talenta PUBLISHER

Jurnal Sistem Teknik Industri
Journal homepage: https://talenta.usu.ac.id/jsti

Lathe Workshop Layout Design Analysis Using Blocplan and SLP Methods

Jeffri*, Uni Pratama Pebrina Tarigan, Anita Christine Sembiring
Department of Industrial Engineering, Faculty of Science and Technology, Universitas Prima, Medan, 20118, Indonesia
*Corresponding Author: jeffrihean12@gmail.com

ARTICLE INFO

Article history:
Received 20 May 2024
Revised 17 July 2024
Accepted 20 July 2024
Available online 29 July 2024

E-ISSN: 2527-9408
P-ISSN: 1411-5247

How to cite:
Jeffri., Tarigan, U. P.P., & Sembiring, A. C. (2024). Lathe Workshop Layout Design Analysis Using Blocplan and SLP Methods. *Jurnal Sistem Teknik Industri*, 26(2), 228-241.

https://doi.org/10.32734/jsti.v26i2.16482

ABSTRACT

An inappropriate layout can result in excessive material movement and increase costs significantly. Therefore, it is important to carefully plan the facility layout so that related activities can be coordinated according to the applicable departments and workflows. Sinar Abadi Lathe Workshop is a company engaged in the machining business, especially in the lathe process. This process involves working with materials by cutting or modifying workpieces using a lathe. This research analyses the layout of the lathe workshop using the SLP and BLOCPLAN methods in order to reduce moving costs, and optimism the use of space in the context of the lathe workshop. The implementation of the BLOCPLAN method in the lathe shop showed labor efficiency with less labor required per production cycle compared to the initial layout. However, a complete change from the original layout may result in higher moving costs. This highlights the importance of cost considerations in choosing a layout method. For layout changes with minimal moving costs, the SLP Layout is proposed as a cost-efficient alternative, as it considers various factors, including distance, material transportation, and labor requirements in planning the layout.
Keyword: ARC, BLOCPLAN, Facility Layout, SLP

ABSTRAK

Tata letak fasilitas yang tidak tepat dapat menyebabkan perpindahan material yang berlebihan dan meningkatkan biaya secara signifikan. Oleh karena itu, perencanaan tata letak yang cermat sangat penting agar kegiatan operasional dapat dikoordinasikan dengan baik sesuai dengan departemen dan alur kerja yang ada. Bengkel Bubut Sinar Abadi, yang bergerak dalam bisnis pemesinan khususnya proses bubut, menghadapi tantangan dalam mengoptimalkan tata letak bengkelnya. Proses bubut melibatkan pengerjaan material melalui pemotongan atau modifikasi benda kerja menggunakan mesin bubut. Penelitian ini menganalisis tata letak Bengkel Bubut Sinar Abadi dengan menggunakan metode Systematic Layout Planning (SLP) dan BLOCPLAN, bertujuan untuk mengurangi biaya pemindahan material serta mengoptimalkan penggunaan ruang. Hasil implementasi metode BLOCPLAN menunjukkan efisiensi tenaga kerja yang lebih tinggi dengan kebutuhan tenaga kerja yang lebih sedikit per siklus produksi dibandingkan tata letak awal. Namun, perubahan total dari tata letak asli dapat meningkatkan biaya pemindahan material. Oleh karena itu, tata letak SLP diusulkan sebagai alternatif yang lebih efisien dari segi biaya, karena mempertimbangkan berbagai faktor seperti jarak, transportasi material, dan kebutuhan tenaga kerja dalam perencanaannya.
Keyword: ARC, BLOCPLAN, Tata Letak Fasilitas, SLP

1. Introduction

Effective facility layout planning is a fundamental aspect of establishing a factory or company. The primary objective of facility layout design is to optimize efficiency and minimize unnecessary movement costs. An inadequate layout can result in excessive material movement, leading to significant increases in operational costs. Therefore, meticulous planning of the facility layout is essential to ensure that activities are well-coordinated across various departments and workflows [1].

Facility layout plays a crucial role in the industrial sector by facilitating the effective and efficient integration of the flow of components within a product's lifecycle. This integration ensures a harmonious relationship between operators, equipment, and the transformation of raw materials into finished products ready for use. The Systematic Layout Planning (SLP) method offers an organized, systematic approach that minimizes material flow while considering spatial relationships and space requirements [2]. One of the key advantages of the SLP method over other methods is its capability to generate multiple alternative solutions.

For instance, the proposed layout design using the SLP method demonstrated significant improvements in efficiency at PT Asam Jawa, reducing the distance between departments and enhancing overall workflow. The analysis of the Error Activity Relationship Diagram yielded a score of 34, with a Total Closeness Rating of 492, and a BLOCPLAN90 R-score application of 0.45, showcasing the effectiveness of the SLP approach [3]. Similarly, the Blocplan (Block Layout Overview with Layout Planning) algorithm was employed to generate an alternative layout for PT Safelock Medical [4]. The initial layout had a total displacement distance of 199.92 meters, while the proposed layout reduced this distance to 128.4 meters, resulting in substantial savings in material handling costs amounting to Rp. 107,689.5 [5]. Sinar Abadi Lathe Workshop, located at Jl. Taman Kebalen Indah No.B1, Kebalen, Kec. Babelan, Bekasi Regency, West Java 17610, specializes in machining processes, particularly lathing. This involves manipulating materials by cutting or modifying workpieces using a lathe, which rotates the workpiece to shape it as required.

Despite the recognized importance of an optimized facility layout, the urgency for layout changes at Sinar Abadi Lathe Workshop has not been adequately addressed. The current layout poses several operational challenges. Field observations indicate excessive material movement, which leads to inefficiencies and increased production costs. Operators frequently transport materials across the workshop, causing significant delays. Additionally, the cramped workspace around key machinery heightens the risk of accidents and disrupts operational flow. Furthermore, the disorganized storage of raw materials and finished products exacerbates these inefficiencies, highlighting the critical need for a systematic facility layout redesign. Addressing these issues through a well-planned facility layout can streamline operations, enhance safety, and reduce operational costs.

2. Theoretical

2.1. Facility layout

Facility layout is a physical element in the arrangement of factory facilities to support efficiency in the production process. This arrangement involves the placement of machinery, production support facilities, material movement flow, as well as temporary and permanent material storage, and worker personnel. In designing the layout of a manufacturing facility or factory, the physical aspects considered include machinery, equipment, operators, and materials. The main goal is to achieve minimal total cost of movement by arranging machinery and equipment in such a way that they are not far apart without violating ergonomic rules) [6]. Facility layout is a critical aspect of industrial engineering and operations management, involving the arrangement of physical spaces within a manufacturing or service facility to optimize production efficiency and workflow. Recent advancements in facility layout planning emphasize the integration of flexible manufacturing systems (FMS) and lean manufacturing principles to adapt to rapidly changing market demands and minimize waste. The design and analysis of facility layouts now frequently employ sophisticated algorithms and simulation techniques to model different layout scenarios and their impact on performance metrics such as throughput, lead time, and resource utilization [7]. The adoption of Industry 4.0 technologies, including IoT and big data analytics, further enhances the capability to monitor and optimize facility layouts in real-time, leading to more agile and responsive production environments [8].

2.2. Systematic Layout Planning (SLP)

Systematic Layout Planning (SLP) is a structured method for designing facility layouts that optimize space utilization, improve workflow, and enhance overall operational efficiency. Developed by Richard Muther in the 1960s, SLP involves a series of phases and procedures to systematically arrange physical spaces within a manufacturing or service facility. The primary goal is to reduce material handling costs, minimize travel distances, and improve production flow by logically positioning departments or workstations based on their interrelationships and the frequency of interactions [9].

Inefficient layouts can cause wastage of time, resources, and bottlenecks that can result in increased costs and decreased competitiveness. SLP, as an improvement method, addresses these issues by analysing the existing layout and operations, identifying areas that require improvement, and designing a new layout optimised for flow and efficiency. The SLP process begins with a comprehensive analysis of the current layout and operations, including material flow, movement of people and equipment, and location of storage and support areas. Recent applications of SLP have demonstrated its effectiveness in various industries. For instance, SLP was employed to redesign the layout of a manufacturing plant, resulting in significant improvements in efficiency and productivity [10]. Similarly, SLP has been integrated with lean manufacturing principles to streamline operations and eliminate waste, as shown in a case study applied to the textile industry [11]. Moreover, the utilization of advanced simulation tools and algorithms has further enhanced the precision and flexibility of SLP, allowing for real-time adjustments and continuous improvement in facility layouts [8].

2.3. BLOCPLAN

BLOCPLAN stands for Block Layout Overview with Computerised Planning using Logic and Algorithm BLOCPLAN is a widely recognized method for designing facility layouts, developed by Donghey and Pire at the Industrial Engineering Department of Houston University. This approach utilizes a hybrid algorithm to evaluate and optimize various layout configurations, aiming to enhance efficiency and reduce material handling costs. BLOCPLAN operates by creating block-type layouts and employing an Activity Relationship Chart (ARC) to score and assess different configurations based on their proximity and interaction frequency between departments or workstations [12]. The BLOCPLAN algorithm uses data, both in quantitative form formed by using an Activity Relationship Chart (ARC), as well as quantitative data that includes product flow and the size of the building area (department) to be occupied by the facility. Once all the data has been entered, the algorithm will generate a randomised layout by continuously swapping facility layouts until it reaches an optimal layout. The number of iterations is limited to a maximum of 20 times. BLOCPLAN can analyse up to a maximum of 18 facilities in one process. In the manual application of BLOCPLAN algorithm, the concept is to select the best layout based on the highest R-Score value. The Adjacency Score (Layout score) is obtained through dividing the total score on the ARC weighting, which can be achieved by multiplying the overall total score by 2.

$$\text{Layout score}=\frac{\text{Total score that can be achieved}}{\text{Total overall score}}\times 2 \quad (1)$$

The rail disc score value is obtained from the sum of all rail disc score values at each department i to department j.

$$\text{Rel-disk score}=\sum_{i-1}^{n-1}\sum_{j=i-1}^{n} d_{ij}r_{ij} \quad (2)$$

The application of BLOCPLAN has been documented across various industries, demonstrating its effectiveness in improving production facility layouts. For instance, a study on the layout optimization of a garment production facility revealed that using BLOCPLAN significantly reduced material handling times and improved workflow efficiency [13]. Similarly, research on home industry production facilities highlighted that BLOCPLAN could propose multiple layout improvements, with the highest R-Score indicating the most efficient layout [14].

2.4. Activity Relationship Chart (ARC)

Activity Relationship Chart (ARC) is a tool used to plan interactions between workstations. In this chart, a combination of letter and number judgements are used to illustrate the reasons and codes for activities. The use of the Activity Relationship Chart helps show whether to bring two parts closer together or further apart, depending on the level of relationship between them. The Activity Relationship Chart (ARC) is a fundamental tool used in facility layout planning to evaluate and document the closeness requirements among different activities within a facility. Developed by Richard Muther in 1973, the ARC method systematically assesses the interactions and interdependencies between departments or workstations, providing a visual representation of their spatial relationships [15]. This tool is crucial in designing efficient layouts that minimize material handling costs and enhance workflow by ensuring that closely related activities are positioned near each other.

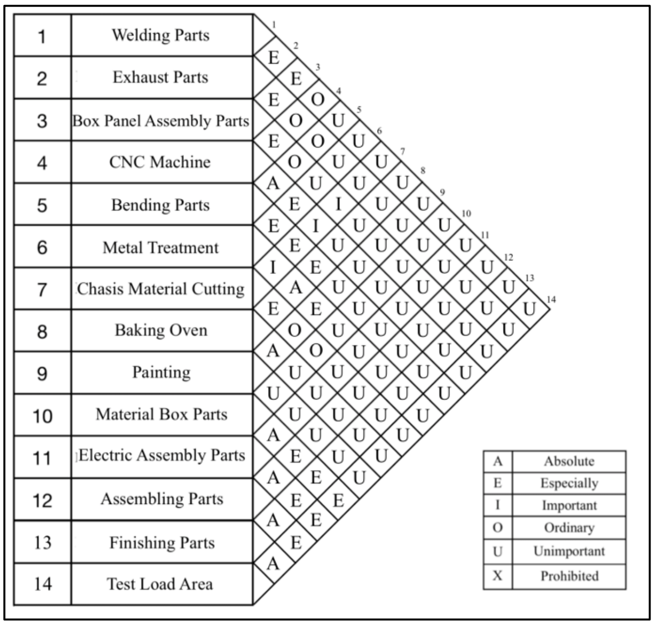

Figure 1. Example Diagram ARC [16]

The functions of ARC are:

- Tidying up the order of departmental activities within the facility.
- Allocate facilities based on activities and their reasons.
- Can show the centre of the busiest activity.
- Shows the degree of proximity between departments and why.
- Can serve as a foundation for further methods.

3. Methodology

The research conducted by the author aims to describe qualitative data, especially in processing information about numerical parameters related to factory or industrial facilities. This data is collected through interviews and direct observation in the field, then analysed to make the data easier to apply mathematical methods and formulas. This research aims to provide a systematic, logical, and factual description related to the methods, properties, and interrelationships of the facilities under study. The production scheme is considered by referring to the theory of layout and material journey adapted to the available facilities.

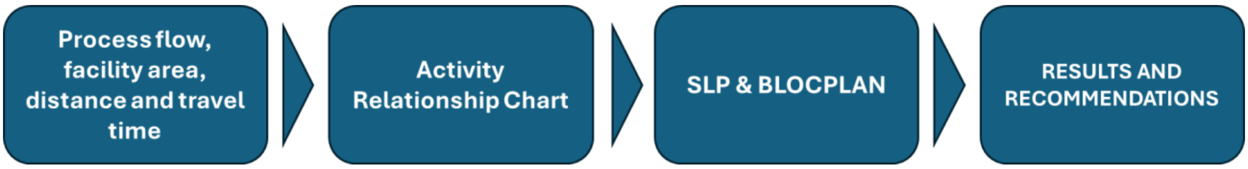

Figure 2. Conceptual Framework

The conceptual framework involves several crucial aspects such as process flow, facility area, distance and travel time, Activity Relationship Chart (ARC), Systematic Layout Planning (SLP), BLOCPLAN, and results and recommendations. Process flow considers the sequence of activities in production, while facility area refers to the total area occupied by the facility. Activity Relationship Chart (ARC) is important to optimise the movement of materials and information. The SLP method is a systematic approach to layout design, while BLOCPLAN organises the workspace by dividing it into blocks or zones. Analysed results involve data related to process flow, facility size, and other factors, while recommendations detail improvement measures to enhance operational efficiency and effectiveness. The integration of these concepts forms a strong foundation for achieving optimal facility layout and continuous improvement in operational processes.

4. Results and Discussions

Based on the formulation of the problem, the data needed to design a facility layout based on the process flow of making crackers in the lathe workshop were collected. The data is the area of each facility. operation process map and process flow, initial facility layout, and material travelling distance needed to run the method in this research. The information can be explained as follows:

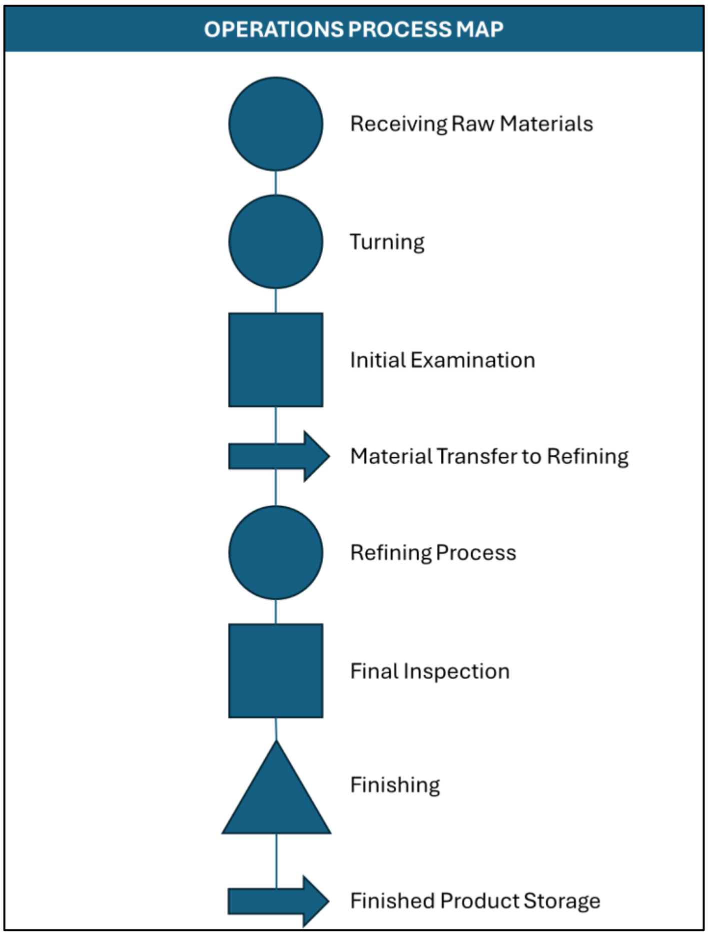

Figure 3. Operation Process Map

Furthermore, the process flow map is presented in Table 1.

Table 1. Process Flow Map

Category	Activities	Number of Units	Time (minutes)	Place Code	Distance(m)	Travel Time (seconds)
Operation	Acceptance of raw materials	1	20	1	-	-
	Turning	1	45	3	15	45
Examination	Initial Inspection	1	15	5	10	30
Transportation and Material Handling	Material Transfer to Refinement	1	-	4	10	30
Operation	Refinement	1	30	4	-	-
Examination	Final Inspection	1	15	5	10	30
Solutions	Finishing	1	20	6	10	30
Transportation and Material Handling	Finished Product Storage	1	-	1	15	45

Moreover, the room data is shown in Table 2.

Table 2. Room Data

Code	Room Name	Length(m)	Width (m)	Floor Area (m²)
1	Raw Material &; Finished Products Warehouse	10	5	30
2	Office	4	3	12
3	Turning Room	8	5	40
4	Refinement & Drilling Space	5	4	20
5	Welding & Inspection Room	6	4	24
6	Solution Space	4	3	12
7	Parking Area	8	4	32
			Total	170

Then, the Machine Facility Data is shown in Table 3.

Table 3. Machine Facility Data

Code	Machine Name	Length(m)	Width (m)	Actual Floor Area (m^2)
A	1000 mm Bubut Machine	3.0	1.5	4.5
B	Maktec MT90 Hand Grinding	0.5	0.5	0.25
C	Seated Grinding	0.5	0.5	0.25
D	Press Machine	2.0	1.0	2.0
E	Motorbike Corter Machine	1.5	1.5	2.25
F	Drilling Machine	1.0	1.0	1.0
G	LPG Tube	0.3	0.3	0.09
H	Oxygen Cylinder 1m3	0.3	0.3	0.09
I	Ragum	0.5	0.5	0.25
J	Vernier Caliper Measuring Tool	0.3	0.1	0.03

There is also distance and travel time as shown in Table 4.

Table 4. Distance and Travel Time

Room of Origin Raw Material &; Finished Products Warehouse	Destination Room Turning Room	Time (Seconds)
Turning Room	Welding & Inspection Room	45
Welding & Inspection Room	Refinement & Drilling Space	30
Refinement & Drilling Space	Welding & Inspection Room	30
Welding & Inspection Room	Solution Space	30
Solution Space	Raw Material & Finished Products Warehouse	30

In this study, the authors developed a facility layout based on the methodology established in the previous chapters. The main objective of this development is to create an optimized layout proposal, which not only improves operational efficiency but also reduces the time and cost associated with the flow of materials and workers.

The first step in the BLOCPLAN method is relationship analysis. Relationship analysis is important because relationship analysis helps in understanding the workflow or process present in a system. The following is a table of analysis of lathe workshop relationships resulting from this study.

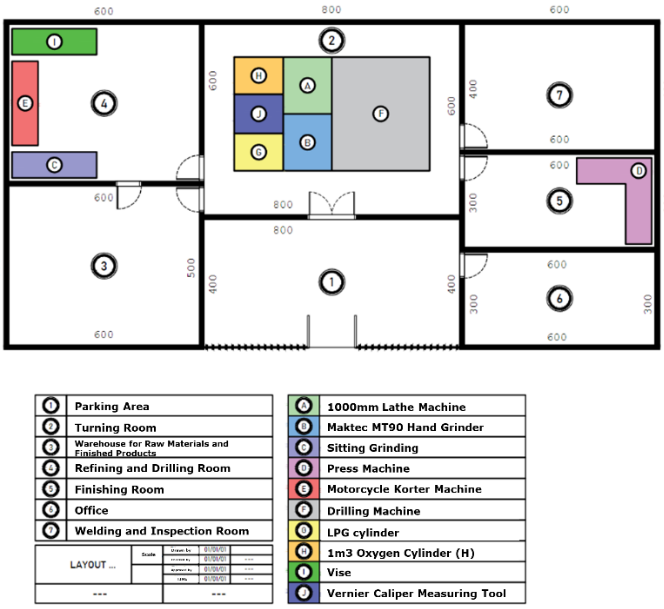

Figure 4. Initial Layout

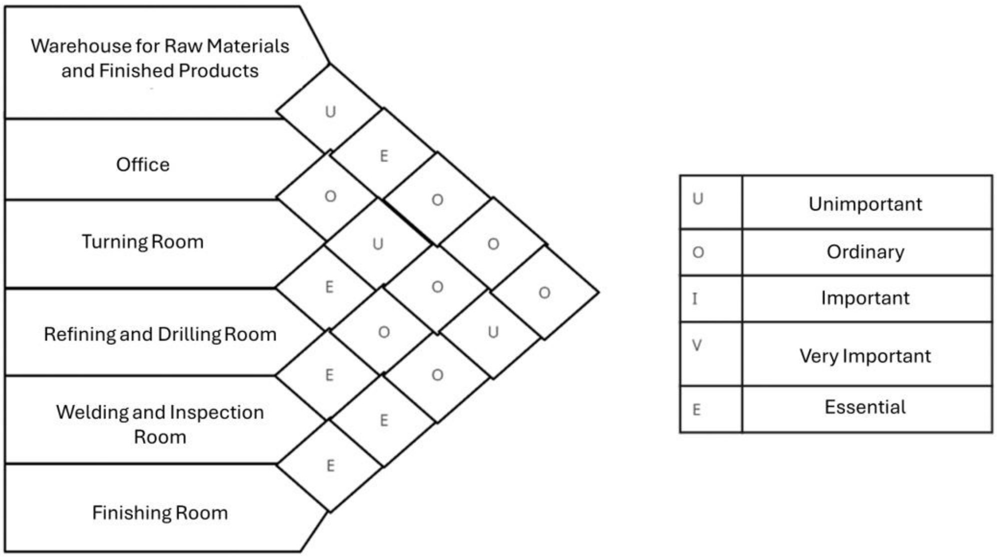

Figure 5. Relationship Analysis Diagram Between Spaces

Such tables will help in designing an efficient facility layout by placing rooms that have an important relationship and are closer to each other to minimize mileage and speed up the flow of operations.

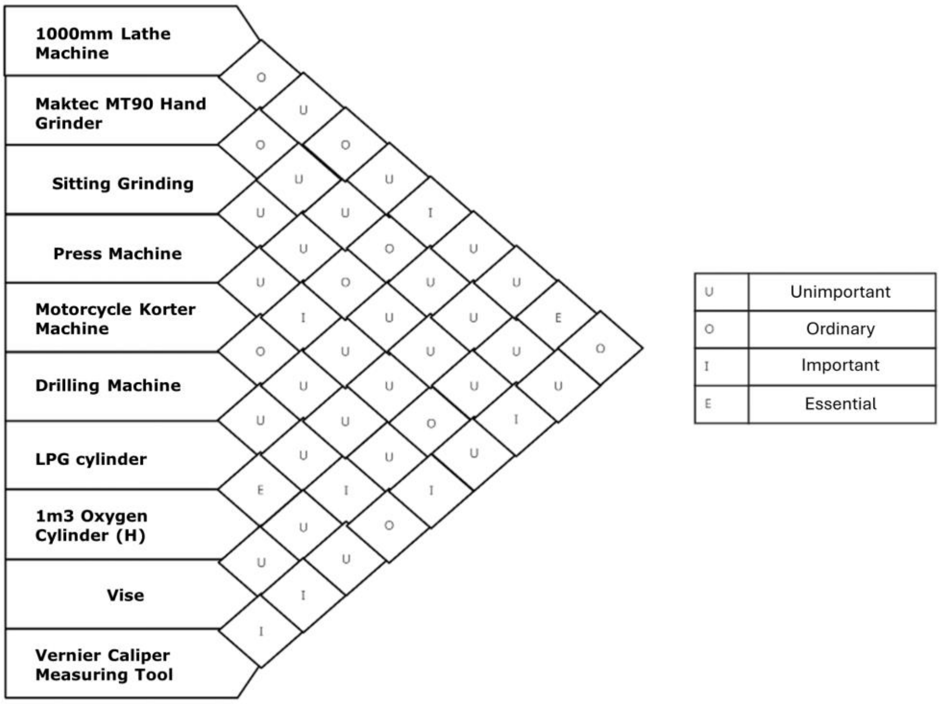

Figure 6. Relationship Analysis Diagram Between Machines

At this stage, the BLOCPLAN algorithm iterates to design an optimal room layout. Each iteration tries different combinations and room arrangements to achieve the best results based on predefined criteria. In this study, room iterations were carried out with a maximum limit of 13 times. The highest room iteration results reached a score of 54 in iterations 3, 5, 7, 10, 14, 15, 18, and 20. This score shows the level of optimality of the layout of the room layout. By doing this iteration, it is hoped that an optimal facility layout can be found for the Sinar Abadi Lathe Workshop, which can improve operational efficiency, reduce displacement costs, and optimize space use.

```
Iteration 1: Score = 43
Iteration 2: Score = 41
Iteration 3: Score = 54
Iteration 4: Score = 44
Iteration 5: Score = 54
Iteration 6: Score = 47
Iteration 7: Score = 54
Iteration 8: Score = 47
Iteration 9: Score = 41
Iteration 10: Score = 54
Iteration 11: Score = 43
Iteration 12: Score = 43
Iteration 13: Score = 43
Iteration 14: Score = 54
Iteration 15: Score = 54
Iteration 16: Score = 43
Iteration 17: Score = 52
Iteration 18: Score = 54
Iteration 19: Score = 43
Iteration 20: Score = 54
```

Figure 7. Results of Blocplan Iteration Lathe Workshop Room

From the results of iterating Rooms with the Blocplan algorithm above, it can be seen that iterations 3, 5, 7, 10, 14, 15, 18, and 20 have the highest results with a score of 54. Here are 3 examples of images of the blocplan results. The rest can be seen in the appendix section.

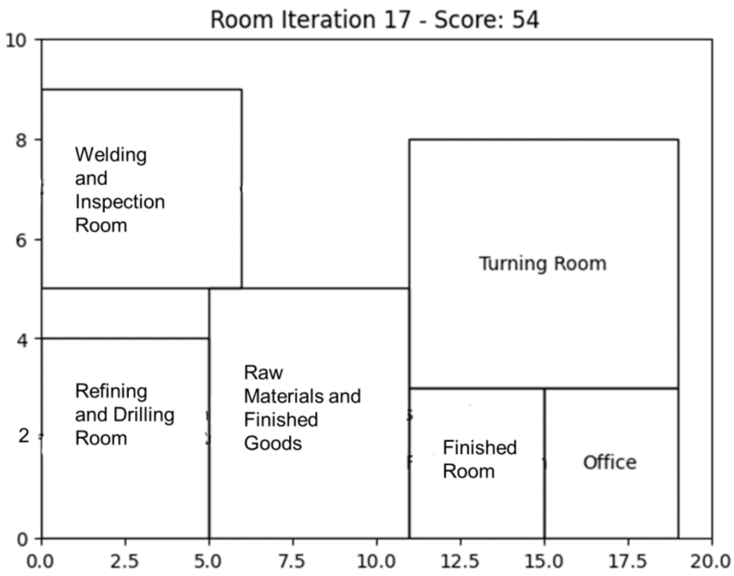

Figure 8. Iteration Room 17 – Score 54

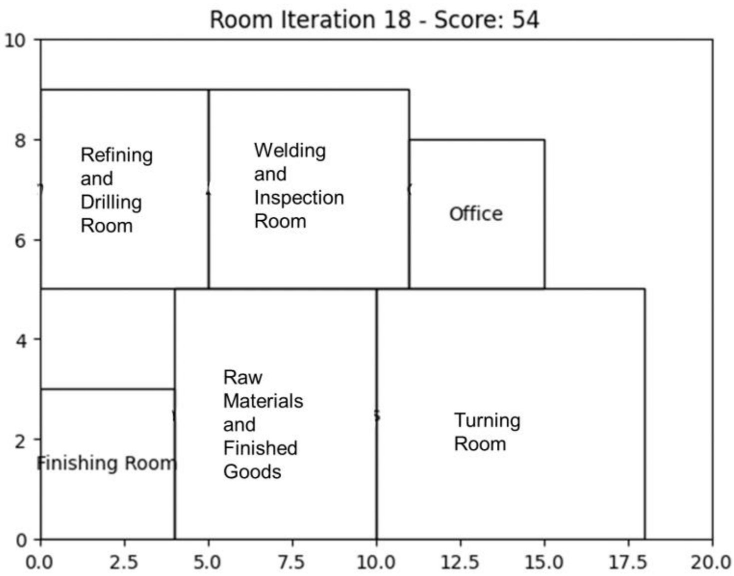

Figure 9. Iteration Room 18 – Score 54

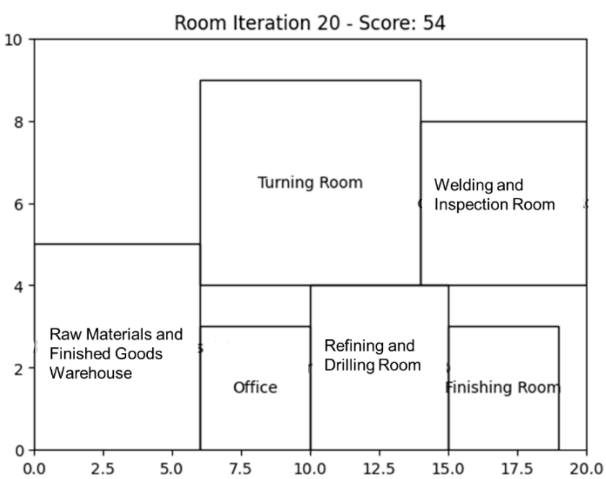

Figure 10. Iteration Room 20 – Score 54

Then, to design the optimal machine layout in the lathe workshop. The BLOCPLAN algorithm tries various combinations and machine settings to achieve the best results based on predefined criteria. Like room iterations, machine iterations also had a maximum limit of 13 times in this study. For machines the results are as follows.

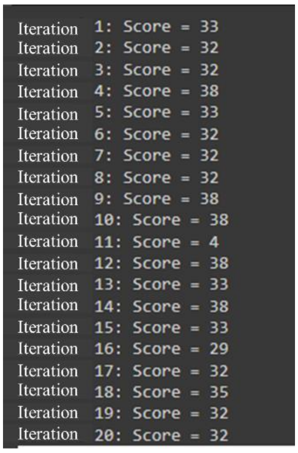

Figure 11. Iteration Results of Blocplan Lathe Workshop Machine

From the results of iterating Rooms with the Blocplan algorithm above, it can be seen that iterations 4, 9, 10, 12, and 14 have the highest results with a score of 38. The layout design of the Sinar Abadi Lathe Workshop facility using the BLOCPLAN method has resulted in significant improvements in space efficiency and work flow. Through 20 iterations, some rooms managed to achieve the highest score, which is 54. The rooms include Raw Material &; Finished Products Warehouse, Turning Room, Refining & Drilling Room, and Welding & Inspection Room. This highest score indicates that the proposed facility layout effectively organizes work flow and space use optimally. This has the potential to increase the productivity and operational efficiency of the Sinar Abadi Lathe Workshop as a whole. Thus, the use of the BLOCPLAN method in the design of the facility layout has contributed significantly to the improvement of the production process and space management in the workshop.

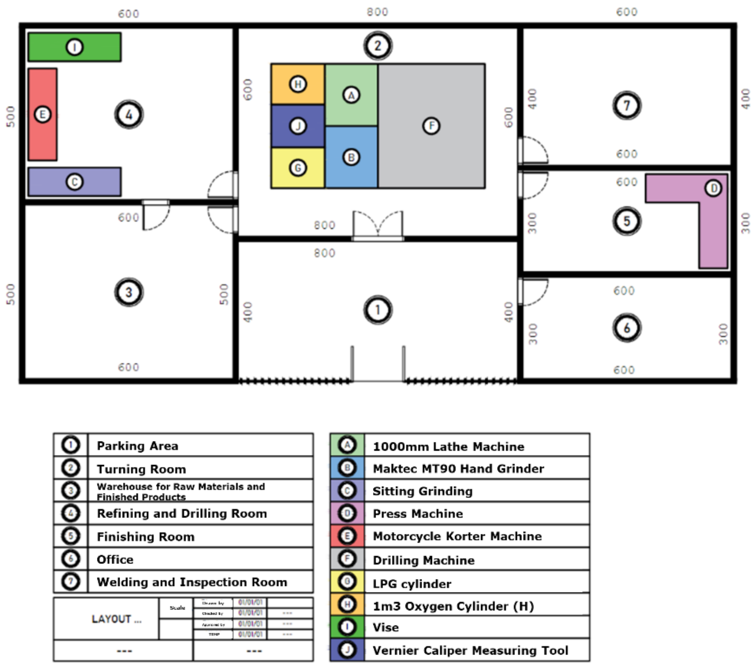

Figure 12. BLOCPLAN Facility Layout

The implementation of the Systematic Layout Planning (SLP) method for optimizing the facility layout of Sinar Abadi Lathe Workshop demonstrated significant improvements in material handling efficiency. The existing layout was analyzed, and a new layout was proposed based on the SLP method, aiming to reduce material movement and enhance operational workflow. The proposed layout using the SLP method focused on optimizing the spatial arrangement to minimize material flow. Key factors considered in the SLP method included the relationship between spaces, space requirements, and available space. The proposed layout aimed to streamline operations, enhance safety, and reduce operational costs.

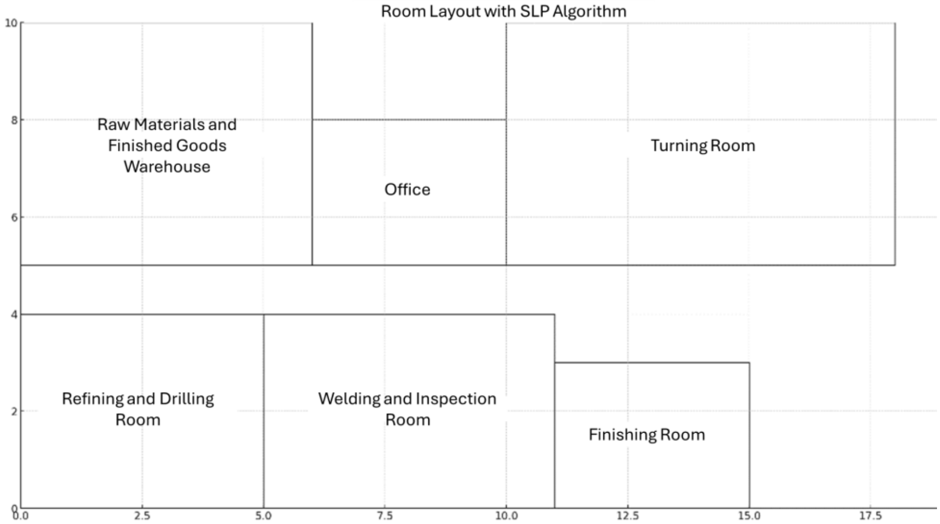

Figure 13. SLP Facility Layout

The facility layout diagram illustrated above represents the results of implementing the Systematic Layout Planning (SLP) method for optimizing the spatial arrangement within Sinar Abadi Lathe Workshop. This optimized layout aims to minimize material handling distances and improve overall operational efficiency. The diagram effectively maps out the relationships between different workstations and departments, ensuring a streamlined workflow and reducing unnecessary movements. After obtaining the final layout results from the two SLP and BLOCPLAN methods, these two methods are then compared with each other and the improvements can be seen from the existing conditions. Below are the values obtained from the results of facility layout analysis from SLP and BLOCPLAN.

Table 5. Distance and Time Calculation SLP Method

Room	Distance (m)	Time (seconds)
Raw Material & Finished Goods Warehouse to Office	2	6.06
Office to Grinding & Drilling Room	4	12.12
Grinding & Drilling Room to Welding & Inspection Room	5	15.15
Welding & Inspection Room to Finishing Room	5	15.15
Finishing Room to Lathe Room	4	12.12
Total	20	60.61

The time calculation above uses the assumption of the speed of movement of people in existing conditions (0.33 m/s) so that the time obtained is like the results above. Each element is positioned based on relationship value to reduce transportation time and costs and increase operational efficiency. SLP ensures that elements that frequently interact are placed close together, such as placing the Raw Materials & Finished Products Warehouse close to the Turning Room and the Welding & Inspection Room adjacent to the Finishing Room. The layout produced by the SLP relies heavily on relationship analysis and is oriented towards improving work flow.

On the other hand, BLOCPLAN uses an iterative approach to place elements in a limited space. This method tries various layout combinations to find the most efficient one, with a focus on avoiding collisions between elements and optimal use of space. Based on the analysis that has been carried out, the distance and time calculation results obtained by BLOCPLAN are as follows.

Table 6. Distance and Time Calculation BLOCPLAN Method

Room	Distance (m)	Time (seconds)
Raw Material & Finished Goods Warehouse to Grinding & Drilling Room	4	12.12
Grinding & Drilling Room to Lathe Room	5	15.15
Lathe Room to Welding & Inspection Room	7.81	23.67
Welding & Inspection Room to Finishing Room	2	6.06
Finishing Room to Parking Area	6.4	19.39
Parking Area to Office	7.5	22.73
Total BLOCPLAN	32.71	99.12

BLOCPLAN produces layouts taking into account the physical size and position of each room and machine, resulting in a compact and organized layout. In the results obtained, BLOCPLAN produces a layout that ensures no collisions between rooms and machines, with efficient placement within the existing space constraints. This method allows flexibility in trying different placement combinations until finding the most efficient layout.

After obtaining the analysis results from the SLP and BLOCPLAN methods, these two results are then compared with the existing conditions to ensure that the results obtained from both are better results than the existing conditions. Below are the comparison results of the three.

Table 7. Comparison of Final Layout Results

No.	Layout	Distance (m)	Percentage Improvement in Distance	Time (s)	Percentage Improvement in Time
1	Existing	70	0%	210	0%
2	SLP	20	71.43%	60.61	71.14%
3	BLOCPLAN	32.71	53.27%	99.12	52.80%

Based on the results of material distance and time calculations carried out for the SLP and BLOCPLAN layouts as well as existing conditions, it can be seen that there are significant differences in the efficiency of space use and material movement speed. For the SLP layout, the total material distance traveled is 20 meters with a total material time of 60.61 seconds. This shows that SLP is able to optimize space use and speed up material movement efficiently. SLP ensures that each step in the operating process has a shorter distance compared to existing conditions, which ultimately reduces material travel time.

On the other hand, the BLOCPLAN layout shows a total material distance of 32.71 meters with a total material time of 99.12 seconds. Even though it is more efficient than the existing condition, the BLOCPLAN layout still has higher distance and travel time compared to the SLP layout. This is caused by the BLOCPLAN layout which has not fully optimized the position between rooms according to the sequence of operation processes.

In existing conditions, the total material distance traveled is 70 meters with a total material time of 210 seconds. This figure shows that the existing condition has the lowest efficiency in terms of space use and material movement. Long distances between rooms and high material travel times indicate the need for layout changes to increase efficiency. From this analysis, it can be concluded that the SLP layout is superior in reducing material distance and travel time compared to existing conditions and BLOCPLAN. The SLP layout successfully minimizes the total material distance and travel time, which contributes to increasing the overall efficiency of the operating process. In contrast, the BLOCPLAN layout requires some further adjustments to achieve the same efficiency as SLP. Meanwhile, existing conditions indicate an urgent need for layout improvements to increase operational efficiency.

5. Conclusion

The analysis of the Systematic Layout Planning (SLP) and BLOCPLAN methods for optimizing the facility layout at Sinar Abadi Lathe Workshop has yielded significant insights into improving operational efficiency.

The implementation of the SLP method resulted in a substantial reduction in material handling distance and time. Specifically, the total material handling distance was reduced by 71.43%, from 70 meters in the existing layout to 20 meters in the SLP layout. Correspondingly, the material handling time decreased by 71.14%, from 210 seconds to 60.61 seconds. In comparison, the BLOCPLAN method also demonstrated improvements, reducing the total material handling distance by 53.27% to 32.71 meters and the material handling time by 52.80% to 99.12 seconds.

These findings can be practically implemented to enhance the operational efficiency of the workshop. Several strategies and steps can be taken to realize these layout changes. Firstly, departments should be reorganized by rearranging the physical locations of machinery and workstations according to the optimized SLP layout to minimize unnecessary material movement. Secondly, implementing a workflow management system that aligns with the new layout will ensure smooth transitions between different stages of the machining process. Additionally, providing training for employees to adapt to the new layout and understand its benefits is crucial for minimizing resistance to change and ensuring a seamless transition. Finally, establishing a monitoring system to track the performance of the new layout and regularly reviewing and adjusting it as necessary will help maintain optimal efficiency and address any emerging issues.

However, the research conducted has several limitations. The study did not account for external factors such as fluctuations in demand, changes in workforce availability, or variations in raw material supply, which could impact the effectiveness of the new layout. Furthermore, several assumptions were made during the analysis, such as constant walking speed for material handling and uninterrupted workflow, which could influence the final results if they vary in practice. Additionally, the practical implementation of the new layout may face challenges such as space constraints, financial limitations, and potential downtime during the reorganization process, which need to be carefully managed to ensure successful implementation.

In conclusion, the SLP method offers a robust solution for optimizing the facility layout at Sinar Abadi Lathe Workshop, significantly reducing material handling distance and time. By implementing the recommended strategies and addressing the identified limitations, the workshop can achieve enhanced operational efficiency and productivity.

References

[1] R. Muther, *Systematic Layout Planning*. Cahners Books, 1973.

[2] Y. Putra, F. D. Sitania, and A. Profita, "Perancangan tata letak fasilitas pada bengkel bubut dan las di CV. Raihan Teknik," *ITSA Jurnal Industri & Teknologi Samawa*, vol. 3, no. 1, pp. 1–10, 2022.

[3] M. M. Rais, "Perencanaan ulang tata letak fasilitas produksi menggunakan metode systematic layout planning pada pabrik kelapa sawit di PT Asam Jawa," M.S. thesis, Universitas Medan Area, Medan, Indonesia, 2021.

[4] H. Imam et al., "Perbaikan tata letak fasilitas produksi pabrik garmen CV XYZ dengan metode Blocplan," *ITSA Jurnal Industri & Teknologi Samawa*, Jul. 2022.

[5] A. F. Faridhatul, "Analisis tata letak fasilitas dengan menggunakan metode Blocplan pada ruang produksi masker PT Safelock Medical Jepara," B.S. thesis, Universitas Diponegoro, Semarang, Indonesia, 2023.

[6] N. A. Fitri and K. Yusup, "Perancangan ulang tata letak fasilitas dengan metode ARC guna memaksimalkan proses produksi pada pembuatan alas karet sandal (CV. Nugraha Rubber Ampera)," *Jurnal Industrial Galuh*, vol. 5, no. 1, 2023.

[7] K. Sari and F. O. Hocaoglu, "Facility layout problem with alternative facility variants," *Applied Sciences*, vol. 13, no. 8, 2023.

[8] J. Kim and Y. Park, "A facility layout algorithm for logistics scenarios driven by dynamic data," *Applied Sciences*, vol. 13, no. 12, 2023.

[9] J. A. Shubin and H. Madeheim, "Systematic layout planning," *Management General*, vol. 1, pp. 45–60, 1965.

[10] L. Gozali and A. Kusuma, "Redesign of facility layout with systematic layout planning, pairwise exchange, and lean manufacturing method at PT Adhi Chandra Jaya," *International Journal of Advanced Research in Engineering and Technology*, 2023.

[11] J. Balakrishnan and C. H. Cheng, "Lean layout design: A case study applied to the textile industry," *International Journal of Advanced Research in Engineering and Technology*, 2023.

[12] I. A. Puspita, M. Iqbal, D. Pratami, and A. Pratomo, "Production facility layout design using Blocplan algorithm," *Advanced Science Letters*, vol. 23, no. 5, pp. 3917-3920, 2017.

[13] H. Henni et al., “Redesign the layout of production facilities at a garment company using the BLOCPLAN method to optimize material handling,” in *Proc. International Conference on Multidisciplinary Research for Sustainable Innovation*, 2024, vol. 1, no. 1, pp. 358-368.
[14] A. H. Adiningih and M. Achmad, “Planning of production facilities layouts of home industry of Cabalu Smoked Salted Egg in Bone District,” in **BIO Web of Conferences**, 2024, vol. 96, p. 07007.
[15] R. Muther, *Systematic Layout Planning*. Management General, 1973.
[16] J. A. Tompkins, J. A. White, Y. A. Bozer, and J. M. A. Tanchoco, *Facilities Planning*, no. 1. John Wiley & Sons, 2010.