

Redesign The Facility Layout with Systematic Layout Planning Method on Battery Workshop at PT GMF Aeroasia

Ardiansyah Rendi Naufalah, Moh Ridwan Enan Sanusi and Ardhy Lazuardy

Department of Industrial Engineering

University of Indonesia

Depok, Indonesia

ardiansyah.rendi@ui.ac.id, moh.ridwan11@ui.ac.id, ardhylazuardy@gmail.com

Nurhadi Wibowo

National Research and Innovation Agency - Republic of Indonesia (BRIN-RI)

KST BJ Habibie

Puspiptek, Serpong, Indonesia

nurh4diwibowo@gmail.com

Abstract

PT GMF Aero Asia Tbk is one of the biggest aircraft maintenance companies in the region, engaged in maintenance or servicing aircraft and parts related. One of PT. GMF Aero Asia Tbk workshop still has the most significant problem and has not optimized on its production floor and does not yet have effectiveness for production. Researchers conducted observations in the field and processed the data using systematic layout planning (SLP) methods to redesign the facility layout approach to optimizing on the production floor. The data selected to be processed through OPC with the number of operations. Data processing using ARC, ARD, and flow process materials for alternative layouts and adjustment factor determination, looseness determination, area calculation. After processing the data, one alternate layout is generated with concern in distances and times. The results showed that decreased workload and decreased movement distance from every operation that already existed from the battery arrived until the end of the process, from 75% up to 95% optimized. By SLP method it can reduce material handling distance, alternative layout has 123.97 m² to 98.6 m² or area optimization as 20.46%.

Keywords

Facility Layout, Systematic Layout Planning, Battery Workshop, Plane Industry and Optimization.

1. Introduction

Facilities planning is a multifaceted process, influenced by numerous factors and variables which are not always necessarily in concert and at times may even have contradictory impact on the decision-making process (Matthew P. Stephens, 2013). Facility planning has a function as a means of supporting all activities that occur within the company in order to improve performance so that the company can develop more. Hence, every organization needs to adapt a good plant layout design that can help the organization reduce the overall process time consumed and the transferring of the materials. It helps the organization to eliminate unwanted work and process the most efficient operations (Kumar and Naga Malleswari 2022).

In designing the layout of the facility, things that need to be considered include the interrelationships between activities or departments in the ongoing production process, the ongoing production flow, and ergonomics aspects (Dema Apsari and Mahachandra, n.d.). Facilities planning analyze, optimize, and improve systems for the production of goods or services (Suhardi et al. 2019). Over the years, maintenance has become one of the most important factors a company or industry must meet. Maintenance includes functional testing, maintenance, repair or replacement of necessary appliances, equipment, machinery, building infrastructure and ancillary utilities in industrial, commercial and residential complexes. It includes several phrases that describe various low-cost practices

for keeping equipment operational. These activities occur before and after an outage. Many parts of an aircraft require maintenance to support the airworthiness of the aircraft (Mustakerov and Borissova 2013). One of the most important parts is the aircraft battery. It is needed to start the aircraft, standby power, and backup electricity in case of emergency. A battery is a device containing one or more cells that convert chemical energy directly into electrical energy. Nickel-cadmium batteries require relatively low maintenance, are reliable, have a wide operating temperature range and suitable for many aircraft types (Vutetakis 2009).

Indonesia is one of the regions with the highest fleet growth (7.4%) among other countries. To ensure the operation and safety of aircraft, regular maintenance and periodic repairs are needed by aircraft maintenance organizations. Aircraft Maintenance Repair and Overhaul (MRO) companies are in a business environment characterized by intense global competition. It requires effective management of maintenance costs, TAT (turnaround time), and accurate job standards (Ayeni et al., 2016). At present, PT GMF Aero Asia Tbk is the most outstanding and largest MRO company in Indonesia, as well as number 4 in Asia and number 9 in the world. GMF provides integrated solutions to 180 customers spread across 5 continents in more than 60 countries in the world (Adi et al., 2021). One of the services is battery maintenance which is carried out by the component maintenance unit (TC) at the battery shop. In general, the implementation of battery maintenance is cleaning, charging, and repairing. This facility has 4 employees that work office hours 08.00 until 17.00 from Monday to Friday. Based on preliminary observations and interviews with the employees, there are some activities that are not needed, crossing, and non-sequential, resulting in a large number of service queues. After being observed several times, the main cause is that there are many non-value-added activities in the service process. The non-value-added activities are back and forth employees for checking and unifying activities that should be separate.

1.1 Objectives

Based on the problems that found, this study aims to redesign the existing layout cause cross traffic in production floor using the Systematic Layout Planning (SLP) method, transportation equipment that helps to move material from the source to the destination such as conveyors and cranes, positioning equipment is used for handling material in one location or work machine so that it becomes easy for handling, machining, and subsequent storage of battery also optimized the layout for smooth production flow. This paper would not only do a critical review of existing facility planning techniques but also would provide future directions for helping both researchers and practitioners.

2. Literature Review

Systematic Layout Planning is a procedure used to set the layout of the workplace in a plant notice to the logical relationship between workplaces with high frequency are placed close to each other. SLP is a set of methodical, step-by-step techniques for the layout of design projects, which are suitable for almost all kinds of layout issues. SLP technique applied to optimize the existing layout. Phase in the Systematic Layout Planning are (Muther and Hales 1913):

Phase I: Determine the location of the area to be laid out.

Phase II: Establish the general arrangement of the area to be laid out.

Phase III: Locate each specific piece of machinery and equipment.

Phase IV: Plan the installation, seek the approval of the plan, and make the necessary physical moves.

Stages in the Systematic Layout Planning are:

1. Depiction Activity Relationship Chart
2. Depiction Activity Relationship Diagram
3. Depiction Space Relationship Diagram
4. Create a proposed layout
5. Evaluation of Improvements
6. Calculate the total moment of movement and time of the proposed process with the future stream mapping

The input data required by Systematic Layout Planning are the research problem's basis and entry point can be summarized into five essential elements of product P, production Q, production line R, auxiliary service department S, and production plan T. Among them, P and Q are the basis of all other conditions (Li et al., 2021). The framework of SLP is shown in Figure 1:

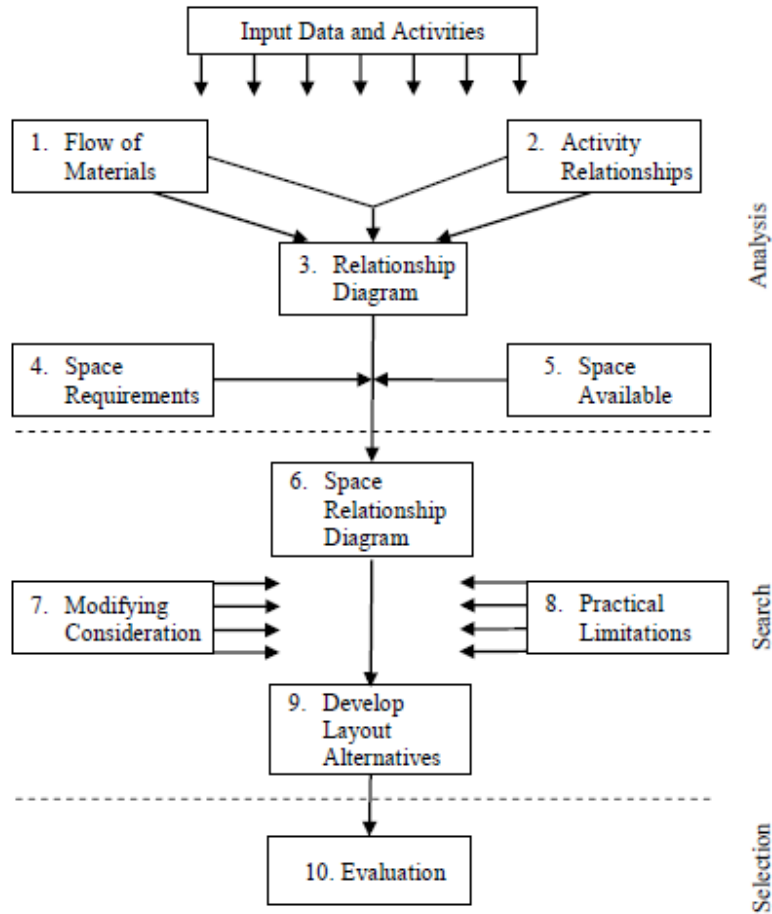


Figure 1. Muther's SLP Methodology (Tompkins, 2003)

Activity Relationship Chart (ARC)

Facility layout design requires consideration of the interrelationships between facilities of every department, office, or service area with every other department and area. Closeness codes are used to reflect the importance of each relationship. There is a degree of closeness to ARC which is expressed in letters and numbers, which can be seen in the following Table 1. (Muther and Hales 1913)

Table 1. Degree of Relationship

Code	Definition
A	Absolutely necessary
E	Especially important
I	Important
O	Ordinary importance
U	Unimportant
X	Closeness undesirable

Activity Relationship Diagram (ARD)

The ARD is a block diagram indicating approximate activity relationship, showing each activity as a single activity template (Apple 1990). The objective of ARD became a basis for planning the relationship between the material flow pattern and the location of service activities related to the production activity. This is what underlies the existence of ARC which is useful for planning and analyzing the linkages between activities, the resulting information is useful if it is processed in one diagram.

Space Relationship Diagram (SRD)

Evaluating the area of space needed for all activities carried out in the company and the available space is a process of making SRD that needs to be considered. making SRD is a continuation of the conclusion of the level of importance between activities in ARD and ARD, thus there are activities that must be close to other activities and vice versa. so that it can be said that the relationship between activities affects the level of closeness between the layouts of these activities (Putra 2022).

3. Methods

The research was done at Battery Shop PT GMF AeroAsiaTbk in Cengkareng home base. The research is expected to be completed within one month, carried out from the beginning of September to the end of November 2022. Research begins with field studies and literature. Furthermore, identify problems based on field studies that have been done. Procedure to relayout the production floor consists of three steps, such as analyzing the existing layout, designing the plant layout based on the SLP and the evaluation of alternative layouts. The determination of research objectives is based on the problem that occurs. Then set the boundaries of research. The next stage is data collection. The data collected are the size of the production floor area, the overall battery shop size, the size of the machinery and equipment, the amount of production per year, and each production process's cycle time. Then the data is processed by taking into account the distance and time during the production process. Generated design layout or new alternatives and minimize waste that occurs. Then make conclusions and suggestions for the research.

4. Data Collection

4.1 Initial Layout

The initial layout of the production floor of Battery Shop PT GMF Aero Asia Tbk can be seen in Figures 2 and 3.

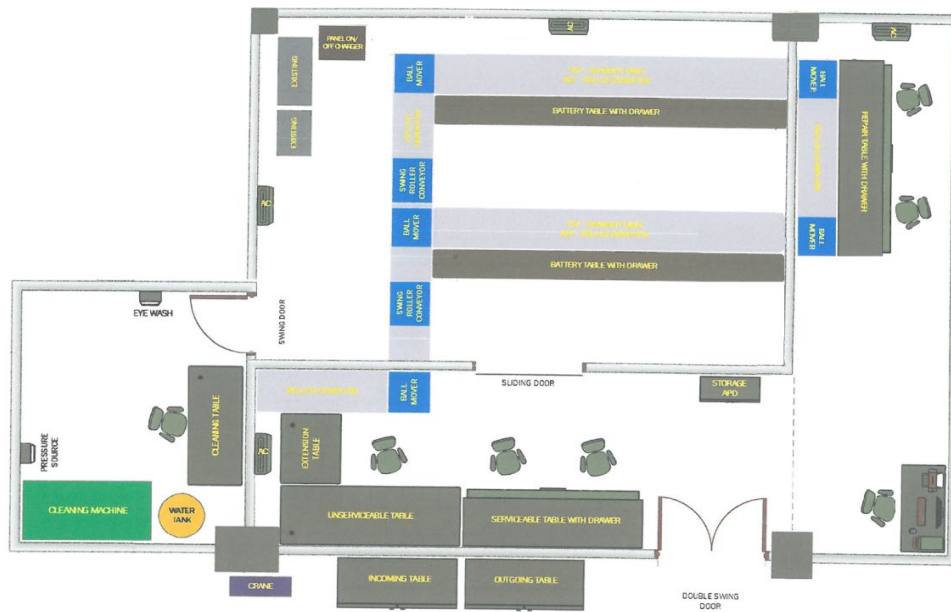


Figure 2. Existing 2D layout of GMF AeroAsia Battery Shop

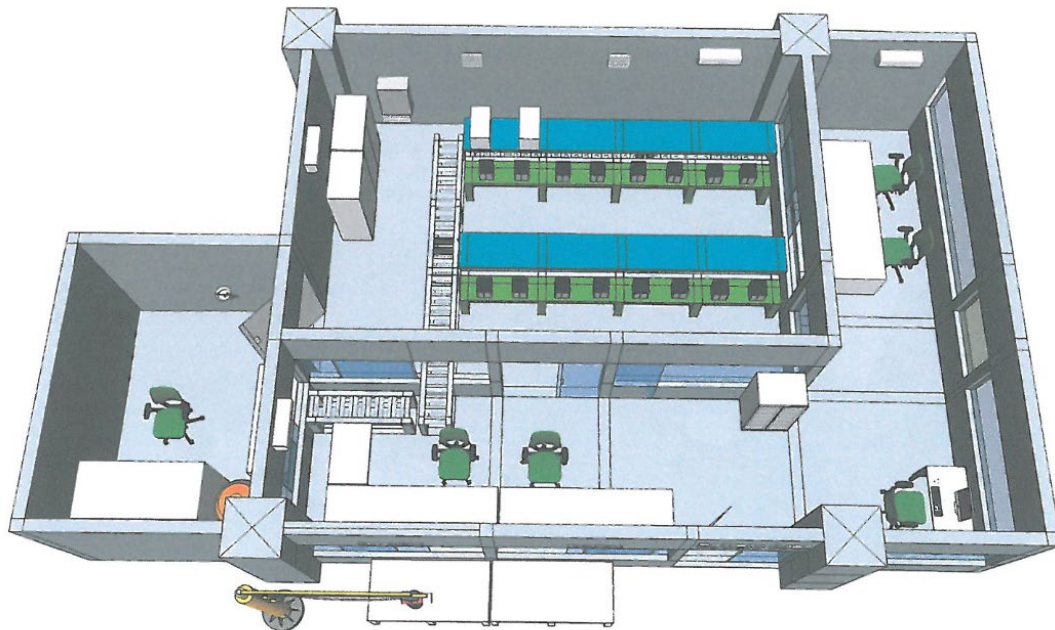


Figure 3. Existing 3D layout of PT GMF AeroAsia Battery Shop

4.2 Floor Area

Based on data collected on the production floor of PT GMF AeroAsiaTbk, researchers obtained data on the area of the production floor is 123.97 m². The following is the floor area data of each process based on the initial layout of PT GMF AeroAsiaTbk as follows (Table 2).

Table 2. Dimension of Battery Workshop

Work Area	Total	Dimensions		Area
		Length (m)	Width (m)	
Unserviceable Area	1	3 m	1 m	3 m ²
Disassembly	1	9 m	3 m	27 m ²
Discharge/Charge	1	9 m	5.75 m	51.75 m ²
Cleaning Area	1	4.2 m	3.6 m	15.12 m ²
Inspection Area	1	5.75 m	2.75 m	15.81 m ²
Assembly Area	1	3 m	2.75 m	8.25 m ²
Serviceable Area	1	3 m	1 m	3 m ²
Total Area				123.97 m ²

4.3 Production Flow

The flow of the battery maintenance process in PT GMF AeroAsia Tbk can be seen in Figure 4.

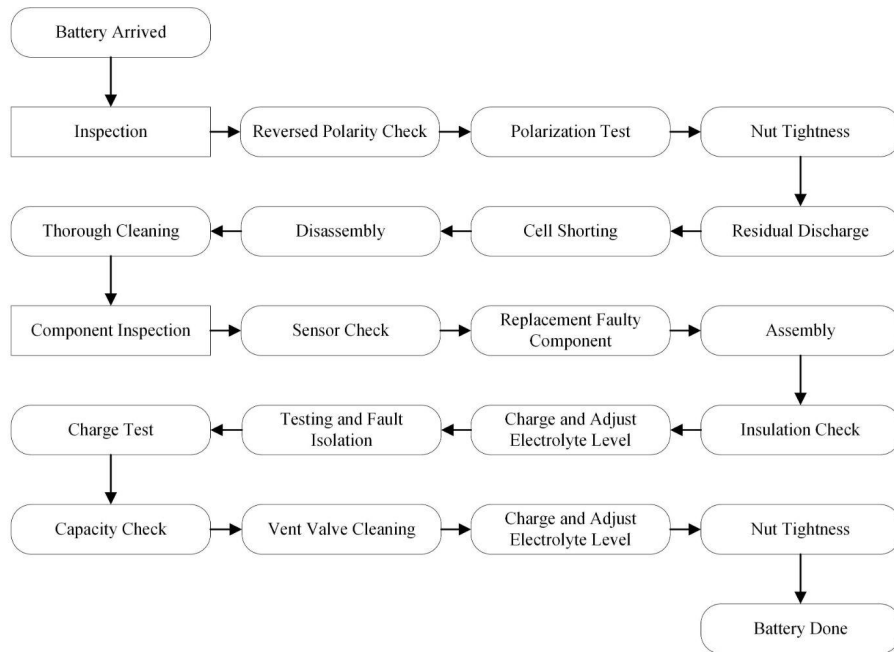


Figure 4. Flow Process of Battery Maintenance

5. Results and Discussion

5.1 Activity Relationship Chart (ARC)

Activity Relationship Chart (ARC) on the workshop floor illustrates the close relationship between existing facilities which is characterized by the degree of relationship along with the reasons (Figure 5 and Table 3).

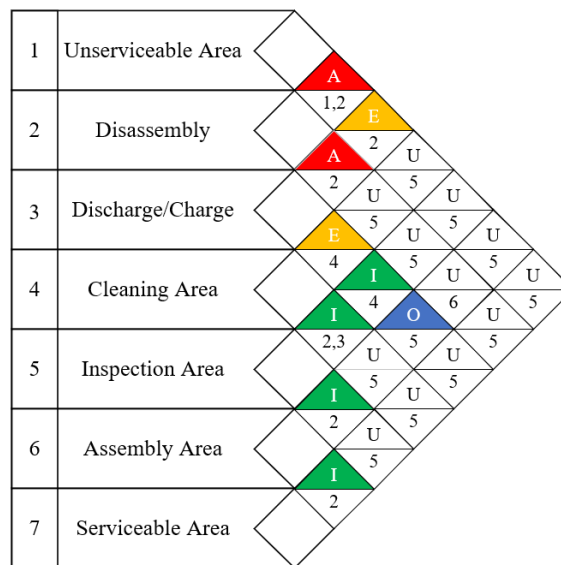


Figure 5. Activity Relationship Chart (ARC)

Table 3. Additional reasons

1.	Using the same notes
2.	Using the same personnel
3.	Using the same room
4.	Personnel relationship level
5.	Workflow sequence
6.	Noisy, dirty, noisy, vibration etc.

5.2 Activity Relationship Diagram (ARD)

Activity Relationship Diagram (ARD) the activity relationship diagram, also called an *affinity analysis diagram*, shows the relationship of every department, office, or service area with every other department and area (Figure 6). It answers the question, how important is it for this department, office, or service facility to be close to another department, office, or service facility. Closeness codes are used to reflect the importance of each relationship (Matthew P. Stephens 2013) (Table 4).

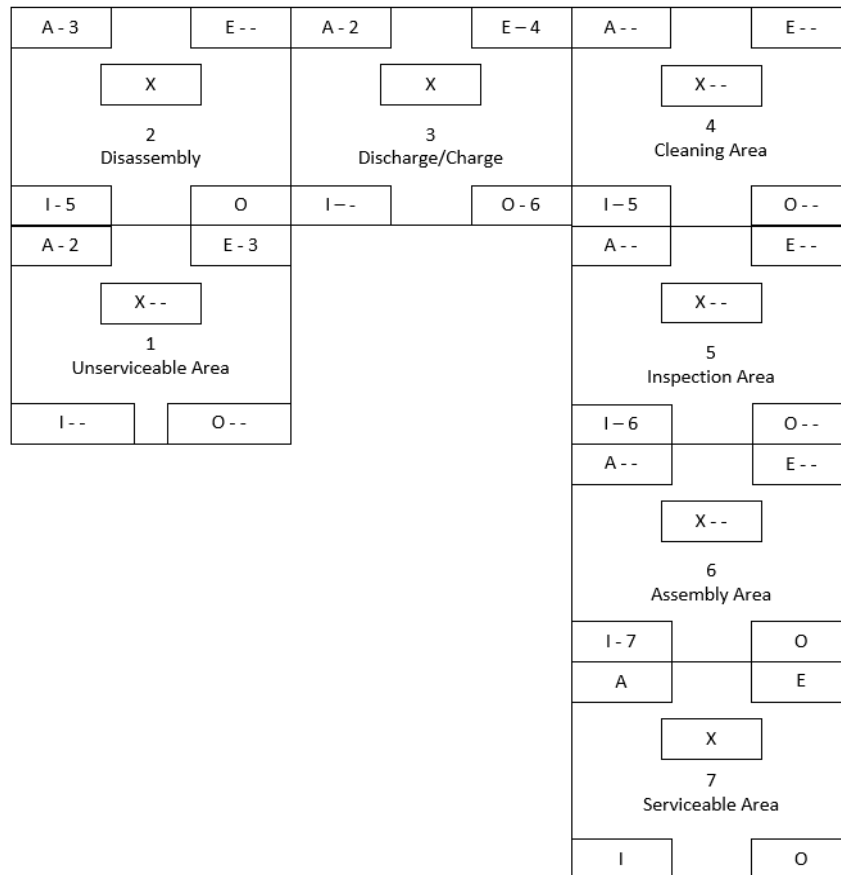


Figure 6. Activity Relationship Diagram (ARD)

Table 4. Degree of Relationship

No	Area	Degree of Relationship					
		A	E	I	O	U	X
1	Unserviceable Area	2	3	-	-	4,5,6,7	-
2	Disassembly	3	-	5	-	4,6,7	-
3	Discharge/Charge	2	1,4	5	6	7	-
4	Cleaning Area	-	-	5	-	6,7	-
5	Inspection Area	-	-	6	-		-
6	Assembly Area	-	-	7			-
7	Serviceable Area	-	-	-	-	-	-

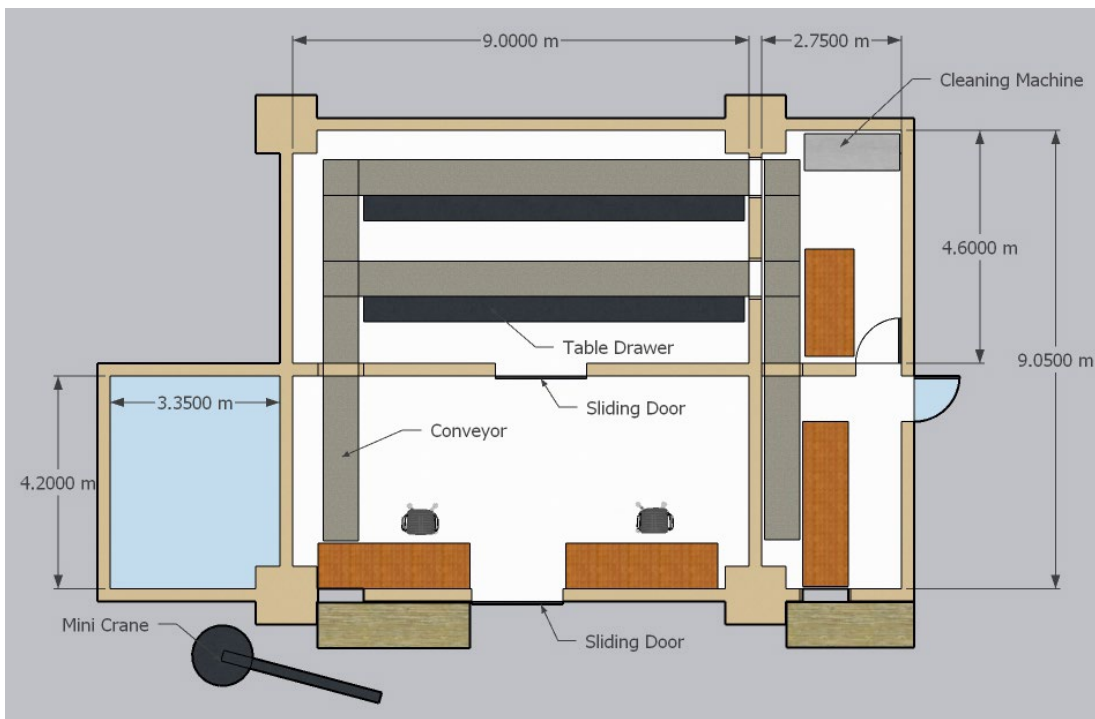


Figure 7. Layout after improvement

Considering the ARD results that have been made, we propose a U-shaped layout to optimize the work process in terms of workload and motion-movement efficiency. A U-shaped line also called U-line is a type of manufacturing layout that is commonly used to replace straight-shaped lines in the JIT cellular manufacturing system (Figure 7). The purpose of utilizing the U-line is to attain compromised benefits between flexibility and productivity resulting from the hybrid operation of job shop and flow shop (Miltenberg 2001). The advantages and issues to be aware of when adopting U-lines in the JIT system were discussed in Aase et al. (2004), Kara et al. (2009) and Erel et al. (2001).

Table 5. Area information for layout after improvement

Work Area	Total	Dimensions		Area
		Length (m)	Width (m)	

Unserviceable Area	1	3 m	1 m	3 m ²
Disassembly	1	9 m	3 m	27 m ²
Discharge/Charge	1	9 m	4.6 m	41.4 m ²
Cleaning Area	1	4.6 m	2.75 m	12.65 m ²
Assembly & Inspection Area	1	4.2 m	2.75 m	11.55 m ²
Serviceable Area	1	3 m	1 m	3 m ²
Total Area				98.6 m ²

After applying improvements, the area that was previously used as a cleaning area was no longer used after optimizing the layout utilization of the entire workshop area. The utilization area after improvement is 98.6 m² or an area optimization of 20.46 % (Table 5).

Table 6. Processes flow and description

Process	Description
A	Battery arrival
B	Inspection
C	Nut Tightness
D	Discharge
E	Disassembly
F	Cleaning
G	Inspection
H	Assembly
I	Charging
J	Serviceable

Table 7. Comparison between existing activity - distance relationship and after improvement

Existing		After Improvement		Optimization (Movement reduction)
Process	Distance	Process	Distance	
A - B	12 m	A - B	3 m	75.00%
B - C	12 m	B - C	3 m	75.00%

C - D	2 m	C - D	0.5 m	75.00%
D - E	4 m	D - E	0.5 m	87.50%
E - F	8 m	E - F	0.5 m	93.75%
F - G	20 m	F - G	4 m	80.00%
G - H	10 m	G - H	0.5 m	95.00%
H - I	2 m	H - I	0.5 m	75.00%
I - J	4 m	I - J	0.5 m	87.50%

5.3 Proposed Improvements

Based on the new layout that has been made in order to achieve optimal design that supports the activity processes and moving material, or the objects must be supported by using an automatic conveyor that can be adjusted for movement back and forth.

6. Conclusion

After analyzing and calculation, research results on applying systematic layout planning methods obtained alternative proposed layouts that can be applied to optimize increase production effectiveness the area utilization existing layout from 123.97 m² to 98.6 m² or area optimization as a 20.46% and decrease movement distance from every operation that already exist from battery arrived and the end of the process from 75% up to 95%.

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Biographies

Ardiansyah Rendi Naufalah was born in Surabaya, East Java, Indonesia, in 1997. He received an associate degree in electrical engineering from Politeknik Elektronika Negeri Surabaya (Electrical Engineering Polytechnic Institute of Surabaya) in 2019. He is an undergraduate student at University of Indonesia majoring in Industrial Engineering. He was a Tourism Ambassador of Surabaya and active in the organization. He is an Aircraft Engineer at PT GMF Aeroasia Tbk and a freelance consultant at CV Mega Karya Manunggal.

Moh Ridwan Enan Sanusi graduated from Politeknik Negeri Bandung (Bandung State Polytechnic) with an associate degree in Chemical Engineering. He previously worked as an operator in the manufacturing industry and as Group Head production in the F & B industry, and then continued his study as a student undergraduate in Industrial Engineering at the University of Indonesia.

Nurhadi Wibowo is an Engineer at The National Research and Innovation Agency – Republic of Indonesia (BRIN-RI). He earned Doctoral Degree from Industrial Engineering Department, Universitas Indonesia. Nurhadi has completed Indonesian government research projects in the mining industry and is concerned with strategy, optimization, and circular economy.

ArdhyLazuardy is a doctoral student majoring in Industrial Engineering at the University of Indonesia. He completed his master's degree at Gunadarma University, Indonesia, majoring in Industrial and Organizational Psychology, and bachelor's Education at Gunadarma University with a major in Industrial Engineering. He has four years of experience as a Quality Assurance in a calibration and testing service company. He continues his career as a lecturer at Gunadarma University until now.