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CONTEXTUALIZATION OF WORKING CONDITIONS IN THE RAILCAR WORKSHOP SECTOR OF A MINING INDUSTRY

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ABSTRACT

This paper presents an ergonomic intervention related to wagon maintenance workstation, in a mining industry. It was performed interviews with workers, as well as field observations about the activities of the tasks and, also a questionnaire. In general, the results showed problems in order: environmental, Biomechanics and Organizational.

KEYWORDS: ergonomics; work conditions; wagon maintenance

1. INTRODUCTION

The Brazilian Railway Industry is the largest in South America, boasting a rail network extending over 30,000 kilometers (ABIFER). It's noteworthy that, in the year 2014, 140,356 tons of cargo were transported using 3,340 locomotives and 103,141 circulating railcars. The majority of Brazil's rail network is concentrated in the Southeast and South regions, primarily utilized for freight transportation. Key products carried by rail transport in Brazil include iron ore, soybeans, sugar, coal, grains, soybean meal, diesel oil, cellulose, steel products, and pig iron.

According to ABIFER (Brazilian Association of Railway Industry), Brazilian railway industries are comprised of both domestic and international companies operating in modern factories, utilizing specialized engineering and labor. Surrounding the entire railway industry process is the railcar maintenance sector, which plays a crucial role in preventing accidents involving both human beings and transported goods. According to Reason and Hobbs (2003), maintenance errors risk lives and resources, adversely affecting business operations. To avoid human errors by railway employees, intervention and the study of ergonomic factors influencing this risk become necessary (Reason, 2017).

Studies conducted in railcar workshops in Sweden have focused on the health of their employees, basing their approach on ergonomic aspects of the work environment. Singh et al. (2015) employed various techniques to extract information related to ergonomics and the performance of specific tasks in railway maintenance work. The primary objective was to identify improvements in maintenance practices and workflow. The study assessed the occupational postures of technicians as they changed brake shoes on railcars through the application of a questionnaire (Standard Nordic Questionnaire) and an occupational posture assessment technique (Ovako Working Posture Analysis System - OWAS). The researchers also observed the maintenance repair time required to change wheel axles on railcars in the workshop, considering the technicians' perception of work demands, their control over work time, and social support while performing repairs. As a result, the authors confirmed that workers complained mainly of back and shoulder pain. The OWAS system showed that 21% of the time required to position brake wedges and pins fell into two OWAS categories: category 3, where "change is required as soon as possible," and category 4, where "immediate replacement is needed." Problems arose from the workstation layout, improper postures, and a lack of access to tools and components. Additionally, the study indicated that the task execution time for changing a railcar's wheel axle was significantly affected by the layout.

Medeiros et al. (2007) conducted a study in the state of Santa Catarina, Brazil, in a railcar maintenance sector, and their findings pointed to the presence of inappropriate occupational postures such as squatting, kneeling, standing, or walking.

The authors also highlighted potential risks of falls and the frequent need for the transport and lifting of heavy loads.

Therefore, considering the importance of maintenance in the railway system, this work addresses the implementation of ergonomic intervention in the workplaces of the Railcar Workshop Sector of a mining industry located in São Luís - MA, investigating the presence of ergonomic constraints (or Ergonomic Demand Items - IDE) and their relationship with working conditions

2. METHODS AND TECHNIQUES

This study is a descriptive research with a qualitative approach, aiming to understand the context of reality by describing it in its nature and peculiar factors, avoiding any interference or modification before interpreting it. The research begins with the enunciation of the problem and the verification of the occurrence of phenomena and their constituent variables, outlining the related factors. Therefore, ergonomics employs descriptive research to assess working conditions and task analysis (MORAES & MONT'ALVÃO, 2010).

Initially, an Ergonomic Intervention was conducted in the workplaces of the Railcar Workshop Sector, focusing on indicators related to the high rate of musculoskeletal absenteeism, as reported by representatives of the industry. To guide the study, the Macroergonomic Work Analysis (GUIMARÃES, 2010) was applied up to the Ergonomic Appreciation phase, along with the Systematization of the Man-Task-Machine System (SHTM) of the Ergonomic Intervention, as proposed by (MORAES & MONT'ALVÃO, 2010), for understanding the functioning of the system in question. Phase 0 (zero), Project Launch (GUIMARÃES, 2010) - the initial phase involves sensitizing workers by explaining the intervention's objectives and details regarding the application of data collection techniques, considering the activities performed by employees. To optimize the launch, a Prospectus was utilized, summarizing the project strategy, distributed to all supervisors and inspectors and then redistributed to all employees.

For the systematization of the target system of the ergonomic intervention (Workplaces of the Railcar Workshop Sector), structured interviews were conducted in two stages. The first was conducted with only 01 inspector from operation M01 (maintenance of trucks and wheelsets) lasting 30 minutes; it's noteworthy that the interview was audio-recorded with the inspector's permission. The second stage was in a written format, where another 02 inspectors from M01 chose to note their responses on the printed interview script. The interview duration ranged from 5 to 15 minutes, with a total of 12 interviewees (10 mechanics and 2 welders). Responses were recorded in field notebooks and audio recorders, then transcribed into an Excel spreadsheet for analysis. After data collection, information was grouped based on affinity, meaning similar responses were considered as the same Ergonomic Demand Item (IDE) (FOGLIATTO & GUIMARÃES, 2010). The frequency and order of items mentioned by interviewees served as the basis for developing a closed-ended questionnaire.

Regarding unsystematic observations, a total of 13 technical visits were conducted, involving photographic and video documentation of mechanics' activities.

Closed-ended questionnaire applications did not require the names of respondents but requested data related to research variables (weight, height, age, work experience, role, manual dexterity). Unlike the weighting of interviews, which values the sum of weights assigned to each item by interviewees, in questionnaires, the weight of the item is generated by its arithmetic mean. The questionnaire was designed to quantify (dissatisfaction, intensity, importance, etc.) the mentioned and prioritized IDEs in open interviews. Questionnaires were administered before teams took over their positions during the shift change at the Railcar Workshop. In total, 25 questionnaires were returned, filled out by the workers themselves according to the roles in the study's workstations (railcar workshop). It is emphasized that, for data collection, a Free and Informed Consent Form (TCLE) was used, detailing the methodological procedures and potential risks for the subjects involved in the research, and formal authorization from the company was obtained.

4. RESULTS AND DISCUSSION

A) Systematization of SHTM: Operation of the Target System

According to the supervisors, the overall goal of the railcar workshop is to achieve established targets. The workshop is divided into operations by lines; the analyzed operations were VPS, also known as M01, which is the production line, and the Traction Exchange, also known as M02, which works in general operations when necessary. There are Control Centers responsible for the railcars entering the workshop for maintenance; they coordinate this work and define tasks for each day. Upon arrival at the workplace, employees must report in.

The employees (mechanics and welders) of the Railcar Workshop are supervised by the Management. The administration is structured as follows: Director (1), General Manager (1), Supervisor (1), Inspectors (3), Mechanics (10), and Welders (2). For the execution of VPS and Traction Exchange operations, 14 teams of 2 people each are required, with each team consisting of 10 mechanics and 2 welders. To ensure the workshop operates without overloading, 4 cycles per shift are performed. Mechanics 1 and 2 in the VPS line are supervised by the Inspectors. The administration is structured with Director (1), General Manager (1), Supervisors - CCP (1), and Inspectors – CCP (4), with Operation M01 formed by 3 inspectors and M02 by 1 (one). There are 4 cycles per shift: Morning, afternoon, and night/early morning. Within a 24-hour interval, 48 railcars are dispatched from maintenance, and 14 employees are required for the maneuver, with each team composed of 2 mechanics, 2 technicians, and 2 auxiliary welders (Railway Operator - OFE).

The work schedule for employees in the VPS and Traction Exchange operations is divided into teams that rotate shifts, starting at 7 PM on the first day, 1 PM on the second day, 7 AM on the third day, and 1 AM on the fourth day. In total, there are 6 hours of work per shift, with fifteen-minute breaks between shifts. At the end of the cycle, there is a 36-hour break.

B) Problematic Aspects of SHTM (Maintenance of Railcars in Lines M01 and M02)

In general, the main ergonomic constraints, identified as Items of Ergonomic Demand (IDEs) during the interviews, include: noise, dust, stuffy environment, inadequate flooring, inadequate roof, excess materials/equipment scattered in the work area, physical effort, difficulty in handling and moving equipment, physical fatigue, body aches, lack of suitable equipment, uncomfortable postures for task execution, delayed planning/projects execution, absence of occupational gymnastics, life-threatening risks, and long distances.

In various situations, improper postures were observed during the execution of tasks throughout the workday. These postures were particularly noticed during the removal of the cotter pin (a piece that secures some parts of the railcar and must be removed for the truck exchange operation), wheelsets, and traction exchange. It is worth noting both biomechanical/anthropometric and accident-related risks, as there was an imminent direct contact of mechanics with the accumulated iron ore under the railcars during the removal of the cotter pin.

Employees assume various postures during the operation, some of which require physical effort (Figure 1), such as: moving and removing parts of the railcar; using tools, moving parts, and equipment during the operation (for part removal, moving levers). And to turn the crank located beside the railcar, occasionally, the use of pieces arranged in the workplace is necessary to assist in freeing the part. This task requires physical effort from the employees.

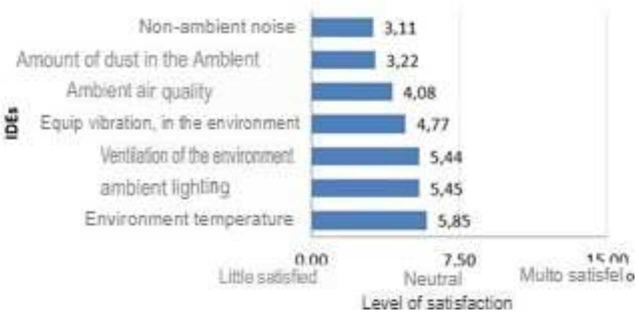
Figure 1: Examples of Inappropriate Postures

One of the most frequently mentioned issues was the absence of occupational gymnastics. At no point during unsystematic observations was any performance of occupational gymnastics observed among the employees.

Additionally, remnants of materials such as screws and other metal objects originating from the local activity were observed obstructing certain areas of the workshop floor. This could lead to the accumulation of remnants, wastage of usable materials, and workplace accidents.

Regarding the questionnaire results, concerning the Environmental Construct (Figure 2), employees in the sector are dissatisfied with all Ergonomic Demand Items (IDEs), particularly with Noise, Dust, Air Quality, and Vibration.

Figure 2 – Results of the Environmental Construct



In the Biomechanics construct (Figure 3), it is evident that employees are dissatisfied with the occupational posture adopted during the performance of their activities, a fact highlighted during unsystematic observations.

Figure 3 – Results of the Biomechanics Construct.

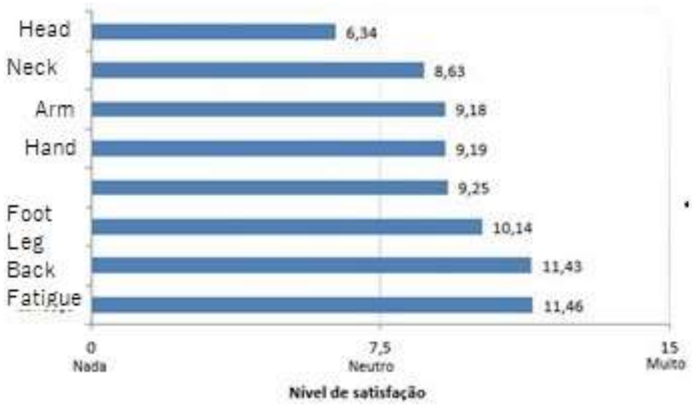
In other items such as handling and moving parts, moving parts with the cart, and moving within the workshop also scored below average. It is essential to highlight the severe problems related to the organization of equipment and parts, which end up causing issues both in terms of movement and posture.

In the organizational construct, the item that showed the highest level of dissatisfaction was related to occupational gymnastics, also mentioned by employees in open interviews, in this case, as a preventive measure for injuries. Excess materials also scored below average, as evidenced in the observations.

Concerning the Company construct, the overall averages showed that the main dissatisfaction was related to the conditions of the cart, as observed during the observations. Items such as hydraulic jacks, hand tools, toolbox, ambient flooring, environmental signage, garbage collectors and slippers, overhead crane, crane controls and elevators, and the location for storing tools also scored below average.

For the discomfort/pain construct (Figure 4), it is noticeable that, at the end of the shift, employees feel tired, with a high level of discomfort/pain in their backs. This level of discomfort can be corroborated by the posture adopted by employees, especially mechanics working underneath the railcars during cotter pin removal and part transportation.

Figure 4 – Result of the discomfort/pain level.



Regarding the work content, Railcar Workshop employees described their work as not very creative, with little autonomy, not very stimulating, undervalued, under psychological pressure, and restricted. They indicated a medium level of monotony in the job, perceiving it as very stressful, requiring a lot of mental effort, intense movement, considerable physical effort, and, primarily, involving a lot of responsibility and risk.

C) CONCLUSIONS

In general, the ergonomic intervention conducted in the Railcar Workshop revealed the existence of ergonomic constraints in the target system, with environmental and workplace/biomechanical aspects being the most evident.

Activities involving aspects like lifting, transporting, and unloading materials in the Railcar Workshop demand a high level of physical effort from the workers and involve improper occupational postures, aligning with existing literature (MEDEIROS et al., 2007; SINGH, et al., 2015). The mechanic's workstation is subject to dynamic activities, with movements during material transport, as well as static activities, involving the adoption and maintenance of improper postures. This scenario is conducive to the risk of musculoskeletal problems. The work can be characterized as repetitive, with its organization requiring a specific pace for the workstations.

There is an estimated excessive cognitive load due to the presentation of information that must be processed in a way that does not respect readability and visual acuity conditions. Additionally, the information is absorbed simultaneously and excessively by more than one sense organ (vision, hearing, and touch).

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