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Re-layout of the Work Area Using the Ergonomic Participatory Method

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Abstract

Re-layout of work areas is very important to pay attention to in small and large industries. In structuring the work area, it greatly affects the sustainability of a company both in terms of worker health and in terms of the company income. The aim of this study is the re-layout of the work area using the participatory ergonomic method. The research method used is an observation method by applying the participatory ergonomic stage. The research was conducted in the CV. Victorina industry from June to August 2022. The results of the research obtained were layout work areas using participatory ergonomic methods, including conducting interviews and group discussions to obtain problem-solving solutions that were approved by all parties involved in the system. Conclusions from the results of the study obtained the design layout of the work area in accordance with the wishes and constraints experienced by workers, the application of personal protective equipment in work activities, and designing work facilities in the form of workbenches and equipment storage cabinets based on ergonomic participatory, so as to create an efficient, comfortable, safe, healthy, and effective working system and avoid accidents due to work.

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1 Introduction

Designing the layout of production equipment is a very important part of the industrial world. To support the smooth production process, the industry needs to plan the factory layout. In planning, some variables affect the layout of production tools, namely the determination of the square area (room). Own area is used as a permanent and temporary location for equipment, machinery, and personnel (operators) (Wignjosoebroto, 2009). Therefore, it is very important that in a workplace, the layout of production facilities is carried out properly, so that workplaces with small and large-scale production. A well-designed facility layout will make a positive contribution in optimizing the company's operating processes and ultimately maintaining the company's survival and company success (Noviyasri et al., 2014).

A friendly designed workplace can also improve the usability of products, equipment, systems, and facilities that facilitate the execution of tasks and efficiencies and achieve user convenience of various elements of the workplace. It is not difficult to know that ergonomic workplace design will ultimately increase productivity and reduce production costs with better prediction and management of production and operational costs during the life cycle of a product (Justine, 2017). There are so many benefits to using ergonomics in workplace design. An ergonomic workplace design approach yields many benefits, including the prevention of injuries and diseases such as the prevention of musculoskeletal disorders such as back pain, neck and shoulder pain, carpal tunnel syndrome, etc. by minimizing the physical workload of working people. A good workplace can reduce the risk of musculoskeletal injury. There is an interdependence among the components of the workplace, the person working, the requirements of the task, the environment, and the habits of body movements and postures adopted by the working person.

Workplace design deals with the shape, dimensions, and layout (i.e. placement and orientation) of the various material elements that surround one or more working people. Examples of such elements are seats, work surfaces, tables, equipment, tools, controls, and displays used during work, but also hallways, windows, heating/cooling equipment, etc. The ergonomic design of the workplace is aimed at improving performance (both in quantity and quality), by minimizing the physical tension and workload of the working person, facilitating the implementation of tasks, that is, ensuring the easy exchange of information with the environment, minimizing physical constraints, etc., ensuring occupational health and safety, achieving ease of use of various elements of the workplace (Marmaras & Nathanael, 2021).

CV. Victorina is an Industry The production of agricultural tools and machinery produced can develop rapidly because the carrying capacity of food crop agriculture and horticulture in Minahasa Regency has so far contributed significantly, including the provision and absorption of employment, business opportunities, and the provision of regional/regional food production. This small and medium enterprise (SME) has 8 workers with a working time of 8 hours. In the production process until it reaches approximately 68,000 tons. Starting from the production process, tool or machine products produced by CV. Victorina still did not pay attention to ergonomic aspects. Judging from the work system and the conditions of the work environment, it still has the potential to cause work accidents. The application of ergonomics needs to be done better through the adjustment of machines, tools, and equipment to the workforce that can support health, comfort, and work efficiency (Margaritis & Marmaras, 2007; Velasquez et al., 2017; Sutapa et al., 2022).

The initial observation of this is shown by the working posture and lifting of the workload in the form of materials and work tools such as cutting machines. Work stations that are located are arbitrary starting from the laying of materials and other equipment irregularly. Planning and observing the layout of the factory is a major foundation in the industrial world because, with good planning and arrangements, it is hoped that the efficiency and survival or success of the work of an industry can be maintained. The thing relating to planning and arranging the layout is the material handling system. The main purpose of planning and arranging the layout of the plant is to organize the work area and all production facilities that are the most economical for production operations, safe and comfortable so as to raise the working morale and performance of the operator. More specifically, a good factory layout planning and arrangement will provide advantages in production (Wignjosoebroto, 2009).

Before starting the layout design, the design team should collect data regarding the activities to be carried out in the designed workplace and the needs of the workers. More specifically, the following information should be collected: The number of people who will work permanently or occasionally. The organizational structure and organizational units it covers. Activities are carried out by each organizational unit. Of particular interest is the need for cooperation between different units (and consequently the relative proximity desired between them), the need for the reception of external visitors (and consequently the need to provide easy access to them), as well as other related needs with the peculiarities of the unit (e.g. safety requirements). Activities carried out by each worker. Of particular

interest is the need for cooperation with other workers, the need for privacy, the reception of outside visitors, the special need for lighting, etc. Equipment needed for each work activity (e.g. computer, printer, storage) (Marmaras & Nathanael, 2021). Based on the description of the problem description above, research was carried out in the form of rearranging the production room that is more organized and neat through an ergonomic approach so that workers can work efficiently, comfortably, safely, healthily, and effectively.

2 Materials and Methods

One of the studies of ergonomics that can be applied in order to carry out a design or design of a tool is the concept of participatory ergonomics. With this concept of participation, it is hoped that various problems and solutions desired by users can be explored in rearranging the production space. In the end, with this ergonomic participation approach, it will be able to create healthy, safe, comfortable, and efficient working conditions and environments so as to increase employee work productivity (Hidayat & Purnomo, 2014). The study was conducted on CV. Victorina is engaged in the production of agricultural tools and machinery located in Minahasa Regency, North Sulawesi Province. This research was conducted in June – August 2022.

Field observations are carried out in order to see the organizational system, work stages, and production processes that are being carried out. This observation is expected to be able to inventory all the information needed in the study. The stages of a participatory ergonomic approach include 1) Initial interviews and group discussions, in order to collect information directly from all involved in the production process, both owners and employees, as well as obstacles encountered during the production process. The results of this interview were then used as a reference to redesign the layout of the work facility. 2) Rearrangement of the production room and layout of work facilities, the advanced stages of the concept of participation as the implementation of the results of the discussions that have been carried out. This layout redesign is also carried out by involving various parties in accordance with their fields so that the design results really have quality technical value and are as expected (Kuorinka, 1997; Kogi, 2006; Lanoie & Tavenas, 1996).

3 Results and Discussions

In the stages of research conducted using participatory ergonomic methods, the following results were obtained:

Field observation results

Field observations are carried out in order to find out the real field conditions starting from the initial process to the final process in the production process. CV. Victorina is an individual company that in the production process involves 8 workers, each of whom has different roles and tasks and some concurrently with other tasks. The production process that is carried out is welding, turning, and assembly. First, the production carried out is cutting material materials, in the activity of workers carry out material handling activities. Second, the welding process, the welding process is carried out after the material is cut according to the predetermined size, the worker's activity carried out is to work with a non-ergonomic work posture, and thirdly, the component assembly process, the result of welding is in the form of a frame, then assembling machine components on the frame and the activities in this process are carried out at the risk of manual material handling workload which is over and over again (Feyen et al., 2000; Grajewski et al., 2013; Caputo et al., 2019).

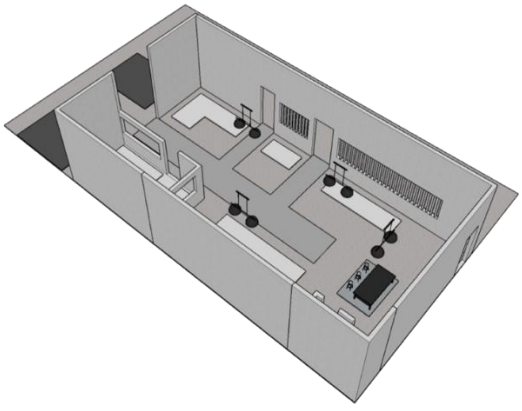
Results of interviews and group discussions

In each stage of the process, a question and answer is carried out in order to explore the information and obstacles faced. The question and answer are carried out showing information that the most vulnerable or important stage to pay attention to is the welding and assembly process, in addition to irregular workspaces starting from the placement of materials and the work facilities used are not in their proper place, so it is not uncommon for workers to often lose work equipment and set work accidents such as: tripping, slipped, pinched, and crushed by the material.

The discussion involved researchers and business owners and their workers. From the results of discussions with all interested parties in the system and outside the system, an ergonomic rearrangement of the layout of the production room was carried out to prevent problems obtained from observations and interviews. The discussion was conducted 2 times for 2 weeks. Based on the results of this approach, several things that need improvement are obtained to be carried out immediately based on mutual agreement, including:

1) Rearrangement of the ergonomic layout of work facilities
   The process of structuring facilities is carried out by carrying out cleaning activities of the production area and regulating the flow pattern of materials by taking an ergonomic approach. Relocating unused materials /materials outside the production room. The relocation of materials or materials that are not used aims to provide wider activity space, so that work accidents faced by workers when doing activities in the production process can be minimized. Then a rearrangement of work facilities in the form of production machines that were previously not ergonomically arranged was carried out which caused workers to move from using work facilities to other work facilities so that production time tended to be longer, as shown in Figure 1. On the basis of these problems, a rearrangement of work facilities is carried out in accordance with a more efficient production flow by arranging the workflow in accordance with ergonomic work stages, as shown in Figure 2. In line with the research conducted by Murnawan et al., (2020), states that arranging the layout of the production process facilities can increase production capacity and have an impact on increasing the economic profit of the production output. Noviyasri et al. (2014), also stated that the results of the redesign of the layout of the production facility showed a displacement time efficiency of 64%. The amount of efficiency in floor area and material handling costs is due to the existing layout conditions, in the work area, there are many components, materials, and objects that are not actually needed by workers. This has an impact on the waste of this work area has an impact on the efficiency of using the area of the room.

Figure 1. Conditions of the production room of the initial state



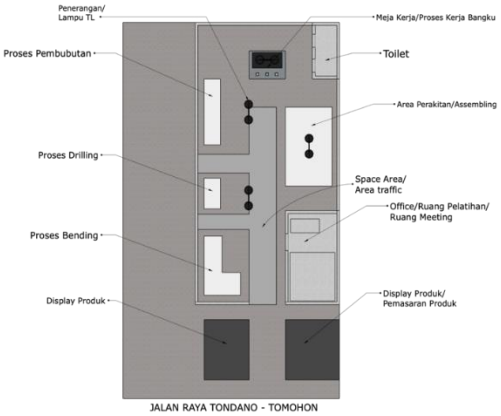


Figure 2. Re-layout of production work area

According to Mercado (2015), Since most of the observed fabrication workshops do not have fixed locations or designated areas for different raw materials, finished products, and processes, researchers form a smooth workflow and workplace layout that can increase the productivity and efficiency of workers taking into account health and safety. Workplace Regulations state that workspaces must have enough free space to allow people to get to and from work and move indoors with ease.

2) Designing workspaces and work facilities that pay attention to ergonomic aspects
   Designing workspaces and work tools that take into account aspects of occupational health and safety (K3) and ergonomics, namely by providing Personal Protective Equipment (PPE) in the form of safety shoes, gloves, heat-resistant gloves, work clothes, and maintaining an ergonomic work environment. Occupational Health and Safety (K3) is a protection effort aimed at ensuring that the workforce or company is always in a safe and sound state. In the agricultural machinery production industry in CV. Victorina has been carrying out her business for a long time, but nowadays cultural factors are very close to work activities in the industry. Workers in carrying out their work do not use complete PPE and K3 facilities are inadequate and poorly considered.

Figure 3. Personal protective equipment

Ergonomic-oriented designed work facilities are the most important part of the production process such as workbenches and work equipment storage cabinets. a workbench designed to support the production process in workers' activities to provide natural changes in work posture so as to avoid skeletal muscle disorders and work fatigue caused by unnatural work positions (Suarjana et al., 2022). Ergonomic workbench dimensions based on worker anthropometry obtained a table height size of 87cm based on the height of the worker's standing elbow. The

width and length of the table are adjusted to the full length of the material, which is 120 x 240 cm, with the function of a multifunctional workbench such as material cutting and other activities so that the work process carried out does not impose the body to work with an unnatural posture. The dimensions of the equipment storage cabinet, obtained the size according to the length of the upward range in a standing position with a size of 240cm, so that the height of the cabinet used to match the anthropometry of workers is with a height of 210cm.

Figure 4. Ergonomic-oriented work facilities

According to Susihono et al., (2016) Designing a product with some input from workers or performers in mind will have a direct impact on ensuring the sustainability of the use of new tools. Ideas that use this section are in the form of creativity and innovation of workers assessed by management in the form of direct implementation in the form of new facility designs. A participatory approach is key to the success of the development scheme because the process of finding problems and solutions independently raises awareness to preserve the findings for a long period of time. The participatory ergonomic approach is also aimed at increasing utility in the development of ergonomics. aspects of work and the workplace. It also aims to promote worker initiatives to achieve the best solutions to improve work facilities. Participatory methods provide a new experience in the form of worker participation to improve the workplace (Burgess-Limerick, 2018; Choi et al., 2017; Shannon et al., 1999).

4 Conclusion

Based on the results of data processing and participatory ergonomic methods as a solution to solving problems faced by workers, namely rearrangement of work areas by relocating work facilities in accordance with the efficiency of worker movement effectiveness so that an efficient production area layout is obtained to shorten the process-distance and production process flow that is more organized and neatly arranged and less handling moments compared to the handling moments in the previous layout. Meanwhile, designing workspaces and work facilities that are in accordance with the anthropometry of workers, so that the work facilities used are more ergonomic and in accordance with the size of the worker's body and avoid health problems in the form of complaints of musculoskeletal disorders and accidents due to work compared to the previous work area.

Conflict of interest statement
The authors declared that they have no competing interests.

Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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