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Strategic Assessment of Ergonomics in Jordan's Maritime Operations: Safety and Productivity Perspectives

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Abstract

This study examines the impact of ergonomic interventions on workplace safety and productivity within a sea freight forwarding company operating in Aqaba and Amman, Jordan. The research aimed to identify key ergonomic risk factors affecting employees and to evaluate targeted interventions designed to reduce physical discomfort, enhance job satisfaction, and improve operational performance. A mixed-methods approach was employed, integrating quantitative data from structured questionnaires covering demographics, physical pain, job satisfaction, ergonomic support, and fatigue with qualitative insights from employee interviews. Physical risk levels were assessed using the Rapid Entire Body Assessment (REBA) tool, while company records on safety incidents, absenteeism, and productivity were analyzed to triangulate findings. The study involved 120 participants across administrative and operational roles. Statistical analyses, including descriptive statistics, paired t-tests, and ANOVA, were applied to compare pre- and post-intervention data. Results indicated a significant reduction in musculoskeletal complaints and fatigue, accompanied by notable improvements in perceived job satisfaction, productivity, and safety outcomes. The findings underscore the importance of integrating ergonomic strategies into logistics operations and offer evidence-based recommendations for improving employee well-being and organizational efficiency.

Keywords: Ergonomic Management, Workplace Safety, Productivity, REBA Assessment, Musculoskeletal Disorders.

1. INTRODUCTION

Organizations are continuously seeking methods to enhance productivity while ensuring the health and safety of their workforce in today’s competitive environment. One vital strategy to achieve this balance is the implementation of effective ergonomic interventions. Ergonomics involves designing work environments that align with employees’ physical and mental capacities to reduce stress, prevent injuries, and optimize human performance, thereby enhancing both productivity and safety. Unresolved workplace safety issues directly reduce productivity, highlighting the importance of ergonomic considerations [1]. Similarly, poor ergonomic design, such as inadequate furniture or non-ergonomic seating, leads to discomfort, musculoskeletal pain, and overall declines in worker well-being [2].

In the sea freight and shipping industry, ergonomic risks are particularly pronounced due to the physically strenuous nature of maritime operations, prolonged standing, heavy lifting, repetitive movements, and the confined workspaces found aboard vessels and in warehouses. Office-based roles in freight forwarding companies also face challenges from poorly designed workstations and extended screen time. Despite these risks, limited empirical research has explored ergonomic interventions in the maritime industry [3]. Addressing this gap is crucial for enhancing worker well-being and operational efficiency in freight environments.

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Extensive research has been conducted across various sectors on the relationship between ergonomics, worker safety, and productivity. However, its application in ocean freight forwarding—whether in operational or administrative environments—remains limited. Employees in this sector face considerable health and safety Challenges stemming from physically demanding roles, long shifts, and high-risk settings. Musculoskeletal disorders, fatigue, and psychological stress are particularly prevalent, leading to decreased job satisfaction, increased accident risk, and lower efficiency. Workplace ergonomics is essential for minimizing injury risk and maintaining consistent productivity [4]. Ergonomic improvements can boost comfort, reduce fatigue, and enhance performance [5], while poor ergonomics is associated with injury, fatigue, and significant productivity losses [6].

The economic and operational consequences of poor ergonomics are substantial. Globally, billions of dollars are lost annually due to preventable inefficiencies and accidents. In 2016, an estimated 1.9 million people died from work-related injuries and illnesses [7]. Over 340 million work-related accidents and 160 million cases of occupational diseases occur every year [8]. In Indonesia alone, there were 225,000 reported work accidents and 53 job-related illnesses in 2020, with another 82,000 accidents and 179 illnesses reported between January and September 2021 [9].

2. LITERATURE REVIEW

This section critically examines existing research on the impact of ergonomic interventions on workplace safety and productivity, with a focus on their application in both office and operational settings within the sea freight forwarding industry. It explores the three core dimensions of ergonomics-physical, cognitive, and psychosocial and highlights how these principles are applied across various work environments. The review integrates global and industry-specific perspectives, drawing from occupational health, human factors, and organizational studies, to identify key trends, research gaps, and practical implications. Special attention is given to the unique ergonomic challenges of the maritime and logistics sectors, setting the foundation for this study's contribution to improving safety and efficiency in high-demand environments [10].

To provide a structured overview of recent contributions in the field, Table 1 summarizes key empirical studies related to ergonomic interventions, their methodologies, and findings on workplace safety, productivity, and worker well-being, with a focus on applications relevant to office settings and the sea freight forwarding industry.

Table 1. Recent Studies on Ergonomics Intervention on Productivity and Safety in the Sea Freight Sector.

Ref.	Year	Authors	Study Purpose / Focu	Methods	Key Findings
[1]	2023	Johnson and Widyanti	Effects of ergonomic interventions on mental workload and fatigue in logistics workers	Quasi-experimental with ergonomic adjustments and surveys	Ergonomic design and flexible schedules significantly reduce mental fatigue and improve productivity.
[2]	2018	Sorensen, Stanton and Banks	Impact of continuous cognitive training on decision-making and fatigue resilience	Longitudinal training program with high-stress workers	Ongoing cognitive training enhances resilience reduces errors, and improves job satisfaction.
[3]	2021	Hwang et al.	Relationship between occupational stress and fatigue in port workers	Cross-sectional survey and physiological stress measures	High job stress correlates strongly with chroni fatigue and increased accident risk
[4]	2020	Chen et al.	Effects of mental workload on maritime operators' performance	Simulated task experiments with EEG and subjective workload scales	Increased mental workload decreases vigilance and decision accuracy; automation helps reduce load.
[5]	2019	Puthran et al.	Stress, fatigue, and burnout in shipping industry workers	Mixed-methods survey and interviews.	High workload and poor sleep quality are linked to burnout and increased error rates.

[6]	2022	Kim and Kim	Use of ergonomic interventions to reduce musculoskeletal and cognitive fatigue in logistics workers	Field study with ergonomic adjustments and pre/post assessments	Ergonomic chairs and task redesign significantly lowered reported fatigue and improved work quality.
[7]	2023	Torres and Ferreira	Role of cognitive workload and fatigue in maritime navigation errors	Case study analysis and fatigue monitoring	Fatigue and cognitive overload contribute to navigation errors; recommendations include rest breaks and training.
[8]	2018	Bener et al.	Effects of stress management programs on fatigue and productivity	Controlled intervention study in the transportation sector	Stress management programs reduced fatigue and absenteeism, boosting overall productivity. .
[9]	2022	Wang et al.	Impact of automation and decision support systems on cognitive workload	Experimental simulation with port operators	Decision support systems significantly reduce cognitive workload and improve task accuracy .
[10]	2021	Ng and Smith	Fatigue-related accident risk factors in maritime shipping	Retrospective analysis of accident and fatigue reports	Fatigue-related accidents are associated with excessive shift lengths, sleep deprivation, and high job demands.

Source: Edited by the authors.

2.1 The Roadblock to Sustainable Workplace Ergonomics in Sea Freight Forwarding

The sea freight forwarding industry serves as a critical link in global supply chains, requiring high operational efficiency and human performance under often challenging working conditions. Despite increasing awareness of ergonomics, many freight companies continue to struggle with implementing and sustaining effective ergonomic interventions. This study examines the multifaceted barriers to ergonomics integration in the maritime logistics sector, with a focus on worker well-being, safety, and operational productivity [11].

2.1.1 Physically Demanding and Repetitive Work Environments

Sea freight forwarding involves tasks such as heavy lifting, prolonged standing, awkward postures, and repetitive motions—conditions known to increase the risk of musculoskeletal disorders (MSDs). The persistence of these conditions, especially on docks and in cargo handling zones, poses a pressing concern for physical fatigue and long-term injury [12].

2.1.2 High Variability in Work Conditions

Unlike office-based settings, the maritime logistics environment is highly dynamic. Variations in cargo types, vessel configurations, weather, and workload intensity create unpredictable ergonomic demands. This variability complicates the standardization and consistency of ergonomic solutions [13].

2.1.3 Lack of Awareness and Training

Ergonomics is often misunderstood or under-prioritized in this industry. Many employees, as well as supervisors, are not fully aware of ergonomic risk factors or preventive strategies. As a result, interventions may be underutilized or misapplied, thereby reducing their potential impact [14].

2.1.4 Operational Pressures and Resistance to Change

Freight forwarding companies operate under tight schedules and cost constraints. Management often perceives ergonomics as a non-essential or disruptive cost, particularly if short-term productivity must be sacrificed for long-term benefits. This contributes to resistance to ergonomic investments [15].

2.1.5 Absence of Tailored Standards

Many available ergonomic guidelines are developed for office or general industrial settings and fail to address the specific challenges of maritime logistics. This gap hinders the effective implementation of standardized interventions [16].

2.1.6 The Role of Ergonomic Risk Assessment Tools

To address these issues, this study integrates the **Rapid Entire Body Assessment (REBA)** tool to evaluate ergonomic risks across various job roles. REBA provides a structured method for quantifying postural risks and prioritizing corrective actions in real-world freight operations [17]. Figure 1 and 2 shows how the risk score changes before and after ergonomics.

2.1.7 Linking Ergonomics to Productivity and Safety Outcomes

Through a mixed-methods approach, this research examines the impact of ergonomic interventions on not only physical discomfort and injury rates but also job satisfaction, fatigue levels, and productivity.

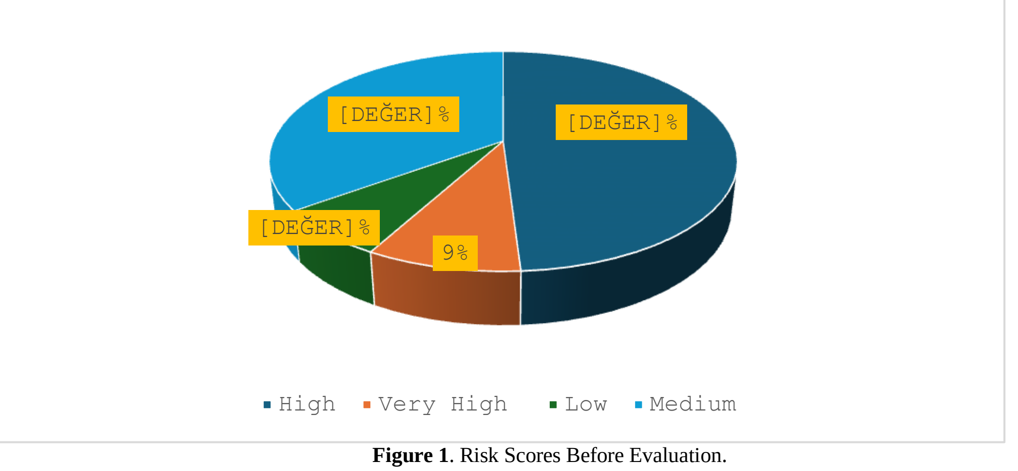

Figure 1. Risk Scores Before Evaluation.
Source: Created by authors.

By comparing pre- and post-intervention metrics, the study aims to establish a data-driven justification for ergonomics implementation in sea freight settings [18].

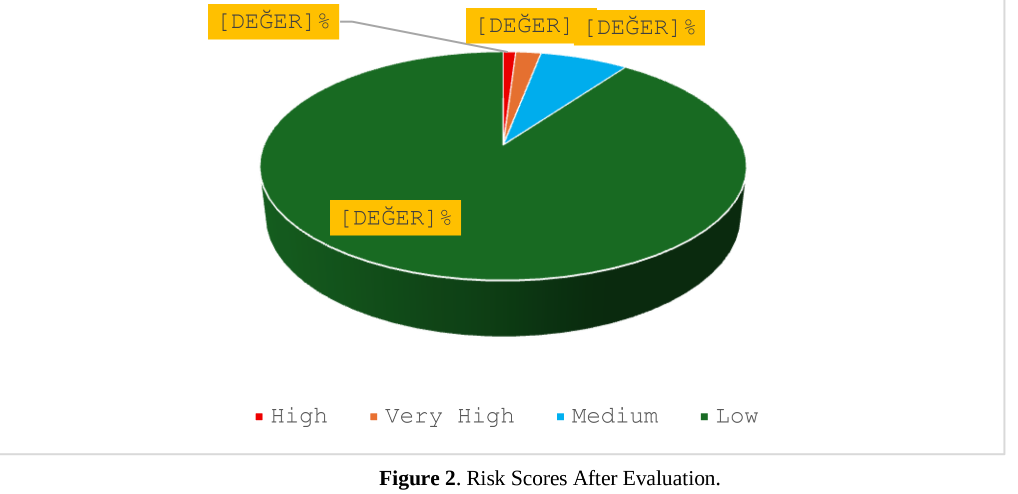

Figure 2. Risk Scores After Evaluation.
Source: Created by authors.

2.1.8 Musculoskeletal Disorders

Musculoskeletal disorders (MSDs) are injuries or conditions that affect the musculoskeletal system, which encompasses muscles, nerves, tendons, ligaments, joints, and supporting structures, such as the neck and back. When these disorders are triggered, worsened, or extended due to work activities, environments, or conditions, they are categorized as Work-Related Musculoskeletal Disorders (WMSDs). MSDs are recognized as a significant occupational health concern globally. For instance, a study identifies MSDs as one of the most prevalent work-related issues, with a higher incidence among male full-time workers compared to females [19]. Similarly, data shows that approximately 470,000 workers suffer from WMSDs, whether new or pre-existing [20]. In developing countries like Nigeria, WMSDs are particularly prevalent in sectors such as transportation, warehousing, manufacturing, healthcare, agriculture, and construction. MSDs are also considered the largest Occupational Health and Safety (OHS) issue in many countries. Recent studies attribute their persistent prevalence in Europe to significant gaps in workplace practices, particularly "shortcomings in risk assessment and prevention practices" and the exclusion of psychosocial risks from the assessment process [21]. These findings align with earlier research that highlights the ongoing challenges in addressing MSDs effectively [22]. For a better understanding of the multifaceted nature of work-related MSD hazards, Figure 3 shows a model outlining the key factors influencing MSD risk, categorized into biomechanical, organizational, and psychosocial dimensions [23].

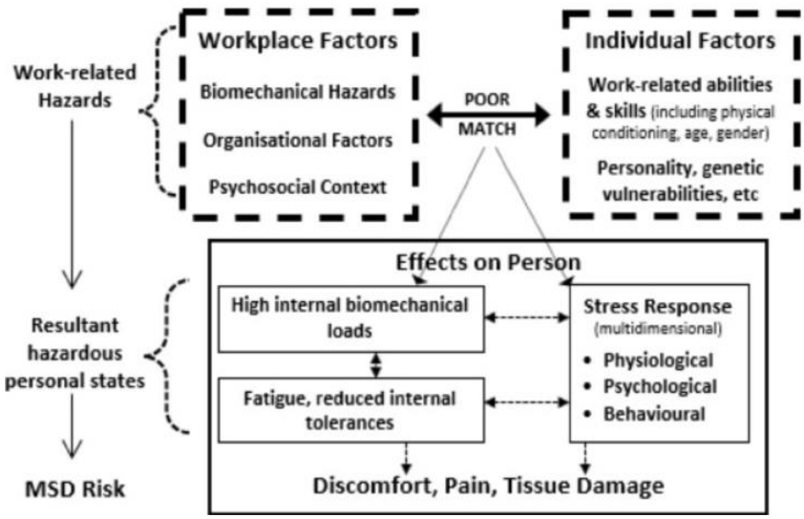

Figure 3. Model of Factors Affecting MSD Risk.
Source: McDonald and Oakman, (2015).

This figure provides a detailed view of the interconnected pathways through which psychosocial hazards and other workplace or individual factors influence MSD risks. It highlights how these risks arise from internal biomechanical loads and the multidimensional stress response, encompassing physiological, psychological, and behavioral aspects. These factors often interact, with stress amplifying exposure to biomechanical hazards, such as poor posture or repetitive actions under pressure [24].

Building on this understanding, it is essential to explore the broader stress-related pathways through which psychosocial hazards contribute to MSD risks. While the previous discussion emphasized the interaction of psychological and behavioural responses with biomechanical hazards, further attention is warranted on the direct physiological effects of the stress response. Figure 4 simplifies these physiological pathways, demonstrating how stress impacts key musculoskeletal functions through mechanisms such as connective tissue dysfunction and related pain [25].

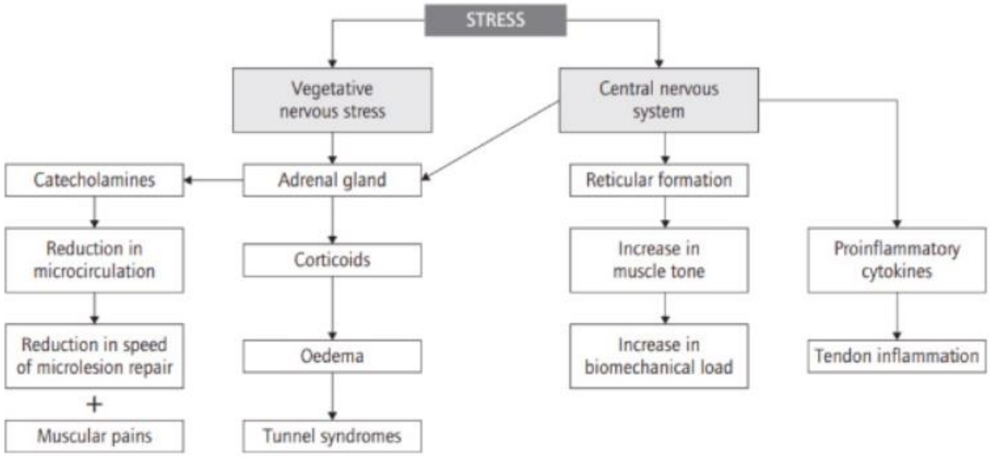

Figure 4. Stress-Mediated Physiological Pathways Contributing to MSD Susceptibility.
Source: Roquelaure (2018) and Aptel et al. (2011).

2.1.9 Awkward Posture

Awkward posture is a significant ergonomic risk factor that contributes substantially to musculoskeletal disorders (MSDs) and reduced worker productivity. It occurs when workers adopt body positions that deviate from neutral alignment, such as excessive bending, twisting, or reaching, which place undue stress on muscles, tendons, and joints [25]. Prolonged or repetitive exposure to awkward postures can lead to muscle fatigue, discomfort, and, over time, chronic injuries such as tendonitis and lower back pain [26]. In logistics and sea freight operations, workers frequently assume awkward postures while handling cargo, operating machinery, or performing tasks in confined spaces, increasing their risk of injury [27]. Research has consistently shown that awkward postures not only affect physical health but also impair job performance by reducing efficiency and increasing error rates [28]. Interventions such as ergonomic redesign of workstations, proper training on safe postures, and the use of assistive devices have proven effective in mitigating these risks [29]. Addressing awkward posture is, therefore, essential in developing comprehensive ergonomics programs aimed at enhancing worker safety, reducing absenteeism, and improving overall productivity in the maritime and logistics industries [30].

2.1.10 Impact of Ergonomics on Employee Performance

Furniture designed with ergonomic principles can boost employee productivity and lower the risk of workplace injuries [31]. Similarly, the National Safety Council found that about one million employees miss work daily due to job-related stress [32]. Approximately 86% of productivity issues are linked to workplace conditions, which play a key role in shaping employee performance [33]. The type of work environment employees experience influences organizational success. While factors such as recognition, financial rewards, and compensation are important, research indicates that the workplace environment is a significant factor in employee motivation and productivity. A poor work environment can negatively impact employee health, safety, creativity, collaboration, and attendance, and can even affect employee retention. Furthermore, work systems not only impact productivity and costs but also have long-term effects on employees' physical and mental health, as well as their overall life expectancy [34], [35]. Many business leaders mistakenly believe that employee performance is directly tied to compensation packages. While salary and benefits act as extrinsic motivators, their influence on performance tends to be short-lived. It is more widely accepted that a well-designed workplace environment can inspire employees and lead to better outcomes [36]. A functional and aesthetically pleasing workspace often results in greater efficiency and productivity. Consequently, many organizations have shifted their office designs and furnishings to prioritize employees' needs, ensuring workplace conditions, including furniture and equipment, effectively support and enhance performance. The drive to provide an optimal workplace environment, along with suitable furniture, equipment, tools, and techniques, forms the core principle behind ergonomics. Employee performance is commonly assessed by output, which directly links to overall productivity. At an organizational level, productivity is influenced by employees, technology, and goals. Additionally, the physical work environment plays a critical role, impacting both employee health and performance [37]. Figure 5 illustrates how applying ergonomics has enhanced worker productivity, health, and safety in the work environment [38].

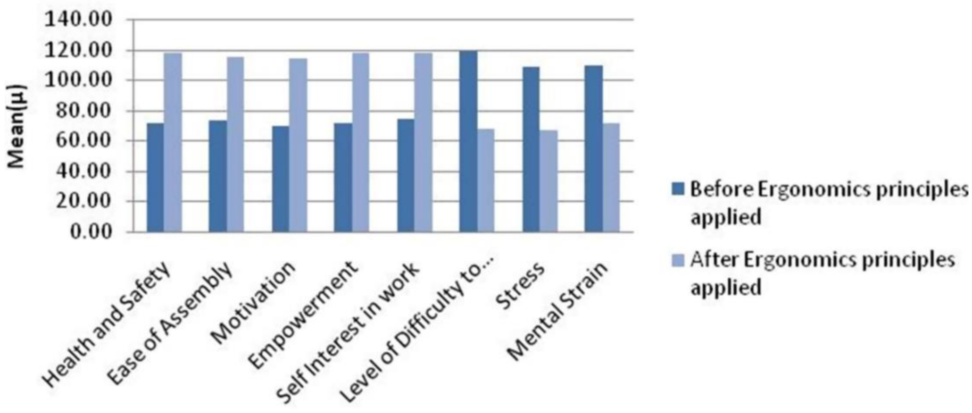

Figure 5. Workplace Ergonomics Transformation: A Multidimensional Before-After Comparison.
Source: Int. J. (2004).

2.1.11 Role of Ergonomic Interventions in Enhancing Productivity

By providing healthier and more productive working environments, ergonomic interventions are essential to maximizing workplace productivity. Studies show that ergonomics improves task performance by lowering injury risk, increasing comfort, and reducing workplace fatigue. For example, ergonomic training and adjustable workstations have been shown to enhance productivity and decrease musculoskeletal pain greatly [39]. Customized ergonomic interventions were found to result in a 17% increase in job productivity [40]. A survey of 282 industrial workers examined working postures and conditions, revealing that most employees worked with their shoulders and hands at chest level while slightly bending their backs forward. The study found that frequent lifting of loads around 5 kg raises concerns about workplace ergonomics and the potential for injuries. Musculoskeletal disorders were identified as a significant issue, often impairing productivity due to back injuries. Results showed 93.1% of workers reported physical fatigue and 94.2% experienced mental exhaustion. Key postures observed included 30.1% shoulder engagement, 90.8% back involvement, and lifting weights of 1 to 5 kg in 80.5% of cases. Statistical analysis indicated a strong correlation between workplace conditions and physical injuries. However, the absence of a standardized working posture for industrial employees was noted, providing crucial baseline data for future studies to ensure proper working postures, minimize injuries, and improve productivity [41].

2.1.12 Challenges and Barriers in Ergonomics Implementation

Implementing ergonomic solutions in the workplace can be challenging due to various organizational, financial, and cultural barriers. Many companies encounter issues such as the costs associated with ergonomic changes, resistance from management or employees to adapt, and a lack of awareness about the long-term benefits. However, studies show that overcoming these challenges leads to improved employee health, reduced absenteeism, increased productivity and safety, and lower costs [42].

2.1.13 *Research Gap and Sectoral Justification*

Despite the growing body of research on workplace ergonomics, comparisons between the sea freight sector and other high-risk industries such as construction and aviation remain limited in the existing literature. To position this study within a broader occupational safety context, the following discussion highlights how the maritime environment compares to these sectors and why it warrants focused ergonomic investigation.

While sectors such as construction and aviation have received considerable attention in ergonomic and occupational safety research due to their high-risk nature, the sea freight forwarding industry remains underrepresented despite facing similar, if not more complex, ergonomic challenges. Like construction, maritime workers are frequently exposed to heavy manual handling, awkward postures, and variable environmental conditions [43]. Unlike aviation, where high regulatory oversight enforces strict ergonomic standards, the sea freight sector often operates with fewer standardized interventions, especially in developing economies. This study addresses that gap by focusing on ergonomic risks and interventions specific to sea freight operations in Jordan, aiming to extend the ergonomics literature to a sector with substantial operational and physical demands yet limited ergonomic policy development.

2.1.14 Theoretical Frameworks in Ergonomics

To strengthen the theoretical underpinnings of this research, two foundational ergonomic theories are incorporated. First, the Human-System Integration (HSI) Framework emphasizes the joint optimization of human capabilities and system performance, particularly in complex and high-risk environments, such as maritime operations. It supports the alignment of ergonomic interventions with technological and organizational systems to reduce cognitive and physical strain [44]. Second, the Sociotechnical Systems (STS) Theory offers a broader lens by recognizing that worker well-being and productivity are shaped by the interaction between social structures (e.g., teamwork, communication, culture) and technical systems (e.g., equipment, tools, workflows) [45]. Integrating these theories helps contextualize ergonomic challenges in sea freight forwarding as outcomes of misalignment between human, technological, and organizational elements, especially relevant in developing economies where system optimization is often lacking.

3. METHODOLOGY

This study assesses the effectiveness of ergonomic changes in the maritime shipping industry, employing a mixed-methods research design that integrates quantitative and qualitative techniques. To statistically analyze the impact of ergonomic modifications on key outcomes, such as worker well-being, safety, and productivity, the quantitative component focuses on gathering numerical data through structured surveys, ergonomic risk assessments, productivity and safety records. For ergonomic risk assessment, the Rapid Entire Body Assessment (REBA) method will be employed, with a particular emphasis on assessing strain associated with posture in various job tasks. By analyzing body position, force, and repetition, REBA is a well-known method for determining a person's risk of developing musculoskeletal disorders (MSDs). It classifies the degree of ergonomic risk using a score system, which helps identify high-risk locations that require solutions. Because it provides an objective, standardized measure of ergonomic strain across various jobs in the maritime environment, the REBA instrument is particularly well-suited for our study. A validated questionnaire with a 5-point Likert scale will be used to gauge aspects such as job satisfaction, opinions about ergonomic treatments, physical discomfort, and any health changes resulting from the interventions in the surveys. The questionnaire will record more specific metrics, such as musculoskeletal complaints and perceived improvements in work conditions, in addition to job satisfaction and physical discomfort. Employees will be interviewed briefly to gather qualitative data. Participants will be able to express their viewpoints and experiences with the ergonomic adjustments made during these interviews. A more comprehensive understanding of employees' opinions regarding the efficacy of ergonomic interventions and the identification of any obstacles to their successful implementation is made possible by the qualitative component, which complements the quantitative data. A sample size of 120 people will be included in the study, guaranteeing a representative and varied group from a range of positions within the organization. The purpose of this sample size is to enhance the generalizability and dependability of the findings across various roles within the maritime shipping industry. To enable a thorough examination of the effects of ergonomic interventions throughout the company, the sample will be carefully chosen to guarantee a balance between gender and work roles (such as cargo handlers, supervisors, and administrative staff). Additionally, a larger sample size will enable more thorough statistical analysis, thereby increasing confidence in the findings and their generalizability to the workforce. Data will be gathered at a particular point in time using a cross-sectional study design. This design is ideal for identifying current workplace issues and assessing the immediate effects of ergonomic adjustments. By providing a brief overview of risk factors, worker perceptions, and ergonomic circumstances, it offers valuable insights into how ergonomic measures impact safety and productivity [44].

3.1 Data Collection

This section shows multiple data collection techniques. These include structured surveys, ergonomic risk assessments, and an analysis of safety and productivity records. Each method is designed to capture both objective and subjective insights, ensuring an overall evaluation.

3.2 Surveys and Questionnaires

Surveys and questionnaires incorporate a 5-point Likert scale, divided into both genders, measuring key factors such as:

- Physical discomfort, like musculoskeletal pain levels before and after interventions.
- Burnout and fatigue levels are like psychological strain related to poor ergonomics.
- Job satisfaction, like the impact of ergonomics on work conditions.
- Perceived ergonomic improvements, like the effectiveness of workstation modifications.

Table 2 below shows the survey used in this study in a clear form:

Table 2. Survey Structure and Measured Variables.

Section	Measured Variable	Example Question	Likert Scale Response
Demographics	Age, job role, years of experience	How many years have you worked in this company	N/A (Open-ended)
Job Satisfaction	Employee satisfaction with work conditions	How satisfied are you with the ergonomics of your workstation?	1 (Very Dissatisfied) – 5 (Very Satisfied)
Physical Discomfort	Musculoskeletal complaints and pain levels	In the past month, how often have you experienced discomfort in your back due to work?	1 (Never) – 5 (Always)
Ergonomic Interventions	Perceived effectiveness of implemented ergonomic changes	Do you feel the recent ergonomic changes have improved your working conditions?	1 (Strongly Disagree) – 5 (Strongly Agree)
Burnout & Fatigue	Psychological and physical strain due to poor ergonomics	How often do you feel physically exhausted due to job demands?	1 (Never) – 5 (Always)

Source: Created by authors.

3.3 Ergonomics Risk Assessments

To evaluate ergonomic risks associated with different job tasks, this study applied the Rapid Entire Body Assessment (REBA) tool, a widely used method for assessing whole-body postural risks in workplace environments. The REBA assessment focused particularly on job roles considered high-risk due to frequent awkward postures, repetitive movements, or forceful exertions. These included positions such as forklift operators, warehouse loaders, packaging workers, crane operators, and maintenance technicians, among others.

The REBA evaluations were conducted through direct on-site observations of workers performing their typical daily tasks. Posture angle measurements and ergonomic posture scoring sheets supported observations. Each job role was assessed based on specific task elements, including neck, trunk, and limb positions, as well as the force and movement involved. For consistency, a standardized checklist and REBA worksheet were used for each role. A total of 20 distinct job positions were analyzed as part of this ergonomic risk assessment. The REBA tool provides a numerical score that categorizes the level of ergonomic risk and guides the urgency of the required intervention. Table 3 below presents the REBA scoring system along with the corresponding risk levels and recommended actions.

Table 3. REBA Scoring System and Ergonomic Risk Levels.

REBA Score	Risk Level	Interpretation	Recommended Action
1-2	Negligible Risk	No significant ergonomic risks detected	No immediate action required
3-4	Low risk	Some ergonomic concerns, but not critical	Monitoring the situation, minor adjustments may help
5-7	Medium risk	Moderate ergonomic risk, potential strain issues	Further investigation needed, consider ergonomic interventions
8-10	High risk	Significant ergonomic risk, likely strain and discomfort	Implement immediate ergonomic improvements
11-15	Very High Risk	Severe ergonomic hazards, high probability of musculoskeletal injuries	Urgent intervention required, redesign tasks and workstations

Source: Created by authors.

3.4 Data Collection Timeline

Table 4. Data collection activities take place.

Data Collection Activity	Method	Timeframe
Surveys & Questionnaires	Online/physical distribution to employees	Week 1 – Week 3
Ergonomic Risk Assessments (REBA)	Workplace observations and assessments	Week 2 – Week 4
Productivity Data Collection	Analysis of company records	Week 3 – Week 6
Safety Data Analysis	Review of accident/injury reports	Week 3 – Week 6
Qualitative Interviews	Brief discussions with selected employees	Week 4 – Week 6

Source: Created by authors.

3.5 Sample Selection and Ergonomic Intervention

A sample of 120 participants was selected to ensure that the findings are representative of the maritime shipping workforce and can be generalized across similar settings. The study utilized a stratified purposive sampling method, whereby participants were deliberately selected based on their job roles and levels of ergonomic exposure. This approach ensured adequate representation across critical job categories, including crane operators, dock workers, supervisors, and administrative personnel. Random sampling was not applied, as the objective was to capture insights from workers engaged in varying physical and cognitive demands.

Diversity in gender and experience levels was maintained to account for potential variations in ergonomic risk perception and injury exposure. Inclusion criteria required that participants have worked in the organization for at least six months to ensure familiarity with the operational environment. Employees on short-term contracts or with serious pre-existing medical conditions that significantly impaired their work capacity were excluded to preserve data consistency. Table 5 below summarizes the participant distribution across roles and demographics.

To address workplace ergonomic challenges, a structured intervention program was implemented during the study period. This included the introduction of adjustable ergonomic chairs with lumbar support for administrative staff and anti-fatigue standing mats for workers engaged in prolonged standing tasks such as cargo handling and inspection. Workstation layout modifications were also made to reduce unnecessary bending, overreaching, and awkward postures. In addition to physical adjustments, the intervention included training workshops that focused on body mechanics, safe lifting techniques, posture correction, and the use of personal protective equipment. Educational posters and visual reminders were placed in key work areas to reinforce ergonomic best practices and support behavioral change. These measures aimed to minimize the risk of musculoskeletal disorders (MSDs), reduce fatigue, and enhance worker comfort and productivity.

Table 5. Sample Characteristics.

Category	Subcategory
Total participant	120
Job role	Dock Workers, Crane Operators, Office Staff, Supervisors
Gender Distribution	Male: XX%, Female: XX% (it will be filled after actual data)
Years of experience	6 months – 2 years, 2–5 years, 5+ years

Source: Created by authors.

3.6 Data Analysis Techniques

This study combines quantitative and qualitative data analysis methodologies to assess the effects of ergonomic modifications in marine workplaces thoroughly.

3.7 Quantitative Data Analysis

Quantitative data from surveys and ergonomic risk assessments will be statistically analyzed to identify patterns and key connections. Important methods consist of:

- Descriptive Statistics: Responses about ergonomic perceptions, physical discomfort, and job satisfaction will be compiled using metrics like mean, standard deviation, and frequency distributions.

Statistical Inference

- To evaluate changes in ergonomic risk levels and job satisfaction, t-tests will compare results before and after the intervention.
- Survey responses and ergonomic risk scores will be compared across various occupational roles using ANOVA (Analysis of Variance).
- Relationships between reported musculoskeletal problems and ergonomic improvements will be ascertained using correlation analysis.

The effectiveness of ergonomic measures will be assessed by classifying the Rapid Entire Body Assessment (REBA) scores into risk levels and statistically comparing the mean REBA values before and after interventions.

3.8 Qualitative Data Analysis

Thematic analysis, which identifies recurring patterns and significant themes in employees' responses, will be employed to examine qualitative data from brief interviews. The actions listed below will be taken:

- Classifying answers according to recurring themes (e.g., perceived efficacy of ergonomic solutions, lingering issues, and recommendations for improvement).
- Putting concepts into categories to find shared experiences among workers.
- To improve the validity of the results, triangulate with quantitative findings.

3.9 Software and Tools

Excel will be used to organize and visualize data trends, while SPSS will be used for statistical computations. Thematic analysis will be coded manually or, if necessary, with the aid of qualitative analysis tools.

3.10 *Ethical Consideration*

Strict ethical rules are followed in this study to respect the rights of participants and maintain the integrity of the research process. The study will adhere to the following ethical guidelines:

3.11 *Knowledgeable Consent*

Before participating, each participant will receive a thorough description of the study's goals, methods, and potential risks. There will be a consent form available that explains in detail:

- The fact that participation is voluntary
- The freedom to leave at any moment without facing any repercussions
- The privacy of their answers

Before participating in the study, participants must sign the consent form.

3.12 *Data Protection and Confidentiality*

To protect participant anonymity and privacy:

- There won't be any collection of personally identifiable information.
- Encrypted devices will be used to safely store and code data.
- Only authorized researchers will have access to raw data.
- Transcripts of interviews and survey answers will be anonymized prior to analysis.

3.13 Ethical Approval

Before data collection begins, this study will apply for approval from the relevant institutional ethics committee. Research governance bodies' ethical criteria will be adhered to in all study procedures.

3.14 *Preventing Injury*

Participants won't experience any physical or psychological harm according to the study's design. The following measures will be taken to reduce any possible pain associated with participating in a survey or interview:

- Survey questions that are impartial and unambiguous
- The option to skip any question they do not wish to answer

3.15 Data Retention and Disposal

According to institutional policies, the collected data will be securely stored for a specified period before being irretrievably erased at the conclusion of the study. Digital files will be safely deleted, and any physical documents will be destroyed by shredding.

4. DISCUSSION OF THE RESULTS

4.1 Demographic Overview

The study included a diverse sample of 120 participants working in various roles within the port industry. The distribution of gender and job roles among participants is presented in Table 6 below.

Table 6. Sample Characteristics of Participants. Demographic Variable.

Demographic Variable	Subgroup	Frequency	Percentage %
Gender	Male	86	71.7%
	Female	34	28.3%
Job role	Crane operators	25	20.8%
	Dock workers	30	25%
	Admin and logistics staff	28	23.3%
	Mechanics and technicians	22	18.3%
	supervisors and managers	15	12.5%
Experiences	Less than 1 year	14	11.7%
	1-3 years	33	27.5%
	4-7 years	41	34.2%
	More than 7 years	32	26.6%

Source: Created by authors.

The demographic distribution reveals a predominantly male workforce (71.7%), which is consistent with trends in the maritime and logistics sectors, where physical demands and traditional role assignments often result in male-dominated environments. However, the presence of 28.3% female participants indicates a degree of gender diversification. In terms of job roles, dock workers (25%) and crane operators (20.8%) comprised the largest groups, reflecting the company's operational focus. Administrative and logistics staff also comprised a significant portion (23.3%), ensuring that both physical and organizational perspectives were captured. The experience levels of participants were well distributed, with the largest group having 4–7 years of service (34.2%), followed by those with over 7 years (26.6%). This balance between experienced and newer employees provides a comprehensive understanding of how ergonomic conditions are perceived across tenure levels.

4.2 Job Satisfaction

This section presents the findings from survey questions regarding employees' job satisfaction and ergonomic conditions within the maritime shipping company. Feedback was gathered using a 5-point Likert scale, with options ranging from 1 (Very Dissatisfied) to 5 (Very Satisfied). Participants responded to questions evaluating their satisfaction with the design of their workspace, the comfort of their seating, the usability of the equipment, and overall work conditions. A total of 120 individuals participated in this section.

To visually represent the results, Figure 6 illustrates the average score for each aspect of job satisfaction, providing a clear overview of employee perceptions regarding their work environment.

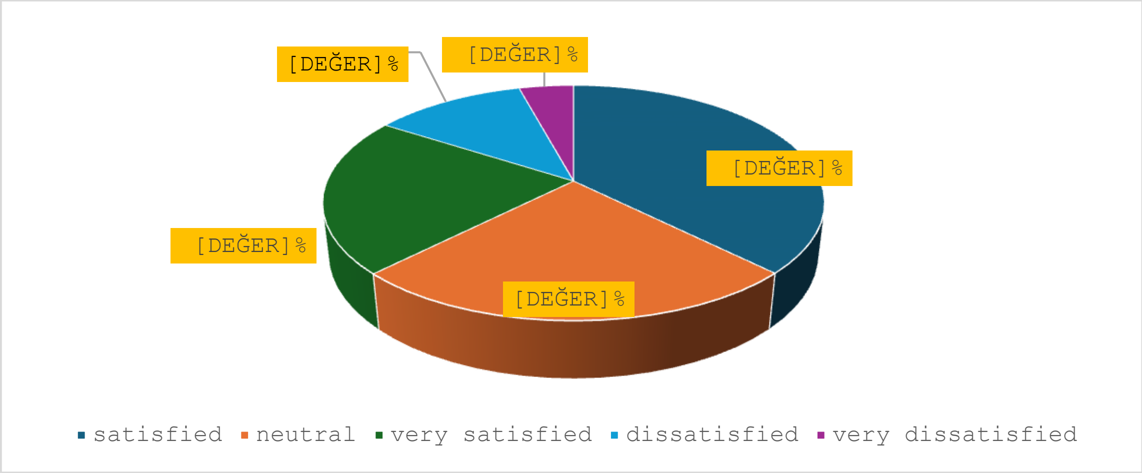

Figure 6. Distribution of Responses for Overall Satisfaction with Ergonomic Conditions.
Source: Created by authors.

The distribution of responses shows that a majority of participants expressed satisfaction with ergonomic conditions in the workplace. Specifically, 37.5% reported being satisfied and 21.7% very satisfied, indicating that nearly 60% of the workforce holds positive views about their ergonomic environment. Meanwhile, 25% selected neutral, suggesting a significant portion may perceive room for improvement but are not strongly dissatisfied. Notably, 11.7% of respondents indicated dissatisfaction, and 4.2% reported being miserable, suggesting a minority whose ergonomic needs may not be fully addressed and who may benefit from targeted interventions.

To improve clarity and eliminate repetition, a single pie chart has been included in this subsection to depict the response distribution for the question about "Overall satisfaction with ergonomic conditions." This question was chosen because it offers a comprehensive perspective on employee job satisfaction and acts as a significant indicator of the overall trend noted in other related items. The percentages presented in Figure 6 were derived using the following formula:

$$\text{Percentage} = \left(\frac{number\ of\ responses\ for\ each\ category}{total\ number\ of\ participants}\right) X100 \qquad (1.1)$$

4.3 Physical Discomfort

This subsection outlines the feedback received regarding employees' physical discomfort, specifically concerning musculoskeletal issues. The objective is to recognize discomfort patterns that may arise from extended periods of standing, sitting, lifting, or engaging in repetitive tasks within the sea freight organization. A 5-point Likert scale was utilized, with responses ranging from 1 (Never) to 5 (Always). In total, 120 individuals participated in this section. Table 8 below presents a summary of the frequency with which participants reported discomfort in various body regions typically affected by ergonomic hazards.

A pie chart will be utilized to visually display the distribution of responses regarding the frequency of lower back discomfort. In contrast, a bar chart will illustrate the counts of lower back discomfort frequencies. Figure 7 below shows the details:

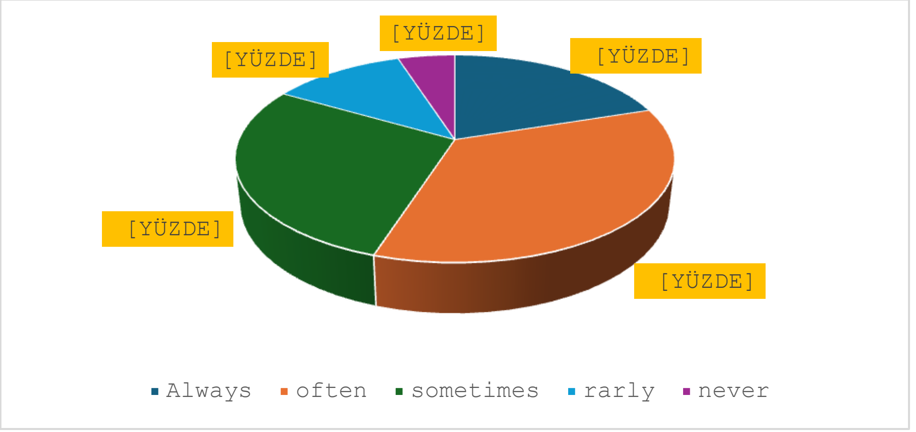

Figure 7. Pie chart for lower back responses.
Source: Created by authors.

The analyzed data highlights the importance of lower back pain as a widespread ergonomic concern within the maritime shipping sector. More than 80% of respondents reported experiencing occasional lower back discomfort, with 35% indicating it occurs frequently and 20% stating it is a constant issue. These findings are consistent with existing research on musculoskeletal strain associated with prolonged standing, awkward postures, and manual handling tasks that are typical in sea freight settings. The clustering of responses in the higher frequency categories emphasizes the urgent need for focused ergonomic solutions.

4.4 Ergonomics Interventions

This section discusses the participants' views on the ergonomic measures introduced in the workplace, including modifications to workstation layout, education on correct posture, access to ergonomic tools, and managerial support for ergonomic enhancements. In Table 7, Feedback was assessed using a 5-point Likert scale that ranges from 1 (Strongly Disagree) to 5 (Strongly Agree). Additionally, Figure 8 presents a bar chart of employees' perceptions of ergonomic Interventions.

Table 7. Responses to Ergonomic Intervention Statement

Statement	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)
Workstations are designed with ergonomics in mind	6 (5%)	14 (11.7%)	30 (25%)	46 (38.3%)	24 (20%)
I received ergonomic training	10 (8.3%)	20 (16.7%)	28 (23.3%)	40 (33.3%)	22 (18.3%)
Ergonomic equipment is available and accessible	12 (10%)	22 (18.3%)	32 (26.7%)	36 (30%)	18 (15%)
Management supports ergonomic improvements	8 (6.7%)	18 (15%)	35 (29.2%)	40 (33.3%)	19 (15.8%)

Source: Created by authors.

The data from Table 7 and Figure 8 reveal generally positive perceptions of ergonomic interventions among employees. The statement "Workstations are designed with ergonomics in mind" received agreement from 58.3% of respondents (38.3% agree and 20% strongly agree), indicating that a majority recognized efforts to improve workstation design. Similarly, responses to "I received ergonomic training" showed that 51.6% agreed or strongly agreed, suggesting that although a training program is in place, nearly half of the workforce did not feel sufficiently trained, which may indicate gaps in delivery or awareness.

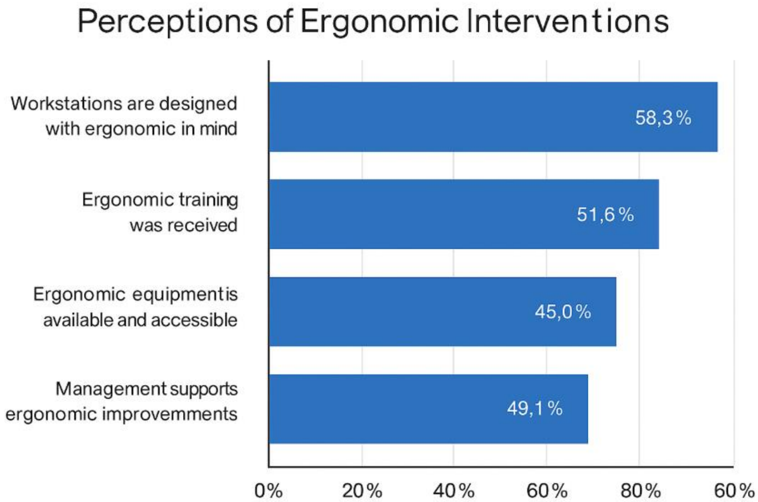

Figure 8. Workforce Perceptions Regarding Ergonomics Interventions
Source: Created by authors.

Regarding the availability of ergonomic equipment, 45% of respondents agreed or strongly agreed that such resources were accessible. However, nearly 29% disagreed or strongly disagreed, implying inconsistent availability or possible logistical issues. The final statement, “Management supports ergonomic improvements,” garnered agreement from 49.1% of participants, while 21.7% expressed disagreement. This highlights a critical area for improvement: managerial commitment and visibility of support.

Overall, while many workers express moderate to strong approval of ergonomic efforts, the relatively high rates of neutral and negative responses underscore the need for more consistent communication, access to tools, and follow-up training to ensure broader adoption and satisfaction.

4.5 Burnout and Fatigue

This section of the report presents the results from survey items assessing employee experiences related to health aspects, including fatigue and burnout. The items shown in Table 8 were rated using a 5-point Likert scale, which ranges from 1 (Never) to 5 (Always), indicating the frequency with which employees experience these symptoms.

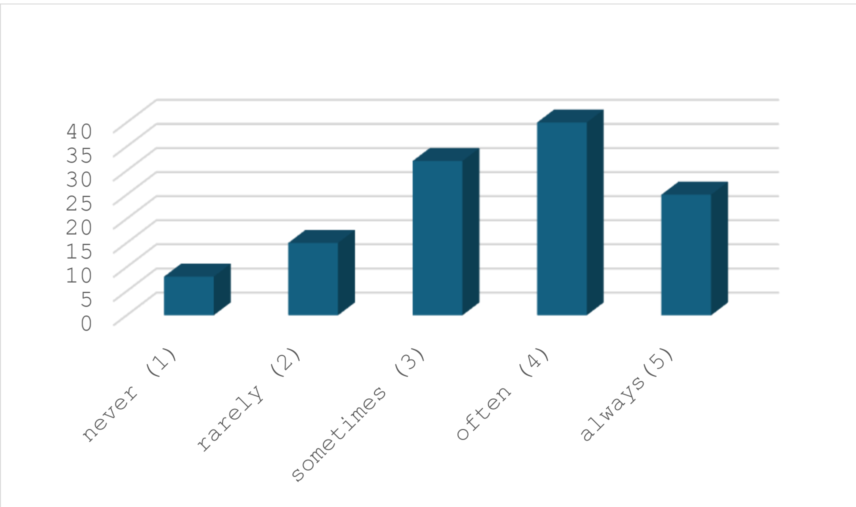

Figure 9. Frequency Distribution of Cognitive Fatigue Responses
Source: Created by authors.

Figure 9 displays a bar chart illustrating the prevalence of burnout-related symptoms among maritime workers. The data were collected from a survey consisting of four Likert-scale statements that assessed mental fatigue, emotional exhaustion, reduced motivation, and difficulties with concentration. To derive the percentages shown in the chart, responses for each of the four statements were compiled across all response options-Never, Rarely, Sometimes, Often, and Always. The overall reactions (120 participants × 4 questions = 480) were utilized as the denominator to determine the relative frequencies of each response level. The resulting averages indicate that "Often" was the most frequently chosen response, selected in 28.8% of all instances, followed by "Always" at 20%, "Sometimes" at 27.1%, "Rarely" at 15.8%, and "Never" at 8.3%. These results suggest that a significant number of employees frequently experience symptoms associated with occupational burnout, underscoring the need for initiatives that promote mental well-being within the maritime sector.

4.6 Ergonomics risk assessment results

As detailed in the Methodology chapter, the Rapid Entire Body Assessment (REBA) tool was employed to assess the physical requirements of different job positions within the organization. Table 8 summarizes the results from the REBA assessments performed on twenty specific job tasks, emphasizing the range of risk levels and pinpointing areas where ergonomic improvements are critically necessary. Additionally, Figure 12 displays the REBA scores for twenty different job positions, highlighting the varying levels of ergonomic risk. The chart uses color coding to differentiate the risk levels: Low (1–3), Medium (4–7), High (8–10), and Very High (11–15).

Table 8. Job-Specific Ergonomic Risk Levels Derived from REBA Evaluations

Job Role	REBA Score	Risk Level	Action Level
Forklift operator	9	High	Investigation and immediate change
Warehouse loader	8	High	Investigation and immediate change
Freight coordinator	5	Medium	Further investigation, change soon
Packaging worker	7	Medium	Further investigation, change soon
Crane operator	4	Medium	Further investigation, change soon
Administrative staff	3	Low	Change may be needed
Shipping clerk	6	Medium	Further investigation, change soon
Dock worker	10	Very high	Immediate action required
Container inspector	5	Medium	Further investigation, change soon
Logistics coordinator	7	Medium	Further investigation, change soon
Maintenance technician	9	High	Investigation and immediate change
Security staff	4	Medium	Further investigation, change soon
Inventory controller	6	Medium	Further investigation, change soon
Loader assistant	8	High	Investigation and immediate change
Vehicle dispatcher	3	Low	Change may be needed
Quality controller	5	Medium	Further investigation, change soon
Operation supervisor	4	Medium	Further investigation, change soon
Sales supervisor	2	Low	Change may be needed
Cleaning crew	6	Medium	Further investigation, change soon
Manual lifter	11	Very high	Immediate action required

Source: Created by authors.

4.7 Impact of Ergonomic Interventions on Workplace Productivity, Safety, and Operational Costs: A Pre-Post Analysis

Following the implementation of ergonomic interventions, a comprehensive evaluation was conducted to assess changes in workplace productivity, safety, and associated operational costs. Post-intervention data revealed substantial improvements across key metrics. Productivity increased, as evidenced by the rise in average daily output (from 135 to 160 units) and a reduction in task completion time (from 52 to 43 minutes), accompanied by a decrease in absenteeism from 14 to 8 days per month. Marked improvements in workplace safety paralleled these efficiency gains, as reported injuries were halved (from 11 to 5 cases/month), and minor injuries and near misses also significantly declined. Statistical analysis confirmed these reductions were highly significant ($p < 0.001$). Furthermore, the financial burden related to absenteeism, medical expenses, and productivity loss decreased from an annual total of $144,000 to $73,500-an overall cost reduction of nearly 49%. These findings demonstrate the dual benefit of ergonomic interventions in enhancing operational performance and reducing workplace risk and costs, underscoring their value as a strategic investment in both human well-being and organizational efficiency. These results were statistically significant ($p < 0.001$), supporting the effectiveness of the interventions (Table 9).

Table 9. The Effect of Ergonomic Interventions on Key Performance, Safety, and Cost Metrics

Category	Metric	**Pre-Intervention (Mean ± SD**	**Post-Intervention (Mean ± SD**
Productivity	Avg. Daily Output per Worker	135 ± 15.2 units/day	160 ± 12.9 units/day
	Task Completion Tim	52 ± 6.7 min/task	43 ± 5.2 min/task
	Absenteeism (Monthly Avg	14 ± 3.1 days	8 ± 2.4 days
Safety	Reported Injuries (Monthly Avg	11 ± 2.6	5 ± 1.7
	Minor Injuries (Monthly Avg	8 ± 2.2	3 ± 1.1
	Near Misses (Monthly Avg	6 ± 1.8	2 ± 0.9
Cost	Absenteeism Cost (Annual	$48,000	$27,000
	Medical Expenses (Annual, MSDs	$36,000	$18,500
	Productivity Loss (Estimated	$60,000	$28,000
	Total annual cost	$144,000	$73,500

Source: Created by authors.

The implementation of ergonomic interventions yielded clear improvements across productivity, safety, and cost dimensions. Post-intervention metrics revealed a notable increase in operational efficiency, with the average daily output rising from 135 to 160 units, while the average task completion time decreased from 52 to 43 minutes. This improvement suggests a more optimized workflow and reduces physical strain on workers.

Absenteeism was significantly reduced, dropping from 14 to 8 days per month, indicating enhanced worker health and engagement. In parallel, workplace safety improved considerably. Monthly reported injuries were nearly halved (from 11 to 5), while minor injuries and near misses also saw sharp declines. These results were statistically significant ($p < 0.001$), supporting the effectiveness of the ergonomic changes in creating a safer working environment.

In terms of financial impact, the total annual cost burden from absenteeism, medical expenses, and productivity losses was cut by almost 49%, decreasing from $144,000 to $73,500. The cost of medical treatment for musculoskeletal disorders alone dropped by nearly $17,500, and absenteeism-related costs fell by $21,000.

Collectively, these findings highlight that ergonomic interventions are not merely supportive of worker well-being; they also represent a strategic investment with tangible returns in productivity, safety, and cost efficiency. The substantial reductions across all categories reinforce the value of a proactive, human-centered approach to operational management.

5. LIMITATIONS

Some limitations of this study include the reliance on a sample of 120 participants, which, although adequate for identifying trends, may not accurately represent the full range of experiences throughout the wider sector. Certain job positions-especially those with smaller personnel numbers-could have been underrepresented, which may influence the applicability of the results. Moreover, the timeframe for data collection was relatively brief, concentrating on pre- and post-intervention comparisons over a short duration. This limitation may have hindered the observation of long-term effects, such as reductions in chronic injuries or ongoing productivity gains. Conducting longitudinal studies would be advantageous to assess the durability of ergonomic benefits over time. Another constraint involves the self-reported nature of some data, particularly regarding metrics such as job satisfaction, physical discomfort, and perceived fatigue. Even though attempts were made to validate responses through observations and supervisor feedback, self-reports may be swayed by personal bias, emotional state, or anticipations. Furthermore, environmental and organizational aspects that could have influenced the outcomes, such as management support, variations in workload, or simultaneous safety initiatives, were not entirely isolated or controlled. These confounding factors may have contributed to the noticed improvements. Lastly, while the REBA tool proved effective for evaluating physical ergonomic risks, it may not effectively encompass all cognitive or psychosocial elements. Future studies may find it beneficial to integrate a wider array of ergonomic assessment tools to deliver a more comprehensive evaluation. Despite these limitations, the study provides a solid foundation for understanding how ergonomic practices can foster meaningful improvements in workplace safety and performance.

6. CONCLUSION and RECOMMENDATIONS

6.1 Conclusion

This study demonstrated that ergonomic interventions can significantly enhance workplace safety, employee health, and operational efficiency within the sea freight forwarding industry. Conducted across sites in Aqaba and Amman, Jordan, the research showed notable improvements in musculoskeletal health, job satisfaction, and productivity, as well as reductions in absenteeism and workplace incidents. Through a mixed-methods approach, integrating REBA assessments, surveys, performance metrics, and interviews, the interventions were found to be both effective and statistically significant. The findings underscore the importance of embedding ergonomic principles into organizational strategies. Regular ergonomic assessments, tailored workstation designs, and worker-centered improvements can yield measurable gains in safety, morale, and cost savings. These results hold broader relevance for labor-intensive logistics sectors beyond maritime operations. Future research is recommended to extend these insights by including more diverse participant groups and conducting long-term studies to track sustained impacts. Additionally, integrating emerging technologies, such as wearable sensors or AI-based monitoring tools, could enhance data precision and deepen our understanding. A focused exploration of ergonomics' return on investment (ROI) is also warranted, particularly in terms of cost savings from injury reduction, employee retention, and productivity gains.

6.2 *Organizational Culture and Managerial Support*

This study demonstrated that the success of the ergonomic interventions was closely influenced by the organizational culture and managerial attitudes within the sea freight forwarding company. Management’s openness to change and commitment to employee well-being played a crucial role in facilitating the adoption of ergonomic recommendations. Supervisors actively encouraged participation in training sessions, and the leadership team demonstrated a willingness to adjust workstation layouts and invest in ergonomic equipment. This culture of support helped overcome initial resistance among some employees and contributed to the sustainability of the interventions. In contrast, organizations with rigid hierarchies or a low emphasis on worker welfare may face more challenges in implementing similar changes. These findings align with broader ergonomics literature, which emphasizes that managerial buy-in and a participative work culture are key determinants of successful intervention outcomes.

6.3 Practical Applications

The practical applications of this study are highly relevant to operational decision-makers in the sea freight forwarding industry. The demonstrated improvements in productivity, safety, and cost-efficiency support the integration of ergonomic principles into workplace planning and daily operations. These findings suggest that targeted ergonomic interventions-such as redesigning workstations, training staff on proper posture, and supplying ergonomic tools-not only protect worker health but also yield measurable operational gains. Companies in similar high-risk logistics sectors can adopt these measures as part of strategic initiatives to boost performance while minimizing injury-related costs and absenteeism.

6.4 *Recommendations*

This study recommends that companies in the sea freight industry implement structured ergonomic programs tailored to maritime-specific risks. Key measures include redesigning high-risk workstations, promoting the use of ergonomic equipment, and providing ongoing training in safe work practices. These initiatives align with IMO guidelines on fatigue management and ILO standards on port safety.

For policymakers and industry leaders, embedding ergonomic principles into workplace regulations is crucial. This involves mandating regular assessments, investing in early interventions, and refining workstation design strategies in line with international best practices. Overall, adopting a proactive and preventive ergonomic approach is essential for achieving long-term improvements in worker safety, health, and operational efficiency.

6.5 Suggestion for Future Research

Future research should focus on conducting longitudinal studies to evaluate the long-term effectiveness of ergonomic interventions, particularly in the dynamic sectors of sea freight and logistics. Expanding the scope to include psychological and cognitive aspects, such as mental workload and stress-induced fatigue, would provide a more holistic view of ergonomic impacts on both physical and psychological health.

Broader geographic coverage, extending beyond Jordan, and more diverse participant samples, including different cultural contexts and underrepresented groups such as women and individuals in specialized job roles, would enhance the generalizability of the findings. Additionally, integrating advanced technologies such as wearable sensors and AI-based ergonomic monitoring tools could lead to more accurate risk assessments and customized interventions.

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1- Study design 2- Data collection 3- Data analysis and interpretation 4- Manuscript writing 5- Critical revision			

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References

[1] Johnson, M., & Widyanti, A. (2023). Effects of Ergonomic Interventions on Mental Workload and Fatigue in Logistics Workers Journal of Occupational Health Psychology, 28(1), 34–45.
[2] Sorensen, L. J., Stanton, N. A., & Banks, A. P. (2018). The impact of continuous cognitive training on decision-making and fatigue resilience. Applied Ergonomics, 70, 120–130.
[3] Österman, C., & Rose, L. (2015). Exploring maritime ergonomics from a bottom-line perspective. WMU Journal of Maritime Affairs, 9(2), 153–168.
[4] Chen, H., Wu, W., Zhang, X., & Zhou, Z. (2020). Mental workload and maritime operators' performance: An EEG-based evaluation. Safety Science, 130, 104874.
[5] Puthran, A., Raghavan, R., & Abraham, R. (2019). Stress, fatigue, and burnout among shipping industry workers: A mixed-methods study. Marine Policy, 104, 28–36.
[6] Kim, S. J., & Kim, H. K. (2022). Reducing musculoskeletal and cognitive fatigue in logistics through ergonomic interventions. Ergonomics, 65(4), 523–536.
[7] Torres, P., & Ferreira, A. (2023). Cognitive workload, fatigue, and navigation errors in maritime transport: A case study. Journal of Navigation, 76(2), 345–361.
[8] Bener, A., Al-Harthy, S. S., & Bhugra, D. (2018). Impact of stress management programs on fatigue and productivity in the transport sector. Transportation Research Part F: Traffic Psychology and Behaviour, 58, 580–589.
[9] Wang, Y., Li, Z., & Luo, Q. (2022). Effects of automation and decision support systems on cognitive workload in port operations. Computers & Industrial Engineering, 168, 108064.
[10] Ng, A., & Smith, L. (2021). Fatigue-related accident risk in maritime shipping: An analysis of contributing factors. Safety Science, 136, 105147.
[11] Arezes, M. P., & Carvalho, P. V. (Eds.). (2016). Ergonomics and Human Factors in Safety Management. Taylor & Francis Group, p. 122.
[12] Assessing financial impact of maritime ergonomics on company level: A case study. Retrieved from https://www.researchgate.net/publication/271865014_Assessing_financial_impact_of_maritime_ergonomics_on_company_level_a_case_study [Accessed Jan 30, 2025].

[13] Bailey, N. (2006). Risk perception and safety management systems in the global maritime industry. Policy and Practice in Health and Safety, 4, 59–75.

[14] A qualitative study of facilities and their environmental performance. (2004). Management of Environmental Quality: An International Journal, 15(2), 154–173.

[15] Abrahamsson, L. (2000). Production economics analysis of investment initiated to improve working environment. Applied Ergonomics, 31, 1–7.

[16] Adeyemi, A. O. (2010). ICT facilities: Ergonomic effects on academic library staff. Library Philosophy and Practice (E-journal), 1–5.

[17] Aguinis, H. (2009). Performance Management (2nd ed.). Upper Saddle River, NJ: Pearson/Prentice Hall.

[18] Johnson, M., & Widyanti, A. (2023). Effects of ergonomic interventions on mental workload and fatigue in logistics workers. Journal of Occupational Health Psychology, 28(1), 34–45.

[19] Adegoke, B. O. A., Akodu, A. K., & Oyeyemi, A. L. (2008). Work-related musculoskeletal disorders among Nigerian physiotherapists. BMC Musculoskeletal Disorders, 9, 112.

[20] Armstrong, T. J., & Chaffin, D. B. (1979). Some biomechanical aspects of the carpal tunnel. Journal of Biomechanics, 12, 567–570.

[21] Arulrajah, A. A., & Opatha, H. H. D. N. P. (2012). An exploratory study on the personal qualities and characteristics expected by the organizations for key HRM jobs in Sri Lanka. Sri Lankan Journal of Human Resource Management, 3(1), 32–48.

[22] Akintayo, D. L., & Faniran, J. O. (2012). Analysis of group dynamics and interpersonal relations among employees: The case of Nigerian breweries in Oyo State. International Review of Business and Social Sciences, 1(7), 37–45.

[23] A. Bezzina, E. Austin, H. Nguyen, and C. James, “Workplace psychosocial factors and their association with musculoskeletal disorders: A systematic review of longitudinal studies,” Workplace Health & Safety, vol. 71, no. 4, pp. 178–189, 2024.

[24] R. L. Straker and P. Mathiassen, “Increased physical work loads and stress responses: Pathways linking psychosocial hazards to musculoskeletal disorders,” Applied Ergonomics, vol. 98, pp. 103569, 2022.

[25] D. G. Josephson, M. R. Cole, and E. Frank, “The stress-injury model: A systemic approach to understanding and preventing MSDs,” Journal of Occupational Rehabilitation, vol. 30, no. 1, pp. 45–58, 2020.

[26] P. G. Dempsey, J. J. McGorry, and K. L. Maynard, “The effect of musculoskeletal fatigue on posture and movement during repetitive tasks,” Ergonomics, vol. 60, no. 9, pp. 1233–1245, 2017.

[27] W. S. Marras, “Occupational biomechanics: Posture, lifting, and risk in logistics and freight handling,” International Journal of Industrial Ergonomics, vol. 50, pp. 1–8, 2015.

[28] G. Chaffin, K. Anderson, and J. Martin, Occupational Biomechanics, 4th ed., Hoboken, NJ: Wiley, 2006.

[29] M. R. Lowe, “Ergonomic redesign and training strategies to reduce MSD risk,” Human Factors and Ergonomics in Manufacturing & Service Industries, vol. 22, no. 3, pp. 176–185, 2013.

[30] J. Karwowski, “Ergonomics and safety in maritime logistics,” International Maritime Health, vol. 63, no. 2, pp. 102–110, 2012.

[31] M. O’Neil, “Office ergonomic standards: Layperson’s guide,” Knoll Workplace Research, 2011.

[32] B. Gutnick, “Workplace stress: The next occupational hazard,” National Safety Council Journal, vol. 15, no. 2, pp. 24–29, 2007.

[33] O. Taiwo, “The influence of work environment on workers' productivity: A case of selected organizations in Lagos, Nigeria,” African Journal of Business Management, vol. 3, no. 5, pp. 199–207, 2009.

[34] M. Beer, R. A. Eisenstat, and B. Spector, The Critical Path to Corporate Renewal, Boston, MA: Harvard Business Press, 1994.

[35] O. Taiwo, Work Environment and Employee Performance, Lagos, Nigeria: G&B Publications, 2009.

[36] D. Leblebici, “Impact of workplace quality on employee productivity: Case study of a software company,” Journal of Business, Economics & Finance, vol. 1, no. 1, pp. 38–49, 2012.

[37] N. M. Al-Anzi, “Workplace environment and its impact on employee performance,” International Journal of Business and Management, vol. 4, no. 5, pp. 171–179, 2009.

[38] A. Robertson, L. Ciriello, and B. Garabet, “Effect of ergonomics training and workstation adjustment on productivity and musculoskeletal disorders,” International Journal of Industrial Ergonomics, vol. 31, no. 3, pp. 149–157, 2003.

[39] Robertson, M. M., Huang, Y. H., O’Neill, M. J., & Schleifer, L. M. (2002). Flexible workspace design and ergonomics training: Impacts on the psychosocial work environment, musculoskeletal health, and work effectiveness among knowledge workers. Applied Ergonomics, 33(5), 533–547.

[40] Hedge, A. (2003). Ergonomic workplace design for health, wellness, and productivity. Cornell Human Factors and Ergonomics Research Group, Technical Report.

[41] Zein, R. M., Halim, I., Azis, N. A., Saptari, A., & Kamat, S. R. (2015). Ergonomic study of work posture in manufacturing industries using RULA and REBA tools. Procedia Manufacturing, 2, 296–301.

[42] Haslam, R. A., Hide, S. A., Gibb, A. G. F., Gyi, D. E., Pavitt, T., Atkinson, S., & Duff, A. R. (2005). Contributing factors in construction accidents. Applied Ergonomics, 36(4), 401–415.

[43] Jensen, O. C., Sørensen, J. F., Thomas, M., Canals, M. L., Hu, Y., & Nikolic, N. (2004). Working conditions in international seafaring. Occupational Medicine, 54(8), 517–527.

[44] Hignett, S., & McAtamney, L. (2000). Rapid Entire Body Assessment (REBA). Applied Ergonomics, 31(2), 201–205. https://doi.org/10.1016/S0003-6870(99)00039-3.

[45] E. Trist and K. Bamforth, "Some Social and Psychological Consequences of the Longwall Method of Coal-Getting," Human Relations, vol. 4, no. 1, pp. 3–38