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Hazard Identification, Risk Assessment, and Control (HIRAC) on Furniture Production Process at Furniture X

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Abstract: Occupational safety and health are critical concerns in the furniture production industry, which involves various potential hazards. Poorly managed risks can adversely affect worker safety and health. This study aims to identify hazards, assess risks, and recommend control measures for the furniture production process at Mebel X using the Hazard Identification, Risk Assessment, and Control (HIRAC) method. The research employs a descriptive approach, utilizing direct observation and semi-structured interviews with business owners and workers. The analyzed production stages include material preparation, cutting, engraving, assembling, sanding, and finishing. Risk analysis is based on the levels of probability and severity, categorized as Low Risk, Moderate Risk, High Risk, and Very High Risk. The findings reveal that certain stages, such as material preparation, cutting, and finishing, carry a Very High Risk level. Key hazards identified include direct contact with sharp tools, exposure to wood dust, and hazardous chemicals such as thinner and paint. The primary contributing factors to these risks are unsafe actions, failure to use personal protective equipment (PPE), and suboptimal working conditions. The study concludes that the furniture production process at Mebel X poses significant risks, necessitating the implementation of risk control measures based on the Hierarchy of Control to ensure workplace safety and create a safer working environment.

Keywords: furniture production, HIRAC, occupational risk, occupational safety and health

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INTRODUCTION

Occupational Safety and Health (OSH) is an essential aspect of industrial operations, ensuring the safety and well-being of workers while maintaining productivity. OSH encompasses all conditions and factors that can impact workers' safety and health. In Indonesia, OSH is governed by Law No. 1 of 1970 concerning workplace safety, which defines the workplace as any space or field, enclosed or open, mobile or fixed, where workers are employed. This definition includes all areas associated with the workplace, such as rooms, fields, yards, and surrounding areas (Irfan, 2018). Despite these regulations, workplace accidents remain a significant challenge, often resulting from unsafe conditions, unsafe worker actions, and interactions between humans and the work environment (Tarwaka, 2014, cited in Putra, 2017).

Work-related incidents, including occupational diseases, cause material losses, injuries, and health issues that disrupt production processes, harm the environment, and ultimately affect society. Effective risk management strategies are essential to mitigate these hazards, prevent incidents, and minimize their impact (Fitriyani et al., 2023). According to ISO 45001, a hazard is a source with the potential to cause injury or ill health. Similarly, OHSAS 18001 defines a hazard as a source, condition, or action capable of causing accidents, injuries, or other adverse effects. Hazard control is thus critical to ensuring safety and health in the workplace. Workers in the informal sector often lack awareness and knowledge about workplace hazards, leaving them vulnerable to risks that can disrupt productivity. These risks include hazardous working conditions and health issues such as musculoskeletal disorders, eye strain, and skin conditions. Informal workers also face challenges due to the absence of formal business entities or employers directly responsible for their safety and health, particularly concerning occupational illnesses and accidents (Suma'mur, 2014, cited in Sunaryo et al., 2022).

At Mebel X, furniture production involves six main stages: material preparation, cutting, engraving, assembling, sanding, and finishing. Due to the predominantly manual processes, workers face numerous potential hazards, including hand and foot injuries, respiratory problems from wood dust, and musculoskeletal disorders. To address these risks, this study applies the HIRAC (Hazard Identification, Risk Assessment, and Control) method to identify, assess, and mitigate hazards in the production process at Mebel X (Willy Afredo, 2021). HIRAC is a key component of Occupational Safety and Health Management Systems (OSHMS), focusing on hazard prevention and control. The HIRAC process involves classifying work types, identifying hazards, assessing risks, and determining risk rankings. By categorizing risks into low, moderate, high, and extreme levels, HIRAC provides a structured framework for implementing effective control measures. This approach ensures a safer and healthier workplace while preventing workplace accidents (Raihan Januar Anggoro, 2023).

METHODS

This study employed a descriptive approach, with data collected through direct observations at the research site and semi-structured interviews with the furniture owner and workers. The sample was determined using the saturated sampling method, in which the entire population becomes part of the research sample. This method was chosen to ensure precise representation and achieve a high level of accuracy. The respondents included four workers, each an expert in specific areas such as cutting, assembling, filling, painting, and polishing furniture.

Data processing was conducted using the HIRAC (Hazard Identification, Risk Assessment, and Control) method. HIRAC was utilized to analyze the consequences of activities performed during the furniture production process at Mebel X. The method involves identifying hazards, assessing risks to determine their potential levels, and establishing control measures based on the collected data to develop a comprehensive HIRAC model. Hazard identification serves to detect potential dangers during production activities. Risk identification forms the foundation of risk management, as effective risk management is not possible without proper hazard identification (Wijaya et al., 2015).

The HIRAC preparation stages followed the standard matrix of AS/NZS 4360:2004, beginning with risk identification to determine sources of hazards from the observed activities (Triswandana & Armaeni, 2020). Subsequently, risk assessment was conducted using evaluations of probability (Table 1) and severity (Table 2). The results of the risk assessment were then used to generate a matrix value (Table 3).

RESULT AND DISCUSSION

Observations and interviews conducted with workers and the business owner of Mebel X revealed various hazards and risks associated with each stage of the furniture production process. The production stages include material preparation, cutting, engraving, assembling, sanding, and finishing. Observations and interviews involved direct examination of each production stage to identify potential hazards. After hazard identification through observations and interviews, an in-depth analysis was conducted based on OHSAS 18001:2007 Clause 4.3.1 and AS/NZS 2004 standards using the HIRAC (Hazard Identification, Risk Assessment, and Control) method, as shown in Table 4. The HIRAC analysis began with hazard identification to determine and recognize potential hazards in each work activity. Risk assessment followed, involving evaluations of probability and severity to understand the potential impacts of identified hazards. The product of probability and severity was evaluated using a risk matrix, categorizing risks as Low, Moderate, High, or Very High. Based on this assessment, control recommendations were made according to the risk levels identified (Marwah et al., 2024).

The HIRARC analysis identified several potential hazards at each stage of the furniture production process at Mebel X. Risk assessment was conducted systematically, considering the probability and severity of each identified hazard. Using a risk matrix, the risks were categorized as Low, Moderate, High, or Very High. Several stages required particular attention and appropriate control measures, with significant findings in the early production stages. During the material preparation stage, hazards categorized as Very High Risk were identified, scoring 20 (probability = 5, severity = 4). This stage involves preparing raw wood materials and cutting them to the required dimensions. A key physical hazard is the risk of contact with machine blades, particularly table saws, which can cause cuts and bleeding. The primary cause of this high risk is unsafe actions, such as failure to use Personal Protective Equipment (PPE) like cut-resistant gloves, which are designed to protect against cuts and punctures (Noventya Cahyani et al., 2022).

The cutting stage also revealed Very High risks, with a score of 20 (probability = 5, severity = 4). Workers use both machine saws for large cuts and manual saws for detailed or specialized cuts. A significant hazard is exposure to wood dust, which can irritate the eyes and potentially cause respiratory issues, including Acute Respiratory Infections (ARIs) when inhaled. Research by Pristianto et al. (2023) demonstrated a high risk of ARIs in the furniture industry, with symptoms such as sore throat, difficulty swallowing, runny nose, and non-productive cough frequently reported. Suboptimal air circulation in enclosed workshop spaces exacerbates wood dust exposure.

In the engraving stage, a Very High risk (score = 20) was identified due to physical hazards such as inhalation of wood dust and direct contact with sharp tools, which can cause cuts and bleeding. Additionally, ergonomic hazards, such as muscle injuries from improper working postures, were identified with a Moderate risk level (probability = 5, severity = 2). Bhatt and Bhatia (2023) found similar risks among traditional wood engravers, noting that poor ergonomics in engraving work can lead to musculoskeletal disorders, affecting long-term health and productivity. Recommendations include ergonomic workstation setups and schedule breaks every 1-2 hours. The assembly stage involves combining wood components using nails, hammers, knives, and adhesives. This stage poses Very High risks (probability = 5, severity = 4) due to the potential for hand injuries from sharp tools. Fitriyani et al. (2023) reported that 76% of furniture workers experienced workplace injuries during assembly, including cuts and blunt trauma. Recommended controls include work instructions, safety signs, and the use of safety gloves to reduce the risk of injuries.

The sanding process revealed two Very High-risk hazards. Manual sanding with abrasive tools presents a physical hazard due to friction with plate edges, which can cause cuts. The inhalation of fine wood dust also poses a Very High risk due to its high probability of occurrence. Schlünssen (2021) noted that exposure to fine wood dust during sanding is particularly hazardous because the small particle size allows deeper penetration into the respiratory system. Recommended controls include the use of respirator masks, leather gloves, and proper ventilation to minimize exposure. The finishing stage involves applying protective and aesthetic coatings, using chemical materials such as wood filler, wood stain, sanding sealer, thinner, and melamine clear. These materials contain harmful chemicals like formaldehyde, nitric acid, sulfuric acid, xylene, and toluene, which can cause skin irritation and contact dermatitis. Witasari and Sukanto (2014) noted that contact dermatitis is one of the most common occupational skin diseases, with hands being the most frequently affected area. Control measures include work instructions, education on Material Safety Data Sheets (MSDS), proper waste management, and the use of PPE such as safety goggles, respirator masks, and rubber or PVC gloves (Azady et al., 2018).

Risk control measures were developed following the hierarchy of control. Recommendations aim to minimize or reduce the identified risks, utilizing control strategies including elimination, substitution, engineering controls, administrative controls, and PPE. Administrative controls such as work instructions and safety signs serve as reminders for workers to adhere to safe procedures. Regular machine maintenance is essential to prevent wear and damage, ensuring safe operation. Compliance with PPE use, mandated by PERMENAKERTRANS (Regulation of the Minister of Manpower and Transmigration) No. PER.08/MEN/VII/2010 ensures workers are adequately protected from workplace hazards.

CONCLUSION

Based on observations and interviews with workers and the business owner at Mebel X, it was found that every stage of furniture production, from material preparation to finishing, involves significant hazards and risks. Using the HIRAC method, the researchers identified, assessed, and categorized risks for each work activity based on probability and severity levels. The analysis revealed a range of risk levels, from Low Risk to Very High Risk, requiring special attention and appropriate control measures. The material preparation stage was identified as having a Very High Risk, primarily due to the potential for direct contact with machine blades. This risk was exacerbated by unsafe actions, such as a lack of vigilance and failure to use appropriate personal protective equipment (PPE). Similarly, the cutting stage exhibited a Very High Risk, with workers facing potential injuries from saws and respiratory issues from wood dust exposure. In the engraving stage, Very High-Risk hazards were associated with exposure to wood dust and sharp carving tools, while ergonomic risks due to improper working postures were categorized as Moderate. The assembly stage presented a Very High Risk due to injuries from sharp objects, such as nails and knives. In the sanding stage, Very High Risk was attributed to exposure to fine wood dust, which can lead to respiratory issues, as well as injuries caused by friction with sanding tools. The finishing stage involved significant risks from hazardous chemicals, including formaldehyde and toluene, which posed threats such as contact dermatitis and respiratory complications. Overall, the furniture production process at Mebel X encompasses various physical, chemical, and ergonomic hazards, with several stages classified as Very High Risk. The primary factors contributing to these risks include unsafe worker behaviors, inadequate use of PPE, and suboptimal working conditions. By implementing control strategies aligned with established occupational safety and health standards, these risks can be effectively minimized. Such measures not only enhance worker safety and health but also contribute to the sustainability of production by fostering a safer and more efficient working environment.

DECLARATION OF GENERATIVE AI

The authors declare that no generative AI or AI-assisted technologies were used in the writing process of this manuscript.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDIX

Table 1. Determination of Probability

Level	Category	Description
1	*Rare*	Rarely occurs
2	*Unlikely*	Small chance of occurence
3	*Moderate*	May occur
4	*Likely*	Likely to occur
5	*Almost certain*	Almost certain to occur

Table 2. Determination of Severity

Level	Category	Description
1	*Insignificant*	No injuries, no financial loss, and minimal material losses
2	*Minor*	Minor injuries requiring first aid, moderate financial and material losses
3	*Moderate*	Lost workdays, requiring medical treatment, significant material losses
4	*Major*	Injuries causing disability or total loss of bodily function, significant material losses
5	*Catastrophic*	Causes death, very significant material losses

Table 3. Risk Assessment Matrix AS/NZS 4360: 2004

Probability	***Severity***					
	Insignificant	***Minor***	***Moderate***	***Major***	***Catastrophic***	***Value***
Almost Certain	***Low***	***Moderate***	***High***	***Very High***	***Very High***	5
Likely	***Low***	***Moderate***	***Moderate***	***High***	***Very High***	4
Possible	***Low***	***Low***	***Moderate***	***Moderate***	***High***	3
Unlikely	***Low***	***Low***	***Low***	***Moderate***	***Moderate***	2
Rare	***Low***	***Low***	***Low***	***Low***	***Low***	1
Value	1	2	3	4	5	

Table 4. HIRAC Analysis of the Furniture Production Process at Mebel X

Job Activity	Hazard	Risk	P	S	RR	Risk Control
Discussion	Physical Hazards	Splinter injury	5	2	Moderate	• Creation of work instructions • Use of safety gloves
		Hit by falling objects	4	2	Moderate	• Creation of work instructions • Installation of safety signs • Use of safety shoes
		Hit by machine blade	5	4	Very High	• Training for workers • Creation of work instructions • Routine maintenance on machines • Installation of safety signs • Use of safety gloves
		Punctured by sharp tools	2	2	Low	• Creation of work instructions • Use of safety gloves
	Ergonomic Hazards	Muscle injury due to incorrect working position	5	2	Moderate	• Provision of trolleys • Manual handling training • Stretching for 3 minutes every 1-2 hours
	Biological Hazards	Animal bites	2	5	Moderate	• Installation of barriers with outside areas • Cleaning the work area twice a week • Use of work clothes, safety shoes
	Psychosocial Hazards	Fatigue	4	1	Low	• Giving rewards to workers • Creating a break schedule
	Physical Hazards	Contact with the saw blades	5	4	Very High	• Training for workers • Creation of work instructions • Routine maintenance on machines • Installation of safety signs • Use of safety gloves
		Inhalation of sawdust	5	4	Very High	• Cleaning the work area twice a week

Job Activity	Hazard	Risk	P	S	RR	Risk Control
						• Installation of safety signs • Worker health checks • Use of respirator masks
		Sawdust skin/eye contact	5	3	High	• Cleaning the work area twice a week • Installation of safety signs • Worker health check • Use of wear packs, safety glasses, and safety gloves
		Noise	4	2	Moderate	• Installation of safety signs • Machine maintenance • Use of earplugs
Cutting		Tripping/falling over tools, materials, and cables	4	2	Moderate	• Safe and neat electrical installation arrangements • Use of cable ties
		Electric shock	4	4	High	• Developing work instructions • Making a schedule for checking electrical installations
	Ergonomic Hazards	Muscle injury due to incorrect working position	5	2	Moderate	• Workstation arrangement that is suitable for body posture • Stretching for 3 minutes every 1-2 hours of work
	Psychosocial Hazards	Fatigue	4	1	Low	• Giving rewards to workers • Making a break schedule
	Biological Hazards	Animal bites	2	5	Moderate	• Installation of barriers with outside areas • Cleaning the work area twice a week • Use of wear packs, safety shoes
	Physical Hazards	Exposed to carving tools	5	2	Moderate	• Making work instructions • Installation of safety signs • Use of safety gloves

Job Activity	Hazard	Risk	P	S	RR	Risk Control
Engraving		Inhalation, exposure to sawdust	5	4	Very High	• Cleaning the work area twice a week • Installation of safety signs • Worker health checks • Use of respirator masks, safety goggles
	Ergonomic Hazards	Muscle injury due to incorrect working position	5	2	Moderate	• Workstation settings that are suitable for body posture • Stretching for 3 minutes every 1-2 hours of work
	Psychosocial Hazards	Fatigue	4	1	Low	• Giving rewards to workers • Making a rest schedule
	Biological Hazards	Animal bites	2	5	Moderate	• Installation of barriers with outside areas • Cleaning the work area twice a week • Use of wear packs, safety shoes
Assembly	Physical Hazards	Fingers/Hands Exposed to sharp objects (nails, hammers)	5	4	Very High	• Making work instructions • Installation of safety signs • Use of safety gloves
		Hit by falling objects	5	2	Moderate	• Installation of safety signs • Use of safety gloves, safety shoes
		Inhalation, exposure to sawdust	5	4	Very High	• Cleaning the work area twice a week • Installation of safety signs • Worker health checks • Use of respirator masks, safety goggles
	Ergonomic Hazards	Muscle injury due to incorrect working position	5	2	Moderate	• Workstation settings that are suitable for body posture • Stretching for 3 minutes every 1-2 hours of work
	Psychosocial Hazards	Fatigue	4	1	Low	• Giving rewards to workers • Creation of a break schedule

Job Activity	Hazard	Risk	P	S	RR	Risk Control
Sanding	Physical Hazards	Exposed to sandpaper/plate edges	5	4	Very High	• Making work instructions • Installation of safety signs • Machine maintenance • Use of safety gloves
		Inhalation, exposure to sawdust	5	4	Very high	• leaning the work area twice a week • Installation of safety signs • Worker health checks • Use of respirator masks, safety goggles
	Ergonomic Hazards	Muscle injury due to incorrect working position	5	2	Moderate	• Workstation settings that are suitable for body posture • Stretching for 3 minutes every 1-2 hours of work
Finishing	Chemical Hazards	Inhalation of paint and thinner	5	3	High	• Making work instructions • Worker health checks • Providing education Material Safety Data Sheet • Installation of safety signs • Use of respirator masks
		Skin/eye contact with paint and thinner	4	3	Moderate	• Creation of work instructions • Worker health check • Providing education Material Safety Data Sheet • Installation of safety signs • Use of wear packs, safety gloves, and safety goggles
		Ingestion of paint and thinner	3	3	Moderate	• Preparation of work instructions • Worker health checks • Providing education Material Safety Data Sheet • Installation of safety signs • Use of masks
		Chemical burns	2	5	Moderate	• Providing education on Material Safety Data Sheet • Installation of safety signs

Job Activity	Hazard	Risk	P	S	RR	Risk Control
	Physical Hazards	Hit by falling objects	4	2	Moderate	• Installation of safety signs • Use of safety gloves, safety shoes
		Splinter injury	5	2	Moderate	• Making work instructions • Installation of safety signs • Use of safety gloves
	Ergonomic Hazards	Muscle injury due to incorrect working position	4	2	Moderate	• Setting up a workstation that is suitable for body posture • Stretching for 3 minutes every 1-2 hours of work
	Psychosocial Hazards	Fatigue	4	1	Low	• Giving rewards to workers • Making a break schedule