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Redesign of facility layout to reduce the production line distance in MSE Silver 999 Malang

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Abstract. To be able to compete, every micro and small enterprises (MSE) must continue to innovate in both product and production process innovation. Silver 999 is MSE which produces jewellery from gold, silver, brass and other raw materials. MSE Silver 999 products have penetrated international markets. The initial layout condition on the Silver 999 production floor was very inefficient because the Blanding work station was located outside the production area which caused the length of material flow to produce rings to be 51.35 meters. Due to improvements in some work equipment on the MSE production floor, it is necessary to redesign the layout to minimize material flow. By using a combination of the Systematic Layout Planning Method and the BLOCPLAN 90 software, a new layout proposal was obtained. By implementing the new layout, the material flow distance for ring production was reduced from 51,350 meters to 23,005 meters, or by reducing the distance by 55.2%.

Keywords: BLOCPLAN, facility layout, MSE, systematic layout planning

1. Introduction

Every Micro and Small Enterprises (MSE) in Indonesia must be able to compete in the current era of globalization. One of the problems faced by MSE in Indonesia is the lack of technology use for innovation, both in the process or in the product sector. In responding to these challenges, MSE Silver 999 has made technological innovations in the form of improvements to several equipment for the production process. To maximize the function and performance of the equipment, it is necessary to arrange the facility layout used in MSE Silver 999. The facility layout is a very important part of the production floor. The facility layout design is created using Systematic Layout Planning (SLP) method and the Blocplan 90 Software to minimize the distance between work stations, or maximize closeness relationship between each work stations.

MSE Silver 999 is a small enterprise that produces handicrafts from silver, gold, brass and others to be used as jewelry products such as rings, necklaces, bracelets and crowns. One of its well-known products is ring jewelry; there are many customers' order either for wedding ring or daily jewelry, as a result this research focus is only ring jewelry production line. MSE Silver 999 which is located at Jl. Ikan Paus I No. 6, Kelurahan Tunjungsekar, Kecamatan Lowokwaru, Malang City has a production floor area of 18.75 m² consisting of 5 work stations, namely a burning and shaping work station, a forging work station, a blanding work station, an assembly work station,



and a finishing work station. This MSE redesigned the production floor because some of the equipment used was replaced with new ones in order to make it easier to perform the production process and be more efficient in time and material displacement, so it was necessary to design a new layout to match the new equipment to be used.

The formulation of the problems in this research are how is the initial facility layout and how is the layout of the facility layout improvements to reduce the distance of material movement in the ring production process in MSE Silver 999? The research objectives are to determine the initial facility layout and make proposals to improve the facility layout with new equipment in an effort to reduce the distance for material displacement in the production process at MSE Silver 999.

2. Methods

2.1 Data collection method

The data collection process was carried out by direct observation in the field, interviews with company owners, and documentation of taking photos and video of the production process at MSE Silver 999. The data needed in this study consisted of 2 types of data, i.e.

- a. Primary data:
 1. Production floor area range
 2. Number of work stations
 3. Each work station area range
- b. Secondary data:
 1. Production process
 2. Production floor layout
 3. List of equipment and machines

2.2 Data processing and analysis methods

In this study, the method used is Systematic Layout Planning by using BLOCPLAN 90 Software. The Systematic Layout Planning (SLP) method is used to process data on the facility layout. First, it is started by distance calculation of material movement before improvement using the aisle method. Second, calculate the Activity Relationship. Third, proceed with making a Flow Process Chart (FPC), Activity Relative Chart (ARC), Activity Relationship Diagram (ARD) and BLOCPLAN 90 Software to obtain an alternative layout that suits the production floor.

3. Results and Discussions

3.1 Production area and work station area range

Based on the results of field observations, the production area is 18.75 m² consisting of 5 work stations, namely the Burning & Shaping workstation, Assembly work station, Forging work station, Blanding work station, and Finishing work station. Of the five work stations, there is one work station located outside the production area, namely the Blanding work station measuring 1.75 meters x 0.3 meters which functions to flatten the workpieces and make wires. Below is a floor plan of the old workstation:

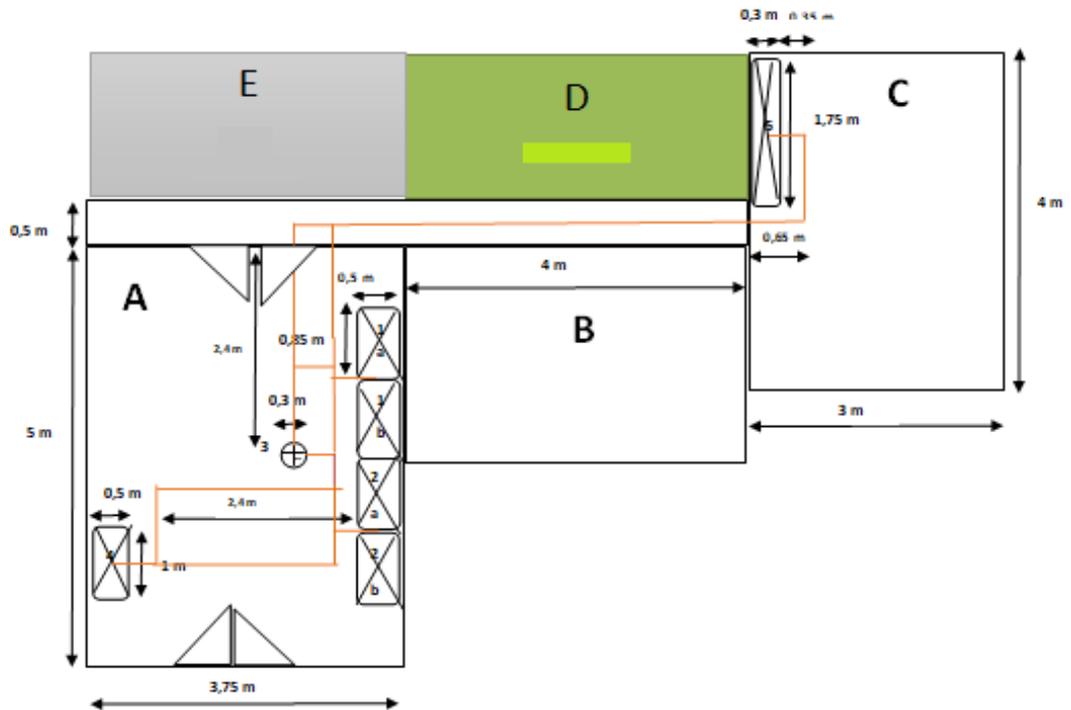


Figure 1. Layout of MSE Silver 999

Description:

- A. Production area (5 m x 3,75 m)
 1. *Burning & Shaping work station* (0.85 m x 0.5 m)
 2. *Assembly work station* (0.85 m x 0.5 m)
 3. *Forging work station* (0.3 m x 0.3 m)
 4. *Finishing work station* (1 m x 0.5 m)
- B. Office dan finished jewelry storage
- C. Garage
 5. *Blanding work station* (1.75 m x 0.3 m)
- D. Green space

3.2 Displacement distance between work stations

The following is a calculation of the production line distance in the ring crafting process using the Aisle method (Table 1). In a single ring production process using a table station requires a distance of 51.35 meters, this distance is far enough for the production of a ring and can result in consuming a lot of time for just one ring production.

Table 1. Calculation of material line distance before repair

No	From work station	To work station	Line distance calculation	Line distance	Frequency	Total line
1	<i>Burning and Shaping</i>	<i>Forging</i>	$(\frac{1}{2} \times 0.5 \text{ m}) + 0.35 \text{ m} + 0.85 \text{ m} + 0.35 \text{ m} + (\frac{1}{2} \times 0.3 \text{ m})$	1.95 m	1	1.95 m
2	<i>Forging</i>	<i>Blanding</i>	$(\frac{1}{2} \times 0.3 \text{ m}) + 2.4 \text{ m} + (\frac{1}{2} \times 0.5 \text{ m}) + ((\frac{1}{2} \times 0.3) + 0.35 \text{ m} + 0.35 \text{ m} + 0.5 \text{ m}) + 4 \text{ m} + 0.65 \text{ m} + (\frac{1}{2} \times 0.5 \text{ m}) + (\frac{1}{2} \times 1.75 \text{ m}) + 0.35 \text{ m} + (\frac{1}{2} \times 0.3 \text{ m})$	10.425 m	3	31.275m
3	<i>Blanding</i>	<i>Assembly</i>	$(\frac{1}{2} \times 0.3 \text{ m}) + 0.35 \text{ m} + (\frac{1}{2} \times 1.75 \text{ m}) + (\frac{1}{2} \times 0.5 \text{ m}) + 0.65 \text{ m} + 4 \text{ m} + (0.5 \text{ m} + 0.35 \text{ m}) + (\frac{1}{2} \times 0.5 \text{ m}) + 2.4 \text{ m} + (\frac{1}{2} \times 0.3 \text{ m}) + 0.85 \text{ m}$	10.775 m	1	10.775m
4	<i>Assembly</i>	<i>Finishing</i>	$(\frac{1}{2} \times 0.5) + 2.4 \text{ m} + (\frac{1}{2} \times 0.85 \text{ m}) + 0.35 \text{ m} + (\frac{1}{2} \times 0.5 \text{ m})$	3.675 m	2	7.35 m
Total line distance						51.35 m

3.3 Work station layout design

The facility layout really needs to be redesigned because there are some improvements to the equipment to help the production process run smoothly. The equipment improvements are new Blanding machine equipped with wire forming, merging of Burning and Shaping, and Assembly work stations into 1 work station, and another new work table for the Finishing workstation. Because of the merger, the new facility layout consisting of 4 work stations.

In designing the work station layout, starting with the creation of an ARC (Activity Relationship Chart), in which there is a use of reason codes to make it easier to analyze the relationship between work stations. Table 2 is a description of the reason code used to create the ARC (Activity Relationship Chart). Table 3 is the Activity Relationship Chart in the production area after improving the existing tools in MSE Silver 999:

Table 2. ARC (activity relationship chart) reason code

Reason code	Description
1	Work flow sequence
2	Using the same workforce
3	Dirty and dusty
4	Using the same equipment
5	Make it easy to move material

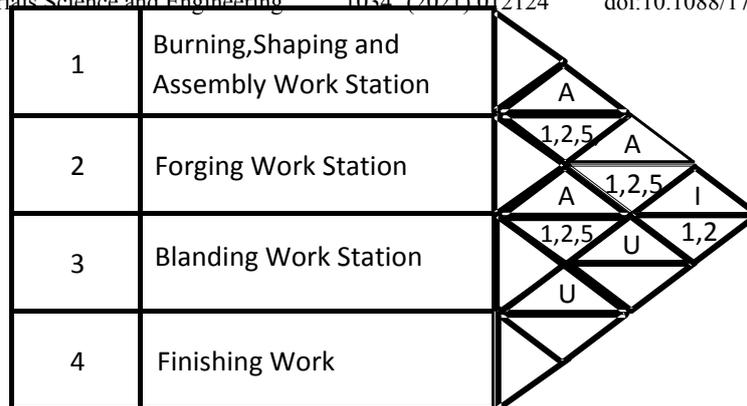


Figure 2. ARC diagram (activity relationship chart)

The following is an Activity Relationship Diagram in the production area after improving the existing tools in MSE Silver 999:

Table 3. Activity Relationship

No	Work Station Name	Degree of Closeness					
		A	E	I	U	O	X
1	Burning, Shaping and Assembly Work Station	2, 3		4			
2	Forging Work Station	1, 3			4		
3	Blanding Work Station	1, 2			4		
4	Finishing Work Station			1	3, 2		

3.4 Required production area

Every work station has different Allowances according to the needs or activities carried out at each work station.

Table 4. Allowance in each work station

	Machine Name	Size			Large		Allowance		Total Large Department (m ²)
		Long	Wide	D	Work Station (m ²)	Machine (m ²)	Every Work Station	Calculation	
Burning, Shaping & Assembly		1.6	0.8		1.28		50%	0.64	1.92
	Gas Cylinders			0.22		0.3454	10%	0.035	0.37994
Blanding	Blanding Machine	1.5	0.8		1.2		70%	0.84	2.04
Forging	Forging Machine	0.88	0.45			0.396	30%	0.1188	0.5148
Finishing	Polish Machine	1.6	0.7		1.12		50%	0.56	1.68
Total Production Floor Required									6.53474

Based on the area table for each work station above, it can be concluded that for the jewelry production floor with the number of machines, tables and operators in the station, it requires a production floor area of 6.53474 m². And the jewelry production floor at MSE Silver 999 has an

actual area of 18.75 m². Between the need for production and the actual area of production, there is a gap of 12.12 m², so that it still has space for transportation areas in and out of the room.

3.5 Alternative workstation layout

In designing a work station layout using the Systematic Layout Planning method, it is assisted by using the BLOCPAN 90 software to obtain layout alternatives. The data that has previously been processed using the Systematic Layout Planning method is then computed to get 10 alternative layouts, then the value of each resulting layout will be displayed. Then the R-score value that is closest to 1 is chosen as Figure 3. It can be seen that the R-Score which is close to 1 or precise 1 is in the 1st layout of 1.00-1. And here are the results of the layout that has an R-score that is close to 1.

LAYOUT	ADJ. SCORE	REL-DIST SCORES	PROD MOVEMENT
1	1.00 - 1	0.82 - 2	48 - 1
2	1.00 - 1	0.47 - 7	51 - 5
3	1.00 - 1	0.82 - 4	48 - 1
4	1.00 - 1	0.47 - 7	51 - 6
5	1.00 - 1	1.00 - 1	50 - 4
6	1.00 - 1	0.58 - 6	59 - 9
7	1.00 - 1	0.47 - 7	51 - 6
8	1.00 - 1	0.82 - 2	48 - 1
9	1.00 - 1	0.58 - 5	59 - 9
10	1.00 - 1	0.46 - 10	54 - 8

DO YOU WANT TO DELETE SAVED LAYOUT (Y/N) ?

TIME PER LAYOUT 0.14

Figure 3. List of alternative layouts with BLOCPAN 90

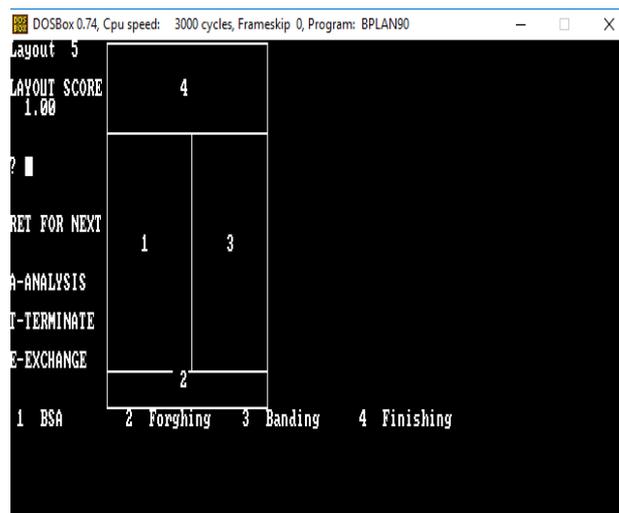


Figure 4. Alternative layout 1 with BLOCPAN 90

The following is an alternative layout 1:

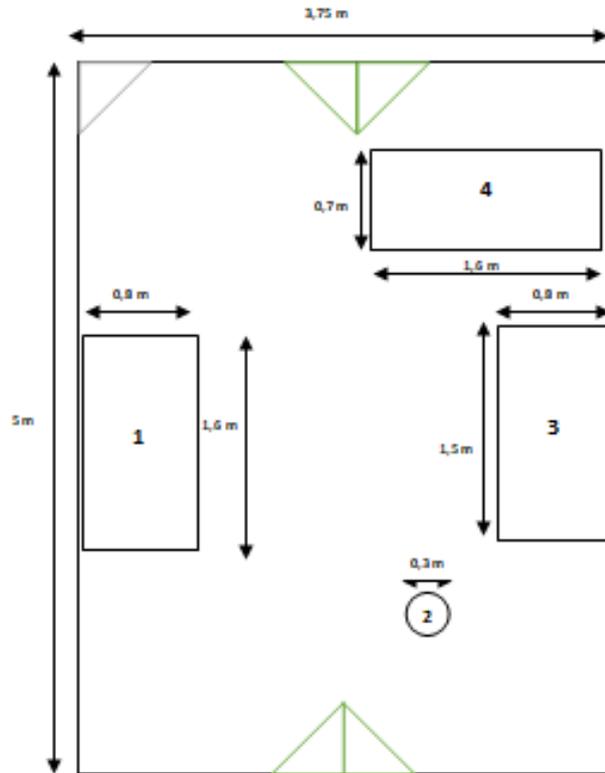


Figure 5. Alternative layout 1

Description:

Symbol 1 : BSA (Work station Burning, Shaping, and Assembly)

Symbol 2 : Forging (Work station Forging)

Symbol 3 : Blanding (Work station Blanding)

Symbol 4 : Finishing (Work station Finishing)

The line distance of the material movement using the Aisle Method in the alternative layout 1 is shown in Table 5.

Table 5. Calculation of alternative material line 1

No	From work station	To work station	Line distance calculation	Line distance	Frequency	Total line
1	Burning, Shaping and Assembly	Forging	$(1/2 \times 0.8 \text{ m}) + 0.25 \text{ m} + (1/2 \times 1.6 \text{ m}) + 0.25 \text{ m} + (1/2 \times 0.3 \text{ m})$	1.85 m	1	1.85 m
2	Forging	Blanding	$(1/2 \times 0.3) + 1.95 \text{ m} + 0.25 \text{ m} + (1/2 \times 1.75 \text{ m}) + 0.25 \text{ m} + (1/2 \times 0.5 \text{ m})$	3.735 m	3	11.205 m
3	Blanding	Burning, Shaping and Assembly	$(1/2 \times 0.8 \text{ m}) + 0.25 \text{ m} + 1.65 \text{ m} + 0.25 \text{ m} + (1/2 \times 0.8 \text{ m})$	2.95 m	1	2.95 m

4	Burning, Shaping and Assembly	Finishing	$(1/2 \times 0.8 \text{ m}) + 0.25 \text{ m} + (1/2 \times 1.6 \text{ m}) + 0.4 \text{ m} + 0.25 \text{ m} + 0.25 \text{ m} + (1/2 \times 1.6 \text{ m}) + (1/2 \times 0.7 \text{ m})$	3.5 m	2	7 m
Total line distance						23.005 m

From the table above, it can be seen that the traveling distance accompanied by the traveling frequency from the Burning, Shaping and Assembly work stations to the Finishing work stations is 23.005 meters. So that the improvement of the work station layout can reduce the ring production line distance from the previous 51.35 meters to 23.005 meters and a reduction of the line distance by 28.345 meters or a reduction of 55%. The following is an alternative layout 2.

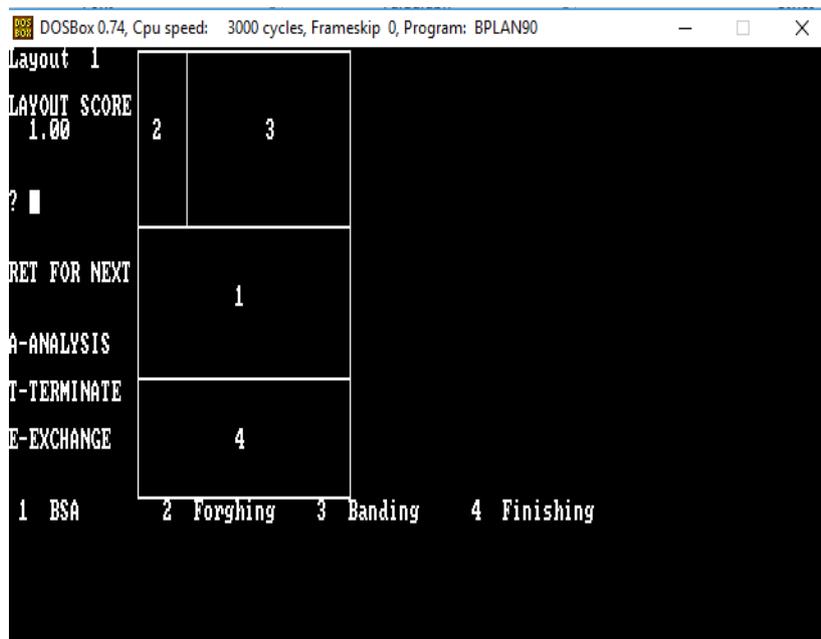


Figure 6. Alternative layout 2 BLOCPAN 90

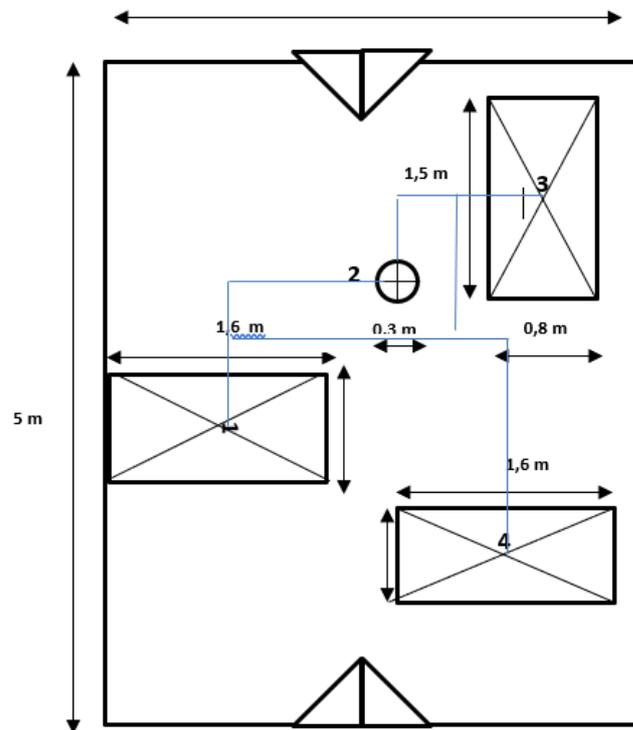


Figure 7. Alternative layout 2

The line distance of the material displacement using Aisle method in the alternative layout 2 is shown in the following table:

Table 6. Calculation of alternative material line 2

No	From work station	To work station	Line distance calculation	Line distance	Frequency	Total line
1	Burning, Shaping and Assembly	Forging	$(1/2 \times 0.8 \text{ m}) + 0.5 \text{ m} + 1.2 \text{ m} + (1/2 \times 0.3 \text{ m})$	2.25 m	1	2.25 m
2	Forging	Blanding	$(1/2 \times 0.3) + 0.5 \text{ m} + (1/2 \times 0.3 \text{ m}) + 0.35 \text{ m} + (1/2 \times 0.8 \text{ m})$	1.55 m	3	4.65m
3	Blanding	Burning, Shaping and Assembly	$(1/2 \times 0.8 \text{ m}) + 0.25 \text{ m} + 1.1 \text{ m} + 1.7 \text{ m} + 0.35 \text{ m} + (1/2 \times 0.8 \text{ m})$	3.65 m	1	3.65 m
4	Burning, Shaping and Assembly	Finishing	$(1/2 \times 0.8 \text{ m}) + 0.35 \text{ m} + 1.8 \text{ m} + 1.5 \text{ m} + (1/2 \times 0.7 \text{ m})$	4.4 m	2	8.8 m
Total line distance						19.35 m

From the table above, it can be seen that the displacement distance accompanied by the displacement frequency from the Burning and Assembly work stations to the Finishing work stations is 19.35 meters. So that the improvement of the work station layout can reduce the

distance of the ring production line from the previous 51.35 meters to 19.35 meters and reduce the line distance by 32 meters with a percentage of 62.31%.

3.6 Results of the work station layout design

Based on the results of data processing carried out on the production floor at MSE Silver 999 using BLOCPAN 90 software which uses 10 suggestions for the production layout improvement, then there is the highest R-Score value that is close to or fits the value of 1 found in the fifth layout. The fifth R-Score value is 1.00-1. And another alternative layout that is used is the first alternative layout with an R-Score of 0.82-2.00.

From these alternatives, it shows that the second alternative is shorter in travelling distance, but considering that in making this new layout it adjusts to the conditions of the room where there is an entrance and an exit in the middle so that the second image is considered ineffective because it can reduce the allowance in several work stations. From the alternative layout 1 that has been generated above, it can be seen that all work stations are close to each other and can provide space for the production process, and in and out of the production room. The following is a plan of the results of the facility layout improvement by considering the existing conditions of MSE Silver 999:

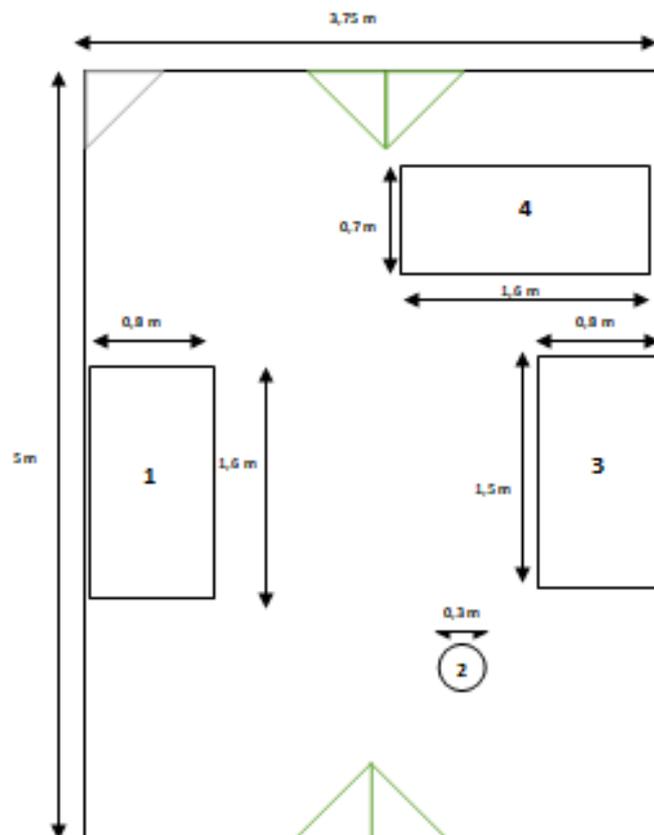


Figure 8. Blueprint of the work station layout design

4. Conclusion

Based on the results of research on MSE Silver 999, it shows that the area of the room is 18.75 m² and the layout in the production area has 5 work stations with one of the work stations outside the production room. With the redesign of the facility layout on the Production floor at MSE using

the Systematic Layout Planning method and the help of the BLOCPLAN 90 Software, it was found that the layout of the proposed new layout improvements occurred in a reduction in the production line distance from the previous 51.350 meters reduced to 23.005 meters. The resulting reduction in the track distance is 28.345 meters or 55.2%.

5. Acknowledgement

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