

# Work-Related Musculoskeletal Symptoms Among Rattan Craft Workers: A Cross-Sectional Ergonomic Assessment

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## ABSTRACT

*Work-related musculoskeletal disorders (WMSDs) represent a significant occupational health burden in labor-intensive industries, particularly in traditional craft sectors. Despite the economic importance of Indonesia's rattan craft industry, no systematic investigation of ergonomic risks and musculoskeletal health outcomes among rattan workers has been conducted. This study aimed to assess the prevalence of WMSDs symptoms, identify task-specific ergonomic risk factors, and propose targeted interventions to improve working conditions in the rattan craft industry. A cross-sectional study was conducted among 100 workers across eight rattan craft workshops in Cirebon Regency, Indonesia. Ergonomic risk assessment was performed using Indonesia's SNI 9011:2021 standard, incorporating postural analysis, workstation measurements, task timing, and environmental monitoring. WMSDs symptoms were assessed using a modified questionnaire adapted from SNI 9011:2021. Chi-square tests examined associations between individual and work-related factors and symptom severity. High prevalence rates of WMSDs symptoms were documented including 66% for lower back, 63% for hands, and 51% for shoulders. Task-specific risk scores ranged from 13 to 19.5, with steaming tasks receiving the highest score (19.5) due to prolonged standing (75.49% of workday), extreme forward bending (37.6° neck flexion, 32.8° torso flexion), and heat exposure (34.45°C). Binding tasks caused severe shoulder complaints in 81.5% of workers due to sustained overhead arm activity. Significant associations were found between symptoms and smoking status (hands:  $p=0.049$ ; lower back:  $p=0.037$ ), gender (shoulders:  $p<0.001$ ), and workstation design. Rattan craft workers experience high rates of musculoskeletal symptoms comparable to the highest reported in traditional craft literature. Task-specific ergonomic hazards, particularly prolonged standing and extreme postural demands in steaming and binding tasks, require urgent intervention. Recommendations include workstation redesign to accommodate anthropometric diversity, introduction of mechanical assists for high-force tasks, environmental controls for heat and lighting, and integration of smoking cessation programs with ergonomic improvements.*

**Keywords:** *work-related musculoskeletal disorders, ergonomic risk assessment, rattan craft, traditional handicrafts, occupational health, SNI 9011:2021*

## 1. Introduction

Work-related musculoskeletal disorders (WMSDs) are a significant global occupational health issue, affecting millions of workers across various industries. These disorders, which involve damage to muscles, tendons, ligaments, nerves, and other soft tissues, are primarily caused by repetitive motions, awkward postures, heavy lifting, and prolonged exposure to ergonomic risk factors (Punnett & Wegman, 2004). According to the International Labour Organization (ILO), WMSDs account for a substantial portion of work-related illnesses, leading to reduced productivity, increased healthcare costs, and long-term disabilities (ILO, 2022). In Europe alone, musculoskeletal disorders are responsible for nearly half of all work-related health problems, resulting in significant economic losses estimated at billions of euros annually (EU-OSHA, 2019). Similarly, in developing countries, the prevalence of WMSDs is rising due to rapid industrialization, inadequate ergonomic practices, and limited awareness of occupational health and safety. Recent studies have shown that prolonged awkward postures, repetitive movements, and poorly designed workstations remain major contributors to WMSDs across labor-intensive occupations, particularly in developing countries and informal work sectors (Krishnan et al., 2021; Prasetya et al., 2024).

The burden of WMSDs is particularly high in labor-intensive industries, where workers are frequently exposed to physical strain and poor working conditions. Studies have shown that industries such as agriculture, construction, and manufacturing report some of the highest rates of WMSDs due to the manual nature of the work (Hagberg et al., 1995; Bernard, 1997). For example, in the textile and garment industry, workers often experience chronic pain in the neck, shoulders, and lower back due to repetitive tasks and prolonged sitting (Das, 2018). Similarly, in the furniture industry, manual handling of heavy materials and awkward postures contribute to a high incidence of WMSDs (Guimarães et al., 2015). Despite the growing body of research on WMSDs in these sectors, certain industries remain understudied, particularly those that rely heavily on traditional and manual labor. This research gap is especially pronounced in traditional craft industries that operate predominantly in the informal sector, where occupational health surveillance systems are weak or absent, and workers lack the protections afforded to those in formal employment.

Among the labor-intensive sectors that remain highly dependent on manual work, traditional craft industries represent one of the most ergonomically vulnerable yet understudied occupational settings. One such industry is the rattan craft sector, which is a vital part of the economy in many regions, particularly in Southeast Asia. Rattan, a climbing plant whose stems are used to produce furniture, handicrafts, and other products, is traditionally processed through labor-intensive methods. In Indonesia, rattan crafts are a leading commodity in regions such as Cirebon Regency, where the industry supports thousands of livelihoods. However, the production process in this sector is predominantly manual, involving tasks such as cutting, steaming, bending, framing, and binding, all of which expose workers to significant ergonomic risks (Arifah et al., 2021). The traditional nature of the rattan industry, combined with the lack of mechanization and ergonomic interventions, makes workers particularly vulnerable to WMSDs.

Preliminary observations in rattan craft units in Cirebon Regency reveal that workers frequently report pain and discomfort in their hands, arms, shoulders, and lower backs, with many exhibiting symptoms consistent with WMSDs. These symptoms are often exacerbated by factors such as prolonged standing, inadequate rest breaks, and poorly designed workstations (David, 2005). Ergonomic studies in industrial settings have emphasized that non-neutral postures, repetitive activities, and inadequate workstation dimensions can significantly increase musculoskeletal strain, particularly in the neck, shoulders, and lower back regions (Prasetya et al., 2024; Akhtar et al., 2025). Despite these challenges, there is a notable lack of research on ergonomic risks and interventions in the rattan industry, particularly in Indonesia. This gap in the literature is concerning, given the industry's economic importance and the potential for ergonomic improvements to enhance worker health and productivity.

This study seeks to address this gap by evaluating the prevalence of WMSDs symptoms among workers in the rattan craft industry, identifying key ergonomic risk factors, and proposing targeted interventions to improve working conditions. By focusing on the rattan industry in Cirebon Regency, this research aims to contribute to the broader understanding of WMSDs in traditional and labor-intensive sectors. Furthermore, the findings of this study are expected to provide practical recommendations for enhancing worker health, safety, and productivity, thereby supporting the sustainable development of the rattan industry in Indonesia.

## 2. Methods

This study employed a mixed-methods approach to investigate WMSDs symptoms in the rattan craft industry in Cirebon Regency, Indonesia. The research focused on identifying ergonomic risk factors, evaluating the prevalence of WMSDs symptoms, and proposing interventions to improve working conditions. Data collection was conducted in eight rattan craft workshops, selected through convenience sampling, with a total of 100 workers participating from various production stages, including cutting, steaming, framing, binding, and decorating. The sample predominantly consisted of male workers (73%). The average age was 47.49 years, ranging from 24 to 70 years. Respondents' ages were grouped into four categories: 20–29, 30–39, 40–49, and  $\geq 50$  years, following the classification by Putsa et al. (2022). Body Mass Index (BMI) analysis revealed that the majority of workers fell within the "normal" category (BMI: 18.5–25) with an average BMI of  $22.6 \pm 3.49$ . Additionally, the average tenure was 23.52 years, with durations ranging from 1 to 58 years. Only 36% of respondents smoked regularly, and only a small percentage engaged in regular physical exercise. The demographic and occupational characteristics of respondents are summarized in Table 1.

**Table 1.** Respondent characteristics (n = 100)

Characteristics	Category	n	%
Gender	Male	73	73
	Female	27	27
Age Group (years)	20–29	1	1
	30–39	10	10
	40–49	48	48
	≥50	41	41
Mean Age	47.49 ± 8.34 years		
BMI Category	Underweight (<18.5)	11	11
	Normal (18.5–25)	68	68
	Overweight (25–30)	19	19
	Obese (>30)	2	2
Mean BMI	22.60 ± 3.49		
Smoking Status	Smokers	36	36
	Non-smokers	64	64
Physical Activity	No exercise	66	66
	Exercise once/week	26	26
	Exercise >1 time/week	8	8

Note: Respondents were recruited from eight rattan craft workshops in Cirebon Regency, Indonesia.

The study began with preliminary observations, including unstructured interviews and walk-through surveys, to gather general information about the rattan production process and identify potential ergonomic risks. Ergonomic risks were then assessed using the SNI 9011:2021 standard, an official Indonesian guideline for evaluating ergonomic hazards in workplaces. This assessment included postural analysis through photographs and videos, measurement of workstation dimensions to assess compatibility with worker anthropometry, and timing of repetitive tasks and prolonged postures to determine exposure duration.

A modified questionnaire, adapted from SNI 9011:2021, was administered to workers to assess WMSDs symptoms. The survey collected demographic data (e.g., age, gender, work experience, and job role) and information on pain, discomfort, stiffness, numbness, or tingling in specific body parts. Symptom severity and frequency were rated on standardized scales, with workers reporting whether they experienced "no problem," "discomfort," "pain," or "severe pain," and whether symptoms occurred "never," "occasionally," "frequently," or "always."

Data analysis focused on determining the prevalence of WMSDs symptoms, identifying ergonomic risk factors, and evaluating potential interventions. WMSDs symptoms prevalence was calculated as the percentage of workers reporting symptoms, while risk levels were determined by combining severity and frequency scores as outlined in SNI 9011:2021. A chi-square independence test was used to examine the relationship between individual/work-related factors (independent variables) and risk levels (dependent variable), with hypotheses tested at a significance level of  $\alpha = 0.05$ . Ethical considerations were maintained throughout the study, with permission obtained from workshop owners and workers, voluntary participation, and confidentiality of responses ensured.

### 3. Result and Discussion

WMSDs symptoms were reported in all body regions, with varying levels of severity over the past year. Complaints were categorized as low, medium, or high based on symptom frequency and intensity, following the guidelines in SNI 9011:2021. High-severity complaints were most prevalent in the lower back (66%), hands (63%), shoulders (51%), arms (34%), and legs (30%). The lower back and shoulders were particularly affected due to the repetitive and physically demanding nature of rattan crafting tasks. Workers in specific roles, such as framing, binding, and decorating, exhibited higher prevalence rates of WMSDs symptoms across multiple body regions. Binding tasks were identified as particularly strenuous, with 81.5% of workers engaged in this activity reporting severe shoulder discomfort. Complaints in the arms, shoulders, and lower back were also strongly associated with the physical exertion and awkward postures required for cutting and steaming tasks.

The ergonomic risk assessment conducted using SNI 9011:2021 identified several factors contributing to the high prevalence of WMSDs symptoms. In cutting tasks, workers consistently displayed awkward neck postures with an average forward flexion angle of 26.8°. Additionally, unsupported arms due to inadequate workstation height were observed, alongside repetitive hand movements during manual cutting. Environmental conditions at the cutting stations exacerbated the risks, with temperatures averaging 33.95°C and lighting intensity measured at 682.5 lux. Steaming tasks, which involved prolonged standing for 75.49% of the workday, required significant physical effort for bending and pulling rattan. Workers exhibited neck flexion angles of 37.6° and torso flexion angles of 32.8°, with repetitive gripping motions further contributing to discomfort. Environmental conditions at these stations were also suboptimal, with an average temperature of 34.45°C and insufficient lighting at 99.5 lux. Binding tasks were characterized by repetitive overhead arm activity, leading to high prevalence rates of shoulder complaints. Framing tasks required frequent forward bending, with angles reaching up to 52.5°, due to low seating and poorly designed workstations. The absence of adequate back support further increased ergonomic risks for workers engaged in these activities.

The chi-square independence test revealed significant associations between WMSDs symptoms and both individual and work-related factors. Smoking status was found to significantly influence complaints, particularly in the hands ( $p = 0.049$ ) and lower back ( $p = 0.037$ ), with smokers reporting higher severity levels. Male workers exclusively accounted for the smoking subgroup, averaging 12 cigarettes per day. Gender differences were also notable, with female workers, who were primarily engaged in binding tasks, reporting significantly higher shoulder complaints ( $p < 0.001$ ). Workstation design played a critical role in influencing complaints, particularly in tasks such as binding and decorating, where poorly designed workstations were linked to higher rates of WMSDs symptoms. The complete chi-square test results are presented in Table 2.

**Table 2.** Chi-Square test results

Factors	Arms	Hands	Shoulders	Lower back	Legs
Gender	0.582	0.055	0.000	0.272	0.339
Age	0.395	0.988	0.266	0.982	0.672
BMI	0.068	0.488	0.468	0.874	0.155
Length of service	0.285	0.282	0.886	0.669	0.270
Smoking status	0.892	0.049	0.072	0.037	0.934
Physical activity	0.561	0.141	0.161	0.124	0.134
Workstation	0.127	0.063	0.000	0.227	0.042

Note :   a significant association was found ( $p$ -value  $< 0.05$ ).

The ergonomic risk scores calculated for each task, based on SNI 9011:2021, indicated varying degrees of risk. Cutting tasks had a total risk score of 16, primarily due to awkward neck postures and repetitive hand movements. Steaming tasks recorded the highest score of 19.5, reflecting the combined effects of prolonged standing, forward bending, and repetitive gripping motions. Binding tasks, associated with prolonged overhead arm activity, had a total score of 15. Framing tasks had a slightly lower risk score of 13, though the risks were compounded by frequent forward bending and the use of low seating. These scores underscore the need for targeted ergonomic interventions across all production stages in the rattan industry.

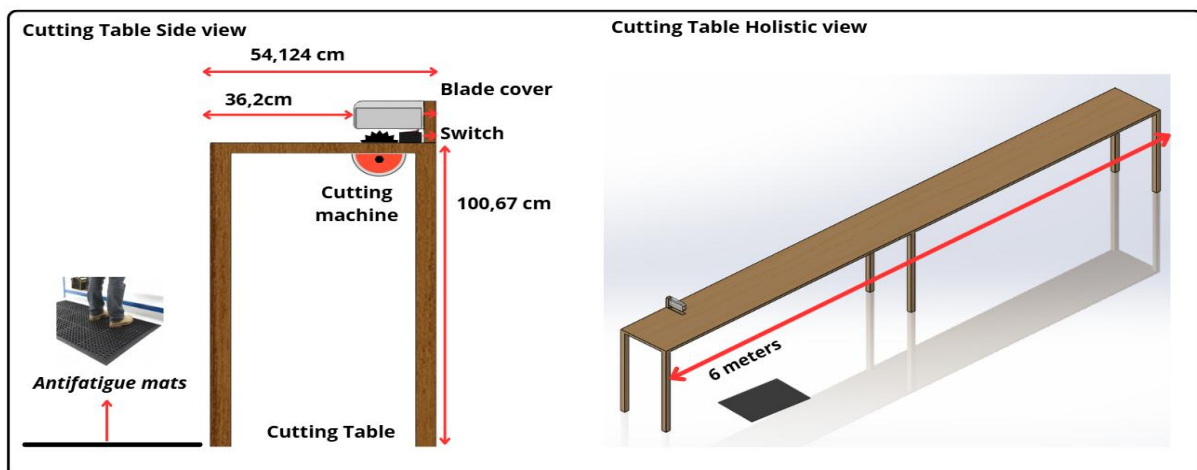
The findings of this study underscore the significant burden of WMSDs symptoms among workers in Indonesia's rattan craft industry, a sector historically overlooked in ergonomic research. The high prevalence of WMSDs symptoms in the lower back, hands, and shoulders aligns with patterns observed in other labor-intensive industries, such as furniture manufacturing and textiles, where repetitive motions and prolonged postures are common. However, the unique workflows of rattan crafting, particularly the sustained overhead arm movements in binding tasks and extreme forward bending during framing, exacerbate risks beyond those seen in more mechanized sectors. For example, the severe shoulder complaints reported by 81.5% of binders exceed rates documented in comparable roles in the garment industry, highlighting the urgent need for task-specific ergonomic solutions tailored to traditional handicraft production.

The interplay of individual and occupational risk factors emerged as a critical theme. Smoking, prevalent among male workers, was significantly associated with heightened severity of hand and lower back complaints. This finding is consistent with previous studies reporting that smoking behavior is associated with increased risk and

severity of WMSDs symptoms due to impaired musculoskeletal recovery and reduced blood circulation to soft tissues (Tran, 2022). While prior studies have linked smoking to impaired musculoskeletal healing, its interaction with occupational strain in traditional industries remains underexplored. This finding suggests that holistic interventions, combining ergonomic redesign with health promotion programs targeting smoking cessation, may yield greater improvements in worker well-being. Gender disparities further shaped WMSDs symptoms patterns, with female workers, predominantly engaged in binding tasks, reporting disproportionately high shoulder complaints. Similar associations between gender, workstation conditions, and WMSDs symptoms prevalence have also been reported among industrial workers in developing countries, particularly in labor-intensive occupations with prolonged static postures and repetitive activities (Fikre et al., 2024). These disparities underscore the need for gender-responsive interventions, such as adjustable workstations to reduce overhead reaching, which could mitigate risks in roles disproportionately held by women.

In addition to individual factors, the characteristics of each production task also contributed substantially to the observed WMSDs symptoms patterns. Ergonomic assessments revealed task-specific vulnerabilities across production stages. Steaming tasks, characterized by prolonged standing, repetitive gripping, and exposure to high temperatures, posed the highest risk, consistent with literature linking heat stress to accelerated muscle fatigue. Previous ergonomic studies also demonstrated that prolonged standing combined with high thermal exposure can accelerate muscle fatigue and increase the likelihood of lower back and lower limb disorders among manual workers (Akhtar et al., 2025). Binding and cutting tasks, meanwhile, involved sustained neck flexion and unsupported postures, known drivers of cervical and lumbar strain. The environmental conditions observed, such as inadequate lighting and extreme temperatures, further compounded risks, echoing findings from studies on informal sector workplaces in developing economies. These insights emphasize the importance of addressing both biomechanical and environmental factors in intervention strategies.

Given the high prevalence of WMSDs symptoms and the identified ergonomic hazards across production stages, targeted ergonomic interventions are required to minimize occupational risks and improve working conditions. Based on the identified biomechanical and environmental risk factors, task-specific ergonomic interventions were proposed by applying the principles of work design, anthropometry, and administrative control to reduce musculoskeletal strain and improve working conditions. The interventions focused on workstation redesign, adjustment of workstation dimensions according to workers' anthropometric characteristics, reduction of excessive physical load and repetitive movements, optimization of reach distance, improvement of environmental conditions, and reduction of manual handling activities across the main production stages. Administrative controls, including work duration limitation, were also proposed to reduce prolonged ergonomic exposure during work activities. The proposed improvements for the cutting workstation focused on changing the workstation from sitting to standing, adjusting table height according to standing elbow height, and increasing the table height by 5 cm to support precision work (Eastman Kodak Company, 2004; Freivalds & Niebel, 2012). A cutting machine was proposed to reduce repetitive manual cutting activities and physical workload (Freivalds & Niebel, 2012). In addition, the cutting point was positioned within the workers' optimal reach zone to minimize excessive reaching movements (ILO & IEA, 2010; SNI 9011-2021, 2021). Natural ventilation, antifatigue mats, and trolley use were also proposed to reduce heat exposure, lower limb fatigue, and manual handling demands. The proposed ergonomic redesign for the cutting workstation is presented in Figure 1.



**Figure 1.** Proposed improvements for the cutting workstation

The proposed improvements for the steaming workstation emphasized the use of a linear actuator to reduce manual pushing and pulling forces during bending activities (Freivalds & Niebel, 2012). The workstation height was adjusted according to workers' elbow height, while an auxiliary support table was added to reduce lifting activities from low positions (Freivalds & Niebel, 2012; SNI 9011-2021, 2021). Environmental improvements included local cooling devices and additional lighting to improve thermal comfort and visibility (SNI 9011-2021, 2021; Kemenkes, 2002). Antifatigue mats, trolley use, and limiting working duration to 8 hours were also proposed to reduce prolonged ergonomic exposure and manual handling demands. The proposed ergonomic redesign for the steaming workstation is presented in Figure 2.

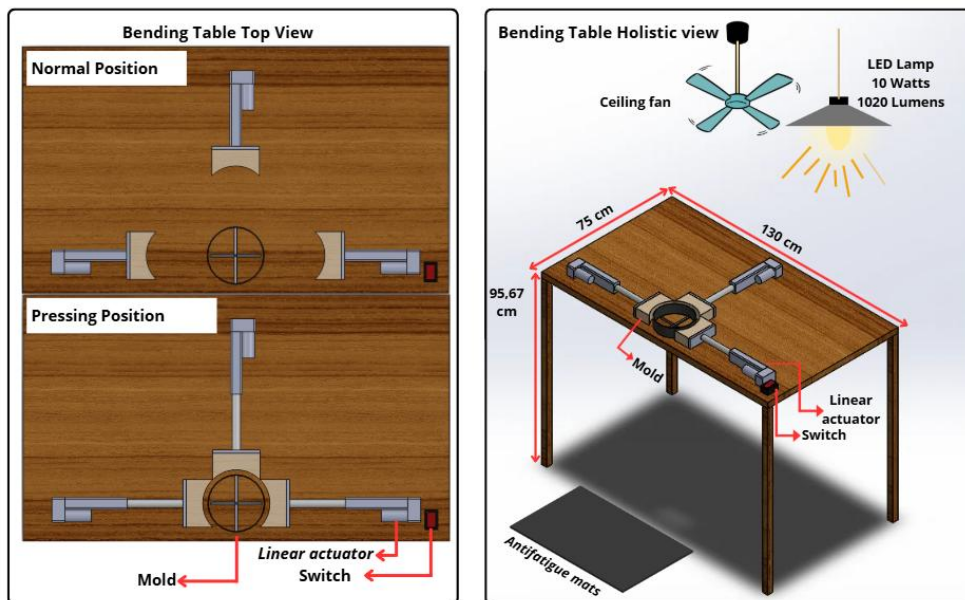


Figure 2. Proposed improvements for the steam workstation

The proposed improvements for the framing workstation focused on changing the working position from sitting to standing and redesigning the assembly table according to standing elbow height to promote more neutral working postures (Eastman Kodak Company, 2004; Freivalds & Niebel, 2012). The assembly table height was reduced by 15 cm, while workstation layouts were optimized to place frequently used tools and materials within the workers' reach zone (ILO & IEA, 2010; SNI 9011-2021, 2021). Additional interventions included improved natural ventilation, antifatigue mats, and trolley use to reduce heat exposure, lower limb fatigue, and manual handling activities. The proposed ergonomic redesign for the framing workstation is presented in Figure 3.

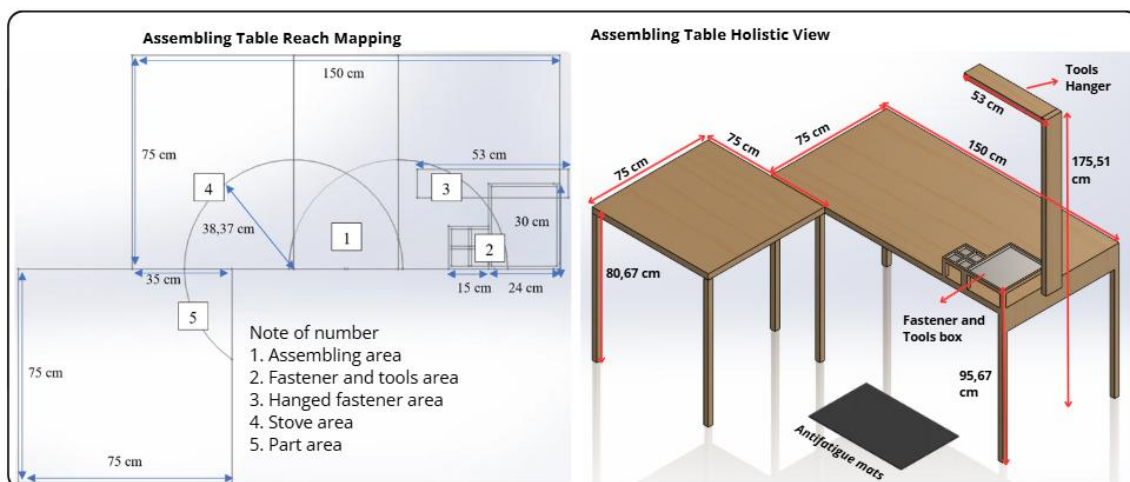
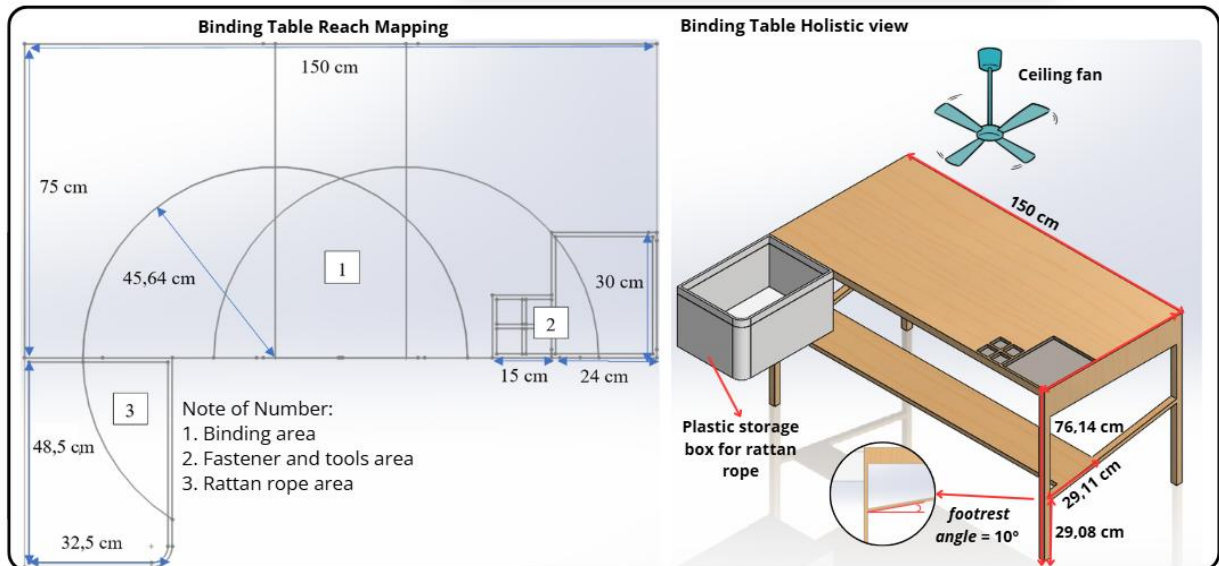


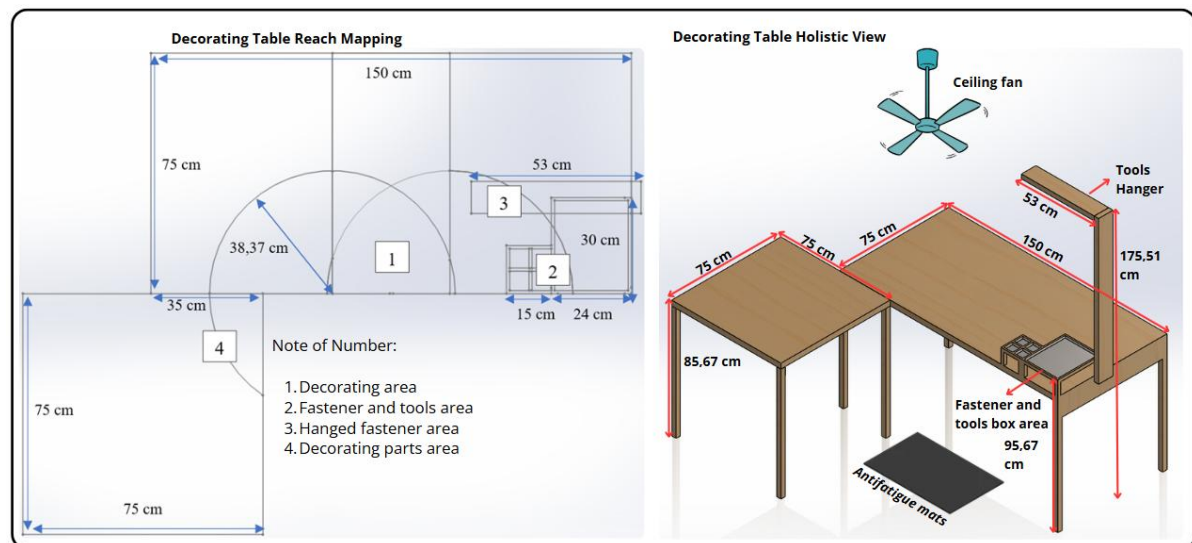
Figure 3. Proposed improvements for the framing workstation

The proposed improvements for the binding workstation focused on redesigning the workstation according to seated elbow height and optimizing the placement of tools and rattan rope within the workers' reach zone to minimize forward bending and excessive reaching movements (Freivalds & Niebel, 2012; ILO & IEA, 2010). An adjustable chair with back support and a footrest were also proposed to improve lumbar support and reduce repetitive ankle flexion during prolonged sitting activities (ILO & IEA, 2010; Eastman Kodak Company, 2004). In addition, local cooling devices were recommended to improve air circulation and reduce heat exposure in the binding area (SNI 9011-2021, 2021; Kemenkes, 2002). The proposed ergonomic redesign for the binding workstation is presented in Figure 4.



**Figure 4.** Proposed improvements for the binding workstation

The proposed improvements for the decorating workstation focused on changing the workstation from sitting to standing and redesigning the decorating table according to workers' anthropometric characteristics (Freivalds & Niebel, 2012). The table height was reduced by 10 cm, while workstation layouts were optimized to place tools and decorating components within the workers' optimal reach zone (ILO & IEA, 2010; SNI 9011-2021, 2021). Additional interventions included the use of antifatigue mats, ceiling fans, tools hangers, storage boxes, and trolley use to reduce heat exposure, improve workstation organization, and minimize manual handling activities (Freivalds & Niebel, 2012; SNI 9011-2021, 2021; Kemenkes, 2002). The proposed ergonomic redesign for the decorating workstation is presented in Figure 5.



**Figure 5.** Proposed improvements for the decorating workstation

This study has limitations inherent to its cross-sectional design and reliance on self-reported data, which may introduce recall bias. The use of convenience sampling, while pragmatic for accessing small scale workshops, limits generalizability to larger rattan producing regions. Nevertheless, the findings provide a foundational understanding of WMSDs in this understudied industry. Future research should prioritize longitudinal studies to track symptom progression alongside targeted interventions, such as the introduction of ergonomic tools like ratchet straps to reduce manual pulling or workstation redesigns to accommodate anthropometric diversity.

## Conclusion

This study demonstrated a high prevalence of WMSDs symptoms among rattan craft workers in Cirebon Regency, particularly in the lower back, hands, and shoulders. Steaming tasks showed the highest ergonomic risk score due to prolonged standing, repetitive gripping, forward bending postures, and heat exposure, while binding tasks were associated with severe shoulder complaints caused by repetitive overhead arm activities. Significant associations were also identified between WMSDs symptoms and several individual and work-related factors, including smoking status, gender, and workstation design. These findings indicate that the traditional and labor-intensive production process in the rattan craft industry exposes workers to substantial ergonomic risks. Therefore, ergonomic interventions such as workstation redesign based on anthropometric principles, reduction of repetitive manual activities, environmental improvements, and implementation of administrative controls are necessary to reduce WMSDs symptoms and improve worker health, safety, and productivity.

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