World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(Research Article)

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Locomotive maintenance facility layout design using systematic layout planning method: Case study of Semarang Poncol locomotive depot

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World Journal of Advanced Research and Reviews, 2023, 19(03), 743–756

Publication history: Received on 06 August 2023; revised on 14 September 2023; accepted on 16 September 2023

Article DOI: https://doi.org/10.30574/wjarr.2023.19.3.1876

Abstract

The Locomotive Depot has a maintenance layout with 6 main lines as maintenance lines. The layout of the facilities is also a problem at the Semarang Poncol locomotive depot because only 1 line can effectively carry out maintenance and repairs so this is a disadvantage because of the dense queue of locomotives wishing to be on duty carrying out daily checks or monthly checks. The problem is that these 3 routes are often 2 of which are not maximized properly and are only used as a place to wait for the repair process and 1 route is effective as a place for maintenance. The Systematic Layout Planning method is a method that plans the layout. The aim of arranging facilities is to increase work productivity and optimize the use of facilities such as work areas, machines and labor. One way to design a facility layout is to pay attention to the sequence of processes and the degree of closeness between units in the facility to be designed. Then, to calculate material handling at the Semarang Poncol Locomotive Depot using the systematic layout planning method, the results obtained from calculating material handling costs from the Semarang Poncol Locomotive Depot were Rp. 99,990/meter and for material handling equipment data, forklifts require material handling costs of Rp. 3,759,649 and for the high diesel speed (HSD) pump requires material handling costs of Rp. 84,288. For the proposed space requirements for each department or room, starting from the spare parts warehouse, the distance changes after calculating 0. Then the used spare parts warehouse changes the distance by -4.7, the lubricant warehouse by -0.1 and the fuel tank by +12.1. Space requirements are seen from the process (towards the maintenance route) after calculating the varying space requirements. From the very first lubricant warehouse and workshop, the distance change after calculating -3. Then followed by TPS B3 used lubricant of -1.9. Then the tool space is +1.1. Then the monitoring room is -5.5. Then the backup generator is -1.5. Furthermore, warehouse facilities are -6. Then the KR/staff space is -3.6. Then the TPS B3 filter is -0.3. Then the rotary spoiler is +13.4 and finally the lubricant warehouse II is +6.3 m2. With these calculations, after carrying out various data processing calculations, the proposed calculation using the systematic layout planning method is in accordance with the character of the Semarang Poncol Locomotive Depot as a service workshop owned by PT. Indonesian Railways. The proposal submitted to the Semarang Poncol Locomotive Depot can be used as a reference in designing the layout of the existing facilities at the Semarang Poncol Locomotive Depot in order to shorten the process flow and material flow for the maintenance process.

Keywords: Systematic Layout Planning (SLP); Facilities Layout; Maintenance Planning

1. Introduction

The Locomotive Depot has a maintenance layout with 3 main lines as the maintenance lines. The maintenance system at the Semarang Poncol locomotive depot has a classification with daily check maintenance as daily maintenance for every time a locomotive wants to be in service and also monthly checks, namely maintenance carried out every month to keep the locomotive in prime condition. Of course, with dense and regular maintenance activities, the Semarang Poncol locomotive depot must utilize every existing facility and an effective layout is needed in terms of maintenance

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and also the time between queues of locomotives for maintenance. The layout of the facilities is also a problem at the Semarang Poncol locomotive depot because only 1 line can effectively carry out maintenance and repairs so this is a disadvantage because of the dense queue of locomotives wishing to be on duty carrying out daily checks or monthly checks. With this problem, the locomotive depot must plan the selection of a suitable facility layout so that the maintenance queue process can be resolved, the maintenance process cuts time quickly, all facilities, both spatial layout and maintenance support facilities, can be used optimally. The Semarang Poncol Locomotive Depot also has a complex locomotive maintenance layout with 3 main lines as a locomotive maintenance place for the large class locomotive depot in the Operational Area (DAOP) 4 Semarang area, but the problem is that these 3 lines are often 2 of which are not maximized properly and are only used as a place waiting for the repair process and 1 effective route as a place for maintenance. Locomotive repairs must maximize work time, efficiency of spare parts and fuel supply on each line and effectiveness of all lines used for maintenance. Apart from that, the layout also influences the performance of the locomotive repair itself because the influence of the work layout also has an important role in the continuity of locomotive repairs. Therefore,

This research has the main objective of designing the layout of a new maintenance facility where with the layout of the new maintenance facility it is hoped that the maintenance process can be made more efficient. Designing a new maintenance layout where the new facility layout is expected to maximize existing maintenance facilities. This research will also look at the development of several journals from year to year, from the publishing country and also related citations to gain an understanding of Systematic Layout Planning and the authenticity of the publisher.

2. Research methodology

SLP (Systematic Layout Planning) is a procedure that describes the steps in the production layout planning process. The aim of arranging facilities is to increase work productivity and optimize the use of facilities such as work areas, machines and labor. One way to design a facility layout is to pay attention to the sequence of processes and the degree of closeness between units in the facility to be designed. This method can also be used to redesign facility layouts to minimize material movement distance, degree of proximity, and production process time. So it can increase product productivity. Continuous improvement is required in product productivity. Selection of appropriate criteria also depends on the situation when carrying out the Systematic Layout Planning (SLP) Method [1].

Use Systematic Layout Planning (SLP) as a powerful, efficient system to improve material flow throughout the manufacturing process and ultimately reduce lead times to increase customer satisfaction and improve energy management. The results of using Systematic Layout Planning minimizing travel distance and material handling along with the energy assessment carried out verified that there was a significant reduction in feet traveled per day and a substantial increase in energy savings. Implementing such a layout improvement project resulted in a 16.66% to 33% reduction in product lead times (heat treatment baskets), a significant reduction in weekly overtime hours, and a sizable improvement in energy use [2].

Application of the Systematic Layout Planning (SLP) methodology and determination of layout indicators with specific application to the restaurant business.first, a previously unexplored area of approximately 5.40 m2 was finally used as a productive area for operations; second, reducing work in process by 40 percent by moving food refrigerators and freezers from production areas; third, indirect indicators, such as customer satisfaction and employees' workplace environment, have improved their performance, as customers are better served and the work environment has become more conducive to good employee performance. in food service businesses, such as restaurants, and proposes the utilization of certain layout indicators [3].

The problem of factory layout between the raw material warehouse and the production area where the two departments have an advantage of more than 29 meters. and takes more than 10 minutes for one movement.The results obtained are 2 alternative layouts with different distances and department positions which have been processed in FTC, ARC, ARD, AAD. The results of this research selected layout alternative 2, because it has shorter distances between departments, a more orderly production/administration process, and less intersection space compared to alternative layout 1[4].

Systematic spatial planning (SLP) is used to improve spatial distances between facilities (machines and work stations) and also improve material flow in the factory. With SLP, it is hoped that material handling costs will be reduced significantly, workers will move faster and overall productivity will increase [5].

MethodSystematic Layout Planning is a method withThe layout is carried out to optimize work processes, always ensuring the safe flow of materials, people and information. There are several layout planning algorithms that can be used, each with its own characteristics, advantages and disadvantages. SLP is a widely used methodology, especially in small to medium-sized companies, due to its accessibility[6].

SLP is a procedural layout design approach. The process of conducting SLP is relatively easy; however, it is a proven tool in providing layout design guidelines in practice in recent decades. AHP allows decision makers to determine their preferences using a verbal scale. This verbal scale can be very useful in helping groups or individuals to make unclear decisions [7].

2.1. Systematic Layout Planning

The layout process using SLP has principles that can be used as a basis for research. The systematic process of the Systematic Layout Planning method which has been generally explained above will be described in the following steps:

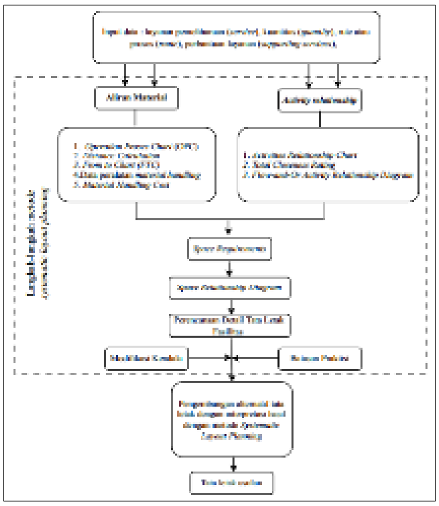


Figure 1 Identification scheme using the Systematic Layout Planning (SLP) Method

3. Results and discussion

3.1. Operation Process Chart (OPC)

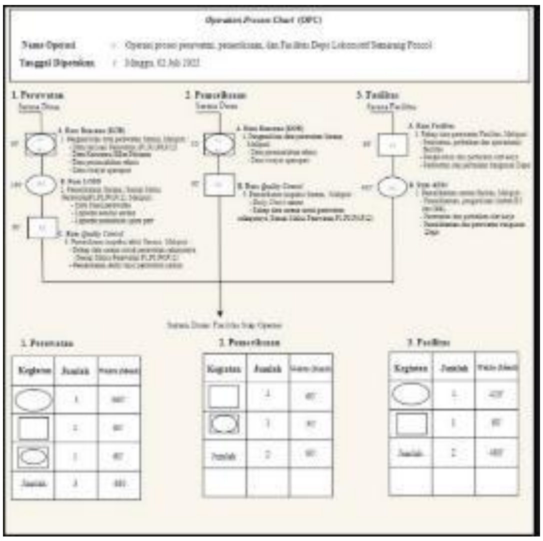


Figure 2 *Operation Process Chart* (OPC) Semarang Poncol Locomotive Depot

In this research case study, because the layout does not produce a product but rather produces a service, the process flow uses an Operation Process Chart (OPC) because the process of maintenance services at the Semarang Poncol locomotive depot is one process on job (one process for one job).). There are 3 service processes at the Semarang Poncol locomotive depot, namely maintenance, inspection and facilities. The operation process at the locomotive depot involves many section divisions that contribute to maintenance, inspection and facilities, of course this operation process is carried out on average in one working day. This is because the service process of the facilities must be maximized so that train travel is not disrupted and the service facilities remain in prime condition.

3.2. Distance Calculation (Distance Calculation)

In this process, by calculating the total distance between departments, From to chart and calculating the total distance of material movement to determine the total existing distance, with the following explanation:

3.2.1. Calculation of distances between departments

Distance calculations between departments are carried out for departments that play a role in the maintenance service process flow of the Semarang Poncol locomotive depot from the supply of spare parts or fuel to the maintenance line, namely as follows:

1. Spare Parts Warehouse withMaintenance Path (Path 1,2,3,4,5,6)

Euclidean formula $\sqrt{(Xa - Xb)^2 + (Ya - Yb)^2}$:

= 71,180 m.

2. Maintenance Line (Line 1,2,3,4,5,6) with Lubricant Warehouse

Euclidean formula $\sqrt{(Xa - Xb)^2 + (Ya - Yb)^2}$:

= 67.079 m.

3. Lubricants Warehouse with DC Room, Pertamina Logistics Room

Euclidean formula $\sqrt{(Xa - Xb)^2 + (Ya - Yb)^2}$:

= 71.424 m.

4. DC Room, Pertamina Logistics Room, Workshop with Lubricant Warehouse

Euclidean formula $\sqrt{(Xa - Xb)^2 + (Ya - Yb)^2}$:

= 73.619 m

5. Lubricant Warehouse, workshop with Tool Room

Euclidean formula $\sqrt{(Xa - Xb)^2 + (Ya - Yb)^2}$:

= 74.559 m

So, the total distance between the maintenance line and the maintenance process flow (spare parts warehouse, lubricant warehouse, DC room, Pertamina logistics room, workshop lubricant warehouse, tool room) until the maintenance process is completed is 357,861 m.

3.2.2. From to Chart (FTC)

From to Chart(FTC) is a conventional technique that is commonly used for planning factory layout and moving materials in a production process. From to Chart, sometimes called a trip frequency chart or travel chart, is a conventional technique that is commonly used for planning factory layout and material movement in a production process. This technique is very useful for conditions where many items flow through an area such as a job shop, machining workshop, office and so on.[1]. The following are the results of calculations from From to Chart using the Systematic Layout Planning method:

Table 1 From to Chart

To / From	Total
Spare Parts Warehouse	71.18 m^2
Maintenance Line	67,079 m^2
Lubricants Warehouse	71,424 m^2
DC Room, Pertamina Logistics	73,619 m^2
Lubricant Warehouse, Workshop	74,559 m^2
Total	**357,861** m^2

3.2.3. Calculation of total material movement distance

The following are the calculation results of the total material movement distance using the Systematic Layout Planning method:

Table 2 Total distance calculation

Material flow		**Total distance(M/month)**
Spare parts warehouse	Maintenance line	71.33 m^2
Lubricant warehouse	Maintenance line	67,259 m^2
Pertamina logistics	Maintenance line	1956,259 m^2
Total Distance		2094,848 m^2

3.2.4. Material handling equipment data

The following is a calculation of material handling using the Systematic Layout Planning method:

Forklift

Material Handling Costs = Forklift Costs + Operator's Salary + Forklift Maintenance Costs

=Rp.689,649 + Rp. 2,950,000 + Rp. 120,000

= Rp. 3,759,649

High Speed Diesel Pump

Material Handling Costs = High Diesel Speed Pump Costs + Operator salary + High Diesel Speed Pump maintenance costs

=Rp.84,288+ 0 + 0

= Rp. 84,288

3.2.5. Material Handling Costs (Material Handling Costs)

The following is a calculation of material handling costs using the Systematic Layout Planning method:

Total Material Handling Costs

Based on material movement costs in material handling movement data of Rp. 3,759,649 and the total distance that must be traveled using a forklift is 37.6 meters.

Material handling costs per meter

Material Handling Costs per meter

$$= \frac{Total\ biaya\ perpindahan\ material}{Total\ jarak}$$

$$= \frac{Rp.3.759.649}{37,6}$$

= Rp. 99,990 / meter

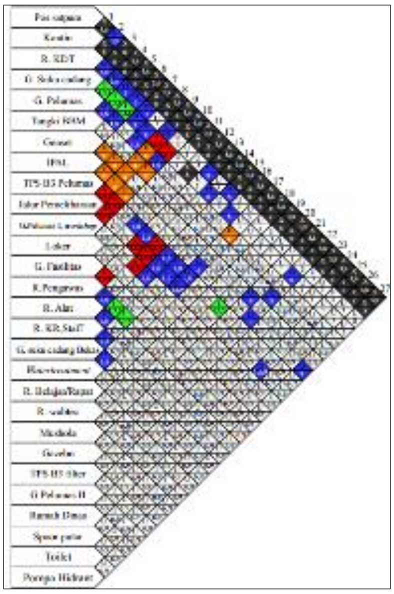
3.3. Other Than Flow Relationships

3.3.1. Activities Relationship Chart

A relationship chart is a cross-sectional form in which the relationship between each one activity (or function or area) and all other activities can be recorded. Relationship charts show which activities have relationships with others. Also, it assesses the importance of proximity between them and supports the ranking with coded backup reasons. These steps make relationship charts one of the most practical and effective tools available for layout planning. This is undoubtedly the best way to integrate support services with operations or production departments and planning the layout of offices or service areas that have little or no material flow[1]. The following is a determination of the Activities Relationship Chart by looking at the existing needs at the Semarang Poncol locomotive depot:

	Reason
1	Movement of equipment & supplies
2	Convenience
3	Administrative work flow
4	Utilities distribution
5	Reception of visitor
6	Risk/Hazard to visitors
7	Light
8	Personal Contact
9	Noise, Disturbance

Value	RELATIONSHIP
A	Closeness absolutely necessary
E	Closeness especially important
I	Closeness important
O	Ordinary closeness OK
U	Closeness unimportant
X	Closeness not desirable



Value	CLOSENESS	No. of Ratings
A	Closeness absolutely necessary	10
E	Closeness especially important	10
I	Closeness important	6
O	Ordinary closeness OK	36
U	Closeness unimportant	314
X	Closeness not desirable	59
Total =	$\frac{N\ X\ (N-1)}{2}$	435

Figure 3 Activity Relationship Chart

In the Activity Relationship Chart (ARC) results above, the relationship between departments can be seen. From the results above, there are reasons underlying this relationship. It is important to have the maintenance line close to the lubricant warehouse/workshop, spare parts warehouse, lubricant warehouse, fuel tank, because it facilitates the movement of materials, maintenance processes and inspection of facilities in order to achieve efficiency in carrying out facility maintenance. Then for the Administration section, the KR Room or Staff Room and the Supervisory Room have a better close relationship, this is aimed at simplifying the administration process and licensing and supervision processes. For generators, waste water distribution installations (IPAL), water treatment, B3 filters and lubricants have an important relationship, especially because they are utility processes from the Semarang Poncol Locomotive Depot. Then for KDT rooms, security posts, canteens/cooperatives, prayer rooms, official residences there are reasons for the degree of employment relationship. The connection between the maintenance line and the spare parts warehouse, lubricant warehouse, lubricant warehouse/workshop, fuel tank is essential to be close because it facilitates the movement of material flow. For the maintenance and waste processing process (IPAL, Watertreatment, B3 Filters and lubricants) it is very important to be a little far away but not too far away because it is a utility process. Lubricant warehouse/workshop, fuel tanks are absolutely essential to be close to because they facilitate the movement of material flow. For the maintenance and waste processing process (IPAL, Watertreatment, B3 Filters and lubricants) it is very important to be a little far away but not too far away because it is a utility process. Lubricant warehouse/workshop, fuel tanks are absolutely essential to be close to because they facilitate the movement of material flow. For the maintenance and waste processing process (IPAL, Watertreatment, B3 Filters and lubricants) it is very important to be a little far away but not too far away because it is a utility process.

3.3.2. Total Closeness Rating

*Total Closeness Rating*is an activity calculation based on the Activity Relationship Chart on the degree of relationship value. This Total Closeness Rating calculation looks for the ranking of which department has the highest number of ratings, which is the department that must be given priority. This Total Closeness Rating calculates the number of numerical values calculated based on systematic closeness relationship ratings.[1]. The following are the calculation results of the total closeness rating using the Systematic Layout Planning method:

Table 3 Calculation of Total Closeness Rating.

Department/Room/Warehouse		**TCR**	**Orders**
1	Security post	-259990	27
2	Canteen, Cooperative	-270000	28
3	R. KDT	-9902	6
4	G. Spare parts	-9627	5
5	G. lubricant	-17833	10
6	Fuel tank	-17851	11
7	Generator Backup	-16852	9
8	WWTP	-15943	8
9	TPS B3 Used lubricants	12182	3
10	Maintenance Line	34061	1
11	G. lubricants, Workshop	22037	2
12	Locker	-29976	26
13	G. Facilities	-19759	13
14	R. Supervisor	-9931	7
15	R. Tools	10139	4
16	R. KR, R. Staff	-19822	14
17	G. Used spare parts	-19939	15
18	*Water Treatment*	-18940	12

Department/Room/Warehouse		TCR	Orders
19	R. Study/Meeting	-19975	23
20	R. Wabtec	-19975	24
21	Prayer room	-19975	22
22	Gazebo	-19966	20
23	TPS B3 Filter	-19948	16
24	G. Lubricants II	-19975	21
25	Official residence	-19975	25
26	Swivel spoiler	-19966	17
27	Toilet	-19966	18
28	Hydrant Pump	-19966	19

3.3.3. Flow-and-Or Activity Relationship Diagram.

The following are the results of determining the Flow-and-Or Activity Relationship Diagram using the Systematic Layout Planning method:

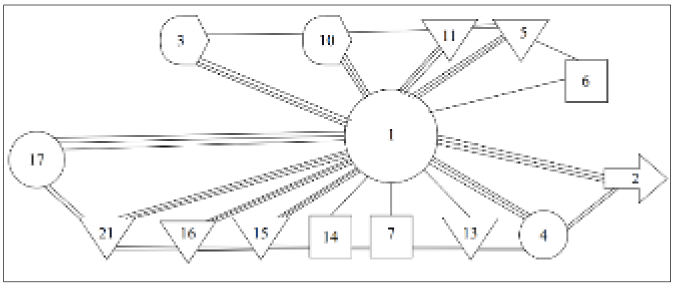


Figure 4 Flow-and-Or Activity Relationship Diagram (seen from the processes at the Semarang Poncol Locomotive Depot from the Activity Relationship Chart)

From the flow-and-Or Activity Relationship diagram, the first process involved in the Semarang Poncol locomotive depot is the Maintenance Line, then the maintenance line involves the process or transportation of materials from the lubricant warehouse and work from the workshop and proximity is especially important. Then the maintenance line also involves the tool room because it is necessary to supply tools for the maintenance process to the maintenance line and proximity is especially important. Then the maintenance line also involves handling from TPS B3 used lubricants because it is necessary to handle used lubricants from the maintenance line and proximity is especially important. Then the maintenance line also involves the Spare Parts Warehouse because of the need to supply spare parts to the maintenance line and proximity is especially important. Then the maintenance line also involves supplies from the Lubricant Warehouse because of the need for lubricant supplies for the facilities that will be carried out maintenance on the maintenance line and proximity is especially important. Then the maintenance route also involves the supply of fuel tanks because it is necessary to supply fuel for the facilities that will be carried out maintenance on the maintenance route and proximity is especially important. Then the maintenance line also involves the used spare parts warehouse because there is a need for a place to control used spare parts from the maintenance line and proximity is especially important. Then the maintenance line also involves handling the TPS B3 filter because it is necessary to handle or clean the air filter from consumables from the maintenance line and proximity is especially important. Then the maintenance line also involves a rotary spoiler because of the need for a place for the locomotive to carry out the rotary shunting, usually the locomotive which has the end section with the best vision will be the front (Example CC201, CC203) on the maintenance line and proximity is especially important. Then the maintenance line involves the process or transportation of materials from lubricant warehouse II and proximity is especially important. And for the important proximity of the maintenance process at the Semarang Poncol Locomotive Depot,

3.3.4. Space Requirements

The following are the results of determining Space Requirements based on the Systematic Layout Planning method:

Table 4 Space requirements are seen in terms of material flow

No	From	To	Distance Change (m2)
1	Spare parts warehouse	Maintenance line	0
2	Used spare parts warehouse	Maintenance line	-4.7
3	Lubricant warehouse	Maintenance line	-0.1
4	Fuel tank	Maintenance line	+12.1

Table 5 Space requirements are seen from the maintenance process

No	From	To	Distance Change (m2)
1	Lubricant warehouse, Workshop	Maintenance line	-3
2	TPS B3 Used lubricants	Maintenance line	-1.9
3	Tool Room	Maintenance line	+1.1
4	Spare Parts Warehouse	Maintenance line	0
5	Monitoring Room	Maintenance line	-5.5
6	Generator Backup	Maintenance line	-1.5
7	Lubricant warehouse	Maintenance line	0
8	Fuel tank	Maintenance line	+12.1
9	Facility Warehouse	Maintenance line	-6
10	KR Room, Staff Room	Maintenance line	-3.6
11	Used spare parts warehouse	Maintenance line	-4.7
12	TPS B3 Filter	Maintenance line	-0.3
13	Swivel spoiler	Maintenance line	+13.4
14	Lubricants Warehouse II	Maintenance line	+6.3

From table 5, space requirements in terms of material flow can be explained that from the spare parts warehouse to the maintenance line with the distance from the Semarang locomotive depot, the change in distance is -3 m^2. Then the used spare parts warehouse goes to the maintenance line with the distance from the Semarang Poncol locomotive depot changing the distance to -4.7 m^2. Then the lubricant warehouse goes to the maintenance line with the distance between the Semarang Poncol locomotive depot and the change in distance is -0.1 m^2. Then the fuel tank goes to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is +12.1 m^2. Furthermore, from table 6 space requirements in terms of material flow it can be explained that from the lubricant warehouse and workshop to the maintenance line with the distance at the Semarang Poncol locomotive depot, the change in distance is -3 m^2. Next, TPS B3 used lubricant goes to the maintenance track with a distance from the Semarang Poncol locomotive depot, so the change in distance is -1.9 m^2. Next, from the tool room to the maintenance track, with the distance from the Semarang Poncol locomotive depot, the change in distance is +1.1 m^2. Next, the spare parts warehouse goes to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is 0 m^2. Next, the supervisory room goes to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is -5.5 m^2. Next, the backup generator goes to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is -1.5 m^2. Next, the lubricant warehouse goes to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is 0 m^2. Next, the fuel tank goes to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is +12.1 m^2. Next, the facility warehouse goes to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is -6 m^2. Next, the KR room and staff room go to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is -3.6 m^2. Next, the used spare parts warehouse goes to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is -4.7 m^2. Next, TPS B3 filters to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is -0.3 m^2. Next, Spoor turns to the maintenance track with the distance from the Semarang Poncol locomotive depot, so the change in distance is +13.4 m^2. Next, Lubricant Warehouse II goes to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is +6.3 m^2. Next, Spoor turns to the maintenance track with the distance from the Semarang Poncol locomotive depot, so the change in distance is +13.4 m^2. Next, Lubricant Warehouse II goes to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is +6.3 m^2. Next, Spoor turns to the maintenance track with the distance from the Semarang Poncol locomotive depot, so the change in distance is +13.4 m^2. Next, Lubricant Warehouse II goes to the maintenance line with the distance from the Semarang Poncol locomotive depot, so the change in distance is +6.3 m^2.

3.3.5. Space Relationship Diagram

The following are the results of determining the Space Relationship Diagram based on the Systematic Layout Planning method:

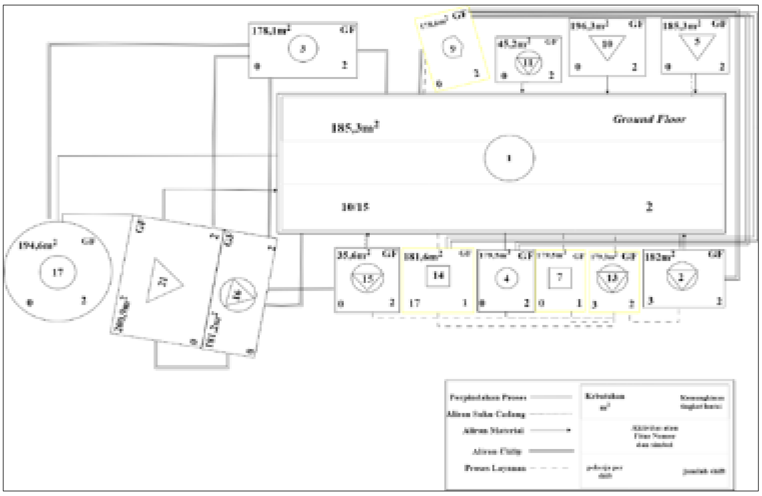


Figure 5 Space Relationship Diagram

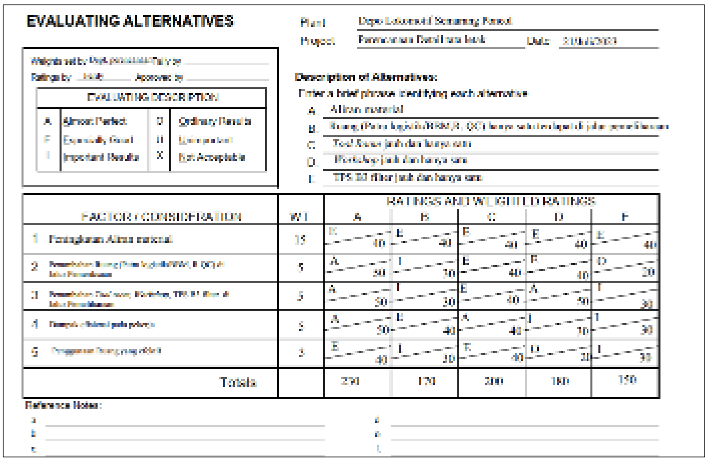
In the space relationship diagram above, it can be explained that the maintenance path requires an area of 185.3 m2 as a first order operational map, the spatial relationship of the maintenance path has a relationship between the process movement space and the rotating Spoor. Then the maintenance line space relationship has a space relationship in terms of material movement with the lubricant warehouse and workshop, spare parts warehouse, lubricant warehouse, used spare parts warehouse, lubricant warehouse II. Then the spatial relationship of the maintenance line in terms of spare parts flow has a spatial relationship with the spare parts warehouse and used spare parts warehouse. Then the spatial relationship of the maintenance line in terms of utility flow has a spatial relationship with the TPS B3 lubricant. Then the spatial relationship of the maintenance line in terms of utility flow has a spatial relationship with the used lubricant B3 TPS. Then the spatial relationship of the maintenance line in terms of the service process has a spatial relationship with the supervisory room, generator, facility warehouse, KR room, staff room. Next, for another space relationship diagram, with an area requirement of 182 m2 for the lubricant warehouse and workshop as the second order inspection map, the space relationship in terms of service processes has a space relationship with the Facility Building. Then the Genset relationship in terms of utility flow has a spatial relationship with the Genset. Next, for another space relationship diagram, with an area requirement of 178.1 m2 used lubricant TPS B3 as the third order operational map, the space relationship for used lubricant TPS B3 in terms of utility flow has a space relationship with the maintenance line, TPS B3 filter, lubricant warehouse and rotary spoor. Next, for another space relationship diagram, with an area requirement of 179.5 m2, the Tool Room as the fourth operational map of the spatial relationship. The tool room has a spatial relationship in terms of the service process with the facility warehouse, crew and staff room, used spare parts warehouse. Then the Genset relationship in terms of utility flow has a spatial relationship with the Genset. Next, for another space relationship diagram, with an area requirement of 185.3 m2, the Spare Parts Warehouse as the fifth order storage map, the Spare Parts Warehouse relationship has a space relationship in terms of material movement with the maintenance line. Next, for another space relationship diagram, with an area requirement of 179.5 m2, the supervisory room as a storage map is in fifth place, the supervisory room relationship in terms of service processes has a space relationship with the maintenance line, facility warehouse, Kr room, staff room. Next, for another space relationship diagram, with an area requirement of 178.6 m2, the backup generator as the ninth order handling map requires 0 workers per shift for the number of shifts consisting of 2 shifts and the possible floor level is Ground Floor. Then the Genset relationship in terms of service processes and utilities has a space relationship with the maintenance line, workshop lubricant warehouse, tool room, Kr room and staff. Next, for another space relationship diagram, with an area requirement of 196.3 m2 for the lubricant warehouse as the tenth order storage map. Then the space relationship for the lubricant warehouse has a space relationship in terms of material movement with the maintenance line. Next, for another space relationship diagram, with an area requirement of 45, 2 m2 fuel tank as the eleventh order storage map, spatial relationship. Fuel tank has a spatial relationship in terms of material movement with the maintenance route. Next, for another space relationship diagram, with an area requirement of 179.3 m2, the facility warehouse as a process and storage map is the thirteenth order of space relationships. The facility warehouse has a space relationship in terms of service processes and utilities, space relationships with the lubricant and workshop warehouse, tool room, kr room and staff, Used spare parts warehouse. Next, for another space relationship diagram, with an area requirement of 181.6 m2. KR and staff space as an inspection map of the sequence of spatial relationships. KR and staff spaces have a spatial relationship in terms of service processes. They have space relationships with maintenance lines, tool rooms, facility warehouses, supervisory rooms. . Then the Genset relationship in terms of utility flow has a spatial relationship with the Genset. Next, for another space relationship diagram, with an area requirement of 35.6 m2, the used spare parts warehouse as a process and storage map is in the fifteenth order of space relationships. The used spare parts warehouse has a space relationship in terms of utility processes, it has a space relationship with the TPS B3 filter. Next, for another space relationship diagram, with an area requirement of 181.6 m2 TPS B3 filter as a process and storage map in sixteenth order, the Genset relationship in terms of utility processes has a space relationship with the maintenance line, TPS B3 Used Lubricants, Used Spare Parts Warehouse, Lubricants Warehouse II . Next, for another space relationship diagram, with an area requirement of 194, 6 m2 Spoor putas as a seventeenth order map of process and storage for Spoor putas relationships in terms of utility processes has a spatial relationship with TPS B3 Used lubricants. Next, for another space relationship diagram, with an area requirement of 200.9 m2 Lubricant Warehouse II as a process map of the sequence of spatial relationships. Lubricant Warehouse II has a space relationship. The rotary spoon in terms of the utility process has a space relationship with TPS B3 Filter.

3.4. Detailed planning of the layout of facilities and workplaces for the Semarang Locomotive Depot.

This sub-chapter explains the evaluation of alternatives after determining layout criteria based on the Systematic Layout Planning method. Here's the explanation:

3.4.1. Evaluation of Alternatives

The following are the results of the determination of Alternative Evaluation based on the Systematic Layout Planning method:


EVALUATING ALTERNATIVES

Description of Alternatives:

A. Aliran material

FACTOR / CONSIDERATION	WT	A	B	C	D	E
1 [illegible]	15	E 40	E 40	E 40	E 40	E 40
2 [illegible]	5	A 50	I 30	E 40	E 40	O 20
3 [illegible]	5	A 50	I 30	E 40	A 50	I 30
4 [illegible]	5	A 50	E 40	A 40	I 30	I 30
5 [illegible]	3	E 40	I 30	E 40	O 20	I 30
Totals		270	170	200	180	150

Reference Notes:

Figure 6 Detailed alternatives evaluation sheet

Figure 6 shows the results of evaluating alternatives. then for the first factor/consideration, namely increasing material flow in alternative A with an evaluation rating rating of Especially Good with a weight of 40, then in alternative B with a weight of 40. Next, alternative C with an evaluation rating rating of Especially Good with a weight of 40. Next, alternative D with a weight of 40. evaluating rating Especially Good with a weight of 40. Next, alternative E has an evaluation rating rating of Especially Good with a weight of 40. Then for the second factor/consideration, namely the addition of tools room, workshop, TPS B3 filter on the inspection route in alternative A, the evaluation rating level is

Almost Perfect with a weight of 50 , then in alternative B the level of evaluating rating Important result with a weight of 30.

3.4.2. Visualization of the New Facility Layout Plan for the Semarang Poncol Locomotive Depot According to the Systematic Layout Planning Method.

The following are the results of the determination of the Visualization of the New Facility Layout Plan based on the Systematic Layout Planning method:

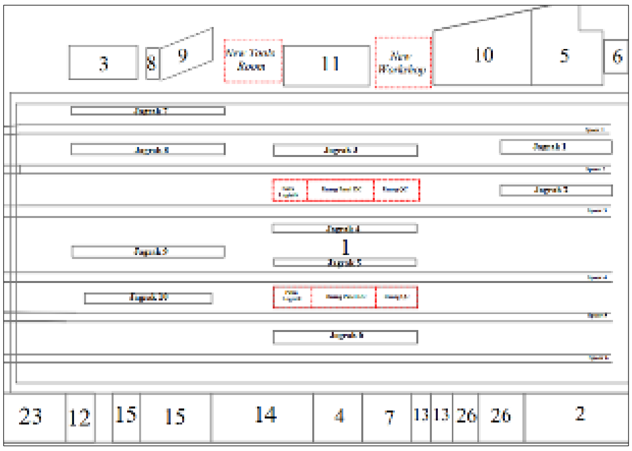


Figure 7 Proposed new Layout

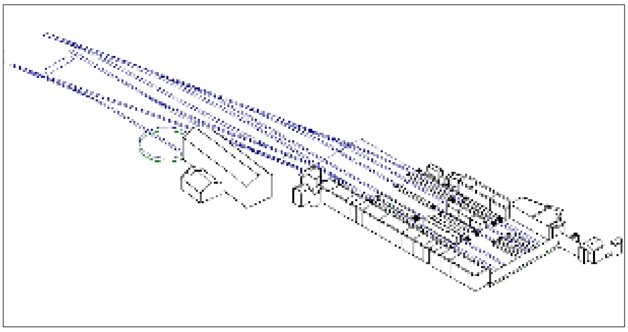


Figure 8 The 3D design image looks perspective (without roof)

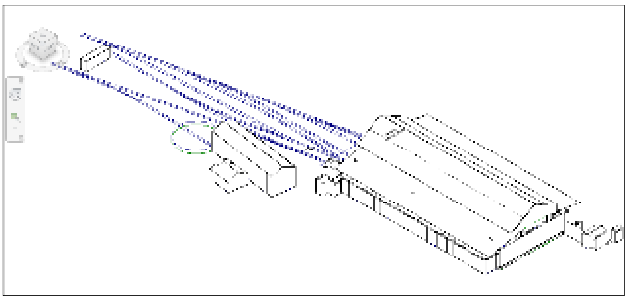


Figure 9 The 3D design image looks perspective (without roof)

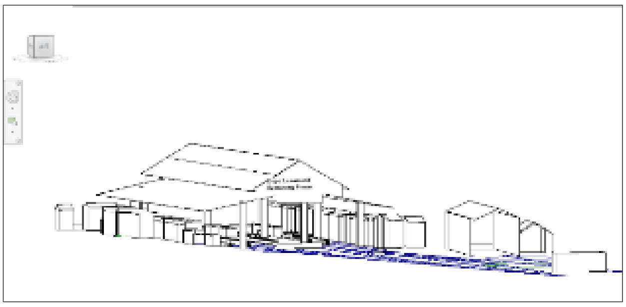


Figure 10 The 3D design image looks from the west

Figure 7 explains the layout of the proposed locomotive depot in accordance with the concept of systematic layout planning calculations and Figure 8 explains the layout with a perspective view (without roof). Figure 9 explains the layout with a perspective view with the roof Figure 10 explains the layout with a perspective view with the roof. As seen in Figures 7, 8, 9, 10, it can be seen that the tool room and workshop are far from the maintenance line and tend to be close to the inspection line. And in Figure 7, by paying attention to the steps of the systematic layout planning method, there is an additional tool room and workshop lane that differentiates between maintenance and inspection lanes (the addition of 2 panel rooms where this panel room consists of a logistics room, a DC panel room, and a QC) is intended to simplify the process flow where this separating line will work or its use is appropriate and can be differentiated. By involving consideration of the existing spatial planning method steps (determining activity areas, knowing the process flow, determining relationship diagrams, determining and calculating space requirements, determining and calculating spatial relationship diagrams, evaluating all existing steps and visualizing the proposed layout plan) then several alternatives are proposed in Figure 7. In this proposed layout, aspects of process efficiency and maintenance time are the basis for considering this proposed layout. Apart from that, the Semarang Poncol locomotive depot must consider the process and efficiency of space and maintenance time.

4. Conclusion

For activity process proposals, the systematic layout planning method provides the largest activity proposals with the largest Total Closeness Rating on the maintenance line, then followed by the lubricant warehouse and workshop, TPS B3 used lubricants, tool room, spare parts warehouse, KDT room, supervisory room, WWTP , backup generator, lubricant warehouse, fuel tank, water treatment, facility warehouse, KR and staff room, used spare parts warehouse, TPS B3 filter, rotary spoor, toilet, hydrant pump, gazebo (smoking area), lubricant warehouse II, prayer room, room study/meeting, wabtec room, official residence, lockers, security guard post and finally the canteen/cooperative/parking area.

To calculate material handling at the Semarang Poncol Locomotive Depot using the systematic layout planning method, the results obtained from calculating material handling costs from the Semarang Poncol Locomotive Depot were Rp. 99,990/meter and for material handling equipment data, forklifts require material handling costs of Rp. 3,759,649 and for the high diesel speed (HSD) pump requires material handling costs of Rp. 84,288.

For the proposed space requirements for each department or room, using the systematic layout planning method, space requirements are seen in terms of material flow (towards the maintenance route), changes in distance after calculating varying space requirements. Starting from the spare parts warehouse, the distance change after calculating using the systematic layout planning method is 0. Then the used spare parts warehouse changes the distance by -4.7, the lubricant warehouse is -0.1 and the fuel tank is +12.1. Space requirements are seen from the process (towards the maintenance route) after calculating the varying space requirements. From the very first lubricant warehouse and workshop, the distance change after being calculated using the systematic layout planning method was -3. Then followed by TPS B3 used lubricant of -1.9. Then the tool space is +1.1. Then the monitoring room is -5.5. Then the backup generator is -1.5. Furthermore, warehouse facilities are -6. Then the KR/staff space is -3.6. Then the TPS B3 filter is -0.3. Then the rotary spoiler is +13.4 and finally the lubricant warehouse II is +6.3 m2. This space requirement is based on calculating space requirements by considering two important plans, namely material flow and process aspects. The meaning of plus (+) itself means increasing the size of the space, while minus (-) means reducing the size of the space according to the needs of the Semarang Poncol Locomotive Depot. Then the KR/staff space is -3.6. Then the TPS B3 filter is -0.3. Then the rotary spoiler is +13.4 and finally the lubricant warehouse II is +6.3 m2. This space requirement is based on calculating space requirements by considering two important plans, namely material flow and process aspects. The meaning of plus (+) itself means increasing the size of the space, while minus (-) means reducing the size of the space according to the needs of the Semarang Poncol Locomotive Depot. Then the KR/staff space is -3.6. Then the TPS B3 filter is -0.3. Then the rotary spoiler is +13.4 and finally the lubricant warehouse II is +6.3 m2. This space requirement is based on calculating space requirements by considering two important plans, namely material flow and process aspects. The meaning of plus (+) itself means increasing the size of the space, while minus (-) means reducing the size of the space according to the needs of the Semarang Poncol Locomotive Depot.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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