Workplace Design Process at Indonesian Manufacturing SMEs

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Abstract. The workplace design process must not be ignored to get a good workplace. A good workplace can support occupational health and safety and comfort of workers while doing work so that it is expected to increase their work productivity. Unfortunately, the environmental conditions of workspaces in most SMEs (small and medium enterprises) in Indonesia do not meet the standards. Besides, production machinery, raw materials, and finished goods are placed irregularly which has the potential to inhibit material transfer. This study is aimed at obtaining an overview of the workplace design process carried out in Indonesian manufacturing SMEs as a first step to finding a suitable workplace design process model for manufacturing SMEs in Indonesia.

Keywords: Occupational Safety and Health, Productivity, Small and Medium Enterprises, Workplace, Workplace Design Process

1. Introduction
Workers need a good workplace to spend their best work. A good workplace can be earned through good workplace design.

Good workplace design should not be underestimated. According to Chim [1], good workplace design can reduce the rate of fatalities and accidents. Moreover, good workplace design is also able to support the working practices become more effective [2], as well as affecting the physical and psychological health, performance, satisfaction, comfort, safety, and productivity of employees [3, 4, 5, 6, 7]. Bakke [8] states that the design of the workplace is an important characteristic of the company. In some particular workplaces, workplace design can also become part of the company's business strategy [9].

The benefits of workplace design as mentioned above can be obtained through a good workplace design process. The process of workplace design is a complex work, requires a long process, and it involves many aspects in the birth of a workplace [10].

In reality, Launis et al [10] state that the practical experience in the industrial workplace design in several countries has shown results are not as expected. Santos [11] also showed that more than one-third of the workplace design should be repaired in the first year. It shows that the process of workplace design is very important to be taken seriously.

Given the importance of the process of workplace design to produce a good workplace design, some countries have published guidelines in the design of the workplace, such as Australia and Norway [8,
The guide serves as a guideline in workplace design in an office to obtain an effective and efficient office workspace.

In connection with the workplace design in the manufacturing industry, some previous researchers have introduced workplace design process models for manufacturing industries [13, 14, 15, 16, 17, 18]. However, if we look further, models of the process of workplace design that was introduced by the previous researchers are more intended to be implemented in medium or large companies, not for small and medium enterprises (SMEs), while SMEs have a role strategic for the economy of a country, especially Indonesia.

Previous studies showed that small and medium enterprises (SMEs) have a very important role, even become a pillar in the country’s economy [19, 20, 21, 22]. SMEs provide a substantial contribution, especially in developing countries, among which accounts for about 36% to 60% of GDP (Gross Domestic Product) and absorbs about 35% to 70% of the entire workforce [19, 20, 21].

SMEs’ conditions in Indonesia, in general, are not much different from the condition of SMEs in other developing countries. The Statistics Indonesia data of 2016 showed that the number of MSMEs (micro, small, and medium enterprises) at least 99%, the contribution to GDP amounted to 62.57%, with employment amounted to 96.50% [23].

Despite having a considerable contribution, various studies indicate that the environmental conditions in the workplace of Indonesian SMEs are less good. The results of the literature review conducted by Hermawati et al [24] showed that most of the workspace in Indonesian SMEs is in stuffy and hot conditions. The results of Herwanto and Suzianti’s literature search [25] also showed that in addition to the heat, workspace environment conditions of most of the manufacturing SMEs in Indonesia, such as noise, lighting, and other factors do not meet the standards set by the government. Moreover, Mufti et al [26] state that the layout of the work stations in Indonesian SMEs is less well thus increasing the risk of the safety and health of workers.

The workplace conditions in Indonesian SMEs as mentioned above can be caused by the process of workplace design which is not good. This study aimed to find out how the process of workplace design done on SMEs in Indonesia, especially SMEs engaged in the manufacturing industry. This study represents the initial phase of the design process to find a suitable workplace design process for manufacturing SMEs in Indonesia.

2. Methods

This study was conducted at three manufacturing SMEs located in Karawang, West Java, Indonesia. The three SMEs are engaged in the manufacturing of machine components, transportation equipment, and other components as well as a vendor for several major companies in Indonesia. The selection of the three SMEs is based on the consideration that Karawang is the largest industrial area in Southeast Asia with thousands of companies in it, whether small, medium, and large companies. Karawang also is one of the areas that has become the center of the development of machinery and transport equipment industry in Indonesia.

As mentioned above, this study aimed to find out how the process of workplace design done in the manufacturing SMEs in Indonesia so far, and how it has affected the workplace conditions of SMEs. This study represents the initial phase to find a suitable workplace design process model to be applied to manufacturing SMEs in Indonesia.

This study begins with the collection of data through interviews with the owners or managers of manufacturing SMEs in Indonesia which is the object of this study. Interviews were conducted to determine how the process of workplace design that had been done on SMEs that they manage. The interview is further illustrated in the form of a flow diagram of the process of workplace design.

In addition to interviews, data collection is also done through direct observation and measurement. Direct observation was conducted to determine the condition of the layout of the workplace of the SMEs concerned. As for knowing the environmental conditions in the workplace, then the direct measurement of the lighting and noise was carried out using a lux meter and noise meter.
The results of measurements of lighting and noise will then be compared to standard lighting and noise in the workspace according with the Regulation of the Minister of Manpower No. 5 of 2018 concerning Occupational Safety and Health of the Work Environment to determine whether environmental conditions (lighting and noise) in the workspace is already compliant or not yet.

Finally, an analysis is carried out to see the effect of the workplace design process on the layout and environmental conditions in the workplace on manufacturing SMEs.

3. Result and Discussion

3.1 Workplace Design Process at SME A

SME A is one of the small manufacturing industries in Indonesia, located in the eastern part of Karawang. This SME produces products in the form of various machine components and other production auxiliary equipment. The products produced by this SME has been used by many companies in Indonesia.

Based on interviews with the owner of SME A, the workplace design process in SME A can be described as shown in Figure 1.

![Figure 1. The process of workplace design at SME A](image_url)

The process of workplace design in SME A begins with the construction of the workplace building. After building up the workplace, further mapping engine placement. This mapping is done by considering the number and dimensions of the machine, as well as space for the movement of workers, regardless of the type of the machine. The machines owned by SME A include five lathes with various dimensions, two milling machines, milling & drilling machines, cutting machines, bending machines, and workbench.

The next process is the installation of machines in the work area or production space based on the results of the mapping that has been done before with some adjustments according to the conditions of
the existing workplace. Once the installation of the machine is finished as desired, the production process can then be carried out.

The results of the field observations on SME A show that the layout of machines and materials in the workplace area (production room) is irregular and not sequentially. This resulted in material handling and the movement of workers to be blocked.

The results of the measurement of the workplace environment condition indicate that the level of lighting in the production room of SME A varies about 40 to 600 lux. According to the Minister of Manpower Regulation No. 5 of 2018 on Occupational Safety and Health of the Work Environment, the work carried out in the SME A requires illumination with an intensity of 300 lux. This means that the lighting in some work areas (production rooms) in SME A is below the standard, while in some other areas that are above the standard.

Noise in the workplace in the SME A when all the machines in operation are above 85 dB, which means above the specified standard. Noise in the workplace area is further aggravated because the workplace of SME A is located on the edge of the highway. Another problem that occurs in SME A is a slippery floor due to splashes of coolant from the lathe to the floor so it is quite dangerous for workers.

3.2 Workplace Design Process at SME B

Just like SME A, SME B is also an SME engaged in the manufacturing industry. The products produced by SME B include the part of the body of a bus, the piano part, and others. In the production process, SME B uses seven types of machines, namely bending machines, cutting machines, stamping machines, milling machines, grinding machines, drilling machines, and welding machines.

According to the results of interviews with the owner of SME B, the process of workplace design on SME B can be described as shown in Figure 2.

![Figure 2. The process of workplace design at SME B](image-url)
The process of workplace design on SME B begins with the construction of the building. The building used for the workplace in SME B is a rental building in a business district. The next step is mapping the location of the placement of machines in the building that has been established. The mapping is done by drawing on paper by taking into account the number, type, and dimensions of the machine. Having obtained the mapping as needed, then machines are installed based on mapping that has been done before until all the existing machines could be placed in the production room. The production process can be run after all the machines are in the area of production space.

One of the problems seen in SME B is machine placement that does not take machine characteristics into account. An example is the placement of cutting machines, stamping machines and bending machines that are positioned in the same area, resulting in a very high noise when the three machines operate together. The risk of noise exposure that can be experienced by these workers is higher because the working hours at SME B can reach 12 hours per day.

In addition to high noise, the level of lighting at the workplace (production room) of SME B is under 300 lux. According to the Minister of Manpower Regulation No. 5 of 2018 on Occupational Safety and Health of the Work Environment, work processes on SME B require a lighting intensity of 300 lux. Thus, the level of lighting in the workplace of SME B is below specified standards. Another problem is the machine layout is irregular, causing the transfer of material from one machine to another to be blocked.

3.3 Workplace Design Process at SME C
Slightly different from the two previous SMEs, SME C was originally a trading company located in Jakarta. Due to the high demand from customers, in 2011 SME C opened a business in manufacturing in the Karawang region. At the beginning of the establishment of manufacturing enterprises, SME C makes various products according to customers' demand with the job order system.

In 2017, SME C is selected by one of the major automotive component producing companies as a subcontractor for the gasket product with a mass-production system. For the gasket production process, based on the input or the request of the company giving the gasket product orders, SME C changed the layout of the workplace in the production room. Currently, besides producing gaskets, SME C is also still producing various engine components according to customer demand.

The process of workplace design on SME C as the result of an interview with the manager of SME C is shown in Figure 3.

As with the two previous SMEs, the process of workplace design on SME C begins with the construction of the workplace building first. After building up the workplace, the next step is to install the machine by considering the number and dimensions of existing machines. The installation of this machine was done without any mapping beforehand. Machine placement is deemed complete if all the machines have been placed and can be accommodated within the workspace. Under certain conditions, SME C receives input from customers to change machine placement.

The problems seen in the working space of SME C production are raw materials, production machines, and storage of finished goods that are placed in the same area, thus disturbing the material removal process. Besides, the distance between one machine and another in a sequence the working process is too far, causing the workers to experience fatigue at the time of the removal of material.

In addition to the things mentioned above, the noise condition in the production room of SME C exceeds the noise level standards which have been determined following the Regulation of the Minister of Manpower No. 5 of 2018 on Occupational Safety and Health of Work Environment. The lighting in this workspace uses only a few lights that are mounted on the side of the production room. This resulted in the lighting levels on production machines are under specified lighting standards. If such a thing is allowed, it will cause visual impairment in workers so that labor can lead to errors.
3.4 Analysis of Workplace Design Process at Indonesian Manufacturing SMEs

Based on the description above, it can be seen that the process of workplace design on the three SMEs have many similarities. The three SMEs started the process of workplace design on the construction of the workplace building. The workplace buildings currently used by SMEs are in part ready-made buildings and the SMEs concerned only buy or rent the building. However, some SMEs build their workplaces from scratch.

Factors considered by the management of SMEs when workplace design only the number and dimensions of the machines, and their placement in the workspace only considers "fit or not fit" of the machines in the workspace, regardless of the sequence of work and other aspects. This study shows the results corresponding to Mufti et al. [26] which states that the majority of SMEs in Indonesia do not pay attention to the layout of facilities and workplaces when designing their workplaces.

In general, it can be said that the process of workplace design in the three SMEs has not paid attention to good procedures and important factors in designing workplaces. This resulted in some problems, such as the distance between machines of the successive working process too far and impede the removal of material, the floor is slippery due to splashes of coolant, and so on. Besides, noise and lighting in the workspace of SMEs do not meet the standards as a result of SME managers do not pay attention to these two factors in the process of workplace design.

The problems mentioned above may ultimately result in interference to safety and health and lower labor productivity.

Although this study shows quite clear results, this study still has at least two weaknesses. The first weakness is the number of manufacturing SMEs involved as an object in this study only three so that the results of this study can not be generalized to the entire manufacturing SMEs in Indonesia. The second weakness is this study has not considered the opinion of the workers in the workplace environment, it is not known how far the level of comfort of workers to their workplace environment.

To overcome these weaknesses, further studies need to be developed with the involvement of more manufacturing SMEs and consider the opinions of workers about the comfort of their workplace so that
the results can describe the process of workplace design in the manufacturing SMEs in Indonesia and their effect on working conditions and comfort of workers in the workplace.

4. Conclusion
In general, the workplace design process carried out in manufacturing SMEs in Indonesia has not yet paid attention to good procedures. This resulted in the emergence of some problems in the workplace, which in turn can reduce productivity, safety, and occupational health.

5. References
[1] Chim J M Y 2018 6Ws in Ergonomics Workplace Design. Proc. of the 20th Congress of the International Ergonomics Association (IEA 2018) (Switzerland: Springer Nature) p 1282
[2] Tu’i’ukuafu A 2016 Future Space. NZBusiness Magazine February 2016 44
[3] Al Horr Y, Arif M, Kaushik A, Mazroei A, Katafygiotou M and Elsarag E 2016 Occupant productivity and office indoor environment quality: A review of the literature. Building and Environment 105 369
[4] Bangwal D and Tiwari P 2019 Workplace environment, employee satisfaction and intent to stay. Int. J. of Contemporary Hospitality Management 31 268
[5] Candido C, Thomas L, Haddad S, Zhang F, Mackey M and Ye W 2018 Designing activity-based workspaces: satisfaction, productivity and physical activity. Building Research & Information 47 275
[6] Li X, Han S, Gül M and Al-Hussein M 2019 Automated post-3D visualization ergonomic analysis system for rapid workplace design in modular construction. Automation in Construction 98 160
[7] Nag P K 2018 Spatial and Behavioural Attributes in Office Design. Office Buildings (Singapore: Springer Singapore) p 29
[8] Bakke J W 2007 The Nordic Workplace Design for Knowledge Work. (Oslo: Nordic Innovation Centre)
[9] Chan J K, Beckman S L and Lawrence P G 2007 Workplace Design: A New Managerial Imperative. California Management Review 49 6
[10] Launis M, Vuori M and Lehtela J 1996 Who is the workplace designer? - Towards a collaborative mode of action. International Journal of Industrial Ergonomics 17 331
[11] Silva e Santos M 2012 The PhOCoe Model – ergonomic pattern mapping in participatory design processes. Work 41 2643
[12] Department of Finance 2014 Flexible and Efficient Workplace Design Guidance. (Parkes: Commonwealth of Australia)
[13] Awad R, Fechter M and van Heerden J 2017 Integrated risk assessment and safety consideration during design of HRC workplaces. Proc. of 22nd IEEE Int. Conf. on Emerging Technologies and Factory Automation (ETFA)
[14] Battini D, Faccio M, Persona A and Sgarbossa F 2011 New methodological framework to improve productivity and ergonomics in assembly system design. Int. J. of Industrial Ergonomics 41 30
[15] Caputo F, Greco A, Fera M and Macchiaroli R 2019 Digital twins to enhance the integration of ergonomics in the workplace design. Int. J. of Industrial Ergonomics 71 20
[16] Harari Y, Bechar A, Raschke U and Riemer R 2017 Automated Simulation-Based Workplace Design That Considers Ergonomics and Productivity. Int. J. of Simulation Modelling 16 5
[17] Mateus J C, Claeyts D, Limère V, Cottyn J and Aghhezzaf E H 2019 A structured methodology for the design of a human-robot collaborative assembly workplace. The Int. J. of Advanced Manufacturing Technology 102 2663
[18] Del Rio Vilas D, Longo F and Monteil N R 2012 A general framework for the manufacturing workstation design optimization: a combined ergonomic and operational approach. SIMULATION 89 306
[19] Gyensare M A, Anku-Tsede O, Boakye K O and Twumasi E 2018 Occupational Health and Safety and Employee Engagement: Evidence from the SMEs Sector in Ghana. *Advances in Safety Management and Human Factors* (Switzerland: Springer International Publishing) p 202

[20] Sinclair R C, Cunningham T R and Schulte P A 2013 A Model for Occupational Safety and Health Intervention Diffusion to Small Businesses. *American J. of Industrial Medicine* **56** 1442

[21] Surienty L 2018 OSH Implementation in SMEs in Malaysia: The Role of Management Practices and Legislation. *Proc. of the 20th Congress of the International Ergonomics Association (IEA 2018)* (Switzerland: Springer Nature) p 650

[22] Unnikrishnan S, Iqbal R, Singh A and Nimkar I M 2015 Safety Management Practices in Small and Medium Enterprises in India. *Safety and Health at Work* **6** 46

[23] Muharram A 2018 *Evaluasi, Pelaksanaan dan Rencana Kebijakan dan Program Kementerian Koperasi dan SME*. (Jakarta: Kementerian Koperasi dan SME)

[24] Hermawati S, Lawson G and Sutarto A P 2014 Mapping ergonomics application to improve SMEs working condition in industrially developing countries: a critical review. *Ergonomics* **57** 1771

[25] Herwanto D and Suzianti A 2019 An Environmental Ergonomics Review of Small Medium Enterprises Workplace Condition in Indonesia. *Proc. of 2nd Asia-Pacific Conference on Research in Industrial and Systems Engineering (APCoRISE)*

[26] Mufti D, Ikhsan A and Putri T M 2019 Workplace Ergonomic Risk Assessment Toward Small-Scale Household Business. *IOP Conf. Series: Materials Science and Engineering* **528** 012013