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## **IMPACT OF SAFETY MEASURES ON OCCUPATIONAL ACCIDENTS AMONG CAST IRON FOUNDRY WORKERS**

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### **ABSTRACT**

*The cast iron foundry industry is highly vulnerable to occupational accidents due to various contributing factors. This study is an attempt to pinpoint the major risk factors for workplace accidents among foundry workers in the cast iron foundry industry, Kegalle district, Sri Lanka. The main objective of this study is to evaluate the relationship between selected three independent variables (use of personal protective equipment (PPE), safety training, and management commitment) and their impact on occupational accidents. Data was collected from 117 foundry workers using the convenience sampling method and analyzed through the SPSS software package. The findings reveal that the use of PPE and safety training have a weak negative correlation with occupational accidents indicating a modest protective effect. On the other hand, management commitment shows a strong negative relationship with occupational accidents, highlighting its crucial role in enhancing workplace safety. In conclusion, the study emphasizes the significance of management commitment in reducing occupational accidents and suggests that while PPE and safety training contribute to safety, their impact is comparatively smaller. These insights call for increased focus on managerial practices to foster a safer working environment in the cast iron foundry industry.*

**Keywords:** Management Commitment, Occupational Accidents, Safety Training, Use of Personal Protective Equipment

### **1. Introduction**

A foundry is a sort of facility where ferrous metals are melted and shaped into desired shapes. Though less well-known, the foundry sector serves several industries including water pumps, marine, automotive, and engineering significantly contributing to the economy of the country (de Silva, 2019). Hence, the productivity and security of these foundry workers are critical to their success. According to Senavirathne & Kularathne (2020) maintaining worker safety is essential for efficient

production and overall organizational performance. Despite its significance, Sri Lanka's foundry sector frequently experiences accidents at work that carry a high risk of damage. The rapidly increasing number of accidents has led to reduced production in the foundry industry as well as a reduction in the quality of products. According to the Worldwide Labor Organization report in 2020, "Approximately 4% of the worldwide gross national product (GNP) is lost due to cost of losses, deaths, and illnesses, work absence, treatments and payments due to disability or death" (Senavirathne & Kularathne, 2020).

Existing research has extensively documented various hazards in the casting industry including cancer, asthma, and musculoskeletal disorders (Mottin et al., 2012). Previous research conducted in other industries like shipyards, construction (Mohammadi et al., 2018), petrochemicals (Zahiri et al., 2020), and electrical work (Baby et al., 2021) has identified several factors that affect occupational accidents. Since the studies focusing specifically on the factors influencing accidents in the foundry industry are very limited, there is a significant knowledge gap regarding these factors in the Sri Lankan foundry industry. Even though some research has touched on ergonomic analysis (Mottin et al., 2012) and the use of personal protective equipment (PPE) in foundries, the specific factors leading to accidents have not been comprehensively addressed. Hence, the purpose of this study is to determine the major risk factors for workplace accidents in the Kegalle district cast iron foundries and to evaluate their impacts. The following research objectives were developed to achieve in the study.

- To determine factors that influence occupational accidents among foundry workers.
- To find out the factor that has a greater impact on occupational accidents among foundry workers.

This study employs a quantitative research approach to investigate the factors contributing to occupational accidents among foundry workers. Data was collected from 117 respondents. The independent variables examined include the use of personal protective equipment (PPE), safety training, and management commitment. Data analysis was performed using the SPSS software package to evaluate the relationships between these independent variables and the occurrence of accidents.

The analysis revealed that management commitment has a strong negative correlation with occupational accidents by emphasizing its critical role in enhancing workplace safety. Both PPE usage and safety training demonstrated a weak negative correlation with accident rates by indicating their notable protective effects. The findings suggest that enhancing management practices and commitment to safety can significantly reduce accident rates in the foundry industry. This research highlights the importance of focused interventions aimed at enhancing

safety protocols and management assistance which promotes a more secure work environment for employees at foundries.

This study holds significant value for foundry management by identifying key factors contributing to occupational accidents, which enables management to take effective preventative actions. Creating a safer work environment is a critical responsibility of management to improve business processes by reducing disruptions caused by accidents, improving productivity, and enhancing product quality. Moreover, reducing accident-related costs such as compensation, labor loss, and production downtime leads to cost savings. Additionally, this study fills a crucial gap in research on occupational accidents within the Sri Lankan foundry industry, contributing valuable insights to improve safety and overall operational efficiency in this high-risk sector.

## **2. Literature Review**

### **2.1. Occupational Accidents**

An occupational accident is an unplanned event occurring in the workplace, often resulting in negative consequences. The body of research highlights the significant effects that occupational accidents have on society, the economy, and health in developed as well as developing countries (Jafari et al., 2019). According to data from the International Labour Organization (ILO), there are over 340 million workplace accidents globally each year with a worker experiencing an accident every 15 seconds that results in death every 15 seconds. According to Porru et al. (2017), the annual economic cost of these incidents is estimated to be 4% of the world's gross domestic product (GDP). Because of the direct and indirect costs of accidents, workplace safety is still a major concern on a global scale.

According to Mottin (2012), there is a corresponding increase in workplace accidents in the casting foundry sector when the workforce and working hours grow. Hence, there are significant threats to the environment and the health of employees associated with foundries.

#### **2.1.1. Foundry Industry-Specific Accidents and Precautions**

The foundry industry is recognized as one of the most hazardous working environments, largely due to the high temperatures, heavy machinery, molten metals, and exposure to harmful substances. The casting processes involve complex mechanical operations which expose workers to numerous risks including burns, cuts, and respiratory issues from inhaling toxic materials.

Workers are regularly exposed to molten metals and hot surfaces like furnaces which increase the risk of severe burns and scalds. Molten metal spills and contact with heated machinery are frequent causes of burns in foundries (Rahmani et al., 2013). Foundry workers often suffer from physical injuries due to heavy machinery, falling

objects, and sharp tools. According to a thorough investigation conducted by the US Department of Labor, 26% of foundry-related injuries affect the hands and fingers, and 23% affect the feet and toes. These wounds are frequently cut, and scrapes are brought on by improper handling of heavy materials. According to Mgonja (2017), workers in foundries are exposed to harmful substances like silica dust, chemicals, and other airborne particles, posing a significant risk to their respiratory health. Long-term exposure to silica dust has been linked to chronic respiratory diseases such as silicosis, a prevalent occupational hazard in foundries.

Local studies highlight the high prevalence of physical injuries and exposure to toxic fumes due to insufficient use of PPE and lack of proper safety protocols (Munasinghe & de Silva, 2005). Moreover, common injuries such as cuts, lacerations, and trauma from heavy machinery are prevalent due to the nature of manual labor in foundries (Mgonja, 2017). Current safety precautions in the foundry industry focus on minimizing exposure to hazards and preventing accidents primarily through the use of Personal Protective Equipment and proactive safety measures. Commonly used PPE includes heat-resistant gloves and protective clothing to guard against burns from molten metals and hot surfaces, respirators and masks to prevent inhalation of hazardous fumes, silica dust, airborne particles, face shields, and safety goggles to protect against splashes of molten metal and harmful debris (Rahmani et al., 2013; Porru et al., 2017). Additionally, steel-toe boots are crucial for protecting feet from falling objects and molten spills while hearing protection such as earplugs and earmuffs, safeguards against noise-induced hearing loss (Mgonja, 2017).

In addition to PPE, foundries implement comprehensive safety training programs to educate workers about proper handling techniques, hazard recognition, and emergency procedures (Senavirathne & Kularathne, 2020). Regular safety audits and inspections are conducted to identify potential risks and ensure compliance with safety regulations.

## **2.2. Management Commitment and Occupational Accidents**

Management commitment involves the participation and involvement of top management in ensuring worker safety. It is a major factor in the success of organizational safety programs. Management's commitment should be evident in both actions and words while management participation is crucial for creating a safety culture with leaders playing roles in safety caring, coaching, and controlling. Effective leaders are highly caring and controlling (Wu et al., 2010).

Evidence shows a direct relationship between management commitment and accident reduction. Research indicates that leadership and safety are interconnected with managers at various levels having

distinct roles in implementing safety (Wu et al., 2010). Strong management commitment reduces workplace risks and improves short-term and long-term safety. Poor management commitment negatively impacts worker health and safety (Berhan, 2020). In the petrochemical industry, poor management commitment is a top factor contributing to occupational accidents.

Studies in the construction industry show that high management commitment significantly improves worker safety (Zin & Ismail, 2012). Management commitment leads to positive changes in employee attitudes toward safety. A positive association exists between management commitment and safety behaviors in manufacturing workers (Hassan et al., 2020). Management commitment is crucial for safety performance in various industries including construction and healthcare (Subramaniam et al., 2016). High management commitment correlates with lower accident rates and enhanced safety compliance while effective communication between management and workers is essential for safety (Setyawan et al., 2021). Even though management commitment is generally a strong predictor of safety performance, some studies indicate that senior managers may prioritize cost reduction and production over safety which affects safety outcomes (Setyawan et al., 2021). This inconsistency suggests that the emphasis on management commitment must be balanced with other organizational priorities.

H1: Management commitment has a significant relationship with occupational accidents among foundry workers in the cast iron foundry industry, Kegalle district, Sri Lanka.

### **2.3. Safety Training and Occupational Accidents**

Safety training is a learning program that educates employees about protecting themselves from workplace hazards. It is a critical factor in organizational success (Senavirathne & Kularathne, 2020) which provides employees with the knowledge and skills to perform tasks safely (Hassan et al., 2020). Implementing safety programs can significantly reduce occupational accidents and injuries in manufacturing organizations (Taufek et al., 2016).

Many countries have enacted occupational health and safety legislation to emphasize the importance of safety training (Senavirathne & Kularathne, 2020). Effective safety training programs begin by identifying training needs and setting safety objectives followed by selecting suitable training methods within the budget constraints (Hassan et al., 2020).

Research in the manufacturing sector in Sri Lanka has concluded that there is not a strong correlation between safety training and the accident rate among workers (Senavirathne & Kularathne, 2020). However, other studies have found a positive relationship between safety training and worker safety behavior consistent with findings in

the vehicle maintenance and construction industries (Zin & Ismail, 2012). Also, safety training has been identified as a predictor of workplace accidents and is significantly associated with safety compliance (Subramaniam et al., 2016).

Effective safety training can lead to behavioral and attitudinal changes among workers which improve safety performance (Setyawan et al., 2021). A positive safety environment enhances workers' job involvement and creates a healthier workplace. Safety training not only reduces accident rates but also cuts costs and saves lives (Zin & Ismail, 2012). It should be a proactive strategy addressing all workplace issues (Subramaniam et al., 2016).

H2: Safety training has a significant relationship with occupational accidents of foundry workers in the cast iron foundry industry, Kegalle district, Sri Lanka.

#### **2.4. Use of Personal Protective Equipment (PPE) and Occupational Accidents**

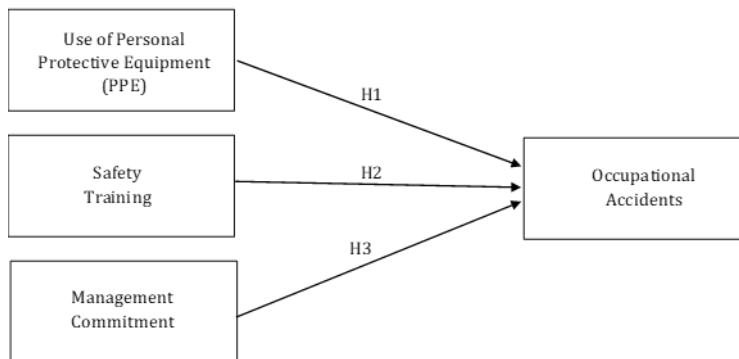
Personal Protective Equipment (PPE) is essential for protecting workers from accidents. Various types of PPE are available to protect different parts of the body. Literature indicates that risky behavior is a major factor influencing accidents (Jafari et al., 2019). Many foundry workers are reluctant to wear PPE because it poses significant threats such as high temperatures, hot metal splashes, radiation, dust, and burns. The usage rate of PPE among factory workers varies between 20.6% and 82.4%, with evidence suggesting that wearing the correct protective device is critical for minimizing accidents (Tessema & Sema, 2022).

Health and safety are crucial aspects of ergonomics and research has found that 80% to 90% of accidents are caused by human error and unsafe behavior. However, research among Latino residential roofing workers shows a negative relationship between safety behaviors and reduced PPE use as workers often find PPE uncomfortable and believe it reduces productivity. In the electric sector, 30% of accidents are due to a lack of protective equipment (Rahmani et al., 2013). Appropriate PPE is effective in protecting workers' health and safety when risks cannot be avoided or processes cannot be improved (Abrampa Apreko et al., 2015). In small-scale industries, low PPE usage exposes employees to various hazards (Balkhyour et al., 2019). Studies indicate that 70.7% of fatal occupational accidents in the U.S. construction sector result from non-use of PPE.

The use of PPE depends on workers' attitudes and behaviors and is often the last line of defense in hazard control especially in developing countries (Hanna et al., 2017). According to WHO, PPE can significantly reduce workers' exposure to various hazards. Globally, 34% of occupational accidents are due to non-use of PPE, while 13% result from improper PPE use (Tessema & Sema, 2022). In developing countries,

inadequate PPE usage is a significant factor contributing to poor health and safety conditions. The high prevalence rate of accidents among construction workers is partly due to the non-use of PPE (Hanna et al., 2017). Many workers spend long hours in unsafe conditions without PPE leading to injuries, underscoring the significant relationship between PPE usage and work injuries.

H3: The use of PPE has a significant relationship with occupational accidents of foundry workers in the cast iron foundry industry, Kegalle district, Sri Lanka.



**Figure 1:** Conceptual Framework.

### 3. Methodology

#### 2.1. Research Design

This study adopts a positivistic research philosophy, suitable for large samples and quantitative methods to provide objective causal explanations. The deductive approach is utilized, starting with established theories from literature and developing hypotheses to test these theories (Baby et al., 2021; Senavirathne & Kularathne, 2020).

A quantitative method is chosen for its structured and specific nature by enabling clear definitions and recognitions. Even though some qualitative methods have been employed in similar research to gather detailed opinions, the quantitative approach is more commonly used to study factors impacting occupational accidents. Data collection is conducted using a survey strategy with self-administered questionnaires which is a method widely used in previous research (Senavirathne & Kularathne, 2020).

This study employs a descriptive cross-sectional design by collecting data at a single point in time to examine the impact of personal protective equipment, safety training, and management commitment on occupational accidents among cast iron foundry workers in the Kegalle district of Sri Lanka.

#### 2.2. Population and Sample

The population of this study includes all foundry workers in the cast iron

foundries in the Kegalle district, Sri Lanka. Due to the difficulty of collecting data from the entire population, the convenience sampling method was employed under non-probability sampling. Two cast iron foundries in the Kegalle district were selected and all 117 workers from these foundries constituted the sample.

The unit of analysis for this study is the individual, where each worker's response is treated as a separate data source. This approach aligns with previous studies on similar topics which also used individuals as the unit of analysis (Hanna et al., 2017).

### **2.3. Data Collection**

Primary data is the foundation of this research as all results depend on the data gathered. To fulfill the research objectives, valuable data were collected using a self-administered structured questionnaire. The questionnaire was translated into Sinhala and comprised 21 items including demographic questions from previous studies (Abrampa Apreko et al., 2015; Shukla & Srivastava, 2016). Secondary data, which are already available, were collected by referring to existing research articles in both foreign and local contexts and company records related to occupational accidents.

The primary data collection instrument was the questionnaire that was designed to gather information necessary for evaluating the research hypotheses. The secondary data helped develop the theoretical framework of the research. The questionnaire consisted of three main sections where section A measured demographic factors such as age, profession, years of working in the foundry sector, education level, and marital status. Section B measured the independent variables including the use of PPE, safety training, and management commitment and Section C measured exposure to occupational accidents, injury, or disease in the workplace.

For measurement scales, this study used closed-ended questions to quantify responses utilizing a five-point Likert scale to measure independent variables where respondents indicated their level of agreement with given statements (1 - Strongly Disagree, 2 - Disagree, 3 - Neutral, 4 - Agree, 5 - Strongly Agree). To measure the dependent variable, which is occupational accidents, a dichotomous scale was used with respondents selecting "Yes" or "No."

### **2.4. Data Analysis**

Data was collected manually from the distributed questionnaires and analyzed using quantitative data analysis tools SPSS software version 26. Descriptive statistical methods were used to summarize and visualize data by making it easier to understand the findings. Pearson correlation analysis measured the relationship between independent and dependent variables while the internal consistency of the



questionnaire was assessed using Cronbach's alpha value. Inferential statistics such as linear regression analysis was also used to understand the impact of independent variables on the dependent variable.

## 4. Results and Discussion

### 4.1. Reliability Analysis

Reliability refers to the consistency and stability of a particular variable over time. A commonly used metric for assessing reliability is Cronbach's alpha which calculates the average correlation between items in a questionnaire. As a coefficient, Cronbach's alpha indicates the extent to which items within a variable are positively correlated. A higher Cronbach's alpha value closer to 1, signifies greater internal consistency and reliability. Generally, a scale is considered reliable if its Cronbach's alpha value exceeds 0.7.

**Table 1:** Summary of Reliability Analysis.

Variable	Cronbach's Alpha	Conclusion
Management commitment	0.880	Reliable
Safety training	0.874	Reliable
Use of PPE	0.767	Reliable

The reliability analysis indicates that all variables have Cronbach's alpha values above the threshold of 0.7, confirming their reliability. Management commitment has the highest Cronbach's alpha value at 0.880 while the use of personal protective equipment has the lowest at 0.767. These results validate the internal consistency and reliability of the scales used in this study.

### 4.2. Correlation Analysis

Correlation analysis explores the associative relationships between variables. This study used Pearson Correlation to assess the relationships between the independent variables (use of personal protective equipment, safety training, management commitment) and the dependent variable (occupational accidents).

**Table 2:** Summary of Correlation Analysis.

Variable	Pearson Correlation	Significance (P-Value)	Relationship
Management commitment	-0.568	0.000	Strong Negative
Safety training	-0.368	0.000	Weak Negative
Use of PPE	-0.370	0.000	Weak Negative

This study investigated the impact of factors such as the use of

PPE, safety training, and management commitment on occupational accidents among foundry workers in the cast iron foundry industry. The findings provide insights that directly link to the objectives of the study.

The first objective was to determine the factors that influence occupational accidents among foundry workers. The study identified three main factors (PPE use, safety training, and management commitment) and the correlation analysis showed significant relationships between these factors and occupational accidents. Specifically, PPE use and safety training had a weak negative relationship with occupational accidents which indicates that increased use of PPE and better safety training are associated with fewer accidents. This aligns with findings from previous studies by reinforcing the importance of these factors in accident prevention (Senavirathne & Kularathne, 2020; Zin & Ismail, 2012). Management commitment showed a stronger negative relationship with occupational accidents highlighting the critical role of management in ensuring workplace safety. This finding suggests that when management prioritizes health and safety, it significantly reduces the likelihood of accidents (Taufek et al., 2016).

The second objective was to identify which factor has the greatest impact on occupational accidents among foundry workers. The results indicated that management commitment is the primary factor impacting occupational accidents followed by PPE use and safety training.

## **5. Conclusion and Implications**

This study explored the impact of PPE, safety training, and management commitment on occupational accidents among cast iron foundry workers in the Kegalle District revealing important insights and implications. The results underscored that management commitment plays the most significant role in reducing occupational accidents showing a strong negative relationship. This finding aligns with the broader understanding that proactive and engaged leadership is critical to workplace safety, especially in industries like cast iron foundries where the risks are elevated due to exposure to molten metal, heavy machinery, and toxic fumes. The data supports the idea that management must take an active role not only in providing safety measures but also in fostering a culture that prioritizes safety at every level.

PPE usage and safety training were also found to contribute to accident reduction though their impact was weaker. In cast iron foundries, PPE must be specially designed to withstand extreme heat and protect workers from specific hazards such as molten metal splashes and harmful dust. According to the OSHA guidelines employers in foundries are required to comply with safety protocols for exposure to hazardous substances like silica and metal fumes, maintain proper

ventilation, ensure the use of PPE, and implement safety training for all workers. OSHA also mandates that workplaces must be kept free from recognized hazards that can cause injury. Hence, the importance of comprehensive safety training in handling industry-specific risks is very important. Though the relationship between these factors and accident rates was not as strong as management commitment, they remain essential components of a safe working environment.

Worker negligence is a significant factor in occupational accidents and is addressed under OSHA regulations through requirements for safety training, proper use of PPE, and adherence to safety protocols. Employers are responsible for ensuring workers understand safety procedures, but workers are also expected to comply with these guidelines. Negligence, such as failing to wear PPE, ignoring safety rules, or bypassing machine safeguards can result in accidents. Despite recognizing the protective benefits of PPE, many workers do not use it which results in production and financial losses (Balkhyour et al., 2019). For instance, only 12% of workers consistently use PPE while 60% do not lead to increased accidents (Abrampa Apreko et al., 2015). Similarly, research in Ethiopia shows that 32.2% of accidents are due to the non-use of PPE and improper PPE usage accounts for 19% of occupational accidents among tree workers in Italy (Proto et al., 2016).

However, the study acknowledges certain exceptions and limitations. The weaker relationships between PPE use, safety training, and occupational accidents highlight the possibility that other unexamined variables such as worker fatigue or operational hazards could play a larger role in accident prevention. Moreover, the small sample size of 117 respondents and the use of closed-ended questionnaires may limit the depth and breadth of the findings, making it difficult to generalize them to other settings or industries.

The study's theoretical implications contribute to the broader literature on occupational safety by reaffirming the critical role of management commitment in preventing workplace accidents. Practically, the findings suggest that cast iron foundries like those in Kegalle District should prioritize management engagement in safety matters, creating a culture where leadership consistently addresses safety risks and responds to worker needs. While PPE and safety training are essential, they must be continuously updated and tailored to the specific dangers inherent in cast iron foundries where the working conditions present unique risks.

### **5.1. Future Research Areas**

Future research should consider expanding the conceptual framework to include additional variables such as work-life balance, housekeeping, overtime work, working conditions, self-esteem, and social support. A larger sample size and the inclusion of open-ended questions could

provide deeper insights and enhance the validity of the findings. Moreover, investigating the moderating roles of demographic factors such as age, occupation, education, and experience could offer a more comprehensive understanding of the factors influencing occupational accidents.

By addressing these areas, future studies can further improve the understanding of occupational safety in the foundry industry which will lead to more effective interventions and safer working environments.

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