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The Implementation of Digital Ergonomics Modeling to Design a Human-Friendly Working Process in a Postal Branch

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Abstract: In today's business world, there are two very important health issues that the employees in the service sector are faced with: Spinal disease, especially in the lower back, and carpal tunnel syndrome. These are well-known musculoskeletal disorders. To preserve the health of its employees and prevent professional illnesses, and to thus maximize their efficiency, companies must use knowledge from the field of ergonomics. This study aims to examine the work-related health problems that the workers in transportation companies are faced with. As a case study, a postal company from Serbia is considered, with particular attention paid to the counter clerks. The research was carried out in one branch of the postal operator. All six postal clerks working at the considered branch were subjects of the study. The workers were observed visually by the researchers and recorded while performing their job tasks. Based on the analysis of their movements and body positions, the evaluation of their level of risk exposure was determined using the Ergo Fellow software, specifically with five packages within this program (Rapid Upper Limb Assessment, Rapid Entire Body Assessment, Ovako working posture analysis system, Moore and Garg, and Suzanne Rodgers). As a result of the implemented tools, the analysts are in a position to conclude what should be changed in the work organization.

Keywords: ergonomics; occupational health; Ergo Fellow; job assessment; postal company

1. Introduction

Human resource management is an essential segment of business which is responsible for adequate organizational performance [1]. One part of the mentioned discipline refers to employees' well-being, which is considered not only from the ethical point of view, but also from the financial point of view. A company's failure in this field leads to lower profits [2].

To protect both the physical and psychological integrity of people, i.e., employees, the employer needs to design and construct the appropriate means of work and arrange the workplace following the ergonomics principles. The International Ergonomics Association [3] defines ergonomics as the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and it is recognized as the profession that applies theory, principles, data, and methods to optimize human well-being and overall system performance. Čičević [4] defined ergonomics as a science that studies the adaptation of work to the possibilities of a human and vice versa, adjusting the working conditions to an individual or group of workers. Ergonomically designed workplaces using digital human modeling software improve employee morale; increase productivity,

quality, and job satisfaction; reduce operating costs; and optimize processes and procedures at the workplace [5–7]. The importance of ergonomics is also enhanced by the strong growth of information and communication technologies that enable the computerization of the process and create the basis for the information society.

The task of ergonomics experts should be to address the problem of a workplace and to suggest a design to adapt the working conditions to the worker and to avoid the unwanted consequences of human-machine interaction. This interaction is increasingly gaining importance in the information age. The main problem is that this interaction poses a danger to humans and leads to various health hazards. In the industrial sector, work on different types of machines and workplaces represents the work activity performed by the operator, and in a large number of cases, this work is done in a seated position. Because a maintaining a sitting position for a long period of time can harm the health of the employee, the workplace needs to be designed according to ergonomic aspects and standards. Numerous authors in different industries have studied these issues and have come to various conclusions. Very often, the authors have identified poor ergonomic conditions. Many studies have conducted among workers have found that musculoskeletal disorder (MSD) is a major problem and that certain controls or changes are needed. In the postal sector, various authors have dealt with different issues related to ergonomics [8], sorting problems [9], the learning process in mail sorting [10], ergonomics of the plant [11], interface design of postal equipment [12], and the improvement of mail processing services [13].

This paper intends contribute to the scientific design of methods that may improve workers' safety in the postal work units, i.e., companies for mail and parcels shipment. Although the investigation of the postal clerks' well-being can be found in the literature [14], according to the authors' knowledge, there are no examples of the proposed ergonomic research in a postal branch. This was an incentive and motivation to examine to what extent the workers in the postal company are exposed to workplace risks. Therefore, there are two main research questions to be considered:

(1) Whether the considered desk jobs in a postal branch influence the health of employees, and
(2) whether the considered desk jobs in a postal branch are appropriately organized.

This paper is structured and divided into five main sections as follows. Section 2 gives an overview of the literature and the state-of-the-art in this field. A review of the literature on continuous improvement practices expands the understanding of the importance of ergonomics and ergonomic tools. Section 3 shows the methodology used in the form of six tools in the Ergo Fellow software. The discussion of the results obtained is presented in Section 4. Section 5 points out the limitations, concludes the paper, and suggests future directions.

2. Literature Review

Work tasks in most jobs in different industries often involve repetitive movement by the operator and cause musculoskeletal discomfort. The authors of previous literature from the field have mainly studied the detection of these issues as well as their elimination and reduction. The main aim of these studies was to increase the flexibility of operations and to propose more efficient work processes with lower costs and increased productivity. The ultimate goal is to protect the worker from work-related diseases.

In the construction industry, as a result of repetitive tasks, workers experience fatigue and Cumulative Trauma Disorders (CTDs) [15–18]. Numerous authors have recognized this and have proposed certain ergonomic measures to eliminate them.

A thorough review of the literature on the Rapid Entire Body Assessment (REBA) method has been proposed by Gutiérrez et al. [19], while an extensive review of the literature on the Musculoskeletal disorders solved by the Ovako Working Posture Assessment System (OWAS) method was proposed by Gómez-Galán et al. [20]. Wahyudi et al. [21] conducted a work posture analysis of manual material handling using the OWAS method. They included 6 workers and 31 work postures in the analysis.

The OWAS method has also been used by Justavino et al. [22]. They applied this method to the forest operations postural assessment problem to establish the advantages and limitations. Beheshti et al. [23] proposed the risk assessment of musculoskeletal disorders using the OVAKO working posture analysis system OWAS and evaluated the effect of ergonomic training on the posture of farmers.

Chakravarthy et al. [24] studied problems occurring in the automotive industry. They listed the following most common problems: Musculoskeletal disorders, lower back injuries, and poor body positions. By applying the Rapid Upper Limb Assessment (RULA), they concluded that 40% of the tasks had a high development risk from MSD and 45% had a high risk according to the REBA method. By introducing certain improvements, they ensured that all tasks lied in the low or negligible risk area according to the RULA method. According to the REBA method, a significant decrease was recorded, and after intervention, 85% of the tasks were in the zone of low or negligible risk. As the authors emphasized, the cycle time was reduced by 8 s and there was a reduction in workforce. Yonathan and Kusuma [25] analyzed the ergonomic issues using REBA and RULA to improve the posture of sandpaper machine operators and to reduce the risk of low back pain. They emphasized that the REBA method could be used when an assessment of ergonomic work posture identifies the need for further analysis, such as analysis of the body parts used; static, dynamic, fast-changing, or unstable posture; modification of workplaces and equipment, training, and monitoring of worker risk behavior.

Saha et al. [26] carried out a study about physiological stress with construction workers who handled handheld materials. Most of the work positions, as concluded in the work, were dangerous for the health of workers. Besides, a comparison of REBA and OWAS methods was performed, and the REBA method was also compared to the OWAS method. It was concluded that most workers suffered from pain in the areas of the head, neck, shoulders, lower back, and arm, and that postural stress and cardiac effort indicated the difficult nature of the work.

Gómez-Galán et al. [27] considered musculoskeletal risks to reveal RULA method applications in terms of knowledge, country, year, and journal categories. Dewangan et al. [28] worked on the *Ergonomic Study and Design of the Pulpit of a Wire Rod Mill at an Integrated Steel Plant*. Various ergonomic tools, such as RULA, REBA, OWAS, Quick Exposure Check (QEC), Moore and Garg, Suzzane Rodgers, and Lehmann, were used in the paper, which was effective in evaluating MSD among workers. In this paper, the modification of the design was made and the proposed methods of work were proposed, which contributed to the reduction of MSD. Claesson and Maanja [29] conducted research at the Volvo Group concerning the ergonomic evaluation in a development workshop focusing on heavy lifting, hand vibrations, and noise and light.

Mercado [30] analyzed the processes and layout of jobs in selected factories and provided some improvements using ergonomic design. The author used three tools of ergonomic assessment, RULA, REBA, and OWAS software, as well as certain direct observations. It was noticed that the existing ergonomic design of work processes and layout at workplaces does not correspond to ergonomic requirements, thus increasing the risk of MSD. All this occurs, as stated in the paper, because of the unfavorable position of the workers, strong strain, and fatigue. In addition, Sun emphasized the importance of the design of the interface appearance on the basis of man-machines [12].

Öngel et al. [31] applied the method of ergonomic risk analysis during the mold production period. The study was carried out in the production section of the mold. The results of the risk were obtained as a result of the "ergonomic risk analysis" using the RULA and REBA methods. A lack of operator training in terms of ergonomic issues was discovered. Problems arose because most of the operators used old and inadequate chairs. The author proposed the replacement of the working chair, i.e., with an appropriate chair design. Kajaks [32] concluded that virtual ergonomics had an impressive impact on the automotive, aerospace, and defense industries.

Saha [18] worked on an ergonomic assessment of postural stress and musculoskeletal disorders with upper extremists of workers at designated sites in India. This study was tasked with assessing postural syndrome related to certain construction tasks involving an uneven static position and intense upper limb activity. In the paper, the Ergo Fellow 2.0 software, as well as the REBA and Moore and

Garg tools, were used for position analysis. The results deviated significantly from the safety standards and urgent intervention was required. The most pains, as stated, were observed in the back, shoulders, and upper and lower extremities. The authors concluded that ergonomic interventions are needed for both the modification of tool design and the orientation of workers at the workplace. It was also stated that a properly planned working cycle of rest and working rotation can alleviate work stress [7].

Hemphälä et al. [8] considered interventions in ergonomics when sorting mail items after the introduction of sorting glasses. In addition to increasing productivity, workers also gained better work positions, a lower inclination of the back, and experienced a significant improvement in eye strain and MSD. Hemphälä et al. [9] emphasized that the cost of equipment might be compensated by reducing the cost of sick leave. Berglund et al. explained the learning process in mail sorting and concluded that basic knowledge of ergonomics was needed. They also highlighted the importance that ergonomists can achieve in helping businesses [10]. There are specific situations that are associated with an increased risk of injuries [4]:

- Bending or stretching regular wrists is associated with a higher risk of experiencing carpal tunnel syndrome.
- Removing the elbow concerning the wrist over 20 degrees increases the risk of pain and other disorders and diseases.
- Abduction or bending of shoulders greater than 60 degrees over 1 h per day increases the risk of acute pain in the neck and shoulders.
- Working hands at or above shoulder level results in an increased risk of tendinitis or various shoulder disorders.
- The greater the angle of the bending of the neck, the more likely it will lead to the potentially dangerous pain in the neck and shoulders.
- The bending of the lower back in the work causes more a higher probability of the occurrence of disease in this region.

It also defines the rules to be followed when working in a sitting position, which is very important for this work given the fact that practically seated workers were considered. These rules are:

- The angle between the lower arm and upper arm should be between 70 and 135 degrees.
- The angle between the lower leg and the upper leg should be between 60 and 100 degrees.
- The angle between the torso and the femur should be between 90 and 100 degrees.
- The feet should be flat in relation to the floor or backing.

Thus, most previous studies on workplace sustainability were conducted based on a consideration of the primarily unfavorable position of the body of the worker and poor design of the workplace. The observation that the same problems occur in different industries was common to most of the studies.

The first of the postulates applied in each observed study is the observation of workers and the detection of both disadvantages and the design of the workplace. In most studies, when looking at a worker working as an operator in a sitting position, those workers had the most problems with their lower back and neck.

The second option is mainly based on making decisions for change as well as remeasuring and monitoring employees. Some authors also have also resorted to the principle that studying and redesigning the components of the workplace could reduce fatigue and decrease production time [31,33,34].

A third option often cited by the authors is the rotation of workers' positions and optimization [35,36]. An especially interesting topic for workers in any mail and parcel shipment companies may be the optimization and redistribution of workers, as well as measuring how this will affect their health.

3. Materials and Methods

During the visit to the working unit, the body positions of 6 workers were marked using certain forms (Figure 1). In addition, several photos were taken to record the selected positions in which the workers were exposed for the longest time. The photos of the workers were taken from different angles with the purpose of collecting data to use by implementing 5 methods that are an integral part of the Ergo Fellow software. The final aim was to determine if and why the tasks of employees caused MSD. All of this was done to show potential bad positions while working behind a counter in the postal branch and to identify the level of risks the workers were exposed to. The positions of the workers' bodies were taken, as well as the positions that the workers spent most of the time in during the work on that day when the recording was done. The Ergo Fellow program itself was also used to find body corners using the Image Analysis tool in Figure 1. This section may be divided by subheadings. It should provide a concise and precise description of the experimental results and their interpretation, as well as the experimental conclusions that can be drawn.

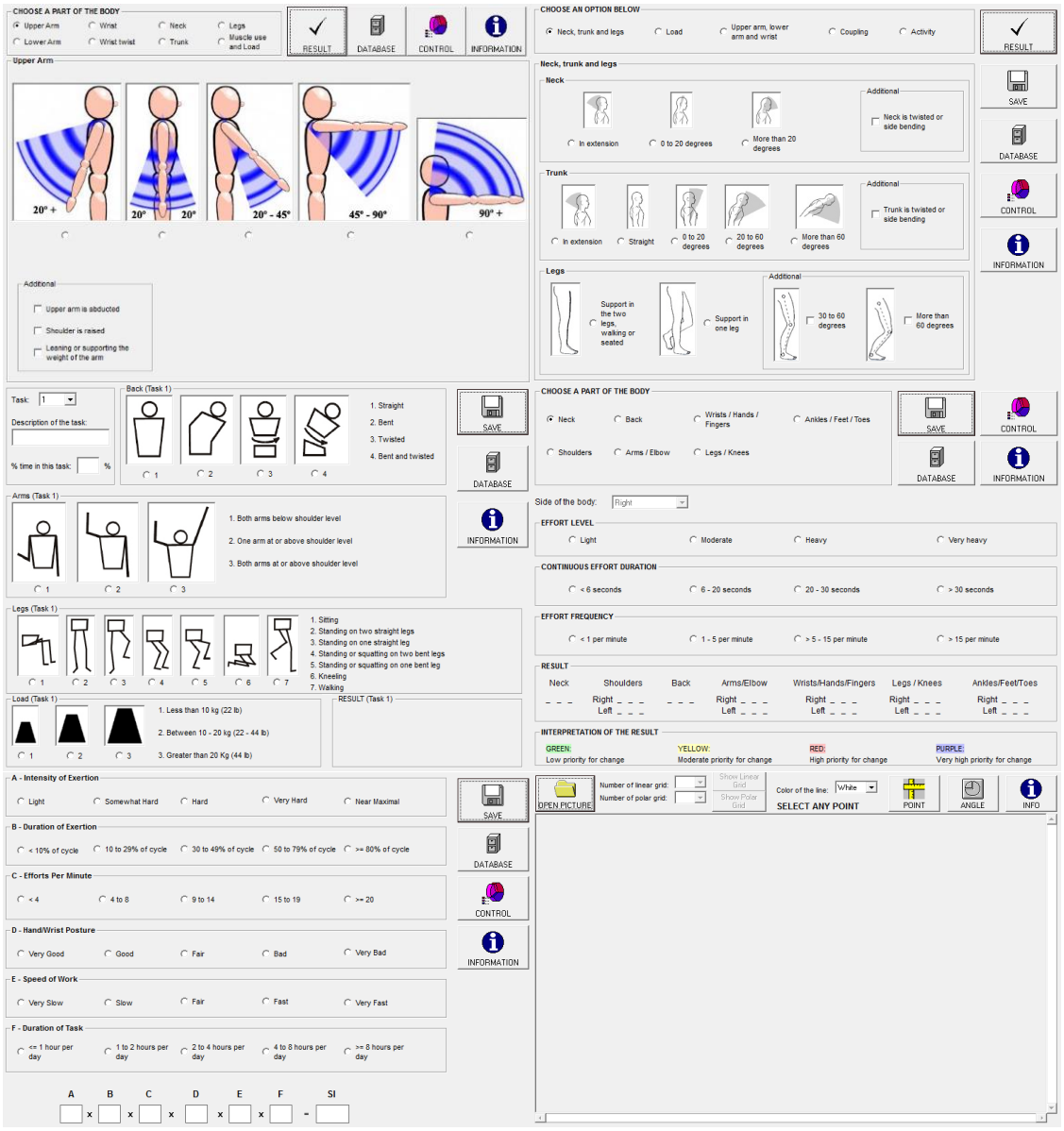

Figure 1. Used modules in Ergo Fellow as well as an Image Analysis tool. Source: (Ergo Fellow).

All recorded observations are entered into five different modules within the Ergo Fellow program. Figure 1 shows the modules that were used in the Ergo Fellow program, as well as the tools for measuring angles: RULA, REBA, OWAS, SUZANNE RODGERS, MOORE, and GARG.

RULA was developed by Lynn McAtamney and Nigel Corlett at the University of Nottingham in England at the Institute of Professional Ergonomics. It was created as a result of research related to occupational diseases in workplaces where upper limb disorders occur. In the RULA analysis window, the data for the positions of the following parts are entered: Upper arm positions, lower arm positions, hand wrist, wrist twist, neck, trunk, legs, and muscle usage, as well as load.

The RULA assessment assesses a moment in the work process, and it is important to observe the positions (attitudes, keeping) of body parts that are adopted during the work process. Depending on the type of study, the longest-held position, or what appears to be the worst-held position, can be chosen (Table 1).

Table 1. Interpretation of results for the Rapid Upper Limb Assessment (RULA) module.

Score	Action Level	Intervention
1 or 2	1	The position is acceptable if it is not reflected or repeated over a longer period of time.
3 or 4	2	Further research is needed and changes can be sought
5 or 6	3	Soon, research and changes are needed
7	4	Research and change are necessary immediately

Source (Ergo Fellow).

The REBA system was developed by Dr. Sue Hignett and Dr. Lynn McAtamne, ergonomics experts from the University of Nottingham University. It is a postural method for assessing the risks associated with the work of disorders of the whole body. The REBA assessment provides a quick and systematic evaluation of the overall postural risk for the worker. The body-holding factor is estimated for each area, and there is a scale for assessing posture as well as notes for adjusting additional considerations (Table 2).

Table 2. Interpretation of results for the Rapid Entire Body Assessment (REBA) module.

Level	Risk
1	Negligible risk
2 or 3	Low risk, there may be a need for a change
4 to 7	Medium risk, further investigation, changes will soon be required
8 to 10	High risk, explore and implement changes
11 or more	Very high risk, implement the changes

Source (Ergo Fellow).

OWAKO is a method of observation used to estimate postural risks. These observations are used for the analysis and control of bad positions, which can also be applied to counter workers. This is the method for estimating postural load during work. As it may be noticed, OWAKO is based on a simple classification of work positions and was developed in Finland. Before selecting a position, the user chooses the number of tasks for a new assessment. Based on the position of the body, arm, leg, and load, certain results are obtained, as shown in Table 3.

Table 3. Interpretation of results for the Ovako Working Posture Analysis System (OWAS) module.

Result	Description
1	No need for action
2	Corrective action needed in the near future
3	Corrective measures should be taken as soon as possible
4	Corrective measures for improvement are needed

Source (Ergo Fellow).

The Suzanne Rodgers module is a useful module that covers all of the body parts to determine the degree of priority for change. The Suzanne Rodgers module also provides a muscle fatigue analysis by assessing three factors: Effort, duration, and frequency. The possible interpretation of results is shown in Table 4.

Table 4. Interpretation of results for the Suzanne Rodgers module.

Result	Description
1	Low priority for change
2	Moderate priority for changes
3	High priority for change
4	Very high priority for change

Source (Ergo Fellow).

Moore and Garg proposed the effort index in 1995. By estimating six risk factors for work and multiplying these six factors, the stress index is obtained.

The factors to be entered include the intensity of effort, duration of effort, efforts per minute, holding the hand or wrist, speed of operation, and duration of the task. Table 5 illustrates the interpretation of the obtained results.

Table 5. Interpretation of results for the Moore and Garg module.

SI Parameter Value	Description
SI < 3	Safe
SI between 3 and 5	Uncertain
SI between 5 and 7	There is a risk
SI > 7	Dangerous

Source (Ergo Fellow).

In addition, the Ergo Fellow program features a tool that shows the positions of the body that the worker has to respect (Figure 2).

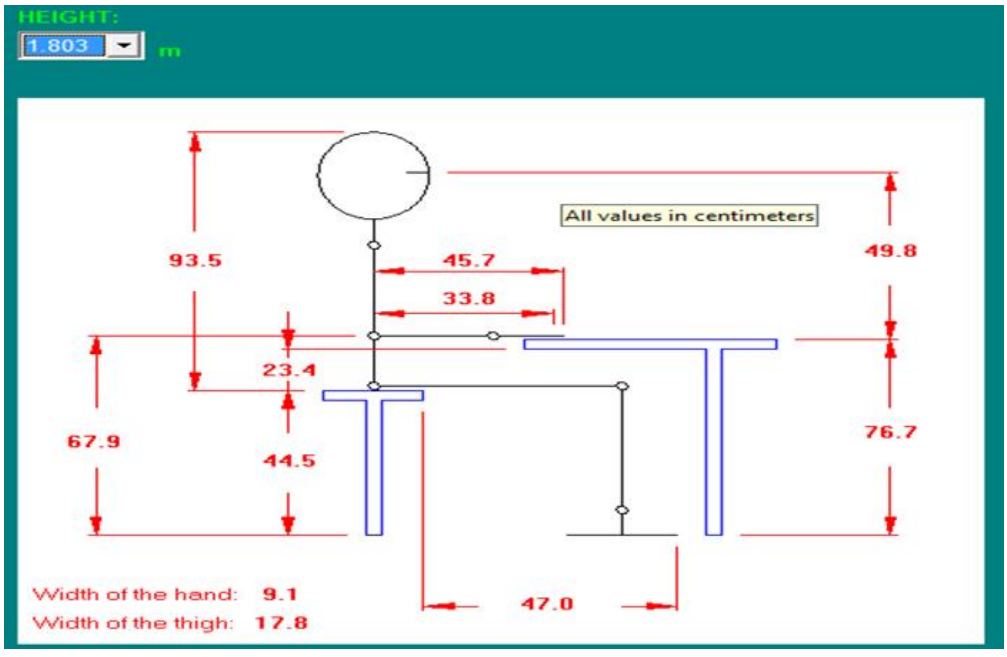

Figure 2. The position of the body of the workforce was 1.803 m in the sitting position in the Ergo Fellow program (values in centimeters). Source: (Ergo Fellow).

4. Discussion

The position of the workers' bodies during performance of the work activities deviates from the ideal position at work. The most commonly observed unpleasant situations include the twisting of the body, handling objects above the level of the head, and bending over or backward, as well as unpleasant hand positions in relation to the torso and bending the elbows with corrected wrists. The more the body experiences these disadvantageous positions while working, the higher likelihood of injuries.

In this paper, the research was carried out in a selected postal and logistics company. The company is responsible for the transportation of various types of goods and has strong background support of the workers who manipulate the goods. In this research, we analyzed six of these workers. The results of the implemented methodology are shown in Table 6.

Table 6. Evaluation results for the four modules shown in the paper.

Worker	RULA	REBA	OWAS	MaG (SI)
1	5.3	8	2	6.75
2	4.2	6	1	3.38
3	5.3	8	2	6.75
4	7.4	11	2	18
5	4.2	5	2	3.38
6	4.2	5	2	3.38

Source: (Authors).

Worker 1 in Figure 3 performed transactions at the payment/payout counter and had a number of disadvantages, some of which can be observed in the given image. Also, RULA analysis gave a score of 5 or 6, action level 3, which means that research and changes were soon required. As in most cases, the results of RULA and REBA methods matched. The REBA module also pointed to certain changes and defined the worker as high-risk. Certain curvature, as well as the position of the leg and the corners between the forearm and forearm of this worker, did not correspond to the position of the body that is considered comfortable.

Figure 3. Photos from the considered work stations. Source: (Authors).

Worker 2 performed his duties as a controller and was also exposed to certain risks, but his retention at this working position was occasional, and more accurately, was not reflected for a longer period of time. The RULA analysis showed a result of 3 or 4, action level 2, and indicated that further research was needed. The REBA module gave a result of 4 to 7, which indicated that the worker was at medium risk, that further investigation was necessary, and that certain changes were welcome. For this worker, the main problem was an incorrect position of the back and neck, as well as the curling of the body due to the computer located to the left of the controller which he used while in the workplace in a sitting position.

With worker 3 in Figure 3, who worked at the information and reclamation desk and occasionally worked payment/payroll jobs, it is noteworthy that the body twisted, mainly due to the use of the printing device which the worker often used, causing the incorrect position of the back, as well as a large number of recurring movements in short time intervals. The result achieved by RULA analysis was 5 or 6, action level 3, which indicated that research and changes were soon needed. The REBA module gave results between 8 and 10, the worker was at high risk, and changes were needed.

With worker 4, RULA and REBA suggested that changes were needed immediately and pointed to the very high risk at the worker's current state. In addition to the curvature of this worker, the position of the elbow relative to the wrist was greater than 20 degrees, the legs and feet were not well balanced, and the feet were not flat in relation to the floor. This worker performed the work of the postman and did not spend a significant amount of time in the delivery department. However, when present, his risk of developing disease was very high. Also, his body deviated significantly from the correct position of the body, and changes are necessary as soon as possible.

Worker 5 worked as a courier in the observed branch. The RULA analysis pointed to a result of 3 or 4, action level 2, which means that further research was needed and some changes were needed. The REBA module gave a score of 4 to 7, which also indicated that further research and changes were needed, and the mid-risk state was defined. The main disadvantage of this job is that, during the time the employee spent in the work unit, he worked with hands at or above the shoulder level. Also, the angle of bending of the neck was quite large, as was the angle of bending the back.

Worker 6 performed delivery tasks, as well as other jobs belonging to him in accordance with the contract. The RULA analysis showed the result from 3 or 4, action level 2, which means that further research was required, as well as certain changes. The REBA module indicated that the worker was at medium risk and that further investigation is required, as well as that the changes were soon necessary. The position of worker 6's back, as well as the positions of workers' backs in the work unit, precisely reflects the disadvantageous position at work. The backrest should follow the natural line of the back, especially the lower part of the back. There was also a certain bending of the neck and legs, and the feet were not well balanced, as the feet did not stand straight in relation to the floor.

As Table 6 shows, the OWAS module showed that corrective measures were needed in the near future for most workers except worker 2, who, according to other modules, showed the best results in the work unit. The main reason why this worker showed better results than others was the time spent at the counter workplace in a sitting position, which was one of the parameters that was considered in the OWAS module.

As it can be seen Table 7, worker 1 had a high priority for changes in the back and neck. Assessing the muscle fatigue analysis for worker 2 in Figure 3, a high priority for changes was found in the segment of the wrist, hands, and fingers. In addition, there was a moderate priority for this worker for changes in the neck area. According to the "Suzanne Rodgers" tool, worker 3 had a very high priority for changes in the legs and knees. There was a high priority for changes in the neck, shoulders, back, arms and, elbows. Worker 4 had a very high priority for changes in the neck, back, legs, and knees. As seen in Table 7, the shoulders were below a degree of moderate priority. Table 7 also shows a very high priority for changes in the hands and elbows for worker 5 in Figure 3. Nevertheless, there was a high priority for changes in the neck area. Using the "Suzanne Rodgers" tool, the results for worker 6 indicate a very high priority for changes in the neck and back areas.

Table 7. Assessment results for the Suzanne Rodgers module for all parts of the body.

Worker/Part of the Body	Neck	Shoulder	Back	Arms/Elbows	Wrists/Hands/Fingers	Legs/Knees	Ankles/Feet/Toes
1	3	1	3	1	1	1	1
2	2	1	1	1	3	1	1
3	3	3	3	3	1	4	1
4	4	2	4	1	1	4	1
5	3	1	1	4	1	1	1
6	4	1	3	1	1	1	1

Source: (Authors).

When we look at the results using the Suzanne Rodgers module, we see that the neck and back were the most endangered body parts of all workers. The neck always had some priority for changes, while the back was a problem with four workers (Figure 4). The only areas for which exposure to changes were not required were the ankles, feet, and toes.

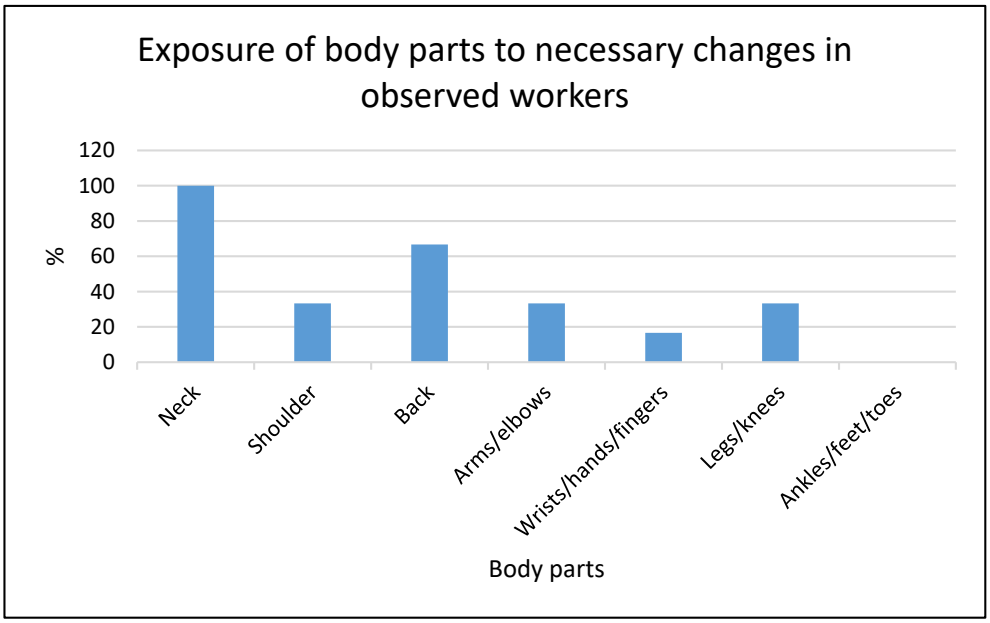

Figure 4. Exposure of body parts to necessary changes in observed workers. Source: (Authors).

5. Conclusions

The efficient functioning of postal branches is an issue important from the standpoint of all stakeholders in the field, including the state, companies, and customers [37]. Solving ergonomic issues represent a possible direction toward this aim.

The assessment of body position in the case of the considered branch was done using five tools that are part of the Ergo Fellow software. It can be concluded that most of the analyzed workers worked in unpleasant and painful positions. This was mainly due to the lack of knowledge from the field of ergonomics and awareness of the possible negative effects in the considered postal branch. Therefore, as demonstrated in this paper, the workers were considered to be at moderate (low) to high risk of musculoskeletal disorders based on the level of risk of these methods.

This paper recommends that ergonomic interventions should be implemented with the appropriate knowledge of experts in this field. Using their knowledge and experience, these experts should educate workers in the postal branch on when to take breaks and which position of the body should be occupied while performing work. Besides, the experts should especially work on the employees' education about the harmful effects of inappropriate body holding to eliminate disadvantages in the workplace and thereby eliminate the risk of developing disease. In this concrete case, particular attention should be put to problems with the neck and back.

When it comes to the limitations of this research, it should be noted that the sample does not represent the whole population in the company. Here, only one branch was considered. In future research, to confirm the conclusions, more workers from various fields should be considered. Besides, some additional methodological approaches that would examine the conclusions would be welcome. For example, supplementing the research with digital simulation and direct measurement methods would be convenient to apply.

This research was carried out following the generalization principles of a case study [38]. This means that the proposed methodology can be applied to other industries and other working positions. Within the postal industry, workforce optimization has been proven to be one of the most important issues of the competitive strategy of postal service providers [39]. Therefore, it would be useful to analyze more branches and more types of postal jobs, such as drivers or postmen, which would create a more realistic picture of the ergonomic conditions of postal workers.

Finally, the intention of this paper was also to inspire other authors to analyze this significant part of the postal system in order to promote safety as well as a healthy working processes.

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