

Optimizing Equipment Layout with ARC and 5S in a Metal Casting Molding Division

Arinda Soraya Putri^{1*}, Puji Hastuti², Afiqoh Akmalia Fahmi³, Eko Setiawan⁴, Fadhillah Tri Nugrahaini⁵, Much Djunaidi⁶, Bayu Permana⁷, and Riva'i Arva Irianto⁸

^{1,2,3,4,6,7} Department of Industrial Engineering, Faculty of Engineering, Universitas Muhammadiyah Surakarta

^{5,8} Department of Architecture, Faculty of Engineering, Universitas Muhammadiyah Surakarta

Jl. Ahmad Yani, Pabelan, Kartasura, Surakarta 57169, Indonesia

E-mail: asp835@ums.ac.id¹, d600210206@student.ums.ac.id², aaf550@ums.ac.id³, es268@ums.ac.id⁴, ftn995@ums.ac.id⁵, much.djunaidi@ums.ac.id⁶, d600210238@student.ums.ac.id⁷, d300210142@student.ums.ac.id⁸

Abstrak

Sebuah perusahaan manufaktur pengecoran logam beroperasi di Ceper, Klaten. Salah satu area utama dalam proses produksinya adalah divisi pencetakan (molding), tempat di mana cetakan pengecoran dibuat. Beberapa masalah diidentifikasi di area ini, termasuk pengorganisasian yang buruk, kebersihan yang tidak memadai, dan kurangnya perhatian terhadap keselamatan kerja. Penelitian ini bertujuan untuk mengevaluasi penerapan budaya 5S (Seiri, Seiton, Seiso, Seiketsu, dan Shitsuke) di divisi pencetakan dan untuk mengusulkan perbaikan guna meningkatkan empat prinsip utama: efektivitas, efisiensi, produktivitas, dan keselamatan kerja. Berdasarkan hasil analisis data kuesioner 5S, tingkat penerapan secara keseluruhan tergolong rendah yakni sebesar 52,78%, dengan Seiso memperoleh nilai tertinggi (66%), diikuti oleh Shitsuke (57%), Seiri (54%), Seiton (51%), dan Seiketsu (35%). Untuk mengatasi masalah-masalah tersebut, beberapa perbaikan diusulkan, termasuk prosedur penyortiran barang, pelabelan peralatan, penerapan rambu-rambu di tempat kerja, penyusunan Standar Operasional Prosedur (SOP) untuk mesin, penjadwalan perawatan mesin/alat, serta pembentukan sistem penghargaan dan sanksi (reward and punishment). Upaya-upaya ini didukung lebih lanjut dengan mengoptimalkan tata letak tempat kerja menggunakan metode Activity Relationship Chart (ARC). Penerapan dari perbaikan-perbaikan ini menghasilkan peningkatan yang signifikan pada pemanfaatan area produksi, yaitu dari 33% menjadi 66%.

Kata kunci: Keselamatan Kerja, Produksi Ramping, Tata Letak Industri, Optimasi Proses

Abstract

A metal casting manufacturing company operating in Ceper, Klaten. One of the key areas in its production process is the molding division, where casting molds are made. Several issues were identified in this area, including poor organization, inadequate cleanliness, and insufficient attention to workplace safety. This study aims to evaluate the implementation of the 5S culture (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke) in the molding division and to propose improvements to enhance four key principles: effectiveness, efficiency, productivity, and occupational safety. Based on the results of the 5S questionnaire data analysis, the overall implementation level was relatively low at 52.78%, with Seiso scoring the highest (66%), followed by Shitsuke (57%), Seiri (54%), Seiton (51%), and Seiketsu (35%). To address these issues, several improvements were proposed, including procedures for item sorting, equipment labeling, implementation of workplace signage, development of Standard Operating Procedures (SOP) for machines, scheduling of machine/tool maintenance, and the establishment of a reward and punishment system. These efforts were further supported by optimizing the workplace layout using the Activity Relationship Chart (ARC) method. The implementation of these improvements resulted in a significant increase in the utilization of the production area, from 33% to 66%.

Keywords: Industrial Layout, Lean Production, Process Optimization, Workplace Safety

1. Introduction

The manufacturing industry is a business unit whose activities involve transforming raw materials into finished or semi-finished products using specific methods, intending to generate profit (Ummah et al., 2023). According to the 2023 BPS survey, the basic metals industry is the second-largest industry after the food industry, accounting for 17.56% (BPS, 2023), as shown in Figure 1. Therefore, the metal casting industry plays a vital role in the country's economic growth.

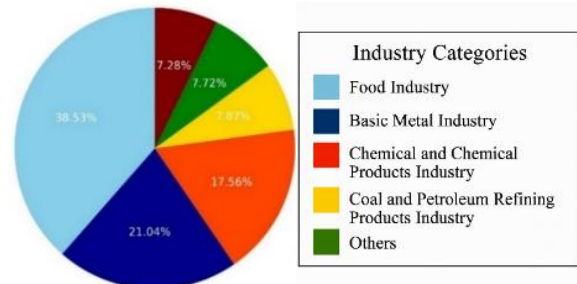


Figure 1: National Manufacturing Industry Sample 2023

^{1*} Arinda Soraya Putri

The production process is the core activity of a manufacturing company. Without a structured production process, the company cannot achieve its predetermined goals (Pratiwi et al., 2015). Therefore, in carrying out the production process, several principles must be applied, including effectiveness, efficiency, productivity, and occupational safety (Zaki et al., 2023). These principles can function optimally if the company considers the layout design of production areas and equipment (Aman et al., 2024). Work culture also significantly influences the performance produced by the company (Kristyanto & Kusdiartini, 2021).

A manufacturing company engaged in metal casting and machining is located in Krenekan, Klepu, Ceper, Klaten, Central Java. The company's production output includes road and pedestrian furniture products, such as streetlight poles, bollards, park benches, antique fences, manhole covers, and others, with the production process utilizing the sand casting method. Sand casting is a traditional metal casting method that uses sand as a mold and is widely used in small industries (Zheng et al., 2020). Before the metal casting process, the mold-making stage must be carried out. Mold making is a tool used to mold a material so that it forms a product according to the shape of the mold (Diswiratna et al., 2022). The material used to make these molds is tailored to the shape, size, and quantity of the products to be manufactured. The types of materials used by the company are MDF (Medium Density Fiberboard) and aluminum.

The mold-making production area in the company has numerous physical problems. These include a messy and unclean production area, as well as items being stored in inappropriate places. Employees and finished products are even located in the forklift lane. This harms employee safety and the quality standards of the products produced. One of the factors contributing to these issues is the suboptimal implementation of workplace culture within the company. Therefore, special attention must be given to the company's workplace culture. One work culture that can be applied in the industrial world is the 5S culture (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke). The 5S culture aims to create a comfortable and organized work environment (Wiguna et al., 2022). If implemented properly, it can meet the principles of the production process and indirectly increase the company's profits. The implementation of the 5S culture can also simplify production activities, save costs and time, and minimize the number of defective products (Shahriar et al., 2022).

Previous studies have examined various approaches to improving productivity through layout optimization and workplace organization. Aman et al. (2024) and Jamalludin et al. (2020) demonstrated that systematic layout redesign can reduce material handling distances and streamline workflows. In contrast, Wiguna et al.

(2022) and Shahriar et al. (2022) highlighted the benefits of the 5S culture in enhancing cleanliness, discipline, and efficiency. However, most of these studies focused on either layout design or 5S implementation separately. Research integrating both approaches remains limited, especially in small-scale metal casting industries, indicating the need for a combined method to improve overall production performance.

The layout design of equipment in the molding area has not been optimized, with certain spaces still not being utilized effectively, even though some employees and finished goods are located in hazardous areas. Additionally, the molding area layout does not consider the production process flow, which can reduce employee productivity. This suboptimal layout can hinder the production process both directly and indirectly. One step that can be taken to optimize the layout in the molding area is to reduce the distance between workstations based on the production process flow. The method that can be used is the Activity Relationship Chart, as this method can design facility layouts based on an analysis of the proximity relationships between areas or production equipment (Jamalludin et al., 2020).

Improvements in the 5S work culture need to be optimized through the design of a new equipment layout, also known as layouting. Layout is an arrangement that has been designed based on the needs of an organization or company regarding the placement of tools, machines, work stations, and departments in a designated area. Layout plays an important role in optimizing the time required to carry out activities. A well-organized layout facilitates storage and retrieval of items (Qin et al., 2024). According to (Cammann et al., 2024), one of the objectives of layout design is to ensure that operational processes run smoothly by prioritizing four main principles: effectiveness, efficiency, productivity, and workplace safety.

Based on the issues identified in the mold-making production area, these problems can be addressed by redesigning the workspace layout using the Activity Relationship Chart (ARC) method, which determines the optimal proximity between workstations to enhance workflow efficiency. The implementation of the 5S work culture (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke) further supports this improvement by fostering a clean, organized, and disciplined work environment. Therefore, this study aims to redesign the layout of the mold-making area by integrating the ARC method with the 5S approach to create a more effective, efficient, productive, and safe production environment that enhances overall operational performance.

2. Research Methods

The design of equipment layout is the basis for organizing the production area so that all processes can run smoothly (Zhang et al., 2024). The method used in

this design is the ARC, supported by the implementation of the 5S culture.

a. Activity Relationship Chart (ARC)

Is a diagram that illustrates the proximity relationships between activities. These activity relationships can be viewed from the perspective of interconnections between flows, such as material flow, equipment flow, information flow, and financial flow, as well as environmental interconnections and interconnections between processes (Ramdan et al., 2020).

The method used is the Activity Relationship Chart, which focuses on the interconnections between facilities or machines and whether they need to be placed closer together or not. The output from the ARC diagram will be further processed using Blocplan software to provide several alternative layout options, from which the best layout will be selected.

The creation of an Activity Relationship Chart plays a very important role in determining various layout improvement alternatives. There are several components needed to compile an ARC diagram, namely work stations, proximity symbols, and proximity reason symbols, which can be seen in Tables 1 and 2 below.

Table 1: ARC symbols

Symbol	Description
A	<i>Absolutely necessary</i>
E	<i>Especially important</i>
I	<i>Important</i>
O	<i>Ordinary</i>
U	<i>Unimportant</i>
X	<i>Undesirable</i>

(Aristriyana & Ibnu Faisal Salim, 2023)

The level of closeness that is absolutely necessary, symbolized by the letter A, can be given if there is an inseparable relationship between departments or facilities, and if separated, it could have a negative impact on the company concerned. The level of closeness that is especially important, symbolized by the letter E, can be given to both departments or facilities that are considered to be very important, but not as important as the level of closeness that is absolutely necessary. Meanwhile, the level of importance symbolized by the letter I is given to two departments or facilities that are important to be brought closer together when possible. The level of ordinary importance, symbolized by the letter O, is given to two departments or facilities whose relationship is not considered to be very close. The unimportant (U) level of closeness is a level where departments or facilities should be kept as far apart as possible, while the undesirable (X) level of closeness is a level where departments or facilities must be kept apart to

avoid disruption or problems, especially in the production process.

In addition, in determining this closeness relationship, consideration is also given to the reasons why work areas need to be brought closer together or moved further apart, in the form of numbers placed under the relationship symbol. According to (Apple, 1977 in Purnomo, 2004), there are three types of reasons for assigning symbols on the Activity Relationship Chart, namely production-related relationships, employee-related relationships, and information flow-related relationships. For further details, please refer to Table 2.

Table 2: Reasons for the Degree of Relationship

Symbol	Description
1	Using the same equipment
2	Using the same records/files
3	Using the same workforce
4	Using the same space area
5	Workflow sequence
6	Performing the same work activities
7	Degree of employment relationship
8	Causing noise, dust, vibration, odor

(Aristriyana & Ibnu Faisal Salim, 2023; Purnomo, 2004)

b. Blocplan

Is one of the software programs used to assist in the design of facility layouts. One of the advantages of this software is that it minimizes distance and maximizes the proximity between facilities. The data used includes the degree of proximity between facilities and the area of the facilities themselves. The output consists of several alternative new layouts that are more effective and efficient (Rahmadiansyah & Susanty, 2021). However, Blocplan has a drawback in that it is an older software that requires assistance from another software/application to open it. The software in question is DOSBox, which facilitates the application of Blocplan itself. It should be noted that Blocplan can only be applied after the Activity Relationship Chart diagram data is available. The following are the steps for applying the Blocplan software:

1. Open the DOSBox software, then type MOUNT C C:\BLOCPAN → C:\ → BPLAN90.EXE.
2. Enter the number and area of each department or work area for which a layout will be created. The maximum number of departments that can be executed by the blocplan software is only 18 departments, followed by the input of the Activity Relationship Chart.
3. Select the ratio size of the layout to be created and display alternative layouts,

namely in the main menu, select the single-story layout menu → automatic search → pop up fixed departments, whether there are departments or work areas with fixed layouts → pop up desired number of layouts, the number of alternative layouts to be displayed.

4. Display the results of the alternative layouts along with the Adjusted Score (score regarding the proximity between work areas), R-Score (layout efficiency score), and Relative Distance Score (score for the distance of material movement between work areas)

c. 5S Work Culture (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke)

Is a method aimed at organizing everything in the relevant area to appear neat, tidy, and orderly, thereby enhancing employees' sense of ownership. Additionally, the implementation of the 5S method can reduce waste caused by the movement of goods or wasteful use of workspace, thereby indirectly reducing operational costs for the company (Mahesa et al., 2021).

This research was conducted through several stages that must be followed. For more details and clarity, please refer to Figure 2.

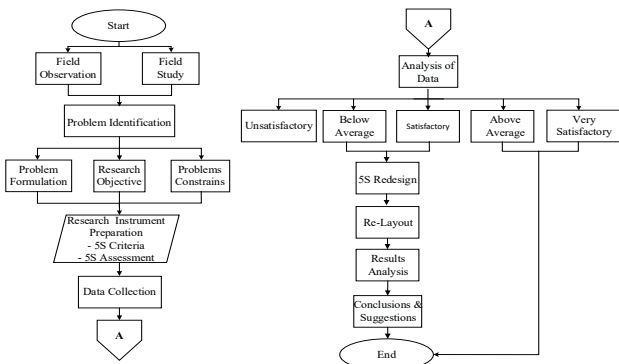


Figure 2: Research Flowchart

The research instrument focuses on how 5S is applied, especially in the molding production area. This instrument was developed by classifying the 5S criteria into each variable, with each variable having four different criteria. The output of this research instrument is a score given by employees in the molding division as respondents. Each statement item in the 5S form is rated using a scale of 1 to 5 for each variable. With a total of 20 statement items, the minimum score that can be obtained is 20 points, while the maximum score is 100 points. To facilitate data analysis, it is necessary to convert the quantitative assessment into a qualitative one by classifying (Sidauruk et al., 2021). The 5S instrument items are shown in Table 3.

1. If the total value of the 5S variable is in the range of 20-40 points, it can be stated as “Unsatisfactory.”
2. If the total value of the 5S variable is in the range of 41-60 points, it can be stated that it is “Below Average.”
3. If the total value of the 5S variable is in the range of 61-70 points, it can be stated that it is “Satisfactory.”
4. If the total value of the 5S variables is in the range of 71-90 points, it can be stated that it is “Above Average”
5. If the total value of the 5S variables is in the range of 91-100 points, it can be stated that it is “Very Satisfactory”

Table 3: Research Instruments

5S FORM		
Location :		
Date :		
Assessment Instructions: Score each question from 1 to 5 based on the actual conditions on site,		
1 = Very Inadequate (5S activities have not yet been initiated)		
2 = Inadequate (5S activities have been initiated, but with many deficiencies)		
3 = Adequate (5S activities have been initiated, but improvements are still required)		
4 = Good (5S activities have been initiated, with only minor deficiencies)		
5 = Very Good (5S activities have been fully implemented in accordance with the procedures)		
(Staquf et al., 2024)		
Variable	Question	Points (1-5)
Seiri	There is a disposal procedure for unused items (Staquf et al., 2024)	
	There is no accumulation of unused items (Patrianagara & Riandadari, 2020)	
	There is a storage area for items that can still be used (Addiba'i et al., 2023)	
	Goods sorting activities are carried out regularly by employees (Nohalim, 2022)	
Seiton	There are shelves for storing goods (Patrianagara & Riandadari, 2020)	
	Each storage area is equipped with clear labels (Staquf et al., 2024)	
	Items are placed in their designated storage areas (Staquf et al., 2024)	
Seiso	Employees conduct inventory control (Patrianagara & Riandadari, 2020)	
	Cleaning equipment is available in sufficient quantities and neatly arranged in the work area (Patrianagara & Riandadari, 2020)	
	There is a schedule and dedicated cleaning staff (Staquf et al., 2024)	
	Adequate trash bins are available (Wicaksono & Susanto, 2024)	
Seiketsu	There is no trash in the production area (Wicaksono & Susanto, 2024)	
	There are Standard Operating Procedures for the machines used (Sidauruk et al., 2021)	
	There are line markings in the production area (Patrianagara & Riandadari, 2020)	
	There are warning signs or symbols in the work area (Nohalim, 2022)	

Variable	Question	Points (1-5)
Shitsuke	Regular inspections or audits of 5S implementation are conducted (Nohalim, 2022)	
	Rewards and punishments are given to employees (Addiba'i et al., 2023)	
	Employees work in accordance with the applicable Standard Operating Procedures (Staquf et al., 2024)	
	Employees consistently practice positive habits (discipline, openness when issues arise, and effective communication) (Nohalim, 2022)	
	Employees understand and apply the 5S work culture (Patrianagara & Riandadari, 2020)	
	Total Score	

3. Results and Discussion

The company has several divisions, one of which is the molding division. This division plays a vital role in the production process. This is because the output from the molding division is used as a reference in the casting process carried out in other divisions. The output of the molding division consists of molds categorized into two types: MDF (Medium Density Fiberboard) molds and aluminum molds, with nearly identical production processes. The only difference lies in the presence or

absence of the casting stage. For further details, refer to Figure 3.

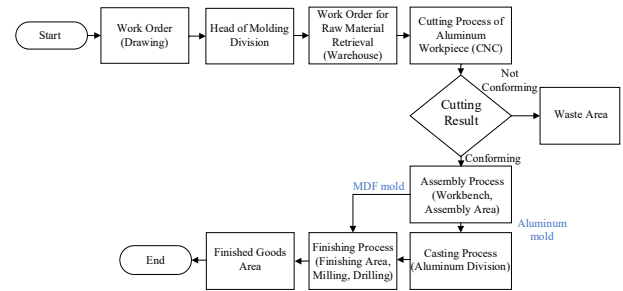


Figure 3: Molding Division Workflow

Based on the problems in the molding division, this study began by analyzing the problems in the work area. The molding division area is 30 meters long and 12 meters wide, with 36.75 m² used as office space and the rest used for production. The layout remains unoptimized, indicated by unused materials, damaged machines, and separated areas with similar functions as shown in Figure 4.

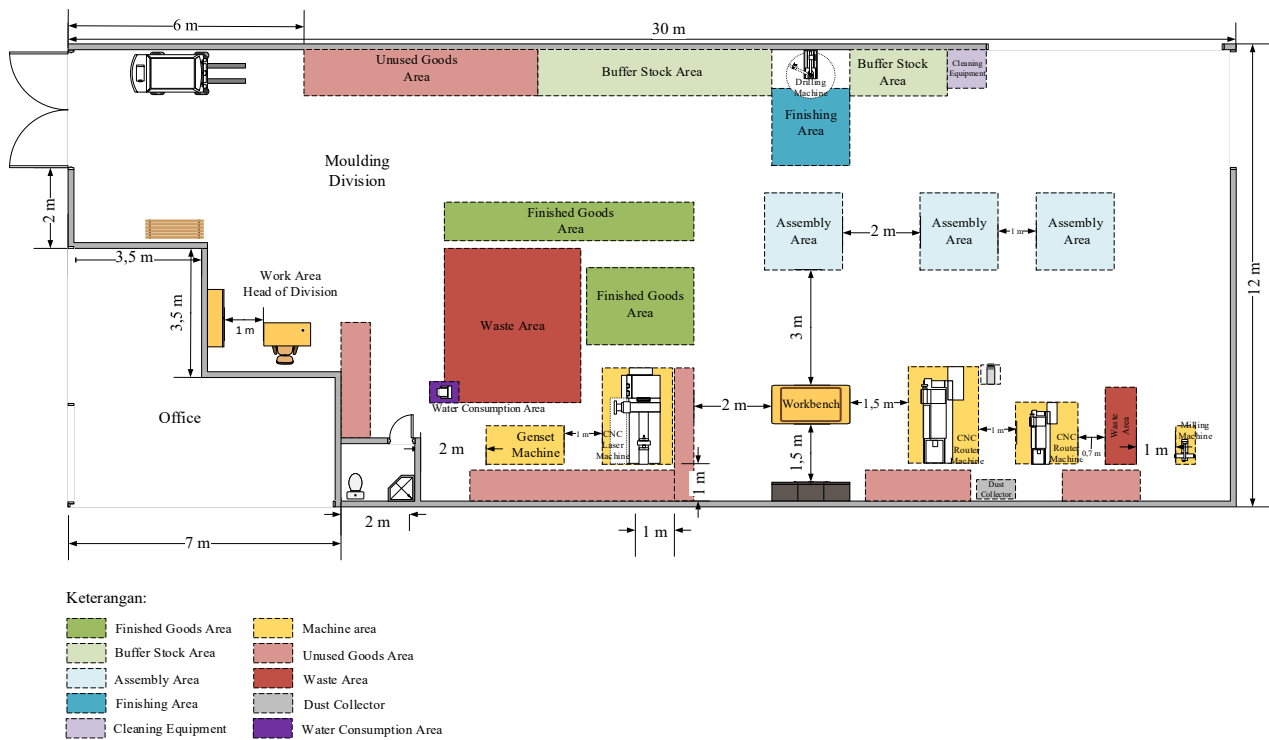


Figure 4: Initial Layout of the Molding Division

3.1. 5S Analysis

Based on the initial layout, several 5S issues were identified. The next step involved distributing questionnaires to the head of the molding division and staff members, totaling nine employees, as shown in Table 4. The questionnaire was developed based on previously designed research instruments, and the results were used to support a detailed analysis of the 5S implementation and to determine whether layout rearrangement is required, as presented in Table 5.

Table 4: Employees of the Molding Division





Code	Employee Name	Position
E1	Maulana Dicky Setiawan	Head of Division
E2	Ahmad Mudhorif	Division Staff
E3	Ahmad Syaifudin	Division Staff
E4	Aldila Chandra Kharisma	Division Staff
E5	Hendra Vida Prabowo	Division Staff
E6	Ikhsan Sri Nuryanto	Division Staff
E7	Muhammad Arifin	Division Staff
E8	Nur Arifin	Division Staff
E9	Nur Hidayanto	Division Staff


Table 5: Summary of the 5S Questionnaire

Employee	Questions																								Total 5S	Description	
	Seiri					Seiton					Seiso					Seiketsu				Shitsuke							
	P1	P2	P3	P4	Total	P1	P2	P3	P4	Total	P1	P2	P3	P4	Total	P1	P2	P3	P4	Total	P1	P2	P3	P4			Total
E1	2	1	4	2	9	2	1	2	2	7	3	5	4	2	14	1	1	1	2	5	2	3	3	4	12	47	Below Average
E2	3	2	3	3	11	3	2	3	3	11	4	4	4	3	15	2	1	3	3	9	3	3	3	3	12	58	Below Average
E3	3	3	4	3	13	2	3	2	2	9	3	5	3	3	14	2	2	1	3	8	3	2	4	4	13	57	Below Average
E4	2	2	2	3	9	2	2	4	3	11	3	3	3	3	12	2	1	1	2	6	2	2	3	2	9	47	Below Average
E5	3	3	3	2	11	2	2	2	3	9	3	3	3	2	11	2	1	2	2	7	2	2	2	2	8	46	Below Average
E6	3	3	2	1	9	4	2	2	2	10	3	4	4	1	12	2	2	1	1	6	2	3	2	2	9	46	Below Average
E7	2	2	3	3	10	3	3	3	3	12	3	3	3	3	12	2	1	3	3	9	3	3	3	3	12	55	Below Average
E8	2	3	4	4	13	4	2	3	3	12	5	5	4	2	16	1	1	2	2	6	2	4	4	4	14	61	Satisfactory
E9	3	3	4	3	13	3	2	3	3	11	3	4	4	2	13	2	1	2	2	7	2	4	4	4	14	58	Below Average
Total	23	22	29	24	98	25	19	24	24	92	30	36	32	21	119	16	11	16	20	63	21	26	28	28	103		
	51%	49%	64%	53%	54%	56%	42%	53%	53%	51%	67%	80%	71%	47%	66%	36%	24%	36%	44%	35%	47%	58%	62%	62%	57%		
Target	45	45	45	45	180	45	45	45	45	180	45	45	45	45	180	45	45	45	45	180	45	45	45	45	180	52,78	Below Average
Average																											

Based on the results of the data processing, it is known that the implementation of 5S in the molding division is still below average. This is evidenced by an average score of only 52.78. To determine the extent to which the 5S culture needs to be implemented, a more in-depth analysis of each variable described in Table 6 below is required.

Table 6: Analysis of 5S Issues

Variable	Problem	Description
Seiri	 <p>Penumpukan barang yang tidak digunakan</p>	Based on data processing, it shows that each criterion of the variables is still far from optimal. After field verification, the results are valid. This is because the overall criteria have not been optimally met, one of which is that there are still piles of unused goods in the production area.
Seiton	 <p>Penempatan barang tidak sesuai & tidak ada label yang jelas</p>	Based on data processing, it is known that the achievement of seiton implementation is still relatively low. The lowest score was found in the criterion of the absence of clear descriptions or labels on each storage rack. This can hinder the work of employees, especially when retrieving or searching for tools.
Seiso	 <p>Penumpukan limbah yang tidak dibersihkan</p>	The implementation of the seiso variable in the molding division has a higher achievement value than the seiri and seiton variables. The highest value reaches 80% with the criteria of having a schedule and special cleaning officers. However, in reality, cleaning activities in the work area are not carried out optimally, as evidenced by the presence of trash or waste in the production area.
Seiketsu	 <p>Tidak ada line marking & rambu tanda peringatan di area kerja</p>	The seiketsu variable has the lowest achievement level compared to the other 5S variables. The problem is closely related to occupational health and safety (OHS) for employees. Among other things, there are no standard operating procedures for each tool or machine used, no line markings or warning signs, and audits are not carried out regularly.

Variable	Problem	Description
Shitsuke		Employee habits greatly influence the Seiketsu variable in the 5S assessment. The implementation of Shitsuke in the molding division also needs to be improved to support a safe and comfortable production process, both between employees and between employees and the equipment and facilities used. Physical issues related to seiketsu include employees not utilizing company facilities to their fullest potential, such as the progress board and storage racks.

3.2. 5S Improvement Proposals

Problems with the sorting and storage of goods, both those still in use and those no longer in use, have led to various other problems, including the accumulation of goods that take up space, untidiness in the production area such as goods not being stored in their proper places, and cleanliness issues such as trash or waste in the production area. In addition to these issues, another factor hindering the optimal implementation of the 5S culture is the absence of clear procedures for the use and maintenance of machinery/equipment in the production area, resulting in some machinery/equipment being damaged and unable to be repaired. The final factor determining whether the 5S culture in the molding division can function effectively depends on employees' habits and discipline in adhering to existing regulations. The following Figure 5, Figure 6, Figure 7, Figure 8, and Figure 9 are proposed improvements to address these issues:

a. Designing a procedure for sorting items

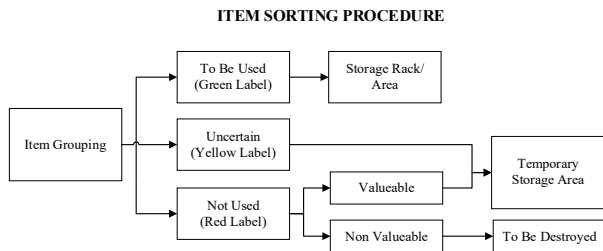


Figure 5: Goods Sorting Procedure

b. Application of equipment labeling & symbols/signs in the work area



Figure 6: Application of Equipment Labeling & Symbols/Signs in the Work Area

c. Designing Standard Operating Procedures for machines


CV. XYZ	Standard Operating Procedure	No. Doc. : Date : Revision : March 1, 2025	
FUNCTION: Drilling Machine Operation			
To create holes in the workplace with specific/variables dimensions			
PPE (Personal Protective Equipment) REQUIREMENTS			
DRILLING MACHINE VISUALIZATION			
			
NO	WORK DESCRIPTION	STANDARD	SAFETY POINTS
1	Install the drill bit and tighten it with the chuck key	Drill bit installation must not be reversed	Be careful, the drill bit may fall if not properly tightened
2	Clamp the workpiece and adjust the table height using the column	Clamp must firmly hold the workpiece	Be careful, risk of being struck
3	Press the On switch on the electrical panel to turn on the machine	Indicator light turns on	Be cautious of electrical parts
4	Perform drilling by turning the drill feed handle	Drill feed handle should be easy to turn	Use adequate force
5	Press the Off switch on the electrical panel to turn off the machine	Indicator light turns off	Be cautious of electrical parts
6	Remove the workpiece by loosening the clamp	Clamp must be easy to release and no workpiece remains stuck	
Approved by : Reviewed by : Created by :		Revision Notes:	

Figure 7: Designing Standard Operating Procedures for Machines

d. Preparation of a schedule for checking and maintaining machinery/equipment

Machine & Equipment Inspection Checklist - Year 2025																
Inspection Period	No	Machine/Equipment	Month													
			1	2	3	4	5	6	7	8	9	10	11	12		
1 Month	1	Hand Bor	Good	Damaged												
	2	Hand Grander	Good	Good												
	3	Ignam	Damaged													
	4	Compressor	Damaged	Good	Damaged											
	5	Cleaning Tools	Good													
	6	Disc Sander Machine	Good													
	7	Lastig Machine	Damaged													
3 Month	1	Electric Fan		Good												
	2	O2 Cylinder														
	3	Drilling Machine														
	4	Milling Machine														
	5	CNC Machine														
6 Month	1	Fire Extinguisher														
	2	Hand Pallet														

Figure 8: Application of Machine Inspection and Maintenance Schedule

e. Designing reward and punishment procedures

Description	This procedure serves as a guideline for evaluating the employees of CV. XYZ regarding their working habits. The evaluation results will be used as the basis for the implementation of a reward and punishment system according to the total points accumulated within one month of work.
Objective	To establish and sustain an optimal 5S culture at CV. XYZ.
Scope	This procedure applies to all employees of CV. XYZ.
Procedure Flow	<ol style="list-style-type: none"> A check sheet is distributed to each division head to assess employees' performance in meeting work targets, their working habits, and the mistakes committed. The check sheet shall be filled in daily at the end of the working hours, using the assessment format YES (10 points) or NO (0 points), accessible through an online system. At the end of each month, the operational team will automatically analyze the recapitulated data to determine the total points obtained by each employee, with the following criteria: <ul style="list-style-type: none"> Maximum score: 1200 points Score above 1000: reward of IDR 100,000 Score between 500-600: verbal warning Score below 500: written warning or punishment The final evaluation results shall be submitted to the Finance and Human Resources Department as supporting data in the annual selection of outstanding employees.

5S Checksheet for April 2025																	
Date	Assessment	Employee Name						Score Recap									
		E1	E2	E3	E4	E5	E6	E7	E8	E1	E2	E3	E4	E5	E6	E7	E8
1	Target Achieved	NO	YES	YES						0	10	10					
	Discipline	YES	YES	NO						10	10						
	Good Attitude	NO								0							
	No Mistakes Made	NO								0							
2	Target Terpenuhi																
	Disiplin																
	Attitude Baik																
	Tidak Melakukan Kesalahan																
...	Target Terpenuhi																
	Disiplin																
	Attitude Baik																
	Tidak Melakukan Kesalahan																
30	Target Terpenuhi																
	Disiplin																
	Attitude Baik																
	Tidak Melakukan Kesalahan																
TOTAL POINTS									10	20	10						

Figure 9: Designing Reward & Punishment Procedures

3.3. Facility Layout Optimization

Layout design must take into account several factors such as the function of the facility or machine, material flow, maintenance, occupational safety standards, and site conditions. The optimization of this layout aims to ensure that the 5S work culture can be implemented effectively and sustainably. The appropriate layout type for the molding division is the product-based layout (process layout), as this layout groups machines or equipment with similar characteristics. This minimizes the likelihood of production processes being interrupted when one machine malfunctions (Chakroun et al., 2022).

Based on the results of interviews conducted with the company, particularly involving all employees of the molding division as shown in Table 4, it was found that there were 17 effective work areas and 2 ineffective work areas, namely the CNC Laser Machine and the Unused Goods Area. These two areas were not included in the Activity Relationship Chart because they were considered to interfere with the smooth running of production activities. For more details, see Figure 10.

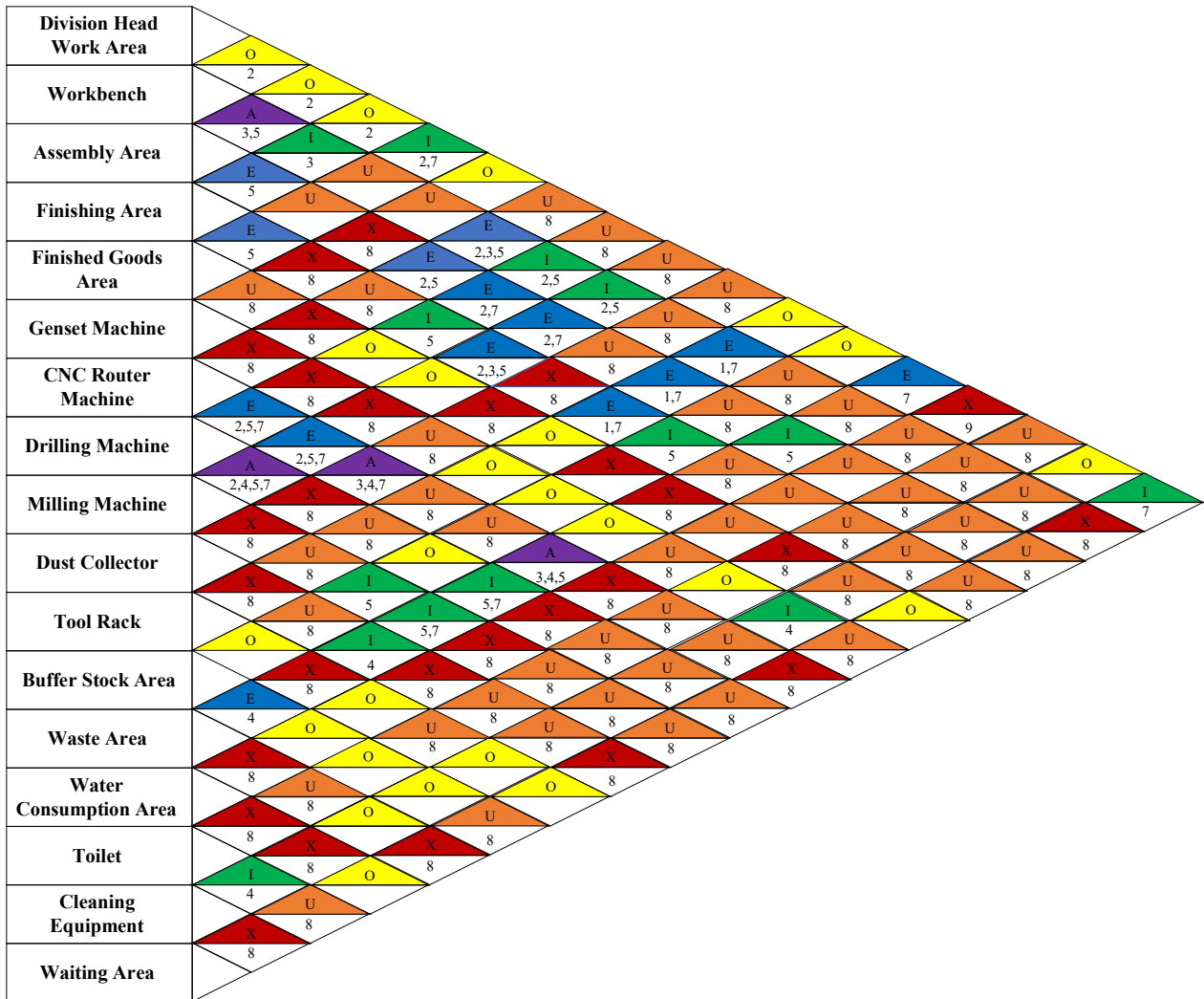


Figure 10: Activity Relationship Chart Molding Area

a. Blocplan

The DOSBox software must be opened prior to running the BLOCPAN software.

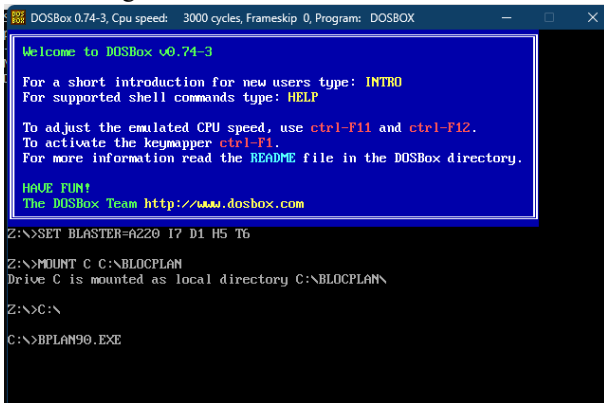


Figure 11: Opening the DOSBox Software

The molding division includes 17 work areas, and the data were entered manually according to the work area codes and their respective areas.

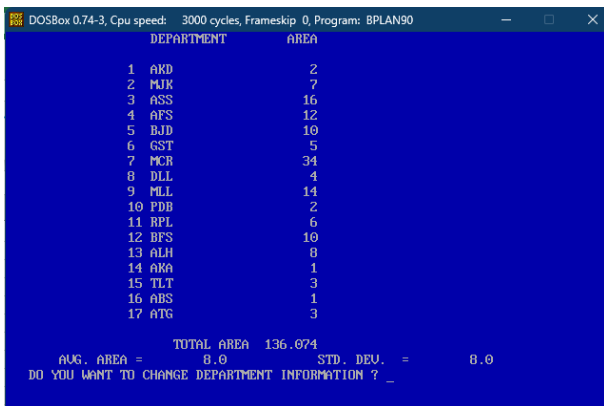


Figure 12: Number & Area of Workstations

The ARC diagram was entered using symbols only, without including the numerical codes representing the reasons for the closeness relationships of work areas, and the process required careful attention as it significantly affects the final results.

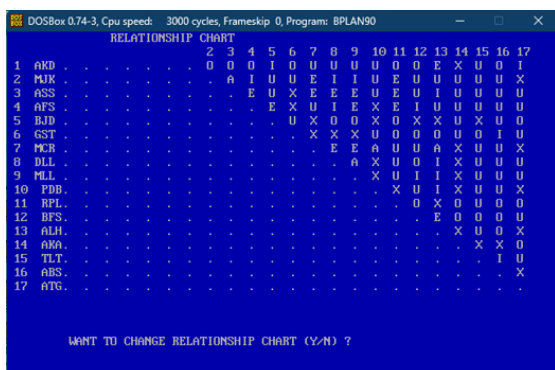


Figure 13: ARC Data Input

The ratio selection was determined by the researcher's judgment in defining the layout configuration.

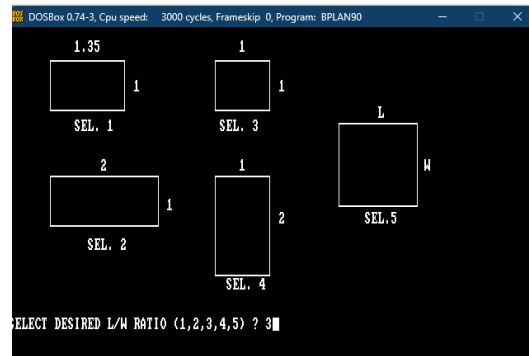


Figure 14: Ratio Dimension

Based on the data processing results, there are 10 alternative layouts with Adjusted Score, R-Score, and Relative Distance Score rankings. These scores are one of the comparison factors for determining which layout is the most optimal as a proposed improvement layout. Based on the Adjusted Score, the optimal layout is the one with the highest proximity between work areas, which is found in layouts 7, 8, and 4. Meanwhile, based on the R-Score, the optimal layout is the one with the highest value, found in layouts 9, 7, and 8. Layouts 9, 8, and 7 are also optimal based on the Relative Distance Score, as these layouts have the shortest or smallest relative distance between work areas compared to the others.

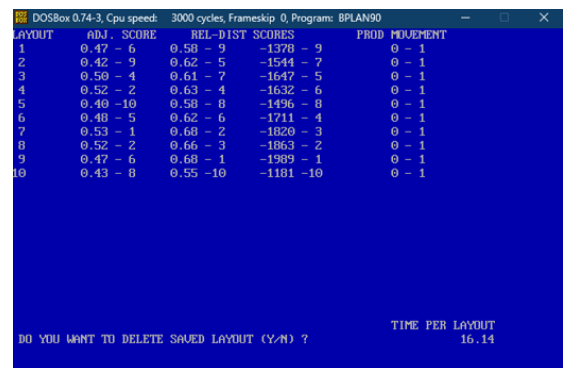


Figure 15: Alternative Layouts

In determining the best layout, it is not only the Blocplan score that is considered, but also other factors such as production process flow, room constraints or conditions, flexibility, and cost. Based on these considerations, the proposed improvement layout is layout number 7. This is because Layout 7 has the highest Adjusted Score of 0.53, indicating a strong emphasis on proximity between work areas. It also has the highest R-Score at 0.68 and ranks third in Relative Distance Score with a value of -1820. Thus, this layout provides a balance between spatial efficiency, smooth production processes, and realistic implementation on-site. Thus, the 7th layout is considered the most optimal for supporting the overall improvement of the molding production system's performance while considering space

utilization. The following is the selected proposed improvement layout in Figure 14.

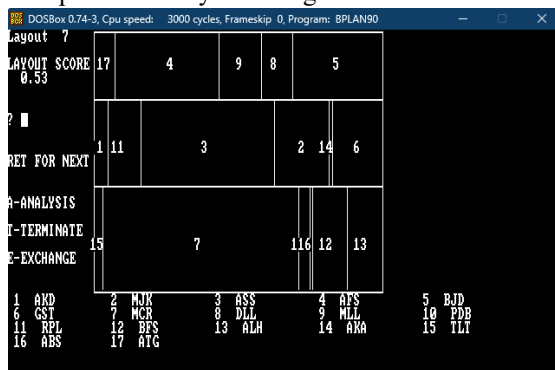


Figure 16: Output of Selected Layout Plan

The final step is to apply the selected layout using Microsoft Visio software, so that the layout will be more detailed and clearer. The final layout

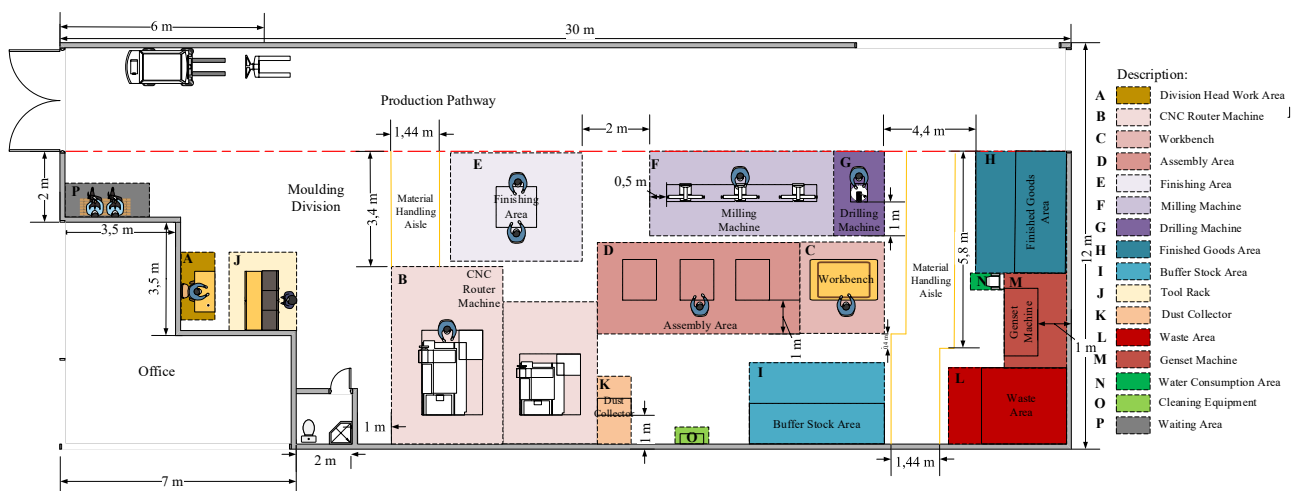


Figure 17: Final Layout of the Molding Division

b. Comparison Analysis of Layouts

Layout comparison analysis involves comparing the layout before the proposed improvements with the layout after the proposed improvements. This analysis consists of two types of comparisons: qualitative and quantitative. The qualitative comparison is based on the results of the 5S analysis, while the quantitative comparison is evaluated using three parameters; the molding division area, the effective area, and the percentage of area utilization.

Qualitative Layout Comparison:

- Seiri
Before the implementation of Seiri, the production area contained piles of unused items mixed with active materials, resulting in disorganization and reduced space utilization efficiency. After Seiri was implemented through a sorting process and layout reorganization, the sorted items were placed in designated storage areas. The new layout reduced irregular item accumulation

size has changed to 30 meters long and 9 meters wide. This change in size occurred because a small portion of the molding division area was used as a road area, both for material handling and employee access. Initially, this pathway area was still used as a storage area and even as a workspace, which could potentially lead to workplace accidents. Therefore, a relayouting was conducted with optimization of the molding division area. The following is the proposed improvement layout designed using the Activity Relationship Chart method with the assistance of Blocplan software and based on the 5S principles (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke), as shown in Figure 17. Proposed Improvement Layout below.

and improved the overall orderliness of the production area.

- Seiton
Prior to the implementation of Seiton, item arrangement in the work area was not standardized, resulting in disorganization and potential safety risks. Following the Seiri improvement, the Seiton stage was implemented by establishing designated storage areas through the use of labeling, as well as work area signs and symbols. This improvement made the production area more organized and facilitated easier identification and retrieval of items.
- Seiketsu and Shitsuke
Improvements in the Seiketsu and Shitsuke stages focused on strengthening the work system and fostering workforce discipline through the development of Standard Operating Procedures (SOP), the establishment of machine inspection and maintenance schedules, and the

implementation of a reward and punishment system that had not previously been applied. These efforts aimed to create a structured and sustainable work system while maintaining occupational safety and health considerations, as well as ensuring the consistent implementation of Seiri, Seiton, and Seiso supported by continuous monitoring.

The quantitative layout comparison is presented in more detail in Table 7 below.

Table 7: Layout Comparison Analysis

Parameter	Initial Layout	Proposed Layout
Molding Division Area	323,25 m ²	233,25 m ²
Effective Area	105,253 m ²	154,1 m ²
Area Utilization	33%	66%

Based on the comparison Table 7, it can be seen that there are three parameters with different values. The initial layout has an area of 323.25 m², while the proposed layout has an area of 233.25 m², which means there is a decrease in area of 90 m². This decrease in area is used as an area for material handling roads and employee roads. Furthermore, the effective area used in the initial layout is only 105.253 m², while the effective area that can be used in the proposed layout increases to 154.1 m². This is because in the initial layout, unused machinery and items are located within the molding division, whereas in the proposed layout, these areas are utilized, including as allowance areas to ensure the comfort and safety of operators. After determining the total area and effective area both before and after the improvements, the percentage of how much the molding division area can be utilized can be calculated. In the initial layout, it was only 33%, while after the proposed improvements, the utilization percentage increased to 66%. This indicates that the proposed layout improvements have brought about significant progress.

4. Conclusion

Based on the research, data processing, and analysis, the following conclusions can be drawn: (a.) The results of the 5S questionnaire (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke) in the molding division, using a Likert scale, indicate that the current implementation of 5S is still below average, with an overall score of only 52.78%. The highest-rated variables were Seiso (66%), followed by Shitsuke (57%), Seiri (54%), Seiton (51%), and Seiketsu (35%). This suggests that significant improvements are needed in order to fully integrate 5S practices in the division. (b.) The molding division's production area, measuring 323.25 m², has an inefficient layout, which is evident from the presence of unused items, damaged machinery, and the disorganized placement of similarly functioning equipment. This

suboptimal use of space hampers productivity and highlights the need for better organization and layout planning.

To address these issues, several improvement suggestions are proposed, such as developing standardized procedures for selecting goods, labeling equipment, creating maintenance schedules, and applying appropriate signs and symbols in the work area. Additionally, by redesigning the division layout using the Activity Relationship Chart method, the area's utilization was significantly enhanced, with its efficiency improving from 33% to 66%.

Recommendations for future actions include a stronger commitment from the company to continuously uphold 5S practices through regular training and socialization for all employees. Furthermore, future research could extend beyond the molding division to encompass other divisions within the company, providing a more comprehensive view of organizational efficiency.

Acknowledgement

This research was funded by the Hibah Riset Kompetitif from the Lembaga Riset dan Inovasi, Universitas Muhammadiyah Surakarta, under contract number 236.15/A.3-III/LRI/VII/2025. The authors would like to express their sincere gratitude for the support provided.

References

- Addiba'i, S. A., Supena, A. N., & Rejeki, Y. S. (2023). Usulan Perbaikan Budaya Kerja Berdasarkan Metode 5S (Seiri, Seiton, Seiso, Seiketsu, Shitsuke) pada Gudang Bahan Baku di PT.Sygma Examedia Arkanleema. Bandung Conference Series: Industrial Engineering Science, 3(2), 726–734. <https://doi.org/10.29313/bcsies.v3i2.9407>
- Aman, M. A., Larasati, R. D., & Purnomo, T. A. (2024). Production Floor Relay to Optimize Material Handling Distance at PT. Sidoagung Farm Magelang. Jurnal Ilmiah Teknik Industri, 23(1), 173–181. <https://doi.org/10.23917/jiti.v23i1.3332>
- Apple, J. (1977). Plant Layout and Material Handling. John Willey & Sons, Inc.
- Aristriyana, E., & Ibnu Faisal Salim, M. (2023). Perancangan Ulang Tata Letak Fasilitas Menggunakan Metode ARC guna Memaksimalkan Produktivitas Kerja pada UKM SB Jaya di Cisaga. Jurnal Industrial Galuh, 5(1), 29–36. <https://doi.org/10.25157/jig.v5i1.3060>
- BPS. (2023). Perkembangan Indeks Produksi Industri Manufaktur 2023 (Vol. 13). Badan Pusat Statistik.
- Cammann, L., Perera, A., Alstad, V., & Jäschke, J. (2024). Design and Operational Analysis of an Alkaline Water Electrolysis Plant Powered by Wind Energy. International Journal of Hydrogen Energy,

- 93, 963–974. <https://doi.org/10.1016/j.ijhydene.2024.10.176>
- Chakroun, A., Zribi, H., Hani, Y., Elmhamedi, A., & Masmoudi, F. (2022). Facility Layout Design through Integration of Lean Manufacturing in Industry 4.0 context. *IFAC-PapersOnLine*, 55(10), 798–803. <https://doi.org/10.1016/j.ifacol.2022.09.507>
- Diswiratna, N., Nugraha, I., & Santosa, A. (2022). Analisa dan Perancangan Mold untuk Membuat Mangkuk Plastik dengan Menggunakan Inventor. *TEDC*, 16(3), 215–219. <https://ejournal.poltektedc.ac.id/index.php/tedc/article/view/608>
- Jamalludin, Fauzi, A., & Ramadhan, H. (2020). Metode Activity Relationship Chart (ARC) untuk Analisis Perencanaan Tata Letak Fasilitas pada Bengkel Nusantara Depok. *Bulletin of Applied Industrial Engineering Theory*, 1(2), 20–22. <https://doi.org/10.61132/venus.v3i3.949>
- Kristyanto, A., & Kusdiartini, V. (2021). Perencanaan Budaya 5S (Seiri, Seiton, Seiso, Seiketsu, Shitsuke) pada Anoegrah Jaya Motor Semarang. *Jurnal Ekonomi, Manajemen Akuntansi Dan Perpajakan (Jemap)*, 4(1), 163–201. <https://doi.org/10.24167/jemap.v4i1.2832>
- Mahesa, A. A., Utami, S. F., & Adiasa, I. (2021). Analisis Perancangan Sistem Kerja Menggunakan Metode 5S pada Ruang Proses Produksi Pupuk Organik Dinas Lingkungan Hidup Kota Tegal. *Hexagon Jurnal Teknik Dan Sains*, 2(2), 59–65. <https://doi.org/10.36761/hexagon.v2i2.1088>
- Nohalim, A. (2022). Analisis Penerapan Seiri, Seiton, Seiso, Seik Etsu, Shitsuke (5S) pada PT Socfindo Perkebunan Nagan Raya. *Universitas Islam Negeri Ar-Raniry Banda Aceh*.
- Patrianagara, P., & Riandadari, D. (2020). Evaluasi Penerapan Seiri, Seiton, Seiketsu dan Shitsuke (5S) di Bengkel Honda Graha PT. Supreme Surabaya Motor Service. *JPTM*, 10(01), 87–96.
- Pratiwi, I., Muslimah, E., & Aqil, A. W. (2015). Perancangan Tata Letak Fasilitas di Insustri Tahu Menggunakan Blockplan. *Jurnal Ilmiah Teknik Industri Universitas Muhamadiyah Surakarta*, 11(2), 102–112. <https://doi.org/10.23917/jiti.v11i2.772>
- Purnomo, H. (2004). Perencanaan dan Perancangan Fasilitas (Edisi Pert). Graha Ilmu.
- Qin, Z., Kang, Y., & Yang, P. (2024). Making Better Order Fulfillment in Multi-Tote Storage and Retrieval Autonomous Mobile Robot Systems. *Transportation Research Part E: Logistics and Transportation Review*, 192, 103752. <https://doi.org/10.1016/j.tre.2024.103752>
- Rahmadiansyah, K. K., & Susanty, A. (2021). Perbaikan Tata Letak Fasilitas Produksi Pabrik Kayu Barecore CV Cipta Usaha Mandiri dengan Metode Blocplan. *Seminar Dan Konferensi Nasional IDEC*, 2579–6429. <https://doi.org/10.24912/jitiuntar.v12i3.28251>
- Ramdan, L. D., Arianto, B., & Bhirawa, W. T. (2020). Perancangan Ulang tata Letak Pusat Pemeliharaan Bus Trans Jakarta dengan Metode Activity Relationship Chart untuk Meningkatkan Efektivitas dan Efisiensi Kerja pada PT Citrakarya Pranata. *Jurnal Teknik Industri*, 9(2), 105–115. <https://journal.universitassuryadarma.ac.id/index.php/jtin/article/view/642/613>
- Shahriar, M. M., Parvez, M. S., Islam, M. A., & Talapatra, S. (2022). Implementation of 5S in a Plastic Bag Manufacturing Industry: A Case Study. *Cleaner Engineering and Technology*, 8, 100488. <https://doi.org/10.1016/j.clet.2022.100488>
- Sidauruk, P. H., Damanik, J., Simangunsong, W., & Lubis, M. F. (2021). Penerapan 5S pada Area Kerja Gudang PT X. *EE Conference Series*, 4, 122–132. <https://doi.org/10.32734/ee.v4i1.1240>
- Staquf, M. R., Nu'man, A. H., & Aviasti. (2024). Perancangan Budaya Kerja Menggunakan 5s (Seiri, Seiton, Seiso, Seiketsu, Dan Shitsuke) pada Area Cement Mill PT. Semen Jawa. *Bandung Conference Series: Industrial Engineering Science*, 4(1), 484–492. <https://doi.org/10.29313/bcsies.v4i1.11755>
- Ummah, I. R., Azizi, A. A., & Yasin, M. (2023). Strategi Orientasi pada Industri Manufaktur Kota Surabaya. *CiDEA Journal*, 2(1), 75–85. <https://doi.org/10.56444/cideajournal.v2i1.806>
- Wicaksono, A., & Susanto, N. (2024). Rekomendasi Perbaikan Warehouse Melalui Pendekatan 5S pada PT Cosmetic Mirror Indonesia. *Industrial Engineering Online Journal*, 13(1). <https://ejournal3.undip.ac.id/index.php/ieoj/article/view/42505>
- Wiguna, W., Susanto, B., & Tukiran, M. (2022). Application of 5S (Seiri, Seiton, Seiso, Seiketsu, Shitsuke) in the Mobile Shop Work Area as an Effort to Increase Work Productivity (Case Study at Pt XYZ). *International Journal of Economy, Education and Entrepreneurship (IJE3)*, 2(3), 726–739. <https://doi.org/10.53067/ije3.v2i3.112>
- Zaki, A., Taqwanur, & Qurratu'aini, N. I. (2023). Analisis Implementasi 6S (Housekeeping 5S Dan Safety) pada Area Warehouse Operation Pt. MMS. *Media Mahardhika*, 21(3), 523–530. <https://doi.org/10.29062/mahardhika.v21i3.639>
- Zhang, H., Yu, Y., Zhang, Q., Yang, Y., Liu, H., & Lin, Y. (2024). A Bidirectional Collaborative Method Based on an Improved Artificial Fish Swarm Algorithm for Ship Pipe and Equipment Layout Design. *Ocean Engineering*, 296, 117045. <https://doi.org/10.1016/j.oceaneng.2024.117045>
- Zheng, J., Chen, A., Zheng, W., Zhou, X., Bai, B., Wu, J., Ling, W., Ma, H., & Wang, W. (2020).

Effectiveness Analysis of Resources Consumption, Environmental Impact and Production Efficiency in Traditional Manufacturing Using New Technologies: Case from Sand Casting. Energy Conversion and Management, 209, 1–12.
<https://doi.org/10.1016/j.enconman.2020.112671>