Redesign Production Layout Using Dedicated Storage Method: Case Study of PT. Solo Grafika Utama

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Abstract. PT. Solo Grafika Utama is one of the companies in the field of newspaper production. The newspaper industry has strict production characteristics. Therefore, it requires a good factory layout in order to create effectiveness and production efficiency. The warehouse layout in PT Solo Grafika Utama still deficient in the application of material handling in warehouses so that it often raises problems. The problem is that the product arrangement in the warehouse is not optimal because there are still products stored in an wrong place. This article aims to provide an effective and efficient proposal to improve warehouse layout in PT Solo Grafika Utama using the dedicated storage method. Dedicated Storage is chosen to improve warehouse arrangement and minimize the distance of product displacement. After the proposed improvement, a better warehouse layout is obtained. In the proposed layout can also minimize the product displacement distance of 23% from the initial distance. Thus it can be said that the proposed layout is better than the initial layout and can be proven to be able to facilitate the handling of materials in the warehouse so that it can make newspaper production more effective and efficient.

1. Introduction

To be able to compete with businesses today, companies must have the ability to continue to grow and always have change. In a company, many factors affect the sustainability of the production process including production planning, production layout planning, receiving, shipping, warehousing, etc (Wingjosoebroto, 2009). In general, a well-planned factory layout will also determine efficiency and will maintain the survival or success of an industry. One important layout plan is the warehousing system. Warehouse is an important part of production in managing the flow of goods, information, and costs. Warehouse is a place to store materials, raw materials, equipment, and finished products. The purpose of the warehousing system itself is to manage and store goods that are ready to be distributed so that the goods can be received on time by consumers. So that a good warehousing system will produce efficiency and effectiveness of the production process (Permana, 2014).

PT. Solo Grafika Utama is a printing company in Surakarta that has a main product, Solopos newspaper. As a local newspaper in the Solo area, SOLOPOS has the potential to promote in the Surakarta, Boyolali, Sokoharjo, Wonogiri, Sragen, and Klaten regions which are the main distribution areas. Solopos general daily production process at PT. Solo Grafika Utama based on orders from its parent company, PT. Solopos script. But along with the development of the company, now PT. Solo Grafika Utama has produced other products, such as tabloids, Student Worksheets (LKS), magazines or orders to print other general daily

The problem faced by PT Solo Grafika Utama is that the company does not have clear arrangements regarding product layout, storage position arrangement, and product arrangement in the warehouse so that
the warehouse arrangement pattern becomes irregular. Therefore, it is necessary to redesign the product storage layout using the dedicated storage method. This method, arranging products by placing one product in one storage location only. This placement is based on a comparison of the activities of each product and space requirements. (Abdullah, 2009) say that the advantage of this method is to propose improvements to the layout of the product warehouse that is more flexible and more effective, minimizes transportation distance, saves material transfer, and makes it easier to arrange goods in the warehouse. While the disadvantage of this method is the low space utilization because the location of the product cannot be changed or used by other products even though the location is empty. The problem at PT Solo Grafika Utama's warehouse was solved by using a dedicated storage method to redesign the warehouse layout, determine the needs of the warehouse area, and determine the distance of initial material handling and proposals. With this research the warehouse is expected to be more tidy and orderly so as to facilitate material handling activities in product storage and retrieval, as well as facilitate operators in the product search process.

2. Methodology
This section contains the flowchart of research conducted in PT. Solo Grafika Utama:

![Figure 1 Flowchart of the Research](image-url)
The research method is carried out in several stages so that the discussion can be structured and the research objectives are achieved. Before doing research, a literature study is conducted on the object to be studied. Furthermore, direct observations were made in the production section of PT. Solo Grafika Utama, Surakarta. These observations are generally carried out in the entire factory area, and specifically in the area in the printing production section. This observation aims to determine the course of the newspaper printing process from raw materials into finished products. At the time of direct observation, interviews were conducted with manpower and foremen who were directly involved in the production process. The next step is to collect the data needed. Data obtained by making observations directly on the work system on the production floor and interviews with business owners, foremen, and operators, as well as by taking from company data sources.

**Figure 1** Flowchart of the Research (continued)
Data that has been collected at the observation stage is then processed according to the data processing stage. Making the initial layout of the company as a reference in this study, then proceed with the calculation of space requirements, throughput, and distance traveled. The proposed improvement method used is the dedicated storage method. This method is done by sorting the product by comparison of the largest throughput and space requirements with the smallest distance.

The analysis step by comparing the initial layout with the proposed layout. The analysis also compares the distance of the old material handling with the proposal. The final stage of this study is drawing conclusions from the processing and analysis of data that has been done to answer the research objectives. Then there are suggestions given to improve the layout of the production floor at PT. Solo Grafika Utama and the next research.

3. Results and Discussion

Problems faced by the company are the irregularity in the layout of the warehousing system and the lack of effectiveness in handling material handling. The layout of the production floor can be a factor in the lack of material handling. Existing space also becomes a limitation in managing goods in the production floor. Space shortages occur when demand exceeds warehouse storage capacity. Additional space requirements are met by considering existing storage space. The design of repairs is done by analyzing the layout of the initial warehouse then designing improvements to the layout of the warehouse. Finally, a discussion of the results of the comparison of the material handling distance of the initial layout and proposals.

3.1 Initial Warehouse Layout

At present the problem faced by the company is that the layout of the product warehouse still does not have definite rules, meaning that the product will be placed in any location that is still empty or with the least number of stacks regardless of the dimensions of the product in one slot. Circumstances like this will allow the need for space for storage to be even greater. It will also lead to a longer search process, thereby inhibiting material handling activities and product delivery times to consumers.

The company’s service system that serves purchases either from regular customers or customers who at any time make an order makes the frequency of ordering products difficult to predict precisely. So the company also does not have the right order lead time. This condition causes the lead time to fluctuate because in reality there are products with a storage period of more than 1 year. Meanwhile, there are also other products that process the entry and exit of it very quickly even less than 1 day. The initial layout of the production floor at PT. Solo Grafika Utama as follows.
The calculation of the total distance of material handling the initial conditions are as in table 1.

| No | No. Blok | Distance | Product Name          | T/S   | Reach |
|----|---------|----------|-----------------------|-------|-------|
| 1  | A1      | 700      |                       |       |       |
|    | A2      | 1800     | Tinta BW News Proc    | 43.71 | 15.50 |
|    |         |          | Yellow                |       |       |
|    | A3      | 600      |                       |       |       |
| 2  | A1      | 700      |                       |       |       |
|    | A2      | 1800     | CD 78.5 cm/45 gsm     | 21.01 | 15.50 |
|    | A3      | 600      |                       |       |       |
| 3  | A1      | 700      |                       |       |       |
|    | A2      | 1800     | Tinta Black SP-H      | 20.83 | 15.50 |
|    | A3      | 600      |                       |       |       |
| 4  | B       | 3100     | Plate Fuji CTP FDT    | 15.65 | 15.50 |
|    |         |          | 889 x 586 x 0.30      |       |       |
| 5  | B       | 3100     | Plate Fuji CTP FDT    | 15.21 | 15.50 |
|    |         |          | 889 x 608 x 0.30      |       |       |

**Sum of Reach**  
77.500

3.2 Proposed Warehouse Layout
The product arrangement in the proposed warehouse layout uses a dedicated storage method which is a product storage layout method based on the activities of entering and leaving the product in the warehouse with the shortest distance to the point I/O. The use of this method aims to facilitate the work of operators in the activities of receiving and shipping products because the goods or products already have a fixed slot (fixed location) in the warehouse. In addition, the distance to be traveled by each product can be ascertained and the time needed in the process of storing and taking the product will be smaller. So it will be known whether the existing warehouse area is sufficient, less, or exceeds the needs. Another reason for choosing this method is that there are many types of products with different product dimensions. So with the application of this method it is hoped that a better arrangement of products takes into account the path of movement of people and goods. This will have an impact on the loading and unloading process which becomes shorter and the process of finding the desired product will also be faster and easier, and will eventually be able to minimize the total distance of material handling. The steps for the dedicated storage method are:

3.3 Space Requirement (S)

Space requirement is the number of places or areas occupied by one type of product. Space requirement is needed to find out the storage capacity in the available slots or storage areas, so that it will be known how many slots are needed to store one type of product and then to calculate whether the number of slots available in the warehouse can be sufficient or not. The need for space on the production floor is one factor that is an obstacle to effective manual handling on a production floor. The condition of a company will change because of the influence of technology, changes in products, changes in the level of demand, and organizational structure in the future. These uncertain conditions cause a facility designer to face difficulties in determining true space requirements (Tompkins, 2003). Table 2 shows the space requirements for each type of product.

| No | Product Name | Amount per Bundle | Average Product Acceptance | Block Capacity | Space Requirement Theoritis | Space Requirement |
|----|--------------|-------------------|----------------------------|----------------|----------------------------|------------------|
| 1  | Plate Fuji CTP FDT 889 x 586 x 0,30 | 200 | 4.938 | 39.500 | 1,65 | 2 |
| 2  | Plate Fuji CTP FDT 889 x 608 x 0,30 | 200 | 4.813 | 38.500 | 1,60 | 2 |
| 3  | Tinta Black SP-H | 75 | 3.250 | 26.000 | 2,17 | 3 |
| 4  | CD 78,5 cm/45 gsm | 35 | 2.750 | 30.000 | 2,68 | 3 |
| 5  | Tinta BW News Proc Yellow | 150 | 6.850 | 54.800 | 2,28 | 3 |

3.4 Throughput (T)

Throughput is a dynamic activity measurement or storage, which shows the flow in storage. Measurement of product reception and delivery activities in the warehouse is used in the calculation of throughput which will later be used as a reference in the placement of products in the available slots in the warehouse. The
priority of placing the product to the entrance and exit is based on the highest throughput value, followed by the second highest throughput value and so on. This is intended to facilitate the process of loading and unloading products by placing products whose activities are dense close to the point I / O so as to minimize the distance of material handling. Table 5 shows the throughput of each product.

| No  | Product Name               | Average Product Acceptance | Average Product Delivery | Goods Transported | Throughput |
|-----|----------------------------|----------------------------|--------------------------|-------------------|------------|
| 1   | Plate Fuji CTP FDT 889 x 586 x 0,30 | 4.938                      | 4.450                    | 300               | 31,29      |
| 2   | Plate Fuji CTP FDT 889 x 608 x 0,30 | 4.813                      | 4.312,5                 | 300               | 30,42      |
| 3   | Tinta Black SP-H            | 3.250                      | 3.000                    | 100               | 62,5       |
| 4   | CD 78,5 cm/45 gsm          | 2.750                      | 3.500                    | 115               | 63,04      |
| 5   | Tinta BW News Proc Yellow   | 6.850                      | 6.262,5                  | 100               | 131,13     |

3.5 Product Ranking Based on Comparison of Throughput and Storage
The process of product placement using the dedicated storage method is done by ranking the products based on a comparison of throughput to space requirement (storage). Ranking is done by sorting the largest T / S value up to the smallest value, and in the end it will be able to know the priority ordering of the products to be arranged. Product ranking based on comparison of throughput and storage is shown in table 4.

| No  | Product Name | Space Requirement | Throughput | T/S |
|-----|--------------|-------------------|------------|-----|
| 1   | Plate Fuji CTP FDT 889 x 586 x 0,30 | 2               | 31,29      | 15,65 |
| 2   | Plate Fuji CTP FDT 889 x 608 x 0,30 | 2               | 30,42      | 15,21 |
| 3   | Tinta Black SP-H   | 3               | 62,5       | 20,83 |
| 4   | CD 78,5 cm/45 gsm | 3               | 63,04      | 21,01 |
| 5   | Tinta BW News Proc Yellow | 3             | 131,13     | 43,71 |

3.6 Calculation of Distance Traveled Between Each Storage Slot with I / O Point
Travel distance calculation is done starting from I / O point to each storage area (slot). Calculations are performed using the rectilinear distance method, where distances are measured along a path using a line perpendicular to each other towards the midpoint of each storage area. After obtaining the distance of each
slot, the next step is to sort from the shortest distance to the farthest from the I / O point. Ordering aims so that the product with the largest T / S can be placed in the slot nearest the I / O point, then proceed with the product with the second largest T / S placed in the next slot and so on until all products are accommodated in the available slots.

3.7 Sorting T / S Values Descending

The proposed warehouse layout uses the dedicated storage method, where the laying process is done based on the ranking of products against T / S starting from the largest to the smallest placed at the shortest distance to the farthest from the I / O point. This rule is done to improve the warehousing system so that operators will find it easier to carry out the search process, because storage of products in slots is only for products in one type. The product placement with the highest T / S value in the slot with the smallest distance is shown in table 5 and the proposed warehouse layout is shown in Figure 3.2.

| No | Product Name                  | Amount per Bundle | Average Product Acceptance | Block Capacity | Space Requirement Theoretical | Space Requirement |
|----|--------------------------------|-------------------|----------------------------|----------------|------------------------------|-------------------|
| 1  | Plate Fuji CTP FDT 889 x 586 x 0,30 | 200               | 4.938                      | 39.500         | 1,65                         | 2                 |
| 2  | Plate Fuji CTP FDT 889 x 608 x 0,30 | 200               | 4.813                      | 38.500         | 1,60                         | 2                 |
| 3  | Tinta Black SP-H                | 75                | 3.250                      | 26.000         | 2,17                         | 3                 |
| 4  | CD 78,5 cm/45 gsm              | 35                | 2.750                      | 30.000         | 2,68                         | 3                 |
| 5  | Tinta BW News Proc Yellow       | 150               | 6.850                      | 54.800         | 2,28                         | 3                 |

3.8 Calculation of Proposed Improvements using Dedicated Storage

In dedicated storage, a special storage location is assigned for each item to be stored. One of the advantages of dedicated storage is the efficiency of data handling because the data collection is fixed from the items that will go into storage. The proposed layout design based on the largest T / S value has the smallest mileage, so ordering the T / S for each product is sorted from largest to smallest and ranks the blocks based on the shortest mileage. The proposed layout based on dedicated storage is as follows:
There was a change in the inventory storage area (A) because in the comparison of T / S values, the inventory area has the largest value so that it is near the I / O point. Space requirements in the raw material warehouse (B) also increase based on the calculation of space requirements and are placed not far from the inventory area. The distance traveled calculation is based on the proposed production floor layout as follows.

**Table 6. The Calculation of Distance Traveled Based on the Proposed Layout**

| No | No. Blok | Distance | Product Name           | T/S | Reach |
|----|----------|----------|------------------------|-----|-------|
| 1  | A1       | 700      | Tinta BW News Proc Yellow | 43,71 | 12.500 |
|    | A2       | 600      |                        |     |       |
|    | A3       | 1200     |                        |     |       |
| 2  | A1       | 700      | CD 78,5 cm/45 gsm      | 21,01 | 12.500 |
|    | A2       | 1200     |                        |     |       |
|    | A3       | 600      |                        |     |       |
| 3  | A1       | 700      | Tinta Black SP-H       | 20,83 | 12.500 |
|    | A2       | 1200     |                        |     |       |
|    | A3       | 600      |                        |     |       |
| 4  | B1       | 800      | Plate Fuji CTP FDT 889 x 586 x 0,30 | 15,65 | 11.000 |
|    | B2       | 1400     |                        |     |       |

**Figure 3S. Proposal Warehouse Layout**
Comparison of Material Handling Distance

After obtaining the results of the material handling distance of the initial layout and layout of the proposed improvements, then a comparison is done to find out the difference between the initial layout and layout of the proposed improvements.

| Layout         | Total Distance | Difference to Existing | Percentage Decrease in Distance |
|----------------|----------------|------------------------|---------------------------------|
| Initial Layout | 77,500         |                        |                                 |
| Proposed Layout| 59,500         | 18,000                 | 23%                             |

Changes in the distance value on the new layout will affect the cost factors associated with material handling, such as the use of material handling tools and material handling life. A good placement will affect material handling activities, meaning that the reduction in distance will be proportional to the decrease in material handling activities and will be followed by a reduction in material handling operating costs. With the minimization of distance means companies can reduce material handling operating costs decreased. Another thing that is affected by this change is the movement of operators and the operation of the warehousing system. With the existence of a good planner, the operator will be easier to check and search for the desired product, so that the warehousing system is increasingly well controlled. These factors will affect the handling process, where later the handling process will be faster and more precise so that service to consumers will also increase.

4. Conclusion

Improvement of factory layout with the dedicated storage method was chosen to improve the arrangement of the warehouse and minimize the distance of product movement so that efficiency and effectiveness occur in the production process. From the results of the discussion it was found that there was a decrease in the total distance of material handling with the application of the dedicated storage method, where in the initial conditions the warehouse total material handling distance was 77,500 m, whereas in the proposed layout it was 59,500 m. This means that there is a decrease in the total material handling distance of 18,000 m from the initial conditions. From the comparative data analysis between the initial layout and the proposed layout it can be seen that there is a decrease in distance of 23%, this shows that the proposed layout has a smaller material handling cost. Thus it can be said that the layout of the proposal is better than the initial layout and can be proven able to facilitate the handling of materials in the warehouse so that it can make newspaper production more effective and efficient.
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