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Occupational Risk Assessment and Workplace Safety Improvement Using HIRARC and 5S in a Plastic Injection Moulding Industry: A Case Study of PT. XYZ

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ABSTRAK

PT. XYZ merupakan perusahaan manufaktur yang bergerak di bidang jasa plastic injection moulding sesuai permintaan pelanggan. Aktivitas produksinya melibatkan berbagai potensi bahaya yang dapat menyebabkan kecelakaan kerja akibat interaksi pekerja dengan mesin, material panas, dan kondisi lingkungan kerja yang belum tertata secara optimal. Penelitian ini bertujuan mengidentifikasi potensi bahaya, menilai tingkat risiko kecelakaan kerja, serta mengevaluasi kondisi tempat kerja menggunakan metode Hazard Identification, Risk Assessment, and Risk Control (HIRARC) yang dikombinasikan dengan 5S. Kombinasi kedua metode dipilih karena HIRARC berfokus pada identifikasi, penilaian, dan pengendalian risiko, sedangkan 5S mengevaluasi organisasi tempat kerja, kebersihan, standardisasi, dan disiplin kerja yang berkontribusi terhadap terjadinya risiko. Penelitian menggunakan pendekatan studi kasus dengan mengintegrasikan analisis kualitatif melalui observasi, wawancara, dan dokumentasi serta analisis kuantitatif melalui penilaian risiko menggunakan skor Likelihood × Consequence. Kategori risiko ditentukan berdasarkan nilai risk rating, yaitu low risk (1–4), moderate risk (5–9), dan high risk (10–25). Hasil penelitian mengidentifikasi 16 potensi bahaya, terdiri atas 1 kategori high risk (7%), 9 kategori moderate risk (60%), dan 6 kategori low risk (33%). Risiko tertinggi ditemukan pada proses injection moulding, yaitu potensi tangan pekerja terjepit mesin. Analisis 5S menunjukkan bahwa aspek Seiton, Seiso, dan Shitsuke masih memerlukan perbaikan, terutama terkait penataan material, kebersihan area kerja, dan kedisiplinan penggunaan alat pelindung diri. Implikasi praktis penelitian ini adalah memberikan prioritas perbaikan bagi perusahaan melalui penguatan SOP, peningkatan pengamanan mesin, penerapan audit 5S secara berkala, penataan area kerja, serta pengawasan penggunaan APD untuk mengurangi risiko kecelakaan kerja dan meningkatkan efisiensi operasional.

Kata Kunci: Keselamatan dan Kesehatan Kerja, HIRARC, 5S, Injection Moulding, Analisis Risiko.

ABSTRACT

*PT. XYZ is a manufacturing company specializing in **plastic injection moulding** services based on customer requirements. Its production activities involve various occupational hazards arising from worker interaction with machinery, hot materials, and inadequately organized workplace conditions. This study aims to identify workplace hazards, assess occupational risk levels, and evaluate workplace conditions by integrating the **Hazard Identification, Risk Assessment, and Risk Control (HIRARC)** and **5S** methods. The combination of these methods was selected because HIRARC focuses on hazard identification, risk assessment, and risk control, whereas 5S evaluates workplace organization, cleanliness, standardization, and employee discipline that contribute to occupational risks. The research employed a case study approach by integrating qualitative analysis through observation, interviews, and documentation with quantitative analysis using **Likelihood × Consequence** risk scoring. Risk categories were classified based on the risk rating values as **low risk (1–4)**, **moderate risk (5–9)**, and **high risk (10–25)**. The results identified **16 potential hazards**, consisting of **1 high-risk hazard (7%)**, **9 moderate-risk hazards (60%)**, and **6 low-risk hazards (33%)**. The highest risk was found in the **injection moulding** process, where workers' hands could become trapped in the injection machine. The 5S analysis further revealed that the **Seiton, Seiso, and Shitsuke** dimensions require improvement, particularly in material organization, workplace cleanliness, and compliance with personal protective equipment (PPE). The practical implications of this study provide a clear basis for prioritizing improvements through strengthened standard operating procedures, enhanced machine guarding, periodic 5S audits,* *improved workplace organization, and stricter PPE compliance to reduce occupational accidents and improve operational efficiency.*

Keywords: *Occupational Health and Safety, HIRARC, 5S, Injection Moulding, Risk Analysis.*

1. Introduction

In today's modern industrial era, the rapid development of manufacturing industries and increasingly intense business competition require companies to improve production efficiency while maintaining occupational health and safety (OHS) standards. One of the manufacturing sectors that continues to develop is the plastic injection moulding industry, which produces various plastic-based products according to customer requirements (Tjandra et al., 2026; Nasution, 2023). The production process in this industry involves various activities, including raw material handling, material mixing, heating, moulding using production machines, cutting, finishing, sorting, and packing. These activities expose workers to various potential hazards, such as being trapped in moving machine components, exposure to hot materials, contact with sharp tools or plastic edges, falling or scattered materials, and unsafe workplace conditions.

The potential hazards in plastic manufacturing activities require serious attention because occupational accidents can directly affect workers, production continuity, and company operational costs. Occupational health and safety is therefore an important factor in supporting productivity and maintaining operational performance (Patradhiani et al., 2022). A safe and comfortable work environment can minimize the potential for workplace accidents and improve employee effectiveness and efficiency. Conversely, inadequate OHS implementation may increase the possibility of workplace accidents, reduce labour productivity, disrupt production activities, and increase operational costs (Hartono, 2026; Putri & Assidiq, 2022). In addition, unsafe conditions may be caused not only by machine-related hazards but also by worker behaviour, inadequate use of personal protective equipment (PPE), poor workplace organization, and insufficient maintenance of production facilities. Therefore, the identification and control of hazards in plastic injection moulding operations are essential to prevent workplace accidents and improve the overall implementation of OHS.

PT. XYZ is a manufacturing company engaged in plastic injection moulding services that produces various plastic-based products according to customer requirements, including plastic trays, food containers, household components, and other customized products. The production activities involve several stages, including raw material preparation, material mixing, initial moulding, heating, final product moulding, inspection, assembly, finishing, and product storage. Based on preliminary observations conducted at PT. XYZ, several conditions were identified that indicate the implementation of OHS in the production area still requires improvement. Some workers were not consistently disciplined in using personal protective equipment (PPE), such as gloves, masks, and safety shoes. In addition, plastic waste and production scraps were found scattered around several workstations, material and product arrangements were not fully organized, and production machines still presented potential hazards during operation. These conditions may increase the likelihood of workplace accidents, particularly in activities involving direct interaction between workers, machines, hot materials, cutting tools, and plastic waste.

One method that can be applied to systematically identify and control workplace hazards is HIRARC (Hazard Identification, Risk Assessment, and Risk Control). The main advantage of HIRARC is its systematic and structured approach, which enables potential hazards to be identified, risks to be assessed based on their likelihood and consequences, and control measures to be prioritized according to the level of risk (Rakhman et al., 2022;

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Amalia et al., 2023). Through this approach, companies can determine which hazards require immediate attention and develop control measures based on the priority of the identified risks. However, risk assessment alone does not fully address workplace conditions that may contribute to the occurrence of accidents, such as poor material arrangement, scattered waste, inadequate equipment maintenance, and low worker discipline.

The 5S method provides a complementary approach by focusing on workplace organization, cleanliness, standardization, and employee discipline. The five principles of 5S, namely Seiri (Sort), Seiton (Set in Order), Seiso (Shine), Seiketsu (Standardize), and Shitsuke (Sustain), help create a more organized, clean, standardized, and disciplined work environment (Itsnani & Hariastuti, 2023; Azmi et al., 2025; Sumitra, 2025). The advantage of 5S is that it addresses workplace conditions and employee behaviour that may indirectly contribute to occupational hazards. For example, proper material arrangement can reduce the risk of falling or obstructing materials, routine cleaning can minimize hazards caused by scattered production waste, standardization can support consistent safety procedures, and discipline can improve compliance with PPE and other OHS requirements.

Therefore, the integration of HIRARC and 5S is important because the two methods address different but interconnected aspects of occupational health and safety. HIRARC focuses primarily on identifying hazards, assessing the level of risk, and determining appropriate risk controls, while 5S focuses on improving the physical organization of the workplace and sustaining safe and disciplined work practices. The results of HIRARC can identify priority hazards that require control, while 5S can support the implementation and sustainability of improvements through better workplace organization, cleanliness, standardization, and worker discipline. By integrating both methods, the analysis can provide a more comprehensive evaluation of OHS conditions by linking specific occupational risks with the workplace conditions and behaviours that may contribute to those risks.

Several previous studies have applied the HIRARC method to identify hazards and assess occupational risks in various industrial environments. Other studies have examined the implementation of 5S as an approach to improve workplace organization, work discipline, productivity, and occupational safety (Itsnani & Hariastuti, 2023; Azmi et al., 2025; Sumitra, 2025). These studies demonstrate the usefulness of HIRARC for identifying and prioritizing occupational risks and the role of 5S in improving workplace organization and employee discipline. However, previous studies generally discuss HIRARC and 5S as separate analytical approaches, while the relationship between the identified occupational risks and workplace conditions related to the 5S principles remains less comprehensively discussed, particularly in plastic manufacturing operations involving multiple production stages and direct interaction between workers and production machinery. This indicates a research gap in the need for an integrated analysis that not only identifies and assesses occupational hazards but also evaluates the workplace conditions and work discipline that may influence the occurrence and control of those hazards.

Based on these problems and the identified research gap, this study aims to identify potential occupational hazards, assess the level of workplace accident risks, and evaluate workplace conditions based on the 5S principles at PT. XYZ. The HIRARC method is used to identify hazards and determine the level of risk associated with each production activity, while the 5S method is used to evaluate workplace organization, cleanliness, standardization, and worker discipline. The integration of both methods is expected to provide a more comprehensive basis for recommending improvements to OHS implementation through risk control, improved PPE compliance, machine maintenance, workplace organization, and the implementation of a sustainable 5S work culture.

2. Research Method

This study employed a qualitative research method using a case study approach. The research was conducted at PT. XYZ in April 2026. The object of this study was the occupational health and safety conditions of production activities in the plastic manufacturing process. The observation focused on several production activities, including raw material preparation, material mixing, initial moulding, heating, final product moulding, sorting, cutting, finishing, packing, and product storage.

Primary data were obtained through direct observation of production activities and workplace conditions. The observation was conducted in the production area to identify potential hazards related to machine operation, material handling, exposure to hot materials, sharp objects, plastic waste, personal protective equipment (PPE), and workplace organization. The study did not use a formal questionnaire or structured survey involving a group of respondents. Information regarding the production process and workplace conditions was obtained through field observation and confirmation with the production supervisor. Documentation of the production area and work activities was also used as supporting data. Secondary data were obtained from company-related information, books, journals, and other literature related to occupational health and safety, HIRARC, and 5S.

The HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method was used to identify potential hazards, assess occupational risk levels, and determine appropriate risk control measures. Hazard identification was conducted by observing each production activity directly. The identified hazards were assessed using two parameters, namely Likelihood and Consequence. Likelihood represents the probability of an incident occurring, while Consequence represents the severity of the impact if the incident occurs. The risk rating was calculated using the following equation:

$$\boxed{\text{Risk Rating} = \text{Likelihood} \times \text{Consequence}}$$

The Likelihood and Consequence scores were determined based on direct observations of the production activities and confirmation of the observed conditions with the production supervisor. The production supervisor was involved because of their direct knowledge of the production process, machine operation, work activities, and workplace conditions. The assessment criteria for Likelihood and Consequence are presented in Table 1.

The validity of the risk assessment was maintained through the comparison of multiple sources of information, including direct observation, confirmation with the production supervisor, and supporting documentation. The identified hazards and assigned risk scores were reviewed to ensure that they corresponded to the actual conditions of the production activities. The assessment results were then confirmed with the production supervisor to verify the relevance of the identified hazards, their likelihood of occurrence, and their potential consequences.

The 5S method was applied to evaluate workplace conditions based on the principles of Seiri (Sort), Seiton (Set in Order), Seiso (Shine), Seiketsu (Standardize), and Shitsuke (Sustain). The analysis focused on material arrangement, tool and product organization, workplace cleanliness, machine and equipment maintenance, standardization of work practices, and worker discipline in implementing occupational health and safety procedures.

The research process began with a preliminary study and initial observation of the production area. The next stage involved identifying the research problems and determining the research objectives. Data were then collected through direct observation, confirmation with the production supervisor, documentation, and literature studies. The collected data were subsequently analyzed using the HIRARC and 5S methods. The HIRARC analysis consisted of hazard identification, risk assessment, and risk control determination, while the 5S analysis was used to evaluate workplace organization, cleanliness, standardization, and worker discipline. The final stage involved interpreting the research findings and formulating recommendations to improve occupational health and safety conditions at PT. XYZ.

3. Result and Discussion

3.1 Company Overview

PT. XYZ is a manufacturing company engaged in injection moulding services. The company produces various plastic-based products according to customer demand, such as plastic trays, food containers, household components, and other customized products. The production process in PT. XYZ involves several stages, including raw material preparation, material mixing, heating process, product molding using injection moulding machines, finishing, and product packaging.

The implementation of Occupational Health and Safety (OHS) in the production area is an important aspect that must be considered because the production process involves machines, hot materials, sharp tools, and manual handling activities that may cause workplace accidents. Therefore, an analysis of occupational health and safety is needed to identify potential hazards and determine appropriate risk control measures in the production process.

3.2 Data Collection and Processing

Data collection in this study was carried out through interviews, direct field observations, and documentation. The collected data were then analyzed using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method and the 5S method. The analysis focused on identifying hazards, assessing risk levels, and evaluating workplace conditions in the injection moulding production area.

The production process at PT. XYZ consists of several operational stages. The process begins with the preparation of raw materials, followed by the mixing process using a mixer machine. After the materials are mixed, the process continues to the initial molding stage using an injection moulding machine. The products then undergo inspection before entering the heating process using a rotary machine. Afterward, the products are molded into final products using a blow moulding machine, followed by another inspection stage. The next stages are assembly and finishing before the products are stored in the warehouse.

The operational process chart of PT. XYZ production activities is shown in Figure 1.

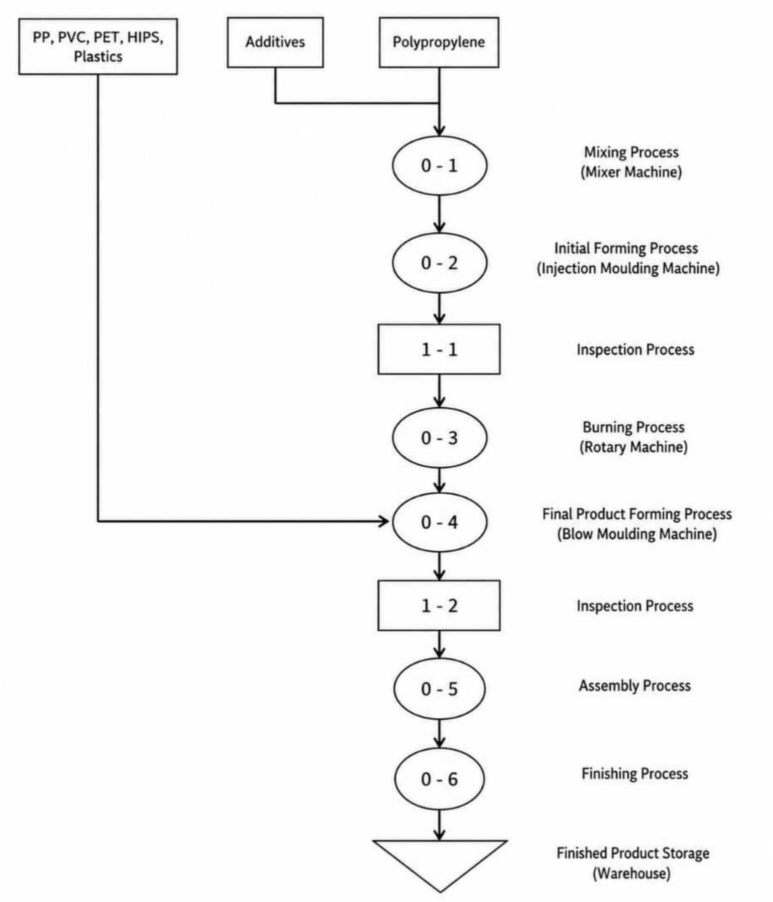

Figure 1. Operation Process Chart of PT. XYZ

Description:

- O-1 : Mixing Process (Mixer Machine)
- O-2 : Initial Molding Process (Injection Moulding Machine)
- I-1 : Inspection Process
- O-3 : Heating Process (Rotary Machine)
- O-4 : Final Product Molding Process (Blow Moulding Machine)
- I-2 : Inspection Process
- O-5 : Assembly Process
- O-6 : Finishing Process
- ▼ : Product Storage in Warehouse

To simplify the data analysis process, the collected data were reduced and classified into tables based on the risk assessment criteria of Likelihood and Consequence. Likelihood indicates the probability of an accident occurring, while Consequence describes the severity of the impact caused if the accident occurs.

Table 1. Likelihood and Consequence Scale

Level	Description	Explanation
5	Almost Certain	≥1 incident occurs in every shift
4	Likely	≥1 incident occurs every day
3	Possible	≥1 incident occurs every week
2	Unlikely	≥1 incident occurs every month
1	Rare	≥1 incident occurs every year
Level	**Description**	**Explanation**
1	Insignificant	No injury, minor financial loss

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2	Minor	Minor injury, small financial loss
3	Moderate	Moderate injury requiring medical treatment, major financial loss
4	Major	Serious injury involving ≥1 person, major production disruption
5	Catastrophic	Fatality involving ≥1 person, very large financial loss, and total operational shutdown

The plastic tray production process begins with the preparation of raw materials received by the warehouse operator. The vacuum machine operator then takes the raw material stock from the warehouse for the molding process. The materials are processed using a vacuum machine and formed into plastic sheets, which are then handled by the cutting operator to shape and trim the plastic trays. After the trays are formed, the products undergo finishing and sorting processes before being packed and delivered to customers.

Risk Rating represents the level of risk identified in each workstation activity. The Risk Rating value was obtained by multiplying the Likelihood value by the Consequence value for each identified hazard. The Likelihood and Consequence scores presented in Table 2 were determined based on direct observations of production activities and workplace conditions at PT. XYZ. The assessment was conducted using the Likelihood and Consequence criteria presented in Table 1 and was confirmed through discussion with one production supervisor who served as the subject-matter expert in the risk assessment. The production supervisor was selected based on their direct responsibility for and practical knowledge of the production process, machine operation, workplace conditions, and potential occupational hazards in the production area.

Table 2. Risk Assessment of Production Activities at PT. XYZ

Work Activity	Potential Hazard	Likelihood	Consequence	Risk Rating
Raw Material Preparation	Hit by materials during unloading process	2	2	4
	Sprained hand while carrying materials	1	2	2
Mixing Process (Mixer Machine)	Hand trapped in machine	1	3	3
	Hand cut by mixer blade	1	3	3
Initial Molding Process (Vacuum and Injection Moulding Machine)	Hand trapped in injection machine	2	4	8
	Hand trapped in vacuum machine	1	5	5
Plastic Melting Process	Hand exposed to heat	1	3	3
	Body exposed to hot plastic splashes	1	2	2
Final Product Molding Process (Blow Moulding Machine)	Hand trapped in machine	1	3	3
	Hand exposed to machine heat	2	2	4
Sorting Process	Hand exposed to hot plastic	2	1	2
	Hand scratched by sharp plastic edges	2	1	2
Cutting Process	Hand cut by cutting blade	2	2	4
	Foot stepped on sharp plastic fragments	2	2	4
Packing Process	Hand scratched by sharp plastic	2	1	2
	Body hit by stacked packaged products	2	1	2

The risk assessment results were based on a combination of direct field observations and expert judgment from the production supervisor. The Likelihood score was assigned by considering the possibility of a hazardous event occurring during the relevant work activity, while the Consequence score was assigned by considering the potential severity of the injury, operational disruption, or other impact if the hazardous event occurred. Each assigned score was reviewed against the criteria presented in Table 1 and confirmed through discussion with the production supervisor to ensure that the assessment reflected the actual workplace conditions.

In several workstations, two possible hazard scenarios were identified and represented by points (a) and (b) to simplify the preparation of the risk matrix. For example, the hazard of workers being struck by raw materials during unloading activities was assigned a Likelihood value of 2 and a Consequence value of 2, resulting in a Risk Rating value of 4. This value indicates that the condition requires further evaluation and improvement.

Table 3. Aspects That Do Not Meet Occupational Health and Safety Standards

Workstation	5S Aspect	Description
Mixer	Seiri	Separate raw materials that are ready to be processed from those waiting for processing
	Seiton	Arrange raw materials properly to facilitate the pouring process into the mixer machine
	Seiso	Clean spilled raw materials around the mixer machine
	Seiketsu	Maintain machine cleanliness by removing attached plastic residue and keeping the surrounding area clean
	Shitsuke	Improve worker discipline in following safety procedures and using safety equipment
Injection Moulding	Seiri	Separate unused plastic waste from the production area
	Seiton	Arrange molded plastic products properly before moving them to the next workstation
	Seiso	Clean plastic scraps remaining around the injection machine
	Seiketsu	Perform regular machine maintenance and inspections to reduce the risk of machine-related accidents
	Shitsuke	Encourage workers to consistently implement the previous 4S principles and remain careful during machine operation
Finishing	Seiri	Separate finished products ready for packing from products that still require trimming
	Seiton	Arrange finished products neatly in one area to simplify the packing process
	Seiso	Collect and clean irregular plastic cutting waste into a designated container
	Seiketsu	Maintain cutting tools regularly and clean the surrounding work area
	Shitsuke	Improve worker discipline in implementing 5S and using gloves and safety footwear

Based on the observations, the workstations with the highest occupational accident risks are the injection moulding section, followed by the mixer section and the finishing section. This condition occurs because several production activities still rely heavily on manual labor despite the availability of machines. Therefore, operator accuracy and awareness are highly important to minimize workplace accidents in the company.

3.3 HIRARC Method Analysis

The HIRARC method was used to identify potential hazards, assess the level of risk, and determine appropriate control measures for each production activity at PT. XYZ. The analysis was conducted based on direct observations of production activities and workplace conditions, followed by confirmation and discussion with the production supervisor as the subject-matter expert. The risk assessment considered the Likelihood and Consequence of each identified hazard, as presented in Table 2.

Based on the risk assessment, the identified hazards were classified into three risk levels: High Risk, Moderate Risk, and Low Risk. The results indicate that the potential

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hazards were distributed across several workstations and production activities. The differences in risk levels were influenced by the possibility of hazardous events occurring and the potential severity of their consequences.

The risk control analysis was conducted based on the hierarchy of controls, which consists of elimination, substitution, engineering control, administrative control, and personal protective equipment (PPE). The recommended controls were determined by considering the source of each hazard, the existing control measures, and the underlying causes of the identified risks. The risk control recommendations are presented in Table 4.

Table 4. Risk Control Recommendations Based on the Hierarchy of Controls

No.	Hazard	Risk Level	Existing Control	Root Cause	Recommended Control	Hierarchy of Control
1	Workers being struck by raw materials during the unloading process	Moderate	Worker supervision and manual handling procedures	Inadequate material arrangement and the absence of a clearly designated unloading area	Improve the arrangement of raw materials, establish a designated unloading area, and improve material-handling procedures	Engineering Control / Administrative Control
2	Workers being exposed to hazards during the operation of production machinery	High	Machine operating procedures and worker supervision	Direct worker exposure to moving machine components and insufficient physical separation from hazardous machine parts	Install or improve machine guards and conduct periodic machine safety inspections	Engineering Control
3	Workers being exposed to hot materials or heated machine components	Moderate	Worker awareness and basic PPE	Direct contact with hot surfaces or materials during production activities	Install heat protection barriers, provide warning signs, and establish safe operating procedures	Engineering Control / Administrative Control
4	Workers being injured by sharp plastic edges or cutting tools	Moderate	Basic PPE and work procedures	Direct contact with sharp edges and inadequate control of cutting-related activities	Provide appropriate cut-resistant gloves and improve procedures for handling sharp materials and tools	Administrative Control / PPE
5	Workers slipping or tripping due to scattered plastic waste and materials	Low	Periodic cleaning	Inadequate workplace organization and inconsistent waste management	Provide designated waste collection areas and conduct routine cleaning and 5S inspections	Engineering Control / Administrative Control
6	Workers not consistently using PPE	Moderate	PPE availability and supervision	Low worker discipline and insufficient monitoring of PPE compliance	Conduct routine PPE compliance monitoring, safety briefings, and periodic evaluations	Administrative Control / PPE

No.	Hazard	Risk Level	Existing Control	Root Cause	Recommended Control	Hierarchy of Control
7	Materials, tools, and products not being properly organized	Low	Informal workplace arrangement	Lack of standardized storage locations and workplace organization	Establish designated storage areas, visual labels, and standardized workplace layouts	Administrat ive Control / Engineering Control

The risk of workers being struck by raw materials during the unloading process is primarily related to the handling and arrangement of materials. Materials that are not placed in a clearly designated and organized area may shift or fall during the unloading process, creating a potential impact hazard for workers. Therefore, the underlying cause of this risk is not solely worker behaviour but also the lack of an effective material storage and handling arrangement. Improving the arrangement of raw materials and establishing a designated unloading area are therefore recommended to reduce the hazard at its source.

The risk associated with production machinery is related to the interaction between workers and moving machine components. Workers who operate or work near machinery may be exposed to contact, entanglement, or crushing hazards if adequate physical protection is not provided. The underlying cause of this risk is the direct exposure of workers to hazardous machine components. Therefore, engineering controls, particularly the installation or improvement of machine guards, should be prioritized. Administrative controls such as operating procedures and periodic safety inspections are also necessary to ensure that the engineering controls remain effective.

The risk of exposure to hot materials or heated machine components is caused by the high temperature involved in the production process and the possibility of direct contact during machine operation or material handling. The root cause is the presence of heat sources in the work area combined with the possibility of worker exposure during production activities. Engineering controls, such as heat protection barriers, should therefore be prioritized, while warning signs and safe operating procedures can support the control measures.

Hazards related to sharp plastic edges and cutting tools occur because workers may directly handle materials or tools capable of causing cuts or other physical injuries. The underlying cause is the presence of sharp surfaces during the cutting and finishing processes. The recommended controls include improving handling procedures and providing appropriate cut-resistant gloves. Although PPE is necessary, administrative controls should also be implemented to reduce unsafe handling practices.

Slip and trip hazards are associated with the presence of plastic waste, production scraps, and materials in the workplace. These hazards may occur because waste and unnecessary materials are not consistently removed from the work area. The underlying cause is inadequate workplace organization and inconsistent cleaning practices. The implementation of 5S, particularly Seiri, Seiton, and Seiso, is therefore important to eliminate unnecessary items, organize materials, and maintain workplace cleanliness. Designated waste collection areas and routine cleaning inspections can further support the control of these hazards.

Inconsistent PPE use is primarily related to worker discipline and the lack of continuous monitoring of PPE compliance. Although PPE may be available, workers may not consistently use it during production activities. The root cause is therefore related to behavioural and administrative factors rather than the absence of PPE alone. Regular supervision, safety briefings, and PPE compliance monitoring are recommended to improve worker discipline and ensure that PPE is used appropriately.

The risk control analysis indicates that the identified hazards cannot be effectively controlled through PPE alone. Controls should be prioritized according to the hierarchy of controls, beginning with measures that eliminate or reduce exposure to the hazard at its source. Engineering controls, such as machine guards, physical barriers, and improved workplace arrangements, are preferable where feasible because they reduce direct worker exposure. Administrative controls, including work procedures, supervision, training, and 5S inspections, are then required to maintain safe work practices. PPE serves as the final layer of protection when hazards cannot be completely eliminated or controlled through higher-level measures.

The integration of HIRARC and 5S provides a complementary approach to improving occupational health and safety at PT. XYZ. HIRARC identifies and prioritizes the hazards requiring control, while 5S addresses workplace organization, cleanliness, standardization, and worker discipline that may contribute to the occurrence of hazards. Therefore, the risk control recommendations derived from the HIRARC analysis can be supported by the implementation of 5S to ensure that improvements in the workplace are maintained consistently.

Table 5. HIRARC Risk Matrix

Likelihood	**Insignificant (1)**	**Minor (2)**	**Moderate (3)**	**Major (4)**	**Catastrophic (5)**
5 (Almost Certain)					
4 (Likely)					
3 (Possible)					
2 (Unlikely)	C1(a), C1(b), C3(a), C3(b)	A1(a), B2(b), C2(a), C2(b)		A3(a)	
1 (Rare)		A1(b), B1(b)	A2(a), A2(b), B1(a), B2(a)		A3(b)

The risk assessment process was conducted by evaluating the likelihood and consequence values of each identified hazard. Likelihood represents the probability of an accident occurring, while consequence represents the severity of the impact caused by the accident. The multiplication of these two values determines the risk rating level shown in the risk matrix.

Based on the risk assessment results, moderate risk was identified as the dominant risk category within the company, consisting of nine potential hazards with a percentage of 60%. These risks include hazards during raw material handling, mixing activities, vacuum molding processes, heating processes, blow moulding operations, and finishing activities involving cutting tools and plastic waste. Meanwhile, low-risk hazards accounted for 33% or six identified hazards. These hazards include sprains during material handling, exposure to hot plastic splashes, and minor injuries during sorting and packing activities. The high-risk category represented 7% of the identified hazards, specifically involving workers' hands being trapped in the injection moulding machine during production operations.

Although moderate and low-risk hazards may not immediately result in severe injuries, their repeated occurrence can have a significant cumulative impact on the company's operational performance. Work-related injuries, even minor ones, may cause absenteeism, reduced employee concentration, temporary work restrictions, and decreased productivity. In addition, unsafe working conditions can disrupt workflow and increase the time required to complete production activities. Consequently, the accumulation of minor incidents and near-miss events may reduce overall operational efficiency and potentially increase the risk of more serious accidents in the future.

The identified risks may also affect product quality. Accidents, worker fatigue, reduced concentration, or interruptions during production activities can increase the possibility of human error, defects, rework, and material waste. For example, disruptions in the mixing, molding, heating, and finishing processes may result in inconsistencies in product dimensions, surface quality, or production output. Therefore, occupational health and safety risks should not only be viewed as threats to worker safety but also as factors that may influence production consistency and the achievement of quality standards.

Furthermore, workplace accidents may generate both direct and indirect costs for the company. Direct costs may include medical treatment, compensation, equipment repair, and the replacement of damaged materials or components. Meanwhile, indirect costs may arise from production downtime, investigation processes, worker replacement, overtime requirements, reduced productivity, and potential delays in fulfilling customer orders. These costs can be particularly significant when accidents occur in critical production areas, such as injection moulding, where the interruption of machinery and the involvement of skilled workers may directly affect production capacity.

Based on the identified risks, the highest risk was identified in the injection moulding section because manual worker involvement is still necessary despite machine utilization. An accident in this area has the potential to cause serious worker injuries, extended production downtime, reduced productivity, and significant financial losses. Therefore, risk mitigation efforts should include improving standard operating procedures (SOPs) for each work activity, strengthening administrative management systems, enforcing stricter safety regulations, and applying sanctions for workers who violate safety procedures.

In addition, the company should increase supervision regarding the use of personal protective equipment (PPE), install hazard warning signs, and establish clear evacuation routes within the production area. Occupational health and safety training programs and certifications should also be provided regularly to improve employee awareness and safety performance. The implementation of these controls is expected not only to reduce the likelihood and severity of workplace accidents but also to minimize production disruptions, prevent quality deterioration, reduce material waste and accident-related costs, and improve overall operational productivity.

Therefore, the implementation of HIRARC-based risk controls should be considered an integral part of the company's operational improvement strategy. Effective risk management can provide dual benefits by protecting workers from occupational hazards while simultaneously supporting production continuity, product quality, cost efficiency, and the long-term sustainability of company operations.

3.4 5S Method Analysis

To provide a more objective evaluation of workplace organization, the implementation of 5S at PT. XYZ was assessed using a quantitative 5S audit checklist. The audit consisted of five dimensions: Seiri (Sort), Seiton (Set in Order), Seiso (Shine), Seiketsu (Standardize), and Shitsuke (Sustain). Each dimension was evaluated using a five-point rating scale, where 1 indicates very poor implementation and 5 indicates excellent implementation. The assessment was conducted through direct workplace observations and verified by the production supervisor.

Table 6. Quantitative 5S Audit Results

5S Principle	Score	Percentage	Category
Seiri	3	60%	Fair
Seiton	2	40%	Poor
Seiso	2	40%	Poor
Seiketsu	3	60%	Fair
Shitsuke	2	40%	Poor
Average	**2.4**	**48%**	**Needs Improvement**

The audit results indicate that the overall implementation of the 5S principles at PT. XYZ achieved an average score of 2.4 out of 5 (48%), indicating that workplace organization and housekeeping practices still require significant improvement. The lowest scores were obtained in the Seiton, Seiso, and Shitsuke aspects, suggesting that workplace arrangement, cleanliness, and employee discipline remain the primary issues affecting occupational health and safety performance.

The Seiri (Sort) assessment obtained a score of 3 (60%), indicating that unnecessary materials had not been completely separated from production areas. Raw materials, finished products, and plastic scraps were frequently stored together, making material handling less efficient and increasing the possibility of workplace accidents.

The Seiton (Set in Order) aspect received a score of 2 (40%). Observations showed that several tools, including cutting knives and supporting equipment, were not consistently returned to their designated storage locations after use. In addition, the layout of the finishing workstation remained disorganized because finished products, raw materials, and production tools were positioned too closely together, reducing workflow efficiency.

The Seiso (Shine) aspect also obtained a score of 2 (40%). Plastic scraps and production waste were still scattered around production machines and workstations. These conditions created slip and trip hazards, reduced workplace cleanliness, and increased the possibility of minor occupational accidents.

The Seiketsu (Standardize) aspect achieved a score of 3 (60%). Although routine maintenance activities had been implemented, no standardized maintenance schedule or documented inspection procedure was consistently applied across all production areas. Consequently, equipment conditions varied between workstations.

The lowest performance was found in the Shitsuke (Sustain) aspect, which obtained a score of 2 (40%). Workers were still inconsistent in complying with established occupational safety procedures, particularly regarding the use of personal protective equipment (PPE). This finding indicates that continuous supervision and reinforcement of safety culture are still required.

Overall, the quantitative audit demonstrates that PT. XYZ has not yet achieved satisfactory implementation of the 5S principles. The identified deficiencies correspond closely with the hazards identified through the HIRARC analysis, particularly those related to scattered materials, poor workplace organization, inadequate housekeeping, and inconsistent PPE compliance. Therefore, strengthening 5S implementation is expected to reduce occupational risks while simultaneously improving workplace efficiency.

The findings of this study are consistent with those reported by Itsnani and Hariastuti (2023), who found that integrating HIRARC with the 5R/5S approach significantly improved workplace organization and supported occupational safety by reducing unnecessary materials and promoting standardized work practices. Similarly, this study found that poor workplace organization and housekeeping contributed to several identified occupational hazards.

The results are also consistent with Azmi et al. (2025), who concluded that implementing the 5R methodology together with Green Productivity improved workplace cleanliness, operational efficiency, and employee awareness of occupational safety. Likewise, the present study identified Seiso and Seiton as the weakest aspects, indicating that deficiencies in housekeeping and workplace organization remain major contributors to unsafe working conditions.

Furthermore, the findings support Sumitra (2025), who demonstrated that consistent implementation of the 5S principles positively influences employee productivity and work discipline. The low score obtained in the Shitsuke aspect in this study suggests that management commitment, regular training, and continuous monitoring are essential for sustaining employee discipline and improving occupational safety performance.

In addition, the findings are in agreement with Patradhiani et al. (2022), who reported that improvements in occupational health and safety management contribute positively to employee productivity. A cleaner, more organized, and standardized workplace not only minimizes occupational accidents but also improves operational efficiency and reduces production interruptions.

Based on these findings, several improvement strategies are recommended. The company should conduct periodic weekly 5S audits, implement monthly evaluations of workplace organization and material handling systems, establish standardized storage locations supported by visual management, and strengthen employee training programs related to 5S implementation. Regular monitoring of PPE compliance, scheduled equipment maintenance, and continuous management commitment are also necessary to sustain workplace improvements. Through these corrective actions, PT. XYZ is expected to reduce occupational accident risks while creating a safer, cleaner, and more productive working environment.

4. Conclusion

This study identified 16 occupational hazards in the injection moulding production process at PT. XYZ using the HIRARC method, consisting of 1 high-risk hazard (7%), 9 moderate-risk hazards (60%), and 6 low-risk hazards (33%). The highest risk was identified in the injection moulding workstation, where workers were exposed to the hazard of their hands being trapped by the injection machine. The quantitative 5S assessment further indicated that workplace organization remained below the expected standard, particularly in the Seiton, Seiso, and Shitsuke aspects, demonstrating deficiencies in workplace organization, housekeeping, and employee discipline.

The integration of HIRARC and 5S provides both scientific and practical contributions. Scientifically, this study demonstrates that combining risk assessment with a structured workplace organization audit offers a more comprehensive approach to evaluating occupational health and safety than applying either method independently. Practically, the findings provide a clear priority for improvement at PT. XYZ, beginning with the injection moulding workstation, followed by strengthening machine guarding, improving workplace organization, implementing standardized storage systems, enforcing PPE compliance, and conducting routine 5S audits to reduce occupational risks and improve operational efficiency.

Future studies are recommended to evaluate the effectiveness of the proposed improvements through pre- and post-implementation assessments using quantitative safety performance indicators, such as accident frequency, near-miss incidents, and productivity measures. Further research involving multiple manufacturing companies or different industrial sectors would also improve the generalizability of the findings and provide broader evidence regarding the effectiveness of integrating HIRARC and 5S in occupational health and safety management.

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