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ORIGINAL ARTICLE

Hazard Identification and Risk Assessment in a Carpentry Workshop: A Case Study

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ABSTRACT

BACKGROUND: Carpentry workshops present numerous hazards that pose significant risks to worker health and safety. Despite the substantial workforce in micro-scale workshops, these environments have received limited research attention. This study aims to identify and assess the risks associated with hazards in a selected carpentry workshop within a wire industry setting.

METHODS: Utilizing the Job Safety Analysis (JSA) method for hazard identification, we delineated the primary tasks performed by carpenters and outlined their respective steps. The AS/NZS 4360:2004 standard was employed to evaluate risk levels.

RESULTS: Our findings revealed that, under the current conditions, 14.3% of identified hazards had a risk priority number of 4, indicating a high risk; 61.9% had a risk priority number of 3, representing intermediate risk; and 23.8% had a risk priority number of 2, signifying low risk. Among the identified hazards, awkward postures accounted for the highest Relative Frequency at 19.04%, followed by falling wood at 14.28%.

CONCLUSION: Based on the findings, implementing appropriate policies, adequate supervision, and adherence to legal requirements were recommended to enhance safety and health. Ergonomic principles and load-carrying techniques in carpentry practices are crucial for mitigating risks in these workshops.

KEYWORDS: *Risk identification, Risk assessment, Risk, Safety, Carpentry workshop*

INTRODUCTION

In contemporary industrial contexts, occupational accidents result in significant injuries to workers, highlighting the adverse consequences of technological advancement and industrial growth within human societies. These incidents also have a measurable impact on companies' economic performance [1, 2]. Statistics indicate that annually, approximately 78 million workers die as a result of occupational accidents, while an estimated 374 million experience nonfatal incidents [3].

Small workshops employ around 80% of the total workforce. Despite being a focal point for employment, these environments often lack effective safety management mechanisms and are characterized by poor health and safety conditions. Contributing factors include inadequate supervision, limited safety awareness, inappropriate and unsafe tools, and the absence of safety protocols. Consequently, the likelihood of accidents in these settings is elevated,

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necessitating increased attention to safety and accident prevention [4].

Historically, investigations into workplace accidents occurred post-incident, often following significant harm. However, with advancements in technology, there is a growing emphasis on proactive measures to prevent accidents before they occur. One effective strategy for reducing occupational accidents and diseases involves identifying and assessing potential risks. Prioritizing risk identification and evaluation is essential for accident prevention and maintaining worker health [5].

Risk assessment is a critical approach for the quantitative and qualitative evaluation of potential hazards, enabling the identification and prioritization of risks. Among the various methodologies available for risk assessment, the Job Safety Analysis (JSA) method stands out as a systematic and reliable tool. It is instrumental in identifying risks and mitigating workplace accidents, thereby enhancing overall productivity. The JSA method, particularly advantageous for small workshops, requires minimal resources, equipment, and financial investment. It relies primarily on the evaluators' experience and interviews with workers, making it accessible for environments with limited facilities. By applying the JSA method, organizations can determine necessary management and engineering controls and appropriate personal protective equipment tailored to each job, empowering them to take proactive measures for safety [6, 7]. Additionally, the implementation of the JSA method can help workers gain a correct understanding of the work process and develop guidelines for safety and health [8]. According to the advantages of the JSA method and its application in small workshops with limited facilities, this approach was chosen for the current study.

Carpentry workshops represent a category of small enterprises that face significant health risks due to exposure to various harmful factors, including wood dust, noise, chemicals, and ergonomic challenges. These workshops are characterized by a high incidence of workplace hazards. A cross-sectional study in Thailand revealed that sawmills accounted for the highest percentage of workers' compensation claims [9]. Furthermore, research in Ethiopia indicated that approximately 14.7% of carpentry workers experienced occupational injuries within the previous year [10]. These findings underscore the critical nature of health and safety considerations in such environments.

Despite the evident risks, more studies are needed to address health and safety issues in small carpentry workshops in Iran. Accordingly, this study aims to identify the most significant risks in carpentry workshops, propose effective control measures, and enhance awareness among carpentry workers regarding existing risks and corresponding control solutions, ultimately reducing workplace accidents within these workplaces.

MATERIALS AND METHODS

This study was conducted in a carpentry workshop of a selected wire manufacturing facility. To implement the Job Safety Analysis (JSA) method, a multidisciplinary team comprising a supervisor, an experienced carpenter, and an occupational health expert was established. The team's diverse expertise and systematic approach ensured the thoroughness of the research. The team systematically observed and investigated the carpentry work processes.

The team carefully examined the working process of the workshop. Based on the team members' comments, it was determined that the main job is making wooden spools for the production process of the wire industry. The team reviewed this task multiple times to delineate the specific steps involved in the process. Following the identification of these steps, potential hazards associated with each were assessed using a combination of direct observation, interviews with workers, and completion of the JSA checklist.

To evaluate the level of risk, we applied the AS/NZS 4360:2004 standard (Standards Australia and Standards New Zealand) [11, 12]. This standard facilitates the assessment of risks based on two critical criteria: the probability of occurrence and the severity of potential consequences. Subsequently, the Risk Priority Number was calculated using Table 1 from the standard. The Risk Priority Numbers were then analyzed using Table 2 to prioritize risks and guide the implementation of appropriate control measures [11].

In the present study, alternatives to reduce the level of risk to a reasonable extent were determined by considering legal requirements, analysis of incidents, the financial status of the industry, available equipment, opinions of experienced workers, and consulting engineers.

Table 1. Determining the risk priority number according to the AS/NZS 4360/2004 standard

Severity	Probability	Improbable (1)	Unlikely (2)	Occasionally (3)	Likely (4)	Repetitive (5)
Catastrophic	5	4	5	5	5	5
Critical	4	3	4	4	5	5
Intermediate	3	2	3	3	4	4
Minor	2	2	2	3	3	3
Negligible	1	1	2	2	3	3

Table 2. Risk assessment criteria (AS/NZS 4360/2004 standard)

Risk Priority Number	Risk potential
5	Very high
4	High
3	Intermediate
2	Low
1	Negligible

RESULTS

This study investigated the task of making wooden spools for industry use. The task was divided into six steps, and each step was examined. Table 3 shows the completed JSA checklist.

In the present study, the risk priority numbers of hazards were investigated. The results of the descriptive statistics of the risk analysis of hazards are presented in Table 4.

The risk priority number analysis results showed that 14.3% of the identified hazards are at a high level and are related to awkward postures and manual material handling (Figure 1). Among the identified hazards, the highest relative frequency was related to awkward postures (19.04%). The relative frequency of wood drop incidents was 14.28%.

As shown in Figure 1, most of the hazards were in the intermediate category. Executive management has recommended planning and action according to the standard logical framework. Figure 2 shows the number of risks in each task.

As shown in Figure 2, the highest and lowest numbers of risks were associated with the tasks of wood cutting and sanding, and carrying wooden spools, respectively.

DISCUSSION

Carpenters face numerous hazards, including manual lifting, forceful gripping, exposure to wood dust, and injuries from various processes such as finishing, planing, scraping, and hammering [13, 14]. Conducting risk assessments is vital for ensuring safety and health in the carpentry and woodworking industries. These sectors are characterized by high accident rates and a range of occupational hazards, making risk assessment a critical aspect of workplace safety management [15]. Research indicates that small-scale subcontractors in related fields often neglect occupational health and safety regulations, resulting in insufficient safety measures [16]. The results underscore the urgent need for heightened awareness and the implementation of risk assessment practices across all levels of woodworking operations.

The Job Safety Analysis (JSA) method is instrumental in evaluating risk levels, including environmental hazards, inhalation of hazardous substances, and other potential injuries. It facilitates the identification of hazards, their effects, and consequences [9]. The current study employed JSA to identify and assess health and safety hazards in a carpentry workplace. JSA offers a structured and systematic approach to pinpointing potential hazards and evaluating the risks associated with specific job tasks [17]. This method allows for a thorough examination of each step in a work process, leading to a comprehensive understanding of workers' exposure to potential dangers [18]. In this study, the carpentry section of a particular industry involved the preparation of wooden spools for use in the company's production process. The results indicated that this carpentry job could be divided into six distinct tasks, and through analysis, a total of 16 different hazards were identified overall. One of the essential strengths of JSA is its adaptability to various work environments. For example, the Construction Job Safety Analysis (CJSA) was developed to address the unique challenges at construction sites, where the physical environment constantly changes [19].

Table 3. Job safety analysis of carpentry

Row	Step (Process)	Hazard	Consequence	Risk assessment		Control measures
				Probability	Severity	
1	Carrying wood	Wood drop incident	Injury, fracture	2	3	Using advanced tools to carry parts of wood, Using proper safety shoes
		Awkward posture, carrying loads	Musculoskeletal disorders	5	3	Training and compliance with the principles of manual material handling
2	Wood cutting	Electrocution	Death, Injury, Burn	1	4	Instructions, Earthing system, Electrical safety
		Displacement of wood	Injury	3	2	Fixing of wood, Instructions
		Projectile wood particles	Eye and face damage	3	3	Protective glasses, Protective face shield
		Awkward posture	Musculoskeletal disorders	5	2	Adjusting the height of the table, Using the right tools
		Cutting saw	Amputation, Injury	2	3	Guard, Emergency key, Working instructions, Using experienced people, Training, not wearing long and stretchy clothes
		Noise and vibration	Hearing loss and physical damage	2	2	Use of personal protective equipment
		Wood dust	Damage respiratory system	2	3	Proper ventilation, Use of personal protective equipment
		Fire	Death, Burn	1	3	Proper maintenance of equipment, Electrical safety, Work instructions, Smoking ban
3	Polishing the wood surface	Rotating Mops of the machine	Amputation, Injury	1	3	Guard, Emergency key, Work instructions, Use of trained and experienced people, Training on safety tips
		Electrocution	Death, Burns	1	4	Earth system, Instructions
		Projectile wood particles	Eye and face damage	3	3	Protective glasses, Protective face shield
4	Connecting the cut parts	Hammer strike to hand	Hand injury	4	2	Use of special gloves and nail storage tools, Change the way of doing work, Use of air hammer
		Pin sinking in the hand	Hand injury	3	2	Use of special gloves and nail maintenance tool, Use of air hammer
		Falling incident of parts	Leg injury	2	2	Use of appropriate safety shoes, Use of cleats
		Breaking the handle of the hammer	Physical injuries	2	2	Proper hammer, Use of air hammer
5	Sanding	Awkward posture	Musculoskeletal disorders	5	3	Adjusting the height of the table, Rest between tasks, Proper placement of tools and materials
		Rasp Woodworking	Hand injury	3	2	Using wooden handles, Using proper tools, Using appropriate gloves
6	Carrying wooden spools	Incident of spools falling	Leg injury	2	3	Use advanced tools to carry, Use appropriate safety shoes
		Awkward posture, carrying loads	Musculoskeletal disorders	5	3	Using advanced tools to carry, Training, and compliance with the principles of manual material handling

Table 4. Descriptive statistics of hazard risk analysis

	Probability	Severity	Risk Priority Number
Maximum	5	4	4
Minimum	1	2	2
Mean	2.71	2.71	2.90
Standard deviation	1.38	0.64	0.62

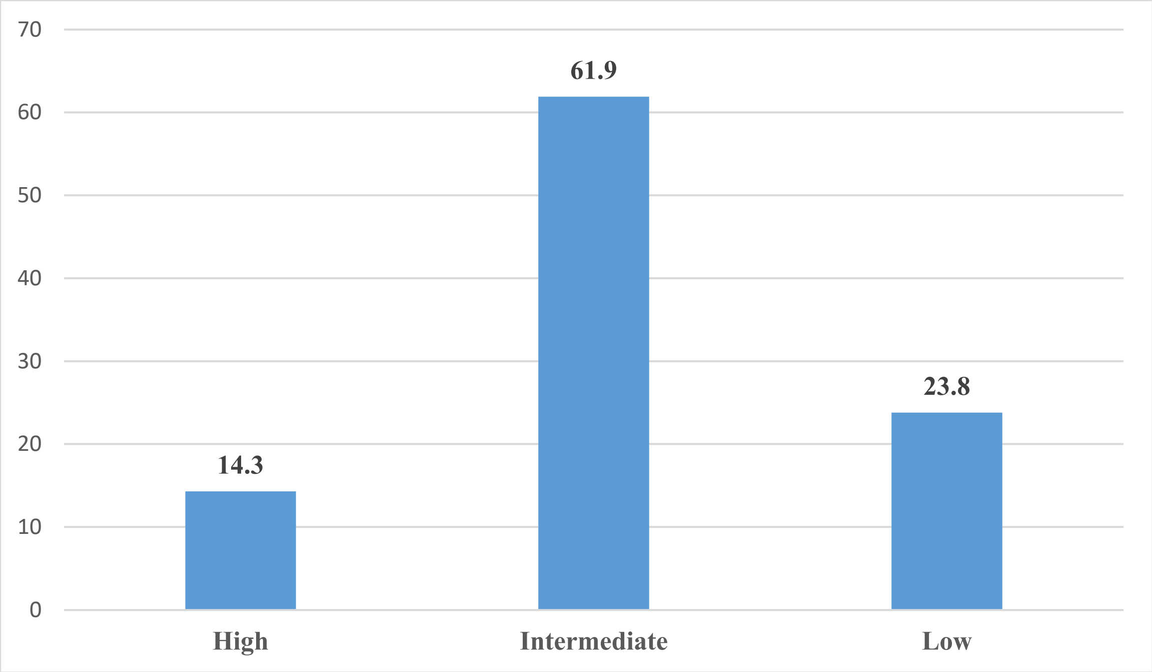

Figure 1. Percentage of risk priority numbers classification

Our results indicate that the most significant risk for carpenters is awkward posture, which received a probability score of 5 (indicating repetitive exposure) across all tasks. This suggests that ergonomic risk factors are prevalent in woodworking activities. Existing literature highlights that carpenters frequently encounter hazardous postures and repetitive motions, increasing their likelihood of developing musculoskeletal disorders [20-22]. Concrete formwork construction has been identified as presenting the highest ergonomic risks within unionized carpentry. Carpenters spend over 40% of their workday in forward torso flexion and more than one-third of their time at or below knee level. Hammering constitutes approximately 17% of their daily activities and is the most commonly performed task [23]. Bhattacharya et al. (1997) demonstrated that the most stressful postures associated with carpentry primarily affect the neck and shoulder regions, followed by the elbow and back [24]. Therefore, it is essential to implement ergonomic interventions and conduct comprehensive job analyses to identify and address specific hazards in carpentry and woodworking tasks [25].

Based on the findings of this study, we conclude that electrocution poses the highest risk level in terms of severity, with a critical severity score of 4. Accidental electrocution during work activities results in significant injuries and mortality, often stemming from workers underestimating the hazards associated with electric wires or high-tension power cables [26]. In the construction industry, including carpentry, electrocution-related fatalities are a pressing issue, underscoring the urgent need for effective early intervention strategies to prevent such incidents and enhance worker safety [27].

The present study revealed that most risks (61.9%) associated with carpentry were categorized as intermediate in terms of risk priority. These hazards included exposure to wood dust or sawdust, falling objects, and hand injuries from tool strikes. Kacha et al. (2014) reported that sawmill workers exhibited significantly lower pulmonary function than predicted,

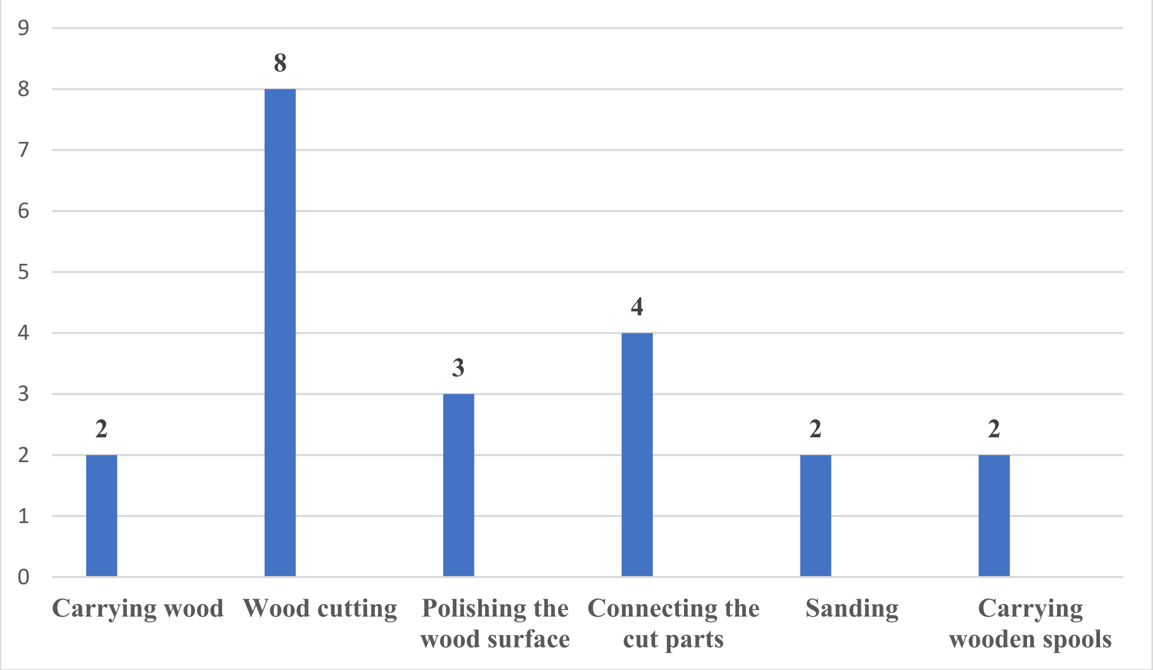

Figure 2. Number of risks in each task

indicating restrictive and obstructive impairments. Chronic exposure to wood dust is known to cause bronchial irritation, contributing to respiratory issues. Notably, the longer workers are exposed to wood dust, the more their lung function deteriorates [28]. Overall, exposure to wood dust can severely compromise lung function, making breathing difficult, increasing the risk of respiratory diseases, exacerbating existing lung conditions, and elevating the likelihood of developing lung cancer [29, 30]. This emphasizes the importance of regular medical check-ups and proper workplace ventilation to reduce respiratory risks.

Furthermore, these findings highlight the necessity for comprehensive occupational health measures within carpentry workshops. Interestingly, despite the recognized importance of Personal Protective Equipment (PPE), its use among carpenters remains inadequate. A study conducted in Uganda found that while 99.3% of carpenters were aware of PPE and its protective benefits, actual usage rates were disappointingly low [31]. This gap between knowledge and practice emphasizes the urgent need for stricter enforcement of occupational health regulations and enhanced awareness campaigns.

The present study provides valuable information for policymaking and promoting safety and health in carpentry workshops. The risk assessment was conducted based on team opinions, interviews, and past conditions. In this regard, there may be differences of opinion for different workshops. Additionally, due to practical limitations, it was not possible to evaluate biological exposure. More studies in this field, using other risk assessment methods, can be helpful.

Despite the many advantages of the JSA method, it also has some limitations. One limitation is its focus on the job itself, rather than considering the risks caused by surrounding factors. Also, due to the lack of a comprehensive list of hazards, some important hazards may be overlooked. Carrying out actions such as preparing a comprehensive list of hazards using existing documents, determining unusual activities around, assessing risk using an integrated method, and observing the control hierarchy can improve these weaknesses.

CONCLUSION

This study's findings indicate that most identified risks within the carpentry workshop are classified as high-level hazards. To enhance and ensure the safety and health of workers, it is imperative to implement appropriate policies, enforce rigorous supervision, fully comply with legal requirements, and provide comprehensive training. Additionally, the results underscore the critical importance of applying ergonomic principles and safe load-handling practices in carpentry workshops.

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CONFLICTS OF INTEREST

The authors have declared that no competing interests exist.

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