Evaluation of Work Fatigue in Furniture and Wood Panel Manufacturing Using the Swedish Occupational Fatigue Inventory

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**Abstract.** This study aims to evaluate occupational fatigue among production workers in a teak wood manufacturing facility using the Swedish Occupational Fatigue Inventory (SOFI). A total of 63 workers from five departments—Bandsaw, Molding, Quality Control, Steel Finish, and Oven—participated in the survey. The results indicate that all departments experienced moderate levels of fatigue, with the highest average scores recorded in the Bandsaw and Steel Finish sections. A dimensional analysis revealed that fatigue manifestations varied across departments: Physical Discomfort was most prominent in Bandsaw and Oven, Physical Exertion in Molding and Steel Finish, and Lack of Motivation in Quality Control. Further analysis based on age and length of service showed no statistically significant differences in fatigue scores, as confirmed by T-test results (p > 0.05). This suggests that work fatigue is more strongly influenced by job characteristics than demographic factors. Based on these findings, several department-specific improvement strategies were proposed, including ergonomic interventions, ventilation enhancements, workload balancing, and motivational programs. The study contributes to occupational ergonomics literature by demonstrating the utility of SOFI in identifying fatigue dimensions and informing targeted interventions. Future research is recommended to evaluate the long-term effectiveness of these strategies and to explore fatigue patterns across different manufacturing sectors.

**Keywords:** Occupational fatigue, SOFI, production workers, ergonomic intervention, manufacturing, work motivation

# introduction

The furniture and wood panel industry, particularly those using teak wood as the primary raw material, plays an important role in global manufacturing and exports. This sector involves intensive manual labor and physically demanding tasks, making workers susceptible to various forms of occupational fatigue [1]. Within a teak-processing facility, multiple departments such as Bandsaw, Molding, Quality Control, Steel Finish, and Oven operate under 8-hour work shifts. Workers are often assigned to repetitive tasks, sustained physical effort, and rigid postures, all of which contribute to fatigue accumulation [2], [3].

Occupational fatigue is defined as a state of weariness that reduces a worker’s ability to perform over time due to excessive physical, mental, or emotional strain [4], [5]. Prolonged exposure to fatigue has been linked to decreased performance, increased error rates, and higher risk of workplace accidents [6], [7]. Common contributing factors include long working hours, insufficient rest, task monotony, and poor ergonomic design [8], [9].

In addition to health risks, fatigue may also diminish quality of life and psychological well-being, affecting motivation, emotional stability, and cognitive performance [10]. Several studies emphasize that both physical (e.g., muscular strain) and psychological (e.g., loss of interest) symptoms must be considered to fully understand occupational fatigue [4], [11]. For this reason, multi-dimensional instruments such as the Swedish Occupational Fatigue Inventory (SOFI) are highly useful, as they allow for subjective evaluation of fatigue across five key domains: Sleepiness, Physical Discomfort, Lack of Energy, Lack of Motivation, and Physical Exertion [5], [12].

This study aims to measure and analyze the fatigue levels among production workers using the SOFI method and examine whether age and tenure influence perceived fatigue. The findings are expected to provide empirical insights that support ergonomic interventions, workload balancing, and motivational programs tailored to department-specific conditions in industrial settings.

# Literature Review

Work-related fatigue is a multifaceted issue that affects workers' physical and psychological health, productivity, and safety. Several studies have identified that fatigue in industrial settings is not only caused by physical exertion but also by psychosocial factors such as lack of motivation, mental load, and job monotony [1], [3], [10]. In the manufacturing sector, particularly in labor-intensive environments like furniture and wood panel production, exposure to repetitive tasks, heavy lifting, awkward postures, and long working hours increases the risk of fatigue-related problems [1], [8].

To assess occupational fatigue, various tools have been developed. One of the most recognized is the Swedish Occupational Fatigue Inventory (SOFI), a subjective measurement tool designed by Åhsberg to capture five dimensions of fatigue: Lack of Energy, Physical Discomfort, Sleepiness, Lack of Motivation, and Physical Exertion [4], [5]. It has been validated in several settings and found to be a reliable instrument in identifying the severity and dimensions of fatigue across job types [11]. Its multidimensional nature allows for a more nuanced understanding of fatigue compared to unidimensional tools like the Stanford Sleepiness Scale or NASA-TLX [7], [3].

SOFI has been applied in various industries, including transportation, healthcare, and manufacturing, with studies demonstrating its sensitivity in detecting fatigue changes before and after interventions [11], [23], [25]. Integrating SOFI results with ergonomic assessments helps companies identify specific areas of concern and formulate targeted interventions, such as rest break scheduling, workstation redesign, or motivation-based improvements [2], [6], [14].

Demographic factors such as age and years of service also influence fatigue levels. Research has shown that younger workers may experience higher levels of motivational fatigue, while older workers often report physical discomfort due to musculoskeletal strain [3], [10], [19]. Longer years of service may also correlate with cumulative fatigue due to repeated exposure to static or monotonous tasks, underscoring the importance of job rotation and recovery strategies [20], [21].

Motivational factors, including recognition and incentives, play a significant role in shaping employee engagement and reducing subjective fatigue [12], [24]. Both financial and non-financial incentives have been recognized as powerful motivators that can buffer the effects of routine tasks and enhance overall job satisfaction [13], [17].

Environmental factors, such as ventilation and temperature regulation, significantly affect workers' fatigue levels. Poor ventilation or high temperatures, particularly in oven or steel finishing sections, contribute to physical exhaustion [20], [22]. Ergonomic and organizational interventions, including the implementation of Workplace Stretching Exercises (WSE), improved ventilation (e.g., turbine ventilators), and optimized rest patterns, have been effective in alleviating fatigue symptoms [14], [18], [22].

# METHODS

This study employed a mixed-method approach, combining observational assessment, field study, and quantitative analysis using the SOFI questionnaire. The preliminary phase included direct observations of worker behavior and task patterns to identify signs of physical and mental fatigue. This helped frame the selection of measurement tools and sampling approach, consistent with guidelines in applied ergonomics research and occupational health practices [9], [13], [17].

A literature review was conducted to collect relevant theories and prior research findings on fatigue dimensions, ergonomic risks, and interventions. The SOFI method, originally developed by Åhsberg [5], was chosen for its multidimensional assessment capability and validated use in industrial and healthcare settings [3], [11]. SOFI comprises 25 items measuring five dimensions: Sleepiness, Physical Discomfort, Lack of Energy, Lack of Motivation, and Physical Exertion. It has been proven effective in capturing both physical and psychological fatigue components [4], [14]. The SOFI scale has also been successfully applied in transportation, healthcare, and logistics industries to detect early symptoms of fatigue in operational roles [25].

Data collection was carried out across five departments—Bandsaw, Molding, Quality Control, Steel Finish, and Oven—with a total of 63 respondents completing the SOFI questionnaire. Respondents also provided demographic information, including age and length of service, which were used to explore potential correlations with fatigue levels.

Quantitative analysis was conducted by computing the average score for each fatigue dimension and department. Fatigue classification was based on the SOFI scale [5]. A T-test was then applied to examine whether age or tenure significantly influenced overall fatigue scores, using a significance threshold of p < 0.05 [15], [16].

The SOFI scale uses a semantic differential format ranging from “low/poor” (far left) to “high/good” (far right), depending on the item phrasing. Fatigue levels are then classified based on the following thresholds:

**Table 1.** Sofi Scale

|  |  |  |
| --- | --- | --- |
| **No.** | **Score Range** | **Fatigue Category** |
| 1 | < 1.13 | Low |
| 2 | 1.13 – 4.87 | Medium |
| 3 | > 4.87 | High |

# RESULTS

## Fatigue Levels in Production Departments (SOFI Results)

Work fatigue data collected using the Swedish Occupational Fatigue Inventory (SOFI) revealed that all five production departments experienced moderate levels of fatigue. The overall average fatigue scores by department are

shown in Table 2.

**Table 2.** Average Work Fatigue Score by Production Department

| **Rank** | **Department** | **Average Score** | **Fatigue Level** |
| --- | --- | --- | --- |
| 1 | Bandsaw | 3.807 | Medium |
| 2 | Steel Finish | 3.806 | Medium |
| 3 | Quality Control | 3.748 | Medium |
| 4 | Oven | 3.729 | Medium |
| 5 | Molding | 3.517 | Medium |

The Bandsaw department showed the highest fatigue level with an average score of 3.807, followed closely by Steel Finish (3.806). Although all departments scored within the same fatigue category, this highlights the importance of analyzing fatigue by dimension to understand specific causes and to propose tailored interventions.

The following tables present fatigue scores broken down by the five SOFI dimensions in each department.

**Table 3.** Fatigue Dimensions – Bandsaw Department

| **Rank** | **Dimension** | **Average Score** | **Percentage** | **Category** |
| --- | --- | --- | --- | --- |
| 1 | Physical Discomfort | 3.953 | 20.77% | Medium |
| 2 | Lack of Motivation | 3.941 | 20.70% | Medium |
| 3 | Physical Exertion | 3.788 | 19.90% | Medium |
| 4 | Sleepiness | 3.718 | 19.53% | Medium |
| 5 | Lack of Energy | 3.635 | 19.10% | Medium |

In the Bandsaw department, Physical Discomfort emerged as the dominant fatigue dimension. This may be attributed to long durations of repetitive posture while cutting teak wood, leading to musculoskeletal discomfort.

**Table 4.** Fatigue Dimensions – Molding Department

| **Rank** | **Dimension** | **Average Score** | **Percentage** | **Category** |
| --- | --- | --- | --- | --- |
| 1 | Physical Exertion | 3.757 | 21.36% | Medium |
| 2 | Lack of Motivation | 3.643 | 20.71% | Medium |
| 3 | Lack of Energy | 3.500 | 19.90% | Medium |
| 4 | Physical Discomfort | 3.500 | 19.90% | Medium |
| 5 | Sleepiness | 3.186 | 18.12% | Medium |

In Molding, the highest fatigue dimension was Physical Exertion, which suggests that manual handling and force-intensive tasks contribute significantly to fatigue levels in this department.

**Table 5.** Fatigue Dimensions – Quality Control Department

| **Rank** | **Dimension** | **Average Score** | **Percentage** | **Category** |
| --- | --- | --- | --- | --- |
| 1 | Lack of Motivation | 4.020 | 21.45% | Medium |
| 2 | Physical Discomfort | 3.880 | 20.70% | Medium |
| 3 | Sleepiness | 3.640 | 19.42% | Medium |
| 4 | Lack of Energy | 3.600 | 19.21% | Medium |
| 5 | Physical Exertion | 3.600 | 19.21% | Medium |

In this department, Lack of Motivation was the most prominent fatigue dimension. This could reflect mental fatigue resulting from routine inspection tasks, which may be perceived as monotonous.

**Table 6.** Fatigue Dimensions – Steel Finish Department

| **Rank** | **Dimension** | **Average Score** | **Percentage** | **Category** |
| --- | --- | --- | --- | --- |
| 1 | Physical Exertion | 3.969 | 20.90% | Medium |
| 2 | Physical Discomfort | 3.969 | 20.90% | Medium |
| 3 | Lack of Energy | 3.815 | 20.00% | Medium |
| 4 | Lack of Motivation | 3.721 | 19.60% | Medium |
| 5 | Sleepiness | 3.556 | 18.70% | Medium |

The Steel Finish department showed equally high scores in both Physical Discomfort and Physical Exertion, indicating the physically demanding nature of finishing tasks involving sanding or polishing.

**Table 7.** Fatigue Dimensions – Oven Department

| **Rank** | **Dimension** | **Average Score** | **Percentage** | **Category** |
| --- | --- | --- | --- | --- |
| 1 | Physical Discomfort | 4.089 | 21.90% | Medium |
| 2 | Lack of Motivation | 3.800 | 20.40% | Medium |
| 3 | Physical Exertion | 3.644 | 19.50% | Medium |
| 4 | Lack of Energy | 3.556 | 19.10% | Medium |
| 5 | Sleepiness | 3.556 | 19.10% | Medium |

In the Oven section, Physical Discomfort was the most significant dimension, likely due to heat exposure and static posture while handling drying equipment or materials.

The highest fatigue was found in the Bandsaw department, followed closely by Steel Finish and Quality Control. While all departments fell under the same general fatigue category, the underlying fatigue dimensions varied.

Each department had a dominant fatigue dimension, which may guide tailored interventions. For instance, in the Bandsaw and Oven sections, the leading cause of fatigue was Physical Discomfort, likely due to prolonged posture and limited mobility. Steel Finish and Molding were dominated by Physical Exertion, reflecting high physical demands, while Quality Control showed the highest levels in Lack of Motivation, possibly caused by repetitive, low-engagement tasks.

These findings highlight that even under the same overall fatigue level (moderate), department-specific factors influence how fatigue is experienced, supporting the need for customized ergonomic and organizational solutions.

## Fatigue by Age and Length of Service

Fatigue scores were also analyzed based on age groups and length of employment. Interestingly, the highest average fatigue score by age was observed among workers aged 21–30 years, while among tenure groups, it was workers with over 20 years of service.

Younger workers (21–30) most frequently reported fatigue related to Lack of Motivation, possibly due to early career disillusionment or lack of recognition. Meanwhile, workers with long tenure (>20 years) experienced more Physical Discomfort, likely due to accumulated physical strain and decreased physical resilience.

These trends indicate that fatigue is multifactorial and shaped by both psychological and physical variables, although not necessarily in a linear fashion. Workers’ age and years of service may predispose them to specific types of fatigue but do not directly determine the overall fatigue score.

To evaluate whether fatigue varied based on demographic factors, respondents were grouped by age and length of service.

**Table 8.** Fatigue Scores by Age Group

| **Age Range** | **Average Score** | **Fatigue Level** |
| --- | --- | --- |
| 21–30 years | 3.778 | Medium |
| 31–40 years | 3.535 | Medium |
| 41–50 years | 3.769 | Medium |
| >50 years | 3.723 | Medium |

The highest fatigue score was recorded among workers aged 21–30, particularly in the Lack of Motivation dimension. This may be related to limited job engagement or unclear career progression for younger employees.

**Table 9.** Fatigue Scores by Length of Service

| **Years of Service** | **Average Score** | **Fatigue Level** |
| --- | --- | --- |
| 1–10 years | 3.683 | Medium |
| 11–20 years | 3.591 | Medium |
| >20 years | 3.724 | Medium |

Workers with over 20 years of service exhibited the highest fatigue levels, especially in Physical Discomfort, possibly due to age-related decline in physical resilience and repetitive task exposure.

## T-Test Results: Effect of Age and Tenure

A T-test was conducted to determine whether age or length of service had a statistically significant effect on fatigue.

**Table 10.** T-Test Results

|  |  |  |
| --- | --- | --- |
| **Independent Variable** | **t-value** | **Sig. (p)** |
| Age | -0.570 | 0.571 |
| Years of Service | 0.823 | 0.414 |

The p-values for both variables exceed 0.05, and t-values are below the critical threshold, indicating that neither age nor tenure significantly influences fatigue levels at a statistical level. This finding supports the earlier qualitative observation that fatigue is more closely tied to job characteristics and physical demands rather than demographic factors alone.

## Proposed Improvements

The analysis revealed that each department experienced fatigue differently, necessitating customized strategies to address the most dominant dimensions. In the Bandsaw department, where Physical Discomfort was the most reported dimension, workers frequently experienced stiff joints. This can be mitigated through Workplace Stretching Exercises (WSE), which have been shown to reduce musculoskeletal discomfort and improve muscle flexibility [18], [19]. Additionally, redistributing workload and implementing task rotation can alleviate the physical burden and prevent localized fatigue [17].

In the Steel Finish department, fatigue was characterized by Physical Exertion, with workers reporting symptoms of overheating and muscle fatigue. Studies suggest that improving ventilation—through the use of turbine ventilators or exhaust fans—can effectively reduce thermal strain in enclosed industrial settings [20], [21]. Incorporating structured micro-breaks during shifts may also help improve physical recovery without disrupting productivity [22].

The Oven department also showed dominance in Physical Discomfort, particularly associated with aching in limbs. This can be addressed by providing appropriate personal protective equipment (PPE), such as insulated gloves and footwear, and ensuring safe handling procedures through proper adherence to Standard Operating Procedures (SOPs) [23]. Cooling down the oven area prior to manual interaction can also reduce exposure to excessive heat.

In the Quality Control department, the most prevalent fatigue dimension was Lack of Motivation. This psychological fatigue is often linked to monotonous tasks and the absence of recognition. To combat this, it is recommended to establish incentive programs, including both financial (performance bonuses) and non-financial (public recognition, certificates) rewards. Research indicates that such interventions can significantly improve employee engagement and satisfaction [24], [25].

For the Molding department, Physical Exertion was again the most dominant issue, particularly linked to excess sweating due to poor airflow. Improving workplace ventilation through the installation of effective exhaust systems is essential in reducing this form of fatigue [20]. Moreover, incorporating short rest periods and promoting proper hydration practices can help workers maintain physical performance over longer shifts.

From a demographic perspective, younger workers (aged 21–30) primarily experienced fatigue in the Lack of Motivation dimension. This could be addressed by offering learning and development opportunities, cross-functional assignments, and clearer career progression paths to increase engagement [25]. Non-financial incentives, such as public appreciation or symbolic rewards, are also proven to be powerful motivators in early-career employees [24].

Meanwhile, long-tenured workers (over 20 years) experienced more Physical Discomfort, potentially due to accumulated physical strain and age-related decline in muscular resilience. For this group, job rotation, postural variation, and shifting to less physically intensive roles can significantly reduce fatigue risks [9], [13]. Companies may also consider regenerating task assignments by allocating physically demanding roles to younger workers while utilizing the expertise of senior staff in supervisory or quality-assurance functions [3], [8].

Collectively, these proposed interventions reflect the need for department-specific, multidimensional fatigue management strategies. Combining ergonomic design, environmental improvements, and motivational systems provides a balanced and sustainable approach to improving worker health, performance, and satisfaction in industrial manufacturing settings.

# CONCLUSION

This study assessed the level and dimensions of work fatigue experienced by production workers in a teak wood processing company using the Swedish Occupational Fatigue Inventory (SOFI). The results indicated that all departments exhibited moderate levels of fatigue, with the Bandsaw and Steel Finish sections reporting the highest average scores. A closer examination revealed that fatigue manifests differently across departments: Physical Discomfort dominated in Bandsaw and Oven, Physical Exertion in Molding and Steel Finish, and Lack of Motivation in Quality Control. These findings suggest that work fatigue is multidimensional and department-specific, requiring tailored interventions rather than generalized solutions.

While analysis by age and length of service revealed that younger workers (aged 21–30) and long-tenured employees (over 20 years) demonstrated slightly higher fatigue scores in different dimensions, T-test results confirmed that these demographic factors did not significantly influence fatigue levels. Instead, the nature of the job and workplace conditions played a more substantial role.

To address the identified fatigue issues, several improvement strategies were proposed, ranging from ergonomic interventions such as ventilation enhancements and job rotation, to organizational measures like incentive programs and pre-work stretching routines. These recommendations emphasize a human-centered approach to managing fatigue, aiming to improve worker well-being while maintaining operational effectiveness.

This study contributes to the growing body of ergonomic and occupational health research by applying a validated fatigue measurement tool (SOFI) within a high-intensity manufacturing setting. Future research could expand on these findings by incorporating longitudinal measurements, biometric data, or exploring the effectiveness of implemented interventions over time. Moreover, comparative studies across different manufacturing sectors could help generalize the applicability of SOFI and refine fatigue mitigation strategies at scale.

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