Automation of Manual Tasks to Reduce Musculoskeletal Problems and Absenteeism in a Cork Company

Alfredo SILVA
DEGEIT, University of Aveiro
Aveiro, 3810-193 Aveiro, Portugal

Ana Luísa Ferreira Andrade RAMOS
GOVCOPP, DEGEIT, University of Aveiro
Aveiro, 3810-193 Aveiro, Portugal

Marlene BRITO
ISEP – School of Engineering, Polytechnic of Porto
Porto, 4200-072 Porto, Portugal

António RAMOS
DEM, University of Aveiro
Aveiro, 3810-193 Aveiro, Portugal

ABSTRACT

Although there has been an improvement in working conditions over time, as well as incentive policies, absenteeism due to occupational diseases is still one of the main issues companies have to deal with, mainly in intensive hand work labor.

This study was conducted at a Portuguese cork stoppers company, faced with a situation of high absenteeism which results in an annual loss of 1,200,000€. It aims to evaluate the company's workstations with greater absenteeism related to musculoskeletal diseases and suggests adequate ergonomic working conditions for those workplaces. Measures such as the automation of a process are also implemented. This automation, however, results in some problems related to decreases in quality and relocation of employees.

Although the automation of the manual tasks avoids many issues related to musculoskeletal diseases, it raises other problems for companies which are difficult to manage, such as the relocation of workers and the resistance to change and new knowledge acquisition by older and more experienced workers. This work reinforces the strategic role of ergonomics in the context of absenteeism in intensive hand work labor industry.

Keywords: Absenteeism, Process improvements; Ergonomics; Work-related musculoskeletal disorders, Action-Research.

1. INTRODUCTION

These days, productivity is a key factor in business success. One of the chief reasons for concern that directly affects this productivity in an industry, is absenteeism [1]. High rates of absence amongst employees are making some companies less profitable and putting others at risk of survival [2]. Some of the downsides of absenteeism are high costs, such as direct compensation costs or replacement costs, and a decrease in productivity [3]. Absenteeism is a short-term absence from work (temporary withdrawal from a company) which originates in issues such as illness, death in the family, or other personal matters [4].

According to [5], diseases of the musculoskeletal system and connective tissue have been the leading causes of absenteeism in industry.

Applying ergonomics in a company, in a systemic way, can have positive effects and save costs, as it has a positive effect on decreasing work-related musculoskeletal disorders, (WMSDs) lowering costs associated with these injuries, improving work productivity, decreasing absenteeism and in turn increasing the number of hours worked overall [6], [7] and [8].

There are a few factors which result in the occurrence of WMSDs: repetitive tasks, awkward postures and strenuous physical load or force exertion. The implementation of ergonomics in the workplace makes it possible to avoid the presence of WMSDs which lead to absenteeism, employee turnover and production drops [9].

Portugal is the world's leading cork producer, accounting for over half of the world's supply. The cork industry is a labor-intensive industry that requires a lot of machinery operated by workers for the production of cork articles. This study was carried out at a cork stoppers production company dealing with a problem of high absenteeism which has an impact of around 1.200.000€ per year. A previous study was conducted which identified the sectors

which have the highest percentage of absenteeism (Fig. 1) and diagnosed its causes. The results showed that most absenteeism occurs in production areas and its main causes have to do with musculoskeletal problems [10].
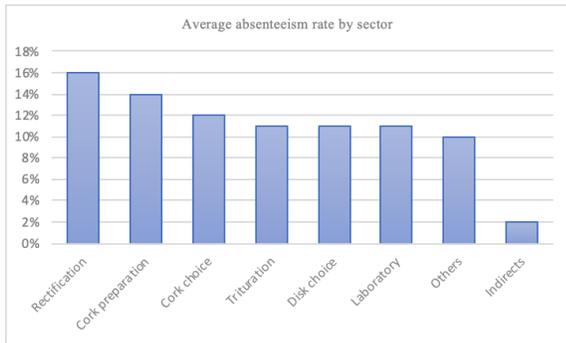

Fig. 1. Average absenteeism rate by sector [10].

The purpose of this study is to evaluate the workstations of a company in the cork sector with great levels of absenteeism related to musculoskeletal diseases and recommend analysis of working condition in these workplaces.

2. METHODOLOGY

This study was executed through interview sessions, observation, videotaping and the evaluation method using Rapid Upper Limb Assessment (RULA) and the Niosh Equation. It shows that the subjects are exposed to high risks and changes are therefore needed. Some measures were also implemented, such as the automation of a process. This automation introduced some problem related to quality failures and relocation of workers.

A research methodology based on Action-Research was followed, which fits the type of study this is. The methodology is now commonly used amongst researchers as a result of its ability to involve all the intervening parties in the problem-solving process, which makes a real difference to all [11]. What sets it apart from other methodologies is its practical side: it is characterized as research in action, not research about action [12]. The Action-Research methodology may be enforced in a project through a cycle consisting of five main phases [13]:

(1) Diagnosis, where analysis of the identified problems and data collection takes place;

(2) Action Planning, which identifies the improvement actions needed;

(3) Implementation of actions, at which time the planned actions are executed in order to address the problems at hand;

(4) Evaluation, which consists of an analysis of results; and lastly,

(5) Conclusions, in which the changes resulting from the implemented improvements are pinpointed, and an

analysis is carried out of the learning and difficulties of the research process. Fig. 2 shows the action-research spiral.
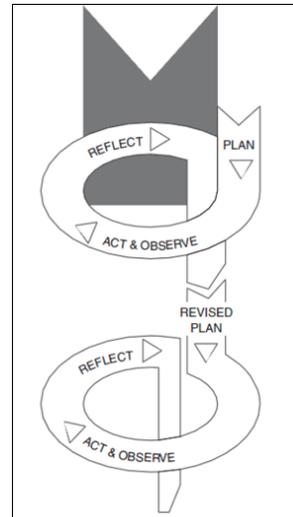

Fig. 2. Action Research Spiral [14].

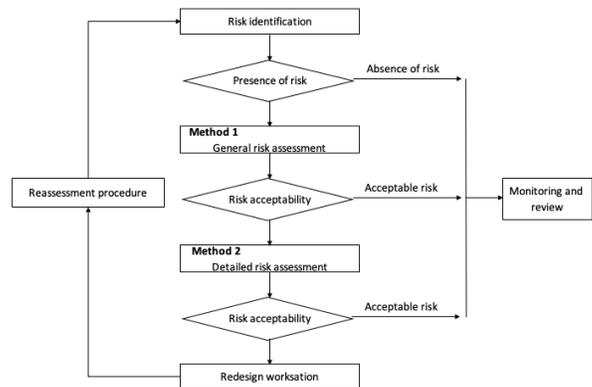The following flowchart shows the risk assessment procedure (Fig. 3):

Fig. 3. Risk assessment model [15].

RULA (Rapid Upper Limb Assessment) was the tool chosen to evaluate the postures, movements and forces exerted by the worker while carrying out the job, given that it is especially useful for scenarios in which work-related upper limb disorders are reported.

The higher the RULA score - varies from 1 to 7, representing the action level to be taken - the greater risk associated and the bigger the urgency to execute a more detailed study and introduce modifications to the job/workstation. Scores 1 and 2 (action level 1) suggest that the posture is acceptable if not maintained or repeated for significant periods of time. Scores 3 and 4 (action level 2) indicate that more investigation is required. Scores 5 and 6 (action level 3) show that changes are needed soon. Scores 7 or higher indicate that changes must take place immediately [16].

The Niosh Equation (Eq. 1), a tool for assessing the manual material handling risks associated with lifting and lowering tasks in the workplace, was also used [17]:

PLR = CC x MH x MV x MD x MA x MP x MF (Kgs)

Eq. 1. NIOSH Equation

Charge constant (CC) = 23 Kgs
Horizontal multiplier (MH) = 25/H
H - Horizontal distance from the charge to the body at the start of lifting.
Vertical multiplier (MV) = 1 –(0.003) x (V-75)
V – Vertical distance from the hands to the ground at the start of lifting.
Distance multiplier (MD) = 0.82 + (4.5/D)
D – Vertical lifting distance between the origin and destination of lifting movement.
Asymmetry multiplier (MA) = 1 – (0.0032xA)
Handle multiplier (MP) = value dependent on the quality of the handle.
Frequency multiplier (MF) = value dependent on the frequency of manipulations.

The company's sectors analyzed were:

Cork stopper rectification sector

One of the areas with a high absenteeism rate is the rectification sector. In it, workers carry out a process composed of three types of machines, a tapping machine which rectifies the tops of the stoppers, a tapping machine which rectifies the sides of the stoppers and a chamfer which makes a small chamfer on the top of the stoppers. The worker's role in this sector is to fill the machines and unlock the ones which jam (Fig. 4).

Fig. 4. Task of unlocking the machines.

Cork preparation sector

Cork preparation was another process identified with high rates of absenteeism. In this process the worker has to supply a stopper counting machine. This machine counts and fills the shipping bag which is previously placed at its exit. As soon as the bag is filled and closed (Fig. 5), it is placed on the pallet until it is filled with the number of bags requested by the customer.

Fig. 5. Bag closing task.

At the end, the pallet is labeled, filmed and placed in the warehouse using a pallet truck.
To do the ergonomic analysis, the Niosh equation was used in addition to the RULA method, as it is a process which looks at manual material handling risks associated with lifting and lowering tasks (Fig. 6). Currently each bag handled by the worker weighs 21.2 Kg.

Fig. 6. Packaging of bags.

Picking sector

The third and final area analyzed was that of the picking process. The worker sits in front of a conveyor belt (Fig. 7) with 330 stoppers going by every minute; without diverting attention, workers have to analyze and remove the defective stoppers. The worker has no control over the speed at which the conveyor belt moves.

Fig. 7. Manual picking process.

This was the area which that got the worst score using the RULA method: 7, which means that changes are required immediately. The task requires maximum attention, the adoption of bad postures, such as arms stretched to reach the (defective) cork stoppers to be removed, and it is a repetitive task. It is important to note that these workers perform this task throughout the entire 8-hour workday, with only three breaks.

3. RESULTS

3.1 Ergonomic analysis of the cork stopper rectification sector

In this sector each worker is responsible for controlling 28 machines and the RULA method was used to do the ergonomic evaluation resulting in score 3, which means that further investigation is needed.

3.2 Ergonomic analysis of the cork preparation sector

The RULA score was 5, which means that changes are required soon. Using the Niosh equation, the recommended weight limit was 14 Kgs. As the weight of the object lifted is greater than the recommended weight, the lifting index (which provides a relative estimate of the physical stress associated with a manual lifting job) was also calculated. This index is calculated by dividing the weight of the object lifted by the recommended weight limit. The result of this division was 1.5, which means there is an increased risk of lifting-related low back pain for a part of the workforce.

3.3 Ergonomic analysis of picking sector

This was the area which that got the worst score using the RULA method: 7, which means that changes are required immediately. The task requires maximum attention, the adoption of bad postures, such as arms stretched to reach

the (defective) cork stoppers, to be removed, and it is a repetitive task. It is important to note that these workers performed this task throughout the entire 8-hour workday, with only three breaks.

3.4 Improvement of the ergonomic condition on the picking section

The RULA method scores obtained for the three production areas analyzed (picking, preparation and rectification) are depicted in Fig. 8.
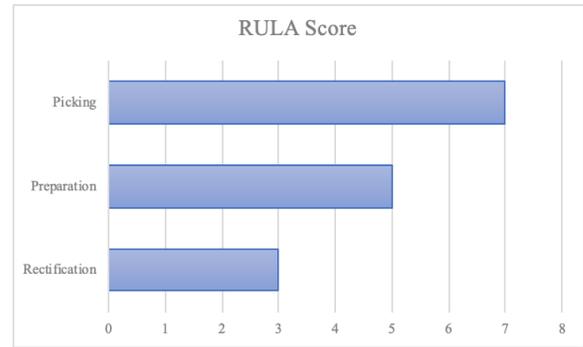

Fig. 8. RULA scores for the analyzed production areas

The picking process area was the one with the worst score attained through the RULA method. This result indicated the need for immediate changes, being the area chosen for the implementation of improvement actions.

A detailed analysis of this process was carried out and the following numbers were determined. Approximately 330 corks per minute go by on the conveyor belt in front of each operator. The purpose of this job is to pick stoppers which have defects, the percentage of which is around 5%, that is, each operator will have to remove a NOK stopper every 4 seconds, approximately. This type of work is strenuous at mental, cognitive and physical levels.

With the objective of not reducing productivity in this sector while at the same time solving the problem of poor working conditions, the team looked into the possibility of automating this process. An automatic sorting machine costing € 20,000 was thus tested (Fig. 9).

Fig. 9. Automatic picking process

These automatic picking machines increased productivity in this sector by 60%. However, there was a need to maintain the manual selection process for about 1% of cork stoppers, due to the need for a greater accuracy which the machine is not able to achieve.

After replacing manual picking machines with automatic ones, it was possible to reduce the number of workers in this section to around half, which means that the company had to relocate half of the employees in this section to other productive areas. This was not an easy task due to the resistance to change and new knowledge acquisition by workers with more experience and age. In some cases, it was necessary to compensate and dismiss some employees, a situation which was not easy to manage.

4. DISCUSSION AND CONCLUSIONS

Despite improving working conditions over the years, and all the incentive policies, absenteeism due to occupational diseases remains one of the biggest problems facing companies.

Continuous improvement remains an objective which is always present in many organizations. However, those companies always aim primarily at productivity gains at the expense of improving working conditions.

In the sector under study, there was a general gain, since with the change from a manual picking process to an automatic one through the shift to electronic machines, the company managed to have the desired productivity gains and a reduction in absenteeism.

However, this type of changes causes some problems for the company. The biggest had to do with the reduction of the number of workers that this change entailed, as well as with the relocation of workers and the resistance to change and new knowledge acquisition by those with more experience and age. Since the vast majority of these people was under permanent contracts, it was necessary to move them to other sections. Whenever this was not possible, there was a need to reach an agreement for the termination of the employment contract. Another problem was the obsolescence of hand-picking conveyor belts, which were discontinued and had no commercial value.

This study leads us to question what the future of workers will be with the new phase of automation of manual tasks, with the arrival of Industry 4.0.

The next step of this work is to analyze the other workstations with high absenteeism rates and define strategies which can improve ergonomic conditions and thereby lead to a reduction of absenteeism caused by WMSD problems.

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