strategies for integrating HFE into Zimbabwean Manufacturing processes.

3.4. Research Method

The study employed a mixed methods approach, which combined qualitative and quantitative data. A Questionnaire was drafted as distributed to workers within the Zimbabwean Manufacturing landscape, and of the distributed questionnaires, 87 responses were collected. The data was then analysed with the goal of identifying key human factors and evaluating the effectiveness of HFE interventions.

4. Survey Results Analysis

4.1. Demographics

Amongst the survey respondents, the distribution of roles within the organisations was as outlined in Figure 1.

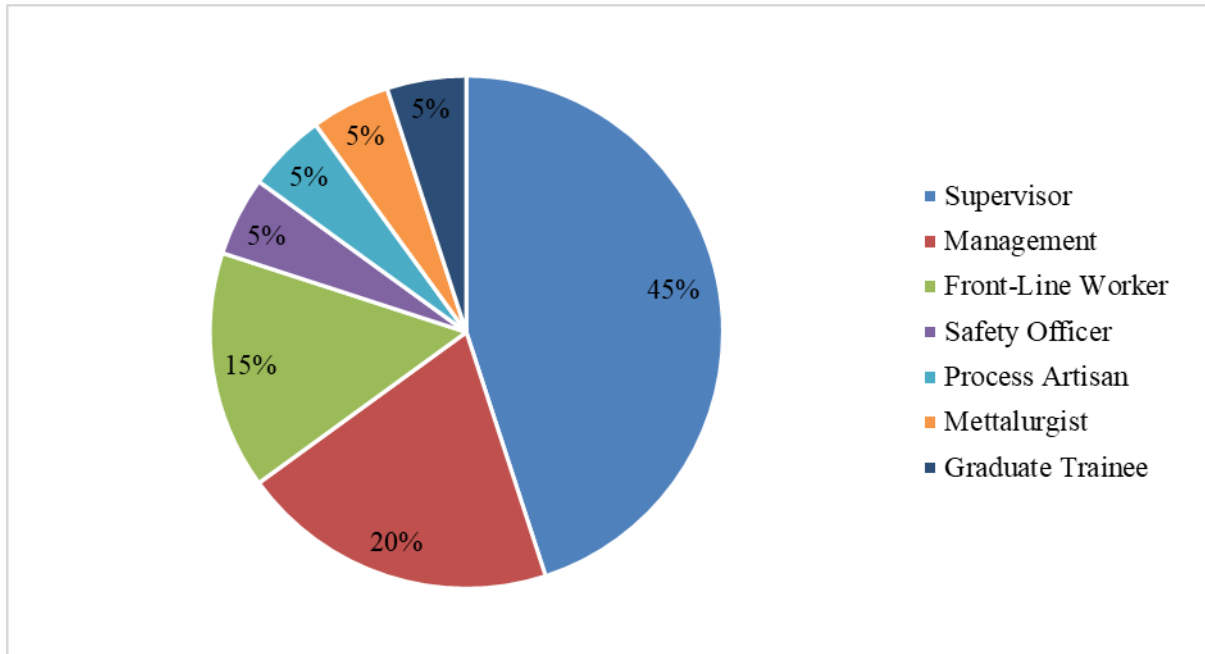


Figure 1 Industry survey response

The survey respondents included supervisors (45%), Management (30%) and Front-Line Workers (25%). The largest segment (45%) of the survey results consisted of Supervisors, indicating that a significant portion of the respondents hold supervisory roles within their respective organisations. The notably high proportion of Supervisors and Management within the respondents’ population suggested that the survey results may reflect perspectives that tend to prioritize oversight and management processes. The relatively smaller representation of Front-line Workers and specialized roles (like Process Artisan or Safety Officer) indicated that while their perspectives are included, they may not heavily influence the overall results.

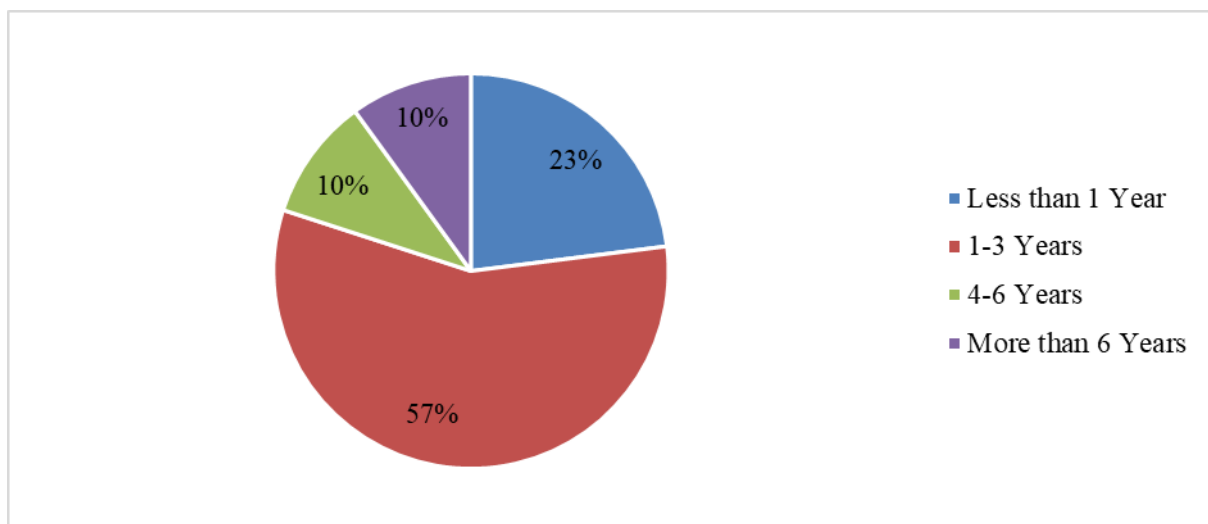


Figure 2 Worker experience on current role

The majority of respondents had significant experience in their roles as shown by Figure 2 and this highlighted a blend of fresh perspectives and established experience within the workforce, which could influence organizational dynamics, decision-making processes, and overall productivity.

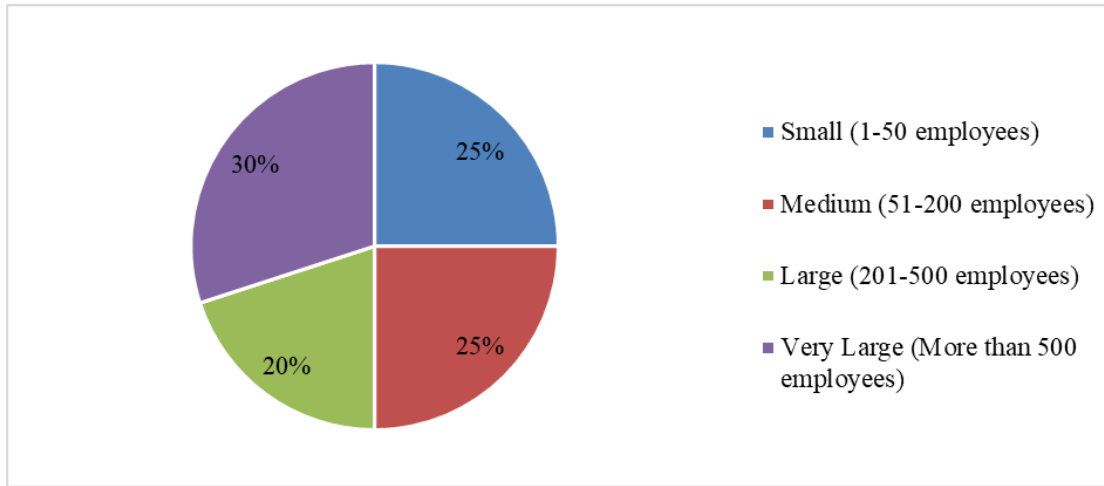


Figure 3 Size of surveyed organisations

This distribution indicated a diverse range of organizational sizes as shown in Figure 3, providing a broad spectrum of perspectives on workplace issues, from the more intimate settings of small businesses to the expansive operations of very large enterprises. This diversity can thus contribute to a more comprehensive understanding of the factors being studied.

4.2. Assessment of Human Factors Engineering in the workplace

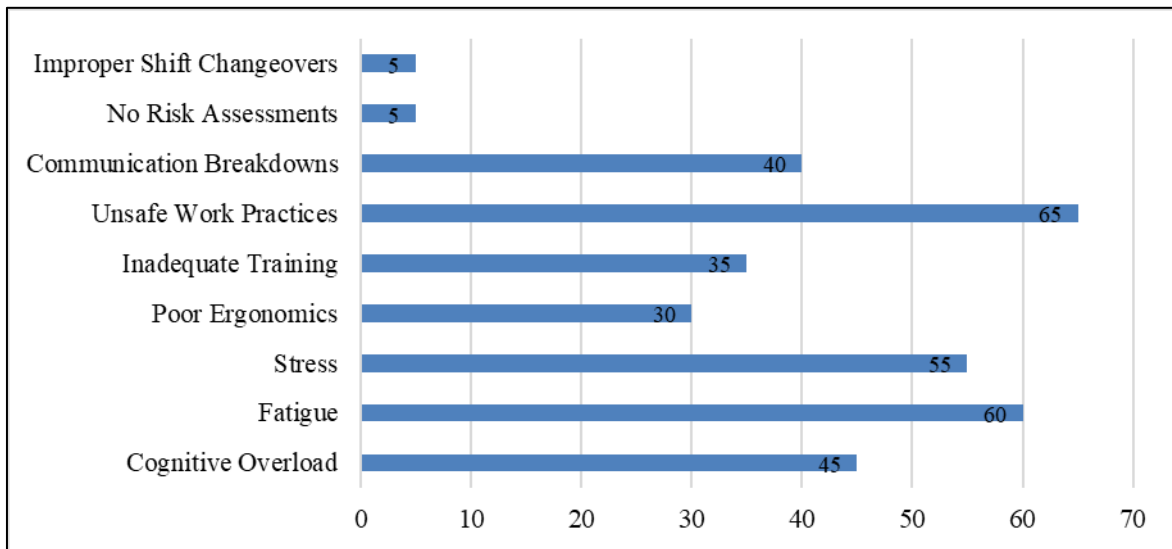


Figure 4 Human Factors Engineering impact to workplace accidents

Based on the findings given on Figure 4, the study suggested focusing more on improving unsafe work practices, managing fatigue and stress, and reducing cognitive overload so as to significantly enhance workplace safety in Zimbabwean manufacturing. Additionally, efforts to improve communication, training, and ergonomic design will further support safety improvements. While risk assessment and shift changeovers are less frequently cited, ensuring they are well-managed will contribute to overall safety culture.

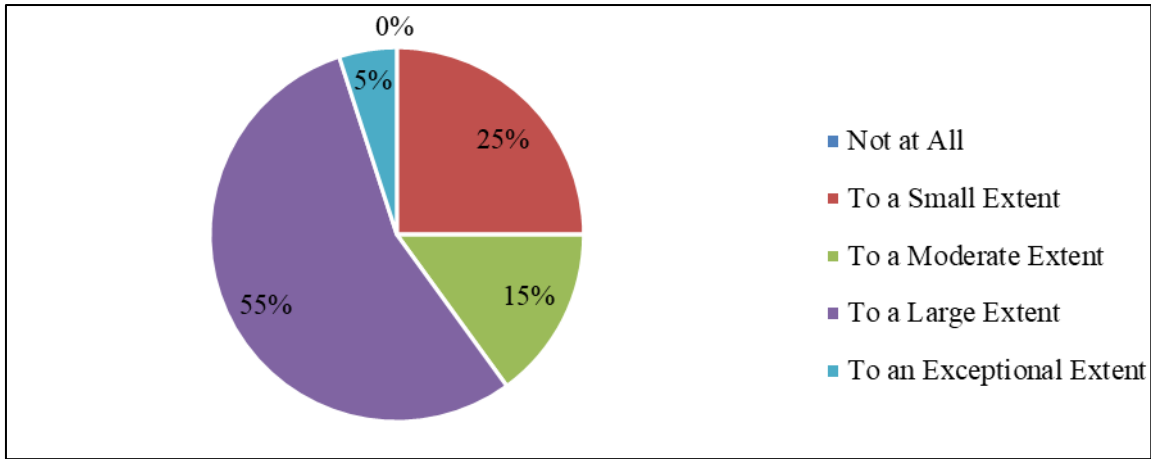


Figure 5 Cognitive overload effect on safety performance

Cognitive overload is widely recognized as a significant factor affecting safety performance, as shown in Figure 5, with the majority of participants believing it impacts their role "To a Large Extent." Given its importance, organizations should focus on mitigating cognitive overload through task simplification, adequate rest periods, better information management, and training. Addressing cognitive overload can potentially reduce accidents and improve overall safety in the workplace.

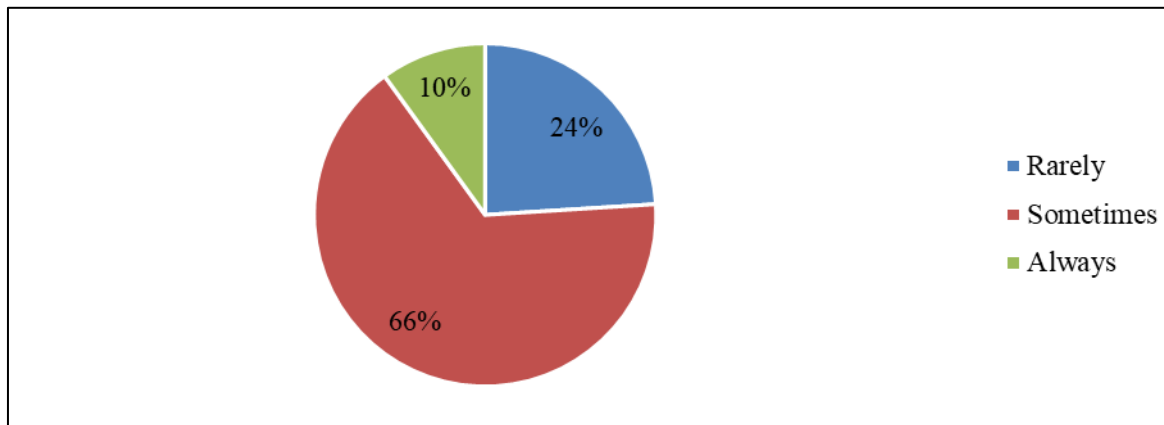


Figure 6 Worker exposure to stress and fatigue

Fatigue and stress are significant factors affecting employees performance, with the majority of employees sometimes experience the stress and fatigue, as evidenced by Figure 6. Given the potential impact on safety and efficiency, organizations should consider strategies to mitigate fatigue and stress, such as providing adequate rest periods, promoting work-life balance, and offering stress management resources. Addressing these factors can contribute to a safer and more productive work environment.

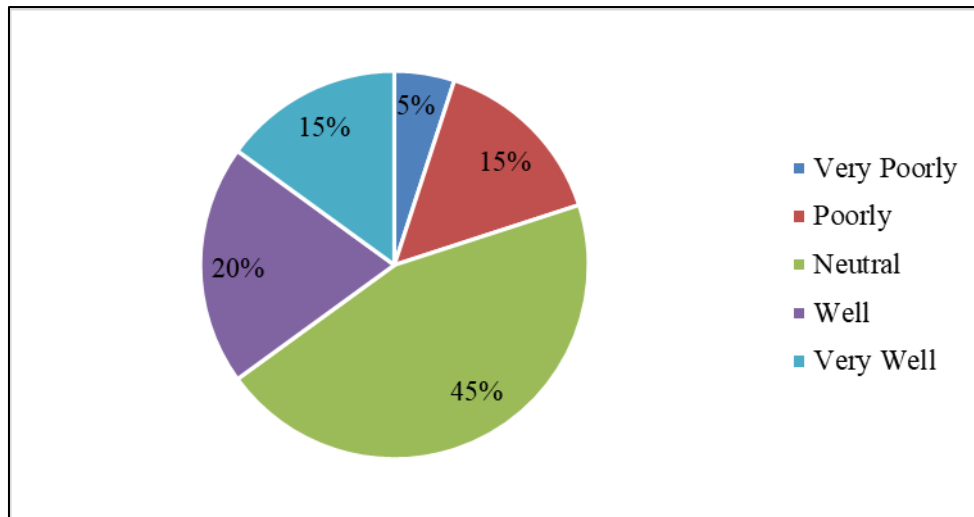


Figure 7 Workplace ergonomic principles implementation level

A portion of the workforce finds the ergonomic interventions satisfactory, a larger segment either finds them neutral or inadequate as given on Figure 7. The prevalence of neutral responses may indicate a general indifference or a lack of noticeable impact from current ergonomic practices. The 20% of negative responses are particularly concerning, as they highlight potential risks that could lead to workplace accidents. This underscores the importance of enhancing ergonomic practices in Zimbabwean manufacturing settings to ensure safety and reduce accidents.

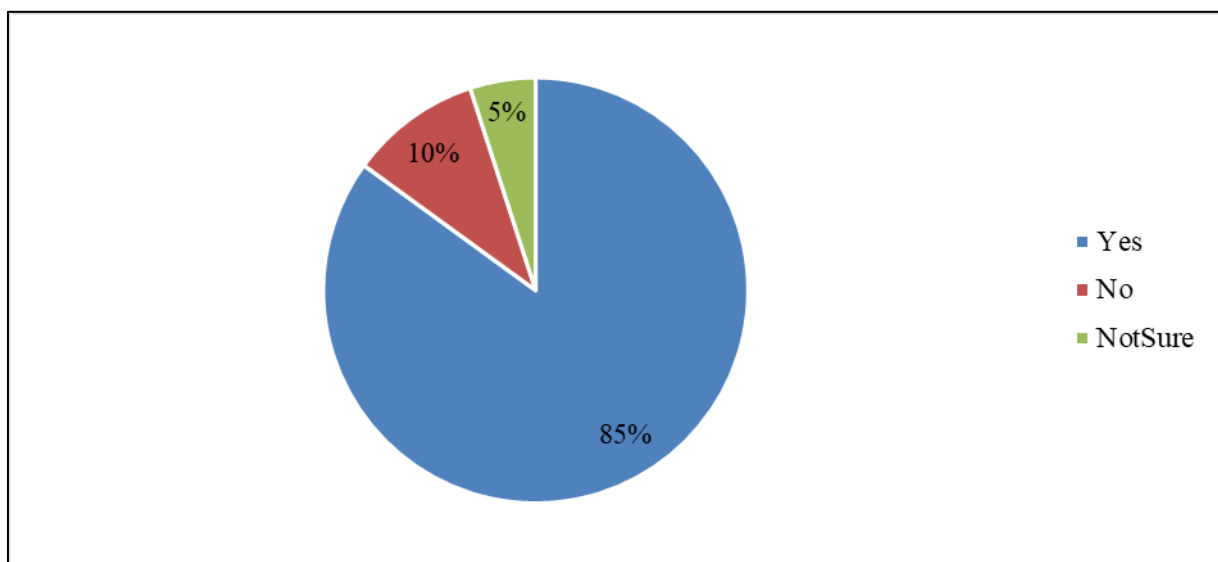


Figure 8 State of worker awareness of implemented ergonomic interventions

The surveyed work places shows a positive outlook on the implementation of Human Factors Engineering, with a significant 85% of participants affirming that such interventions have been adopted as shown in Figure 8. However, the 10% of workplaces without HFE interventions and the 5% of uncertain responses highlight areas where further awareness and implementation efforts may be needed. Ensuring that all employees are aware of and benefit from these interventions is crucial for maximizing their impact on workplace safety and accident reduction in Zimbabwean manufacturing settings.

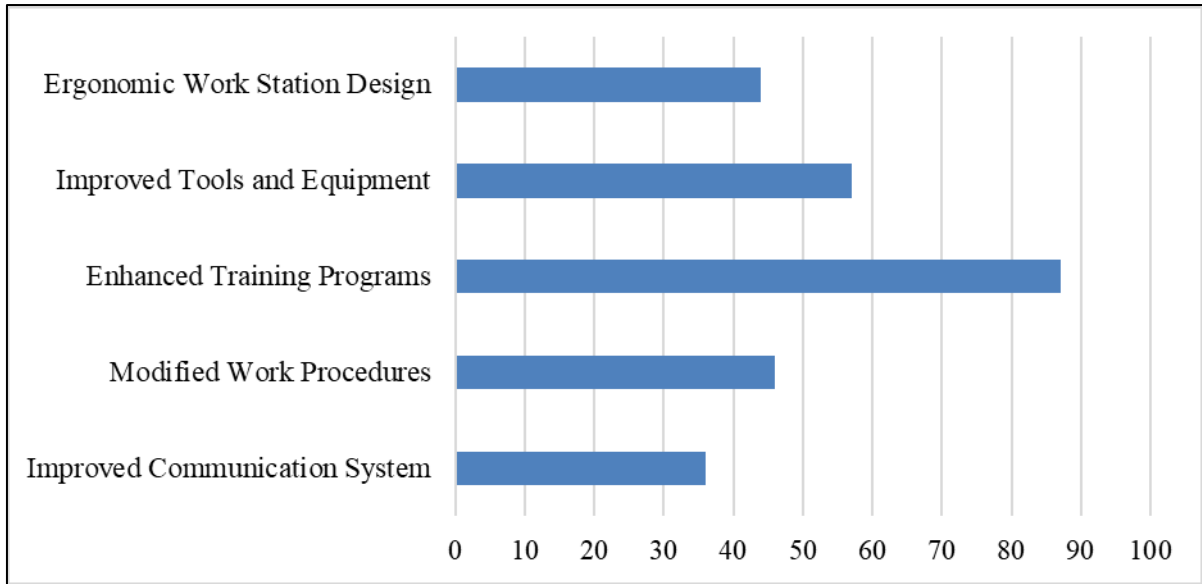


Figure 9 Implemented human factors engineering interventions by industry

Enhanced Training Programs are the most common HFE interventions as shown on Figure 9, with a strong emphasis placed on educating workers about safety practices. Other significant interventions include ergonomic workstation design, improved tools and equipment, and modified work procedures, all of which contribute to creating a safer and more efficient work environment. Improved communication systems, though selected by fewer respondents, remain a vital component of effective HFE strategies. Overall, these findings suggest that the integration of multiple HFE interventions is essential for enhancing workplace safety in Zimbabwean manufacturing settings.

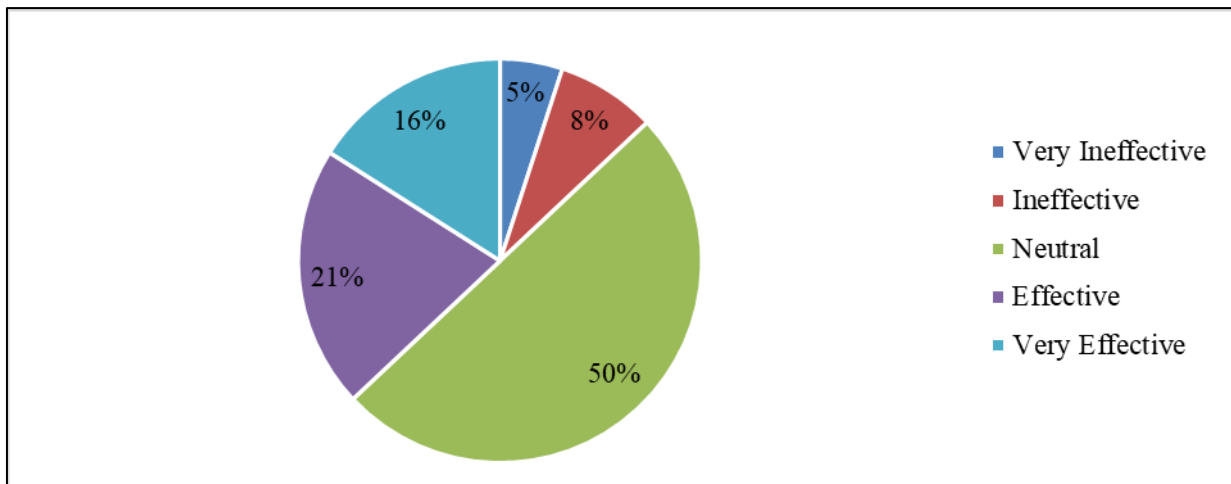


Figure 10 Human factors interventions effectiveness

The results as shown in Figure 10 suggest that while some individuals see the HFE interventions as beneficial, a significant portion of respondents either remain neutral or are sceptical about their effectiveness in reducing workplace accidents in Zimbabwean manufacturing. This highlights a need for re-evaluating and possibly strengthening these interventions to achieve better safety outcomes.

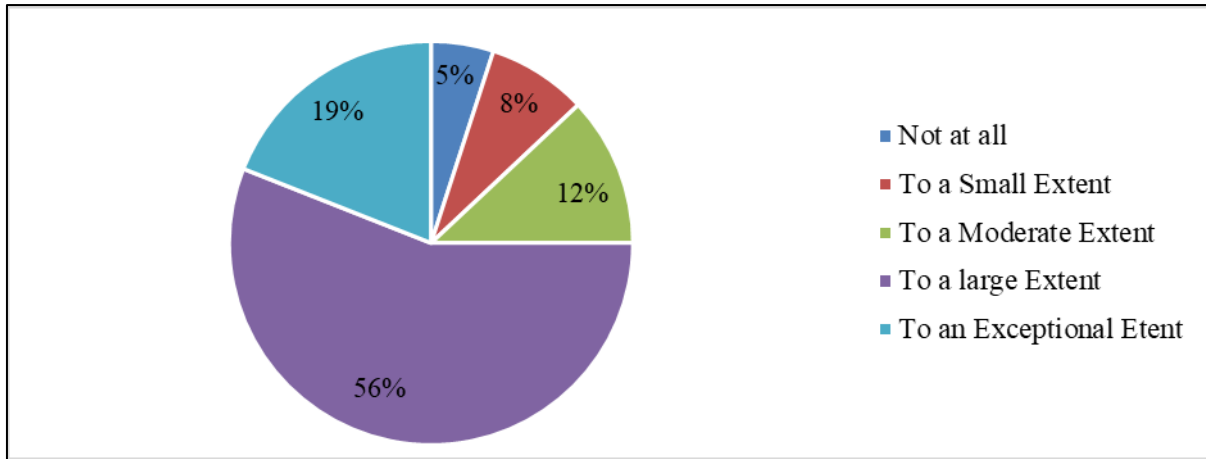


Figure 11 Improvements due to Human Factors Engineering Implementations

The findings as shown in Figure 11 suggest that the HFE interventions in the Zimbabwean manufacturing sector are generally perceived as effective in improving worker comfort and performance, with a majority of respondents experiencing significant positive impacts. The data supports the value of these interventions, while also highlighting the need to address the concerns of the few who feel they have seen little to no benefit.

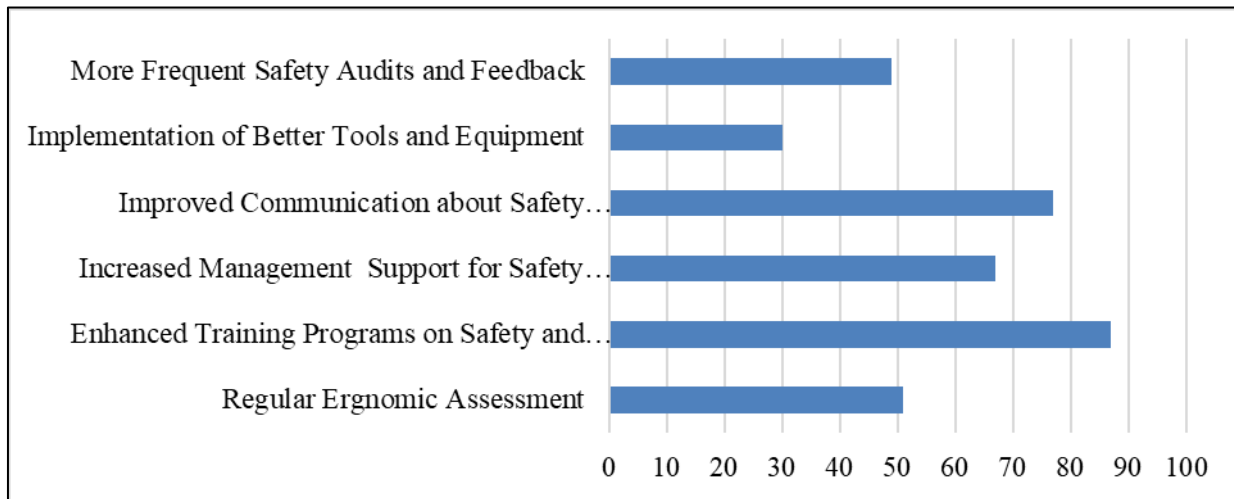


Figure 12 Industry suggested Human Factors Engineering Interventions

The results from Figure 12 suggests that while various interventions are valued, there is a strong preference for enhancing training programs and improving communication and management support within the organization. These are seen as the most effective ways to improve safety, indicating that any future efforts should prioritize these areas. Regular ergonomic assessments and safety audits are also important, but less so than the top priorities. The relatively lower emphasis on better tools and equipment might indicate that these are seen as secondary to human factors and organizational practices in enhancing safety.

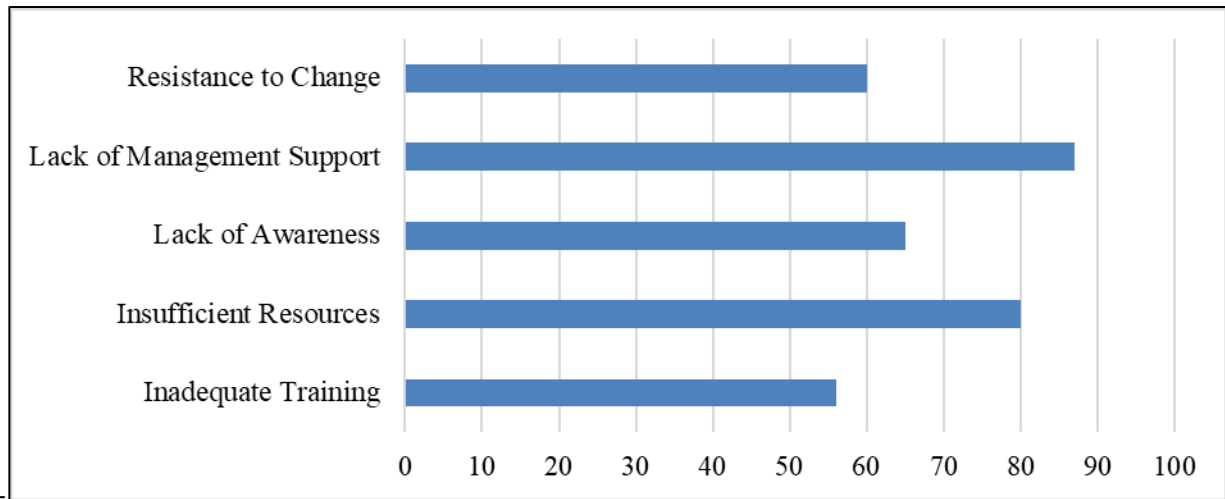


Figure 13 Barriers to Human factors Engineering implementation

The main barriers identified are a lack of management support, awareness, and resources, along with resistance to change and inadequate training. To successfully implement HFE, addressing these issues through leadership engagement, awareness campaigns, and training programs would be crucial.

5. Discussion

The findings of the study suggest that HFE interventions, particularly ergonomic design and enhanced training programs have the capability to significantly improve workplace safety within the Zimbabwean Manufacturing Sector. However, the study also highlighted the need for stronger support from the Management as well as awareness campaigns to ensure the successful implementation of HFE strategies.

6. Conclusions

The study concluded that, Human Factors Engineering offers a viable approach to reducing workplace accidents in the Zimbabwean Manufacturing sector. By addressing key human factors such as safety culture, ergonomic design and training, Manufacturers can thus create safer and more productive work environments. Future efforts though can focus on strengthening management support and awareness in order to maximise the impact of HFE interventions.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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