# Ergonomic Work Analysis of Industrial Quality Control Workstations

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**Abstract.** Work-related musculoskeletal disorders (MSDs) affect millions of workers in Europe and cost employers billions of Euros. Quality control workstations usually demand the adoption of awkward and uncomfortable postures for long periods, which may stress and fatigue supporting muscles and tendons, leading to the development of MSDs. An Ergonomic Work Analysis covered the working conditions of an industrial quality section and the main risks factors were highlighted. The main objectives were: to assess the actual working conditions; to establish relationships between these and the complaints workers presented; to characterize each task in terms of the associated MSDs development risk; to present preventive measures. Rapid Entire Body Assessment and Ovako Working Posture Analyzing System analyzed seventeen postures. Both methods scored three and five postures, respectively, with a high risk of developing MSDs whereas ten postures were qualified as of medium risk. Technical and organizational solutions were proposed and implemented.

**Keywords:** Risk assessment · Musculoskeletal Disorders (MSDs) · REBA · OWAS · Ergonomic work analysis

## 1 Introduction

Human Factors/Ergonomics (HFE) focuses on systems in which humans interact with all the other elements. When we talk about HFE we should have in consideration that two related outcomes are relevant: performance (e.g. productivity, efficiency, effectiveness, quality, innovativeness, flexibility, (systems) safety and security, reliability, sustainability) and well-being (e.g. health and safety, satisfaction, pleasure, learning, personal development). Reduced performance and well-being can occur when there is a mismatch between the system and human capabilities and aspirations. Thus, these two outcomes are related e.g., performance can influence well-being, and this last one can influence performance, both in the short and the long-term [1]. The possibility of performing to a high standard at work is an important prerequisite for satisfaction and wellbeing. In other words, wellbeing and performance are strongly connected and


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should be understood to promote good outcomes. When this does not occur, fatigue and work-related musculoskeletal disorders (MSDs) could arise among workers performing these jobs [2].

Quality deficiencies, wasted products, human errors and ergonomics problems often have the same cause. In many cases they can be ascribed to the design of work, workplace and environment, and to factors such as noise, light, postures, loads, pace and/or work content, among others [3]. There is strong evidence that working groups with high levels of static contraction, prolonged static loads, or extreme working postures involving neck/shoulder muscles are at increased risk for neck/shoulder MSDs. Over 40 epidemiologic studies have examined physical workplace factors and their relationship to neck/shoulder and back MSDs [4].

MSDs are one of the most common work-related ailments. Throughout Europe they affect millions of workers and cost employers billions of euros [5, 6]. In fact, work related MSDs are among the most costly health problems that society is facing today [7].

As known, at assembly work systems, workers can face to some of this risk factors. Quality control workstations usually demand the adoption of awkward and uncomfortable postures for long periods of time, which may stress and fatigue supporting muscles and tendons, leading to the development of MSDs.

An Ergonomic Work Analysis covered the working conditions of an industrial quality section and the main risks factors were highlighted.

The main objectives were: to assess the actual working conditions; to establish relationships between these and the complaints workers presented; to characterize each task in terms of the associated MSDs development risk; to present preventive measures.

## 2 Materials and Methods

### 2.1 Stages of the Study

This study comprised three fundamental stages:

- 1st stage: General characterization of the Work Situations;
- 2nd stage: MSDs risk assessment and lighting condition characterization;
- 3rd stage: Preventive measures.

The 1st stage began with the characterization of operators and the quality control workstation. Therefore, it included task's identification and characterization, in terms of prescribed objectives as well as in terms of general executing conditions. At this stage, the characterization of the work situations focused on the prevalence of complaints (physical annoyance, discomfort and pain or eyestrain).

The 2nd stage aimed to better characterize the problematic situations identified in the previous stage. Therefore, the risk of MSDs development and lighting conditions were assessed.

The 3rd stage consisted of the proposal of technical and organizational preventive measures and included an "anti-fatigue" mat study.

## 2.2 Data Collection and Procedures

Different methods and techniques were used to characterize the work situation and workers involved, such as:

- Conversation with workers;
- Documental Analysis (e.g.: task procedures, risk assessment and lighting assessment reports, occupational accidents reports…);
- Free/systematized and retrospective observations;
- Environmental characterization with particular emphasis on lighting conditions and dimensional characterization;
- Image/video recording;
- a questionnaire specifically developed for this purpose.

For Image/video recording, a digital camera with 4 megapixel and 1920 × 1080 HD resolution - Sony HD ACHO Full HD1080 handycam 4.0.

The dimensional characterization of the workstations was made using a measuring tape.

The questionnaire was based on the adapted version of the Nordic Musculoskeletal Questionnaire [8, 9] and intended to identify key parameters for the workers' characterization, evaluate their perception of the real working conditions, as well as to identify self-reported symptoms in terms of physical annoyance, discomfort or pain and eyestrain. On the first section, sociodemographic items such as gender, age, anthropometric data (height, weight, dominant upper limb), seniority and second job were integrated to better characterization of the workers. Additionally, this section integrates items to characterize the operators' relationship with the organization (such as, number of hours worked per week, type of schedule, frequency and duration of work breaks). The second section integrated items to better characterization of the activity. The operators were asked about *"the necessity for rotate between different workplaces jobs"*, *"the receive/not receive instructions before starting the activity"*, *"why they need to compare different pieces under inspection" and "what is the main difficult felt when they make the pieces' inspection which have different colors? (for example: gold or grey)"*. The third section included items to determine the occurrence of musculoskeletal symptoms and respective intensity of pain (a four-level Likert scale was used, where 1-low intensity and 4-very high intensity). For this purpose a body discomfort chart was added. The musculoskeletal symptoms (annoyance, discomfort and physical pain) were assessed over the last 12 months and the last 7 days. Symptoms of pain or discomfort were recorded as occurrence of pain. In this session the presence of visual fatigue and respective frequency (a four-level Likert scale was used, where 1-very low frequency and 4-very high frequency) were also evaluated. The operators were also asked about "How often they feel difficult to perceive the information as a consequence of the visual strain" and "how they classify the work in terms of stress?" For the last two questions a four-level Likert scale was used (1-Never/not stressful; 2-sometimes/moderate stressful; 3-Very often/very stressful; 4-Always/Extremely stressful).

To participate in this study a verbal consent of the operators involved was previously obtained. The workers responded to the questionnaire independently and anonymously. In all cases, the confidentiality of data were insured. All workers (N = 17) agreed to participate in the study.

MSDs developing risk assessment relied on two methods: Rapid Entire Body Assessment (REBA) and Ovako Working Posture Analyzing System (OWAS). A complete description of the REBA and OWAS methods can be found in the works written by Hignettand McAtamney [10, 11] and by Louhevaara and Suurnäkki [12], respectively.

In terms of methodology, both methods were applied according to the flowchart illustrated in Fig. 1.

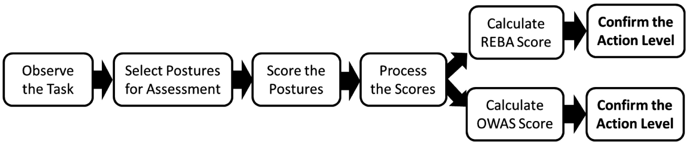



**Fig. 1.** Flowchart illustrating the REBA and OWAS methodology applied.

Seventeen postures were analyzed in two particular tasks accomplished in that section: “2-pieces cans’ inspection” and “tops’ inspection”.

For postures’ selection the following criteria were used, taking in account that the decision could be based on one or more criteria: most frequently repeated posture; longest maintained posture; posture requiring the higher muscular activity or the greatest forces; posture known to cause discomfort; extreme, unstable, or awkward posture, especially where a force is exerted.

Considering that different operators can use different strategies for the same task, several images were collected. By providing several task images it was possible to identify the strategy with the lowest level of risk.

As a reference, low REBA score and low OWAS score indicate that the work posture is acceptable but for the higher scores, an action is suggested [11, 12].

In REBA method load ranking was based on biomechanical criteria. Considering that scores obtained for neck, trunk and legs are combined in a particular score called score “A” and those for shoulder, elbow and wrist give a particular score “B”, both were also highlighted. In REBA method, group B postures were scored for the left and the right sides, always, considering the worst posture adopted on each side.

Considering that both methods have a different action level scale, REBA and OWAS Scores were adapted to facilitate the comparison between both approaches. The relationship between each REBA Score, OWAS Score and corresponding adapted Action Level is showed in Table 1.

The illuminance (lux) level was assessed with a digital Krochmann lux meter, 106E model, which was strategically put on the surface of the workstations, following the procedures recommended by EN 12464-1:2011 standard [13].

**Table 1.** OWAS score, REBA score and respective action levels.

| OWAS Score | REBA Score | Risk Level | Action Level | |
|---|---|---|---|---|
| 1 | 1-3 | **Low** | **1** | indicates that the posture is acceptable and no actions are needed |
| 2 | 4-7 | **Medium** | **2** | indicates that further investigation is needed, and changes may be required |
| 3 | 8-10 | **High** | **3** | indicates that investigation and changes are required as soon as possible |
| 4 | 11-15 | **Very High** | **4** | indicates that investigation and changes are required immediately |

Adapted from [11],[12].

A grid system was created to indicate the points at which the illuminance should be verified for the task and the surrounding areas. Ratio of the length to width of the grid was kept between 0.5 and 2 and the maximum grid size was obtained with Eq. 1.

$$p = 0.2 \times 5^{\log d} \tag{1}$$

where,

$p$ – maximum grid cell size (m);

$d$ – longer dimension of the area (m).

The number of points in relevant dimension is given by the nearest whole number of $d/p$.

All measurements were made during the night shift to register the illuminance levels exclusively due to the artificial light. Three different workbench positions (A, B and C) were used to evaluate lighting. A and B represent the positions of benches for the "tops' inspection" task, while C represents the position for the "2-pieces cans' inspection" task. Positions A and B were evaluated in order to realize if there are significant differences in terms of illuminance, since there are different types of luminaires and lamps installed on site and operators are free to place the benches wherever they want. Both A and B positions were selected by the operators on the day of the measurement and were considered to be less favorable to the occurrence of reflections and shadows which impair performance. The location of bench C corresponds to the location most frequently selected by the operators, when performing the respective task. On benches A and B, measurement were made in two different zone (Zone1, Zone2) considering the different positions of the two operators.

The correlated colour temperature (CCT) values of each lamp were registered.

For "anti-fatigue" mat study, three suppliers were contacted, in order to test three different products with the operators. Each "anti-fatigue" mat was tested for two consecutive weeks in order to involve all operators in the process. At the end of the 1st week using the "anti-fatigue" mat, operators were asked to respond to an opinion questionnaire. The most well-accepted mat would be proposed to be acquired for all workstations.

### 2.3 Data Analysis

For data processing the SPSS© software was used and descriptive analyzes were performed using measures of location and dispersion.

The BMI variable was calculated considering weight (kg) and height (m) data provided by the workers (BMI = weight/height$^2$).

The corrected Action Level 2 was considered the level for which MSDs development occurs according to both methods (OWAS and REBA).

To interpret the illuminance (lx) levels, the values recommended by EN12464-1:2011 Standard [13], were used. The corrections proposed by NF_X35-103:2013 Standard [14], taking into account age (>45), reflection and contrast factors, error relevance, task frequency and lack of natural lighting, were considered when needed. Considering the high-level visual demand in both tasks, the recommended Illuminance (lx) and the uniformity values were 750 lx and >0.7, respectively, for the task area. For the surrounding area a 500 lx Illuminance level was recommended. In terms of light color appearance, CCT above 5000K is recommended.

The illuminance level was measured at each defined point and the average ($E_{average}$), the maximum and the minimum ($E_{max}$ and $E_{min}$, respectively) values as well as the uniformity (U) value were calculated.

## 3 Results and Discussion

### 3.1 Socio-Demographics' and Job's Characteristics

All workers (N = 17) of the quality control section were female and agreed to participate in the study. The age of participants ranged from 19 to 53 years (mean = 36.94 years; SD = 10.17 years). The participants weigh 68 kg on average (SD = 9.94 kg; range = 53–90 kg) were 1. 64 m high on average (SD = 0.06; range = 1.54–1.80 m) and presented an average BMI of 25.2 kg/m$^2$ (SD = 3.24 kg/m$^2$, range = 19 and 32 kg/m$^2$), which mean that more than 58.8% are overweight. The majority of operators (82.4%) reported that they were not involved in regular physical activities/sport. All workers were right handed.

The operators had been working in their current job for 1 to 55 months (mean = 13.94 month; SD = 17.84 month). The mean daily and weekly working hours were 8 and 40 h, respectively. All workers alternate between two shifts (Shift 1:8 h to 16 h; Shift 2:16 h to 24 h) on a weekly base. Workers are allowed to take two breaks/day (one with 10 min and another with 30/45 min duration). This means that all participants are involved in working periods longer than 2 h in each shift. All participants were paid on a piece-rate salary system. Seventy-one percent of the workers feel their work as moderately stressful. No workers had a second job.

### 3.2 Self-reported Symptoms

Considering the self-reported symptoms (annoyance, discomfort and pain) 76.5% of the workers reported complaints and it was possible to identify five main body regions affected: neck (47%), upper and lowerback (53%), legs (59%) and feet (29%) (Fig. 2). The results also show that the majority of the participants had experienced MSDs on the feet (100%), the lower back and the wrist (67%), the legs (60%), the upper back (44%) and the neck (12%), over the last 7 days. In terms of intensity, the majority of the situations, ranged between moderate and very high. It is important highlight that it was high or very high in 33% of cases.

Prolonged standing postures can be responsible for the complaints reported with particular emphasis on legs, feet and lower back.

Considering visual fatigue, 58.8% of the workers complained. Fifty percent out of the workers that reported visual fatigue considered that these symptoms had some impact in perceiving information. The main symptoms appointed were itchy eyes (50%) red eyes and headache (40%), blurred vision (30%) and tears or others symptoms (10%) (Fig. 3).

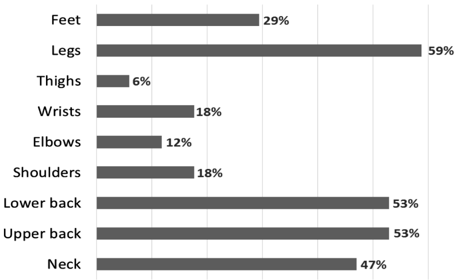



**Fig. 2.** Body regions presentingMSDs Symptoms (prevalence of physical complaints - annoyance, discomfort or pain).

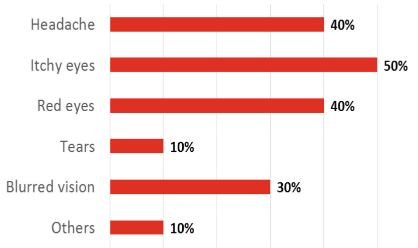



**Fig. 3.** Main visual fatigue symptoms reported by workers (N = 10).

### 3.3 OWAS and RULA Scores

As mentioned before, for OWAS and REBA assessment, 17 postures were selected in two particular tasks: "2-pieces cans' inspection" and "tops' inspection". Table 2 shows the sub-tasks and respective number of postures selected to be assessed with both methods.

**Table 2.** Sub-tasks and respective number of postures selected to be assessed with OWAS and RULA methods.

| "2-Pieces cans' inspection" | "Tops' inspection" |
|---|---|
| - Checking can's defects (6)<br>- Transportation of cardboard with cans to the lift platform (2)<br>- Download the lift platform (1)<br>- Put defective cans in the trash (1)<br>- Placing the non-defective cans in the cardboard at ground level (2)<br>- Reach the cans for further verification (1)<br>- Complete the cardboard with the previously checked cans (1) | - Grab the sachet with tops to check (1)<br>- Choose the tops to check (1)<br>- Attach the tops that are inside the tube (1) |

OWAS and REBA methods scored three (17.6%) and five (29.4%) postures, respectively, with a high risk (Risk level = 3) of developing MSDs whereas ten postures (58.8%) were qualified as of medium risk (Risk level = 2) (Table 3). Therefore, bearing in mind the OWAS's and REBA's results, the risk for the development of MSDs is present in 76.4% and 88.2% of the sub-tasks/postures assessed (Risk Level $\geq$ 2). These results indicate that investigation and changes are required as soon as possible or that further investigation is needed, and changes may be required.

Considering the OWAS results, the three worst postures presenting high risk for MSDs developing were: *Reach the cans for further verification*, *Placing the non-defective cans in the cardboard at ground level* and *Grab the sachet with tops to check*. The trunk and the Legs scores are responsible for the 1st sub-task and the last two sub-tasks results, respectively. These results can explain the complaints concerning the trunk and legs reported by 53% and 59% of the workers, respectively. When, considering the REBA results, the worst postures were the same highlighted with the OWAS method, one of the six postures adopted in *Checking can's defects* and one of the two postures adopted in *Transportation of cardboard with cans to the lift platform*.

The upper arms score (REBA) was $\geq 3$ for 58.9% of sub-tasks/postures assessed, probably because they were flexed between 45° and 90°, sometimes with a slight abduction or with a flexion higher than 90°. The lower arms score for the majority (76.5%) of tasks was = 2 which reflects the need for operators to flex more than 100°. The wrist score for the majority (70.6%) of tasks was $\geq 2$: wrists were in extension (sagittal plane) of 15° or more (47.1%) and sometimes with a radial or ulnar deviation (23.5%). The neck scores = 2 for 52.9% of the sub-tasks/postures also indicates a high proportion of neck frontal flexion above 20°. The trunk scores $\geq 2$ for 88.2% of the sub-tasks/postures also indicates a high proportion of trunk frontal flexion above 20°, sometimes twisted/side bended. The legs scores $\geq 2$ for 53% of the sub-tasks/postures also indicates that there was strain on the lower limbs. Only four (OWAS)/two (REBA) sub-tasks/postures assessed presented a Risk Level of 1 (e.g. an acceptable working posture- no actions are needed).

**Table 3.** Distribution of REBA and OWAS Scores (n = 17).

| | REBA Score | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) |
| Upper arms | 4(23.5) | 3(17.6) | 8(47.1) | 2(11.8) | - | - | n.a | n.a | n.a |
| Lower arms | 4(23.5) | 13(76.5) | n.a | n.a | n.a | n.a | n.a | n.a | n.a |
| Hands/wrists | 5(29.4) | 8(47.1) | 4(23.5) | n.a | n.a | n.a | n.a | n.a | n.a |
| Neck | 8(47.1) | 9(52.9) | - | n.a | n.a | n.a | n.a | n.a | n.a |
| Trunk | 2(11.8) | 7(41.2) | 3(**17.6**) | 3(**17.6**) | 2(**11.8**) | n.a | n.a | n.a | n.a |
| Legs | 8(47.1) | 6(35.3) | 2(11.8) | 1(5.9) | n.a | n.a | n.a | n.a | n.a |
| **Score A** | 2(11.8) | - | 5(29.4) | 4(23.5) | 3(17.6) | 1(5.9) | 1(5.9) | 1(5.9) | - |
| **Score B** | 1(5.9) | 4(23.5) | 1(5.9) | 5(29.4) | 3(17.6) | 2(11.8) | - | 1(5.9) | - |
| **REBA Score** | - | 1(5.9) | 1(5.9) | 5(29.4) | 4(23.5) | 1(5.9) | - | 3(17.6) | 2(11.8) |
| **Risk Level** | 2(11.8) | 10(58.8) | 5(29.4) | - | | | | | n.a - not applicable |

| | OWAS Score | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) |
| Trunk | 5(29.4) | 11(64.7) | - | 1(5.9) | n.a | n.a | n.a |
| Arms | 6(35.3) | 5(29.4) | 6(35.3) | n.a | n.a | n.a | n.a |
| Legs | 2(11.8) | 10(58.8) | 2(11.8) | 2(11.8) | 1(5.9) | - | - |
| **OWAS Score** | 4(23.5) | 10(58.8) | 3(17.6) | - | n.a | n.a | n.a |
| **Risk Level** | 4(23.5) | 10(58.8) | 3(17.6) | - | | | n.a - not applicable |

### 3.4 Lighting Conditions

The quality control area is equipped with three types of suspended luminaires (each one fitted with two lamps) with no shielding or diffusion components. Three different lamps were identified: (Lamp1:CCT = 4000 K; Lamp2:CCT = 5500 K; Lamp3:CCT = 6500 K). Table 4 summarizes the number of measuring points on each bench.

**Table 4.** Number of measuring points on each bench.

| | | Number of points | |
|---|---|---|---|
| | | Task area | Surrounding area |
| Bench A | Zone1 | 8 | 4 |
| | Zone2 | 8 | 4 |
| Bench B | Zone1 | 8 | 4 |
| | Zone2 | 8 | 4 |
| Bench C | – | 13 | 7 |
| Total | | 45 | 23 |

The average value, the maximum and minimum values and the uniformity value of Illuminance measures are summarized in Table 5.

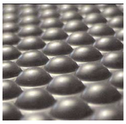
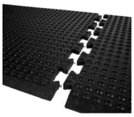
**Table 5.** Task and Surrounding Illuminance (E) and Uniformity (U) values obtained on each bench.

| Bench | Zone | Task area | | | | Surrounding area | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $E_{average}$ | $E_{max}$ | $E_{min}$ | U | $E_{average}$ | $E_{max}$ | $E_{min}$ | U |
| A | 1 | 1095 | 1170 | 1040 | 0.95 | 1114 | 1165 | 1060 | 0.95 |
| | 2 | 822 | 890 | 753 | 0.92 | 850 | 920 | 770 | 0.91 |
| B | 1 | 1088 | 1160 | 1040 | 0.96 | 1041 | 1120 | 970 | 0.93 |
| | 2 | 945 | 970 | 863 | 0.91 | 974 | 1020 | 930 | 0.95 |
| C | – | 892 | 1032 | 740 | 0.83 | 886 | 1130 | 700 | 0.79 |

### 3.5 "Anti-fatigue" Mats Study

Three "anti-fatigue" mats ($A_{mat}$, $B_{mat}$ and $C_{mat}$) were tested with the workers. The main characteristics of each anti-fatigue mat are summarized in Table 6, as well as the operators' opinion after the 1st week of use.

**Table 6.** "Anti-fatigue" mats characteristics and operators' opinion.

| Mat ID | Picture | Characteristics | Operators' opinion |
|---|---|---|---|
| $A_{mat}$ |  | Material: 100% polyurethane<br>Warranty: 5 years<br>Thickness: 15 mm<br>Available dimensions:<br>40 cm * 200 cm<br>Solid mat throughout, no hollow bubbles that collapse; Anti-static properties; Silicone & latex-free<br>Price: 127,88 €/unit (10% off for $\geq$ 10 units) | **Positive opinion**. The workers liked and complained less about their feet and legs during the testing weeks |
| $B_{mat}$ |  | Material: Nitrile rubber<br>Warranty: unknown<br>Thickness: 14 mm<br>Available dimensions:<br>60 cm × 200 cm<br>Good resistance to slipping; Bevelled safety edges on all 4 sides; Bubble-like surface assisting in the stimulation of blood circulation<br>Price: 79.20 €/unit or 1214.86/full roll<br>(60 cm * 18.3 m) | **Positive opinion.** The workers liked but reported preference for the $A_{mat}$ |
| $C_{mat}$ |  | Material: soft PVC sponge mat and High durability resilient rubber base.<br>Anti-slip; anti-fatigue; oil and grease resistant; Cleaning<br>Warranty: 1 year<br>Thickness: 12.7 mm<br>Price: not available | **Negative opinion**. The workers didn't like it and after the 1st week of testing they said that they prefer not to use it |

## 4 Proposed Solutions

As known, Organizational and Technical solutions involve different costs to the company. Considering organizational solutions are easier to implement, have short-term effects, and are affordable for the company we will present them first. At the end, some technical solutions are proposed as well.

Operators should be trained to be aware of their postures and better understand the MSDs etiology. They should be encouraged to use the means at their disposal such as gloves, lift platform, anti-fatigue mat and hearing protectors,… Sensitize and train workers to take an active role in the work situation by proposing improvements and give opinion about other proposals.

Marks on the pavement should be made to identify the places where the operators should place benches (they currently place the bench in a random manner). This would prevent workbenches from being inadequately oriented in relation to the current arrangement of the luminaires, and minimize light reflections. Figure 4 shows the proposed marks on the pavement (230 cm × 70.5 cm), where operators should place the benches.

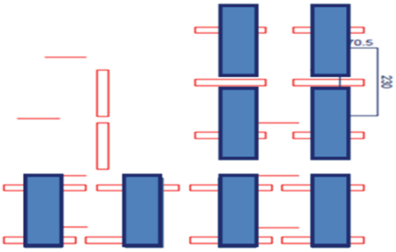



**Fig. 4.** Blue mark on the pavement to identify the place where the operators must place the benches.

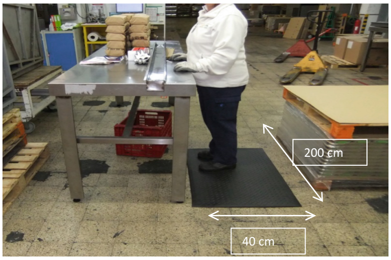



**Fig. 5.** Anti-fatigue mat (dimension recommended) and respective position on workstation.

Considering the positive impact observed during the "Anti-fatigue mat" testing we advise the $A_{mat}$ to be acquired for each workstation, with the following dimensions: 200 cm * 40 cm (Fig. 5).

Acquisition and assembly of wheels on the benches would have a positive impact, since they have to be moved as required. Nowadays, the operators struggle to move the benches alone.

Acquisition of benches with adjustable height, since it is necessary to adjust the height of the work surface. The height of the benches should vary between the height of the worker's elbow and the height of his shoulder. Accurate measures are not suggested due to the great diversity of operators and each operator should adjust the working plane to his own height.

Considering that this is a temporary workstation and there are problems in terms of acoustic, thermal and lighting environment, a solution to solve these problems was thought. The solution integrates a metallic structure (Fig. 6) which consists of pillars and an overhead grid, in which luminaires would be installed, as well as an air conditioning system to control the thermal environment. Since the structure has no walls, removable panels (Fig. 7) were considered. These panels may all be open, thus forming a completely covered area. Since it is a temporary workstation, when the panels are in a corner, the area could be used for other type of tasks and still be tidy.

**Fig. 6.** Example of a metallic structure.

**Fig. 7.** Example of panels applied to the metallic structure to isolate thequality control workstations.

## 5 Conclusions

This study has revealed that the work done in these quality control workstations entails risks factors for its operators which may be responsible for the development of musculoskeletal disorders and visual fatigue complaints. As a limitation of this study we can highlight the short case study design which not allowed us to study the influence of workstation comfort and risk factors on the incidence of musculoskeletal complaints.

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