FACTORY LAYOUT DESIGN FOR NATURAL FIBERS SHARING IN WONOSOBO

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Abstract

Currently, many Micro, Small, and Medium Enterprises (MSMEs) consider their production spaces as small workshops without optimally considering better layout plan. As result, the space sometimes suffers from mixed functions or repurposed, deviating from the workshop's original space functions. This problem happened because the layout did not meet factory standards planning, often resulting in compromised space circulations, safety, comfort, and cleanliness. The primary reason for the failure is financial constraints or lack of knowledge about factory layout regulations. In response, the Ministry of Cooperatives and Small and Medium Enterprises (KemenKopUKM) has launched the factory sharing government program, aims to provide a platform for SMEs with similar commodities to manage their production processes simultaneously together within a cooperative framework. This research focuses on natural fiber textiles management to improve production standards, expand market reach, and facilitate collaboration among MSMEs in the natural fiber textiles industry. The study using qualitative approach to apply factory layout design methods in determining its basic form, and focuses on literature concerning fundamental simple manufacturing and workshop technology, as well as extensive field data from related case studies. The findings are expected to provide practical guidance for efficient implementation of factory sharing, particularly in the natural fiber textile industry with a case study in Wonosobo. This study aims to demonstrate how functional interior design that adheres plant layout standards can support sustainable economic development and strengthen the competitiveness of local MSMEs in the global market.

Keywords: Factory sharing, natural fibers, plant layout, textile MSMEs, KemenKopUKM policy, sustainable textile industry

A. INTRODUCTION

Indonesia, a country rich in natural resources, possesses immense potential in the natural fiber textile industry. Despite their substantial potential, Indonesian natural fiber textile MSMEs face various obstacles that hinder their growth and competitiveness. Some of the challenges confronting industry players include limited technology and infrastructure, diverse product standardization, and restricted market access. According to a 2018 survey by the Organisation for Economic Cooperation and Development (OECD), Indonesia's competitiveness in product quality and standards ranks 4th in Southeast Asia (KemenKopUKM, 2020). This indicates that national MSMEs must improve to enhance their competitiveness by increasing exports and transitioning from simple to advanced technologies to gain global recognition.

One of the primary challenges faced by natural fiber textile MSMEs is the absence of production facilities equipped with modern technological tools capable of producing products that meet industry quality standards. In response to this need, in 2020, the Ministry of

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Cooperatives and Small and Medium Enterprises initiated the factory sharing program as a solution (KemenKopUKM, 2020). This program aims to address several major issues faced by natural fiber textile MSMEs, particularly in terms of industrial technology, quality standardization, and expansion of market reach, both domestic and global.

The initial implementation of the factory sharing program, focused on natural fiber textile commodities, is located in Wonosobo, Central Java. The selection of Wonosobo as the location is inseparable from the region's potential in natural fiber textile production, especially ramie fiber. According to interview with Mellie Indarto, a member of the Indonesian Fiber Council (DSI), as an organization overseeing natural fiber textile businesses DSI plays an active role in initiating the construction of the natural fiber textile factory sharing in Wonosobo, emphasizing the importance of collaboration between the government and industry stakeholders (Indarto, 2024).

As the factory sharing is built with the aim of standardizing product quality with modern technological facilities (Alkatiri, 2024), this research aims to analyze the layout design of the factory sharing located in Wonosobo. The importance of appropriate, efficient, and effective layout arrangements is crucial to ensure safety, cleanliness, and comfort, enabling optimal production and collaboration among natural fiber textile producers to meet industry standards. This research is conducted as an application and dedication to scientific knowledge and community development. The results of this study will be applied to the natural fiber textile factory sharing in Wonosobo.

B. RESEARCH METHOD

This research employs a qualitative method to gain a deeper understanding of the implementation of the factory sharing program in the natural fiber textile industry in Wonosobo. Data collection methods include three primary techniques: interviews with relevant parties contributing to this program, including representatives from MSMEs and the Indonesian Fiber Council (DSI), to broaden perceptions, experiences, and expectations related to the factory sharing program; direct observation conducted at the research site in Wonosobo, Central Java, chosen for its potential in natural fiber textiles, especially ramie; and document analysis involving literature review on factory layouts, policies, and reports related to the factory sharing program. This qualitative approach helps researchers obtain a comprehensive and contextual picture of the impact and potential of the factory sharing program in enhancing the competitiveness of natural fiber textile MSMEs in Wonosobo. Through thematic analysis of field data, this research aims to identify key factors in the efficient implementation of factory sharing and formulate recommendations for further program optimization.

C. FINDINGS AND DISCUSSION

NATURAL FIBER INDUSTRY IN INDONESIA

Natural fibers are thread-like or ribbon-shaped tissues from animal or plant sources without human engineering (KBBI, 2023). Indonesia has several types of fibers, such as ramie, pineapple, cotton, silk, and wool. These fibers are important in the textile, construction, paper, and household product industries.

Natural fibers are divided into several types: plant fibers, animal fibers, and mineral fibers. Natural fibers from plants consist of cellulose, which is found in insoluble fibers in fruits, vegetables, and other plants. Meanwhile, natural fibers from animals are composed of animal proteins.

Figure 1 Type of Natural Fiber
Source: Wibowo, 2024

Despite its potential, Indonesia's natural fiber textile industry still faces challenges. For example, dependence on cotton imports. One of the problems in Indonesia's natural fiber textile industry is that Indonesia cannot yet meet its own raw material needs, especially cotton. Indonesia still has to import cotton from China, Vietnam, Turkey, and Hong Kong. According to United Nations Community Trade Statistics, imports of cotton raw materials per year from the United States, Brazil, Australia, and India reach 700 thousand tons (United Nations Commodity Trade Statistics, 2017).

PLANT LAYOUT

Plant layout is a functional and efficient arrangement of units, machines, tools, equipment, and support services within a factory. Its main purpose is to maximize profits by creating the best system to reduce production costs. A good layout includes optimal arrangement of buildings, people, machines, and materials in the production process. Aspects of plant layout include production flow, manufacturing methods, cleanliness, factory operations, and finished products systems (Singh, 2006).

The main objective of an effective plant layout include minimizing material movement, smooth product circulation, maximum space utilization, worker safety and efficiency, and flexibility to accommodate future changes (Singh, 2006). A good layout also considers work methods, production cycle effectiveness, plant maintenance, operational productivity, and product quality with low capital costs.

The main benefits of a good plant layout include reduction in human and machine operating hours per production units, effective and economical space utilization, unobstructed workflow, reduction in manufacturing time and floor space requirements, and reduction in material handling. An efficient layout also creates a better work environment with adequate lighting, ventilation, and welfare facilities for workers, improving overall operational efficiency and worker well-being (Singh, 2006).

TYPES OF PLANT LAYOUT

According to Singh, plant layout types are divided into four categories: fixed or position layout, manufacturing process or functional layout, line or product layout, and combination layout (Singh, 2006). Fixed position layout is suitable for large products produced in small quantities, such as ships and aircraft. This layout faces challenges, particularly high equipment handling costs. Manufacturing process layout groups similar machines together and is ideally used in production

based on customer orders. This layout system arranges machines according to the sequence of operations and is suitable for large-scale production with market-driven demand. Line layout arranges the machine system according to the sequence of operations, making it suitable for mass production with stable demand. Combination layout merges the systems of manufacturing process layout and line or product layout, offering a machine sequence that aligns with the operation order while allowing for flexible work allocation. This layout can reduce machine set-up time and material handling but may be time-consuming and costly to implement. The choice of layout depends on product characteristics, production volume, and the level of flexibility required in manufacturing. Proper selection can significantly impact the efficiency and productivity of factory operations.

FACTORY LAYOUT ERGONOMICS

In factory layout design, ergonomic aspects and operational efficiency are primary considerations. There are several standard provisions for aisle dimensions and machine spacing to optimize workflow and safety in factories (DeChiara & Crosbie, 2015). Main aisles have a minimum standard width of 3 meters to accommodate two-way movement of material handling equipment. For secondary aisles, the minimum width is 90 cm for worker access, recommended to facilitate effective factory operation and maintenance.

Individual workspaces have a recommended minimum standard of 70 cm width with a length between 1.2 meters to 1.5 meters, depending on job characteristics. The space around equipment should be at least 45 cm, particularly around electrical equipment, to ensure comfortable access for maintenance. In practice, factory layouts must also be adapted to industry-specific needs, safety regulations, and ergonomic considerations to create an optimal work environment (DeChiara & Crosbie, 2015). These standards aim to enhance worker safety, improve operational efficiency, and facilitate smooth workflow within the factory setting.

FACTORY SHARING PROGRAM BY KEMENKOPUKM

Factory sharing is a program initiated by the Ministry of Cooperatives and Small and Medium Enterprises (KemenKopUKM) aimed at providing a production facility for Micro, Small, and Medium Enterprises (MSMEs) to ensure their products meet industry standards and can reach global markets (Masduki, 2022). The development of factory sharing is directed towards production centers, accommodating similar MSME commodities with modern technology. Business actors involved in factory sharing can collaborate and share resources, knowledge, and experiences. Through factory sharing facilities managed by cooperatives, this program assists MSMEs in improving product quality standards, including obtaining Home Industry Food Permits (PIRT), halal certification, and meeting the standards set by the Food and Drug Supervisory Agency (BPOM) (KEMENKOPUKM, 2023).

In establishing joint ventures, factory sharing must be managed by entities with aligned operational motives and legally recognized by the government. Cooperatives are considered the most appropriate collaboration model, given their ideal organizational structure for joint ventures in Indonesia. The cooperative management system, which adheres to the principles of mutual cooperation and kinship, serves as the main foundation in achieving MSME business goals, especially for this program (Koperasi Kelurahan Oro Oro Ombo, 2020).

Cooperatives play a vital role in achieving the shared business objectives of MSME members. The main goals include: producing quality goods and services, optimizing production cost efficiency, and ensuring customer satisfaction (KEMENKOPUKM, 2023). Through this approach,

factory sharing not only becomes a practical solution to the operational challenges faced by MSMEs but also strengthens their competitiveness in an increasingly competitive market while building a sustainable business ecosystem.

RESULT

Researcher conducted observations at the Ramie Factory, CV. Rabersa, located on Jalan Kalikajar, Wonosobo in March 2024 and at the Eha-Bond Glue Factory on Jalan Raya Serang, Cikupa, Banten in April 2024. Field observations were necessary to analyze the factory layouts. The following are some of the data collected by researcher:

RAMIE FACTORY CV. RABERSA ON JALAN KALIKAJAR, WONOSOBO

According to interviews with Mr. Wibowo Akhmad, the CEO, and Mr. Warsono, an employee of CV. Rabersa, this factory employs 26 workers operating within the facility. The ramie factory area encompasses production processes that transform raw materials in the form of ramie stems into both coarse and fine fibers (Akhmad & Warsono, 2024).

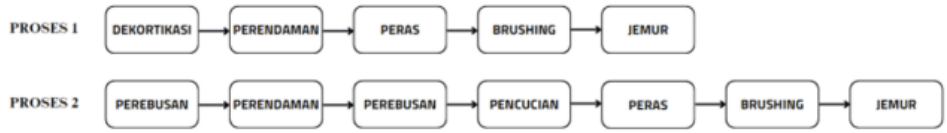


Figure 2 Hemp fiber processing procedures
Source: Personal documentation

The production process at Rabersa divided into two main stages. Proces 1 is transforming ramie stems into coarse fibers. This includes: decortication or extraction of ramie stems, soaking, squeezing, brushing, and sun-drying. Process 2 is bleaching to whiten the ramie fibers. This includes: boiling, soaking, washing, and sun-drying.

Figure 3 Existing Layout of CV. Rabersa
Source: Personal documentation

Figure 3 illustrates that the production flow remains suboptimal due to an inefficient layout and processes that are positioned too closely together. This issue is particularly evident in the degumming and bleaching processes, which comprise Process 2. Both processes require squeezing and brushing stages; however, the necessary equipment for these operations is located in the Process 1 area. Consequently, operators who complete Process 2 must return to the Process

1 area to access the squeezing and brushing machines. This arrangement leads to a non-linear workflow and has the potential to decrease overall production efficiency.

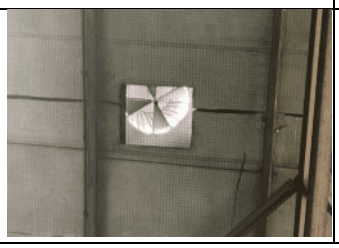
Figure 4 Conditions of the CV. Rabersa Work Area
Source: Personal documentation

Figure 4 illustrates the condition of the raw material area, which borders the pressing, brushing, drying, and decortication areas. From the displayed image, it is evident that the circulation of machinery, work areas, and employee spaces are still mixed, causing the room to become cramped and untidy. The raw materials are simply placed on the floor of the transition area from the entrance to the decortication process. The decortication and soaking processes, which use a lot of water, result in the floor becoming muddy with standing water. Besides the disrupted aesthetics, the factory's safety also becomes a primary concern that may be overlooked in the current layout. The slippery floor, made of cement and soil mixed with water, along with the limited employee mobility circulation, causes the factory to fail to meet the standard size requirements.

EHA BOND FACTORY AT JALAN RAYA SERANG, CIKUPA

Table 1. Eha Bond Glue Factory Observation Data
Source: Personal documentation

Name	Pict. 1	Pict. 2	Pict. 3
Arrival / entry area			
Layout			

Machine layout			
Ventilation / lighting			

As the researcher approached the factory area, they passed a 7 m^2 road. Mr. Cun Hwat, one of the factory employees, explained that according to factory standards, the 7 m^2 width of the access road to the factory area is adequate for smooth truck traffic during loading and unloading processes (Hwat, 2024). Upon entering the factory area, the researcher was greeted by a stabilizer at the entrance, which neutralizes the electrical current before entering the work area. The addition of a stabilizer at the factory entrance demonstrates efforts to maintain electrical stability before entering the work area. This is crucial for protecting workers from electric shocks within the production area. Eha Bond Factory utilizes a vertical 2-story layout for space efficiency. Ventilation is provided by exhaust fans and ceiling fans, while lighting is a combination of natural and artificial sources. The machines are powered by dynamos and three-phase electricity. Electrical control panels are strategically placed for ease of monitoring. The factory's design and system adhere to modern standards, ensuring smooth production, workplace safety, and energy efficiency.

FACTORY SHARING LOCATION

Figure 5 Location of Natural Fiber's Factory Sharing
Source: Personal Documentation

The natural fiber sharing factory that will be designed is located in Wonojoyo Village, Bomerto, Wonosobo. The location was chosen because it is highly strategic, situated along the main road with the potential for land expansion of approximately 5000 m^2 and road access to Mount Sindoro.

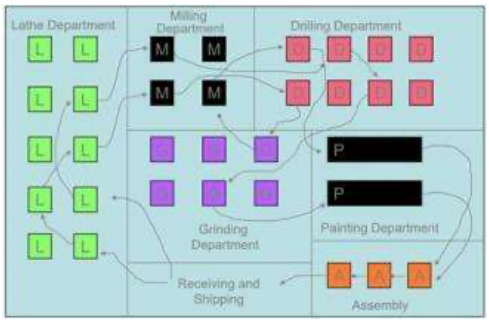


Figure 6 Manufacturing Process Layout
Source: Modul PLTF Atma Jaya

In designing the layout for a shared factory for the natural fiber textile industry in Wonosobo, the researcher used a manufacturing process layout method, as shown in Figure6. This approach was chosen because market demand for natural fiber textile products is still primarily made-to-order, making it more suitable than a layout based on grouping finished products. This method focuses on arranging work areas according to the sequence of the production process, taking into account the logical relationships between work areas and the frequency of interaction between them according to their functions. The goal is to optimize the movement of materials and the interaction between work areas in the production process of natural fiber textiles that are still tailored to orders.

DISCUSSION

Currently, the natural fiber sharing factory is allocated for the production of natural fiber textiles, including ramie, cotton, pineapple, and *eri* silk. The production flow is as follows:

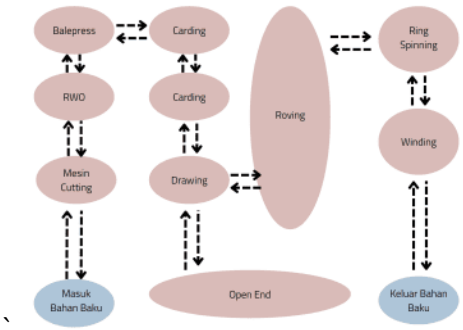


Figure 7 Production process in factory sharing
Source: Personal documentation

In Figure 7, it is explained that the incoming material in the form of fine fibers that have been bleached will enter the cutting process using a cutting machine and be refined with an RWO machine. The chopped fibers will then be compacted with a balepress machine. The compacted fibers will be cleaned and separated according to their size into slivers in the carding machine. Next, the slivers will be combined and stretched to become more even through the drawing machine. The sliver process will then branch into two paths: Open End, which produces fine yarn in sizes 16S–30S (larger sizes), and continues to Ring Spinning to produce fine yarn in sizes 40S–60S (smaller sizes). To produce smaller-sized yarn, the sliver from the drawing machine will be processed through the roving machine to create thick yarn that is less likely to break. The thick yarn is then spun into fine and strong yarn on the ring spinning machine. To transfer the yarn

from the ring spinning bobbin into large cone-shaped rolls, a winding machine is needed. After winding, the yarn is transported to the finished goods warehouse using a yarn trolley or bobbin ring trolley.

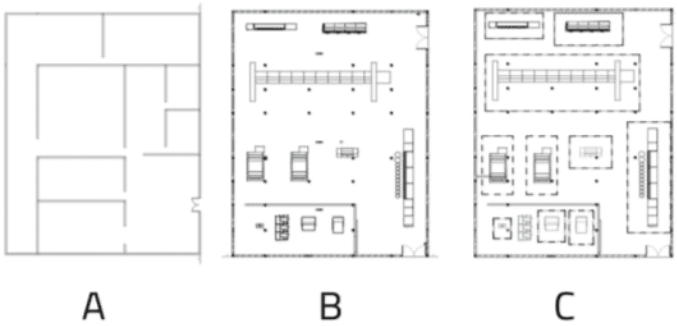


Figure 8 Factory sharing layout
Source: Personal documentation

Figure 8A shows the current layout conditions inside the building. It is evident that many walls have the potential to hinder the production process flow, considering the large size of the equipment used. This layout is allocated for the production house that processes bleached fine fibers into yarn in large quantities.

Figure 8B displays the machine layout, while Figure 8C shows the work area layout recommended by the researcher. The suggested solution involves demolishing interior walls, leaving only the main column foundations. The production flow is designed in an S-shape. By adopting the manufacturing process layout type, each natural fiber textile business using the factory sharing facility can utilize the same machines alternately.

In the latest factory sharing design, the researcher optimized natural ventilation by replacing some solid walls with perforated blocks and leaving the high roof without a ceiling to ensure good air distribution. Lighting is designed with a combination of natural sunlight and hanging lamps.

The main focus in the work area design is the separation of circulation for machinery, workers, and employees. The researcher established a minimum distance of 60 cm on the right and left sides of the machines and 120 cm in the work area where workers operate the machines, in accordance with the building's dimensions and factory layout standards. The work area layout distances are adjusted to the size of the factory and the relatively low worker mobility, so wide aisles are not required.

To enhance safety, yellow markings are used in the layout as machine boundaries. This can it make easier for non-worker employees to identify the circulation boundaries for materials, workers, and traffic lanes. The use of green epoxy flooring was also chosen to facilitate floor maintenance and cleaning.

D. CONCLUSION

In conclusion, the plant layout design for the natural fiber textile factory sharing in Wonosobo adopts an efficient manufacturing process layout approach. This facility is designed to produce various types of natural fiber textiles available in the factory sharing, such as ramie, cotton, pineapple, and eri silk, with a comprehensive production flow from fine fibers to yarn. The new design eliminates most internal walls to create an efficient S-shaped production flow, supported by natural and artificial ventilation and lighting. The layout considers safety and efficiency aspects by implementing standard distances, color-coded boundaries, and special materials for the flooring. This approach allows for the alternating use of machines by factory sharing users, namely, natural fiber textile businesses. Moreover, the design, which adheres to standards, can enhance the efficiency of equipment and space utilization while providing flexibility to meet

varying market demands. The factory sharing design is not only created for optimal production processes but also aims to create a safe and comfortable working environment, supporting the sustainability of the natural fiber textile industry in Indonesia, particularly on the island of Java.

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