Application of Ergonomics Analysis of Work in a Small Shoe Business

Henrique Simonetti*, Aline Marian Callegaro*

* Production Engineering Department, Federal University of Rio Grande do Sul, Porto Alegre, Brazil

Email: henrique_simonetti@yahoo.com.br, alinemc@producao.ufrgs.br

Abstract

This article's main objective is to report the results after conducting an Ergonomic Work Analysis (EWA) in a small business located in Porto Alegre. The subject company is a shoe store located in the city center. The ergonomic intervention was performed in accordance with the recommendations of Guerin et al. (2001) and aimed to analyze the organization of the company's work, in which the focus was to observe how the flow of information ran from the entry of an order until the final stage of repair of a product. The starting point was the account of the need that the owner had to hire one more shoemaker, but with the restriction that there is no possibility of increasing the company's physical space, thus justifying the application of EWA with a focus on work organization. By making the diagnosis it became evident that the company's main problems were related to the shop assistants dependence on the shoemakers to provide budget information and delivery time to customers and the organization of the layout. Among the results, it was performed a temporal analysis of two recurrent activities of the company in order to ascertain possible losses related to the displacement and the search for material. It was also proposed a new layout scheme, aimed at organizing the work stations, facilitating the stock and the removal of tools and equipment, and providing space so the hiring of a new shoemaker became possible within the present boundaries of the company.

Keywords: ergonomics intervention; work organization; shoe business.

1 Introduction

Ergonomics is drawing attention of many productive sectors because its application is a way to raise overall productivity and workers satisfaction. These aids conquering better quality on the final product and lowering both error index and occupational accidents (MOURA, 2001).

According to Messing *et al*. (1998), task efficiency is directly affected by the interpretation of supervisors when developing a process or an array of activities for a worker. For example, the exclusion of the workers from the process and the ambient layout may carry over many difficulties to people involved on cleaning and maintaining that area. This can result in loss of efficiency during these tasks or even worse, work related diseases may harm the workers due to unnecessary movements when performing their job.

A great advantage of the ergonomic approach is the combination of the current situation analysis and the functional analysis of possible improvements. If this analysis is revolving around the processes, there is a possibility of re-thinking a concept layout with process and task demands (REMIJN, 2006).

Pohjonen *et al*. (1998) explains that the ergonomic work analysis (EWA) can have good results related to the workers and, consequently, to the business as a whole. The explanation for such achievement is that the EWA is a great method to develop work content and to reduce the load on heavy demand tasks. The EWA also helps workers learn to use their own abilities and necessities to adjust work frequency, not to mention it raises their self-confidence and interest on ergonomics itself.

In short words, among a great diversity of positive effects of the ergonomic work analysis, comfort and raise of productivity are the most current on literature (VINK *et al*., 2006). This makes EWA and process organization a must for improvement studies on any enterprise that wishes to achieve a bigger share of the available market.

The goal of this research was to analyse ergonomically the process organization of a shoe store located in Porto Alegre's downtown (Rio Grande do Sul, Brazil) and the layout of the shoemakers work stations, and to provide improvements to these areas. The article structure follows as: the second session presents the bibliographic research, session three contains methodological procedures, session four describes the results and the fifth session presents the study conclusions.

2 Bibliographic Research

In a most recent perception work is organized by managers and workers, based in part on the workers perceptions, their abilities and tasks characteristics (Messing *et al*., 1998). Relating to this perception, Wilson (2000) affirms the contemporary vision of any work activity is part of a supply chain, in which every element is both a supplier and a client to the other elements. In this system, interactions happen in a wide net and they are the true focus of the ergonomics.

In the context of interactions, Parsons (2000) affirms ergonomics can be defined as the application of the knowledge of human characteristics on system conception. People inside work systems behave confined in a determined ambient, and ergonomics is concerned in analysing how they interact in this ambient (with an ergonomic perspective).

Reinforcing this concept, ergonomics can be understood as the fundamental knowledge of human behavior and performance while interacting with socio-technical systems and the application of this knowledge on interaction concept on a practical context. Inside this definition, socio-technical systems can be anything from someone using a tooth brush to an entire residential complex, or an operator monitoring a video display of a complete train station (WILSON, 2000).

Among the attribution of a researcher, Guerin *et al*. (2001) make it clear that the job of the ergonomist is to verify and analyse, through the study of current work tasks, or simulation of future tasks, the incoherence and risks that may harm workers health and their activity dysfunction. That being said, the practice of ergonomics is only viable if it aims the transformation of work situations.

Ergonomics, sometimes, have a negative connotation for being related to diseases or guidances that hinders innovations on the work ambient (VINK *et al*., 2006). According to Carayon and Smith (2000) its goal is to improve both efficiency and safety of everyone involved. That being so, the concept of work organization is directly related to ergonomics. However, some work organizations are more efficient than others, on the perspective of reaching goals related to performance and safety.

In search of a higher industrial competitiveness, new approaches about work organizations has appeared, appreciating the human being and promoting its development, improving the performance on work tasks (MOURA, 2001). Carayon and Smith (2000) propose the Equilibrium Theory emphasizes a systemic approach where every element of the work system must be considered in order to achieve gains related to performance and safety and health of the workers. In the following lines there is a brief description of each element of the work system proposed by this theory.

- Ambient: special attention to aspects related to the physical characteristics as stressors, including noise level, luminosity, temperature, air quality and layout.
- Task: many of the psychosocial factors fall inside this aspect: work demand, activity rhythm and cognitive demands, and the content of work, where the monotony or challenge levels are evaluated.
- Technology: the lack of adequate abilities to handle current technologies, and the fear of losing the job by replacement due to automation, leads to lack of motivation, stress and diminished performance. On the other hand, when new technologies are correctly applied, abilities and work content can be improved, leading to better motivation, better performance and stress reduction.
- Organizational factors: the organizational context in which tasks are performed often have considerations that relate to motivation, stress and overall work performance. The way that workers are introduced to changes, and organizational support that they receive – such as

training and acclimation time – have strict relation to stress and performance, and to the possibility of getting better and being promoted.

- Individual: some personal worker characteristics can affect how they are going to interact with other elements of the system. They are included, but not limited to, personality, physical health, anthropometry, skills and competence and previous experiences.

Reinforcing the importance of new approaches to the analysis of work organization, Battini *et al*. (2011) suggest that at least two types of variables must be studied. They include the technological variables – all variables related to product characteristic, factoring processes, industrial market and available plant space – and the ambient variables, which are all those related to work force and physical and mental safety, also considering psychosocial factors.

Vink et al. (2006) indicate that it is necessary to have knowledge of some factors that must be taken into consideration in order to apply ergonomics with success. Some of them are:

- promote direct worker participation;
- organize support for management;
- maintain a good inventory;
- utilize a step-by-step approach;
- promote the creation of a leading group with responsibilities;
- evaluate the effects, including the negative ones, on an early stage;
- not focus on health questions only;
- describe the cost-benefit relation in monetary terms and also in non quantitative measures.

The first and the second factors are about the group participation and stakeholders (including managers, engineers, ergonomists and workers), and are an essential topic for project success. The next four items concern with the approach and the process, aiming to evaluate early if it is possible or not to apply the ergonomic intervention and create a support group to lead the study. The last two focus on content and objective, promoting a way to present to final user the results of health, comfort and productivity found.

Smith and Carayon (1995) drag attention about the revolution of technology in relation to work that caused a huge change on how work is managed and organized. Starting from this integration, emerges the necessity of work and layout organization to attend to real worker necessities both on macro and microergonomic level. That organization can be made easier, according to Johnson (1996), by using computational tools. They can aid the user interface development, layout sketches, and many others.

Wahlström (2005) add to the matter that interventions which include layout and task technique optimization reduce physical load. As consequence, there is a better worker performance and a reduction of work related diseases.

3 Methodological Procedure

Guerin (2001) recommendations were used in this research, because the methodology of Ergonomic Work Analysis (EWA) permits the production process characterization by means of open and systematic observations and interviews. These tools contribute to the improvement of working conditions proposed, while taking into account the objectives of maintaining the workers health and the range of productivity expected by the shoe store.

On a first stage the research was based on observations that, according to Moura (2001), are important to the EWA and allow the understanding of the fabrication process by the man and the utilization of the devices and tools in the process. On the first visit to the shoe store there has been made free observations and interviews with the employees and the owner, in order to familiarize with the business, service system, organizational logic and general problems. Photographic resources were used to register the layout.

After the first visit a primary diagnosis has been made and guided focused observations and open questions made on the second visit to the shoe store. The second visit was focused on the conclusions of the researchers found on the primary diagnosis, which were the organizational process and layout.

It was also registered on the second visit two work cycles of a shoe maker with the aid of a digital chronometer. Also, questions to the workers and the owner were made to better understand their necessities for future confrontations with the ergonomic analysis made by the researchers.

The data collected on both free and focused observations, interviews and other employees and owner verbalizations were registered on a field notebook. The registry was analysed, along with the photographs, via quantifications, comparisons and inferences.

The analysis was grouped on big categories related to *i*) demand characterization and process characterization; *ii*) process organization analysis; *iii*) layout analysis; and i*v*) temporal analysis of activities.

It is worth adding to the matter that the analysis of tasks correspond to the real work identified executed by the employees. Not only being essential for its understanding, the ergonomic analysis allows task break down in many parts. In a different way, the sum of the parts means the representation of the real work, observed by the analyst and described by the operator, who in this study is the shoe maker (MOURA, 2001).

When the ergonomic analysis finished, a general diagnosis was formulated, containing improvements propositions.

4 Results

This section presents the demand characterization and process demand, the primary diagnosis, the procedure organization analysis, the layout analysis, the temporal analysis of activities, the general diagnosis and proposals for improvements.

4.1 Demand Characterization and Process Demand

The microenterprise being studied in this research is a shoe business from the service sector, localized in Porto Alegre's downtown. The microenterprise control is based on family. Three shoemakers, two clerks and two owners are part of the human resources. The employees are between 20 and 50 years old. One of the shoemakers is in the company for 24 years, the other one for four years and the others are recent. The company has another clerk in training for the shoemaker position. Owners intend to organize the environment to place a workstation for a fourth worker.

There is no division of work among shoemakers, but there is division between shoemakers and clerks. In times of very large demand, on winter for example, shoemakers provide support for clerks on schedule customer service.

The process demand involves the repair around two hundred pairs of shoes per week. Each of the two employees responsible for the sector provides around twenty pairs per day. There are no pre-defined goals, but shoemakers must comply with the deadlines for product delivery to customers.

Employees work eight hours per day. Their work schedules are from Monday to Friday, nine a.m. to seven p.m. They have a break hour during this period. According to the interview, employees work on Saturdays when deliveries tend to delay.

Each shoemaker accomplishes the full repair of the pair of shoes; the type of repair varies from the other. A complete cycle of work broadly includes the following steps: removal of parts of the damaged shoe repair activities that include cutting, gluing, drilling, sewing, polishing, fixing of the parties and painting.

4.2 Primary Diagnostic

According to the free observations, interviews, business owner's goals and workers' views, the main problem sectors are related to the process organization and the environment layout, where the workstations are placed.

From the viewpoint of employees, ventilation, lighting, organizing the bench, the workstations and the shelves could also be improved. The distribution of workstations between clerk and shoemaker should also be redefined.

The main problem related to the process organization focuses on the interdependence of employees responsible for customer service to those responsible for the repair. That is, the clerks rely on information from shoemakers to provide budget and delivery period of products subject to repair. Shoemakers depend of provided requests by the clerk to perform the proper repair.

4.3 Process Organization Analysis

The process organization includes a flow of tasks that are performed for the provision of the shoes repair (Figure 1). This organization involves order entry repair, a repair type setting, budget and delivery date, communication between clerk and shoemaker, shoe storage in boxes to organize the demand as the day of the week to be delivered, the repair itself, subsequent storage of the repaired product on the shelf and delivery of product to the customer.

The main problem diagnosed in the process organization focuses on communication between clerks and shoemakers. Clerks move from the service desk to the workstation to request information about the type of repair, budget and delivery date. The delivery date is predefined at the beginning of the work shift, but when customers request a different date from pre-determined, clerks require date definition by shoemakers.

The difficulty is related to the interruption of the work cycle of the shoemaker to provide information to the clerks. This determines a dependency relationship that is constantly being modified; in this case the time of the shoemakers would be optimized.

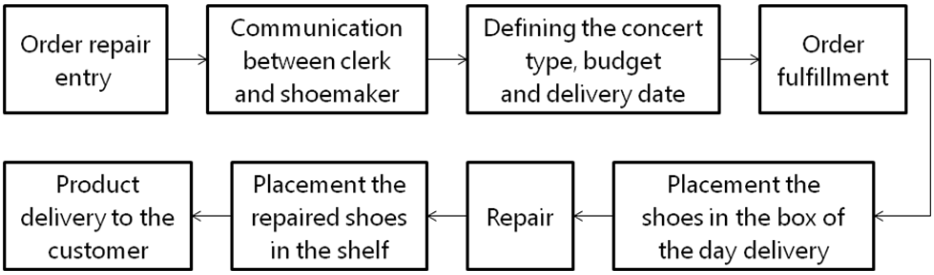

Figure 1: Flowchart of tasks process.

4.4 Layout Analysis

The layout has problems related to disorder and physical space (Figure 2). Materials are arranged in pots positioned on the shelf between the two workstations.

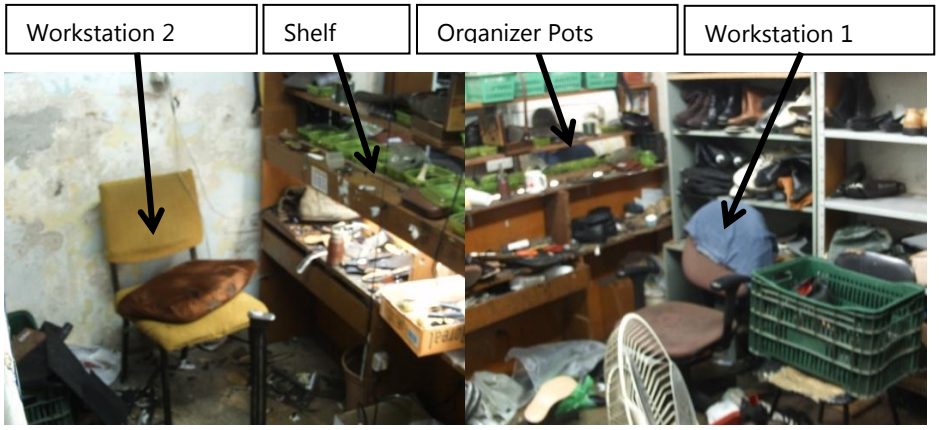

Figure 2: Workstations and shelf with materials organizers pot.

There is sanding machine used in all repairs located in a room near the workstations (Figure 3-A). Thus, shoemakers need to move from your workstations. There is a painting station in another environment (Figure 3-B) that is used by both shoemakers. The painting station is used only on specific repairs.

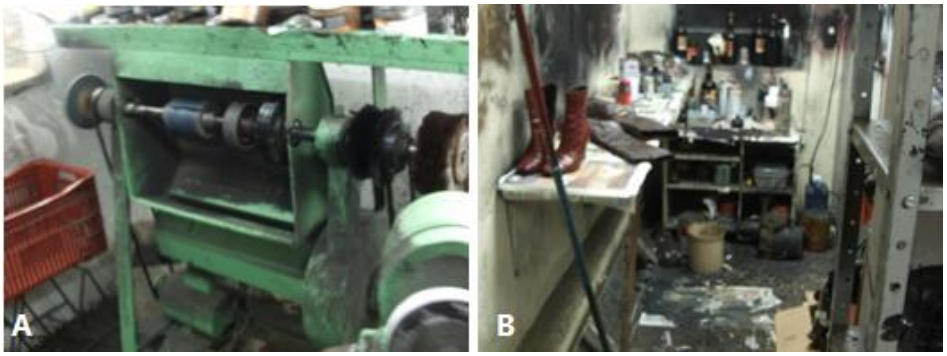

Figure 3: A- Sanding machine station; B - Painting station.

This analysis allows the construction of the scheme for the microenterprise layout as Figure 4. Workstations 1 and 2 highlighted are the same illustrated in Figure 2, they belong to the primary environment. This environment is the subject of the ergonomic analysis of this study, where owners want to organize the production process to insert other two workstations, i. e., one to the shoemaker in training and another one to a new shoemaker.

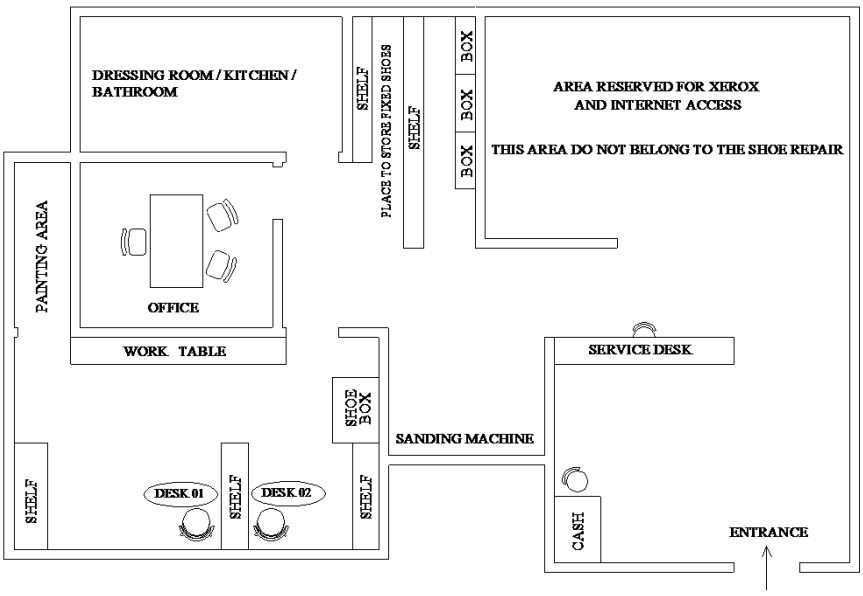

Figure 4: Scheme of the microenterprise layout.

4.5 Temporal Analysis of Activities

In order to organize the shoemakers' workplace layout, in addition to observations and interviews, two work cycles of two types of repairs of a shoemaker were considered, timed during the second researchers visit. This assessment is focused on the possibility of organizing the tools used by the employee in a better way, optimizing the execution time of the task, reducing the displacements to catch these tools and losses due to the layout organization.

Therefore, it was shown graphically (Figure 5) the total execution time of the repair activity of heel height of a pair of shoes, divided into task time, displacement and loss. The displacements refer to the up from the workstation and move to the sanding machine. The losses are indicative of the search time, catching the tools and necessary materials for repairs and preparation of material to be used in the activity.

In the case of this first activity, it can be seen that the losses correspond to 7% of the execution total time of the heel height repair, which equals 41 seconds of the total time (10 minutes and 4 seconds). This loss specifically refers to the searching time for the hammer and material used for the repair by the shoemaker.

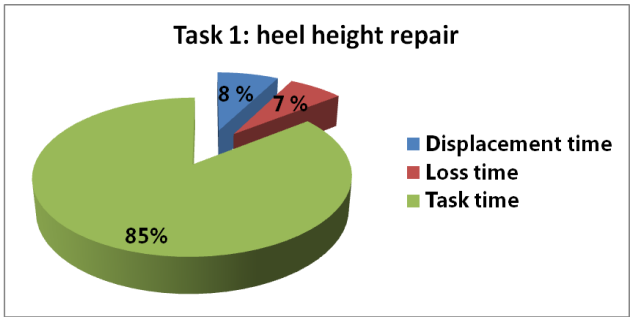

Figure 5: Temporal distribution of the heel height repair activity.

The displacement that correspond to 8% of total time of the activity execution (46 seconds) includes two displacements: the first realized until the sanding machine localized in the environment beside workstations, and the second displacement from sanding machine station to the shelf to store the ready product for delivery.

The work cicle of the second activity analyzed (Figure 6) refers to the reinforcement and shoe heel tip repair, the most frequent types of repairs in the shoe business, with the execution total time of 22 minutes and 3 seconds. The percentage refers to the loss (6% - 1 minute and 22 seconds) and displacements (4% - 50 seconds) are lower than first work cycle analyzed. The losses in this second case include the search for material, the actions to catch and prepare the material, as well as the failure to perform.

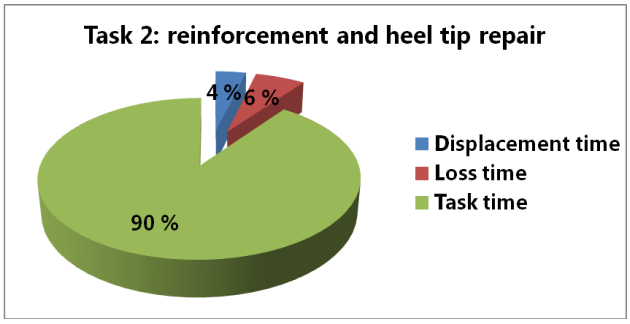

Figure 6: Temporal distribution of the reinforcement and heel tip repair activity.

4.6 General Diagnostic and Proposals for Improvement

Based on these analyzes, it can be inferred that the more specific findings confirm the primary diagnosis. That is, the general diagnostic clarifies that the main failures are in the process organization, the shoemaker-clerk interdependence specifically and the layout organization. Both malfunctions affect the

shoemakers' productivity. Thus, proposals for improvements are based on the general diagnosis, the study of workers interaction with objects they use in the practice of their tasks, along with the work environment.

First it is proposed a pre-determination by shoemakers of specific numbers for exceptions relating to the delivery date, with the possible maximum anticipation for those customers who request urgency. This definition must be stated before the schedule of service in order to solve the problem related to the interdependence shoemaker-clerk. Second, it is appropriate a table with the types of concerts and their prices, which should be available to clerks to avoid interruption of shoemakers work. Thus, the shoemakers will only be interrupted in cases of extreme necessity.

Based on the layout and activities analysis, it can be proposed a layout organization that provides better arrangement of tools and materials needed for repairs. Each operator should have their tools in order to reduce the search time and minimize losses. Materials of common use must have pre-defined places for both shoemakers to know where to find them as quickly as possible, minimizing the search time.

As displacements are due to the need of using the sanding machine and, according to interviews with the owners and employees, there cannot possibly put it closer to Workstations. Then, it is suggested that the shoemaker perform task steps that does not require the use of the sanding machine in more than one pair of shoes. When the shoemaker goes to the sanding machine station, the station's task steps will be performed in at least two pairs of shoes, reducing the total number of daily displacements in half.

Taking all these aspects into consideration, compared with employees and owners' goals, a scheme for layout organization of the workstations environment is suggests (Figure 7).

According to this proposed scheme (Figure 7), owners need to invest in a further bench, replacing the counter current by the shelf which is originally placed along of the workstation 1. The shelf shown in Figure 2 positioned between the Workstation 1 and 2 would be replaced by another bench. The new bench will be placed together to that existing one, because this second bench on the wall would leave the original position and it would pair with the new bench.

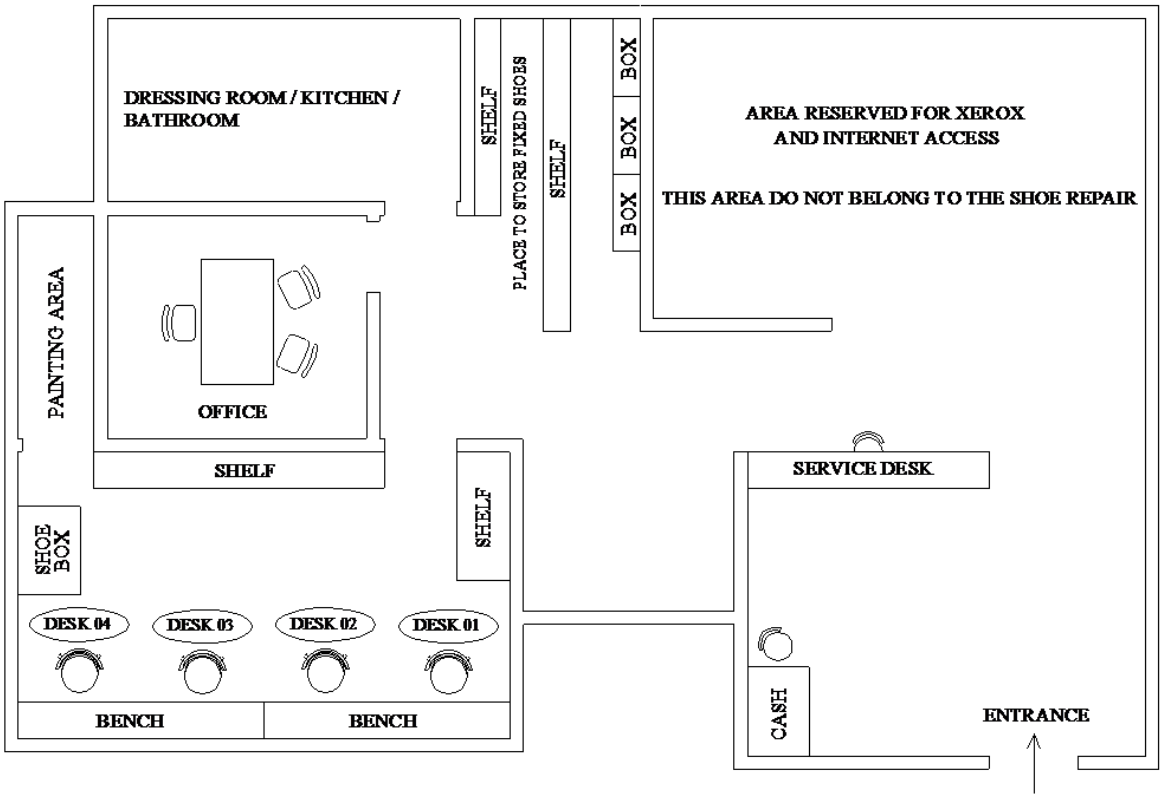

Figure 7: Organization proposed to the workstations environment.

Materials' organizer pots should be placed on these benches available to all shoemakers. The shelf's constituent material, shown in Figure 2, could be used for the production of shelves above the bench. Thus, each worker could organize their tools and materials. Emphasizing that each shoemaker should have their own tools and materials needed to repair on an operating range to avoid frequent displacements and search for materials.

The box for the demand organization that is positioned within the shoemakers' working environment would be repositioned on the opposite wall to its original position. This new proposal for organizing the layout, the lighting requires review to provide the shoemakers visual comfort on their workstations.

5 Conclusions

The ergonomic analysis is essential to adapt the workplace to the main subject, the employee. Therefore this study conducted an ergonomic analysis of the process and environment layout organization of a small shoe business in Porto Alegre city, proposing improvements.

According to the research, the main failures observed found in the task organization process, i. e., the clerks needs to communicate with shoemakers requesting information about the type of concert, delivery time and budget of the service to help themselves about the kind of concert, delivery time and service's budget frequently. Layout problems were also identified, because there is a need to improve the work environment and workstations for current employees, as well as creating two other workstations to new employees.

It was proposed to the shoe business a better organization of communication between shoemakers out of opening hours and making a handy table with types of frequent repairs and their prices. It was suggested furniture and workstations arrangement to reorganize the layout, such as replacing a shelf for a new bench, organizing shoemaker's tools and materials available. These suggestions would assist workers and reduce the time required for each repair with consequent losses reduction.

This study can also be continued with a focus on the proposal of making possible official proposals to reorganize the layout with the relevant furniture provisions, as well as tools and materials distribution. Other ergonomics analysis with differentiated approaches aiming noise, lighting and ventilation analysis can be performed. Problems like these were also found in this small shoe business and they are being resolved by the owner, but that could be supported by an ergonomist.

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