**PROC. INTERNAT. CONF. SCI. ENGIN.**
Volume 4, February 2021
Page 176-181

ISSN 1504607797
E-ISSN 1505707533

# Redesign Facility Layout and Minimize Material Handling Cost on PT ABC in Pandemic Era

**Riska Dwi Oktalia[1], Siti Inaratul Nafiah[2], Hersa Ajeng Priska[3], Rahma Fariza[4]**
[1, 2, 3, 4]Industrial Engineering Department , Faculty of Industrial Technology, Universitas Islam Indonesia,
Jl. Kaliurang KM. 14,5 Yogyakarta 55584, Indonesia.
[1]Email: 18522238@students.uii.ac.id

**Abstract.** Since March 2020 the news of Covid-19 has spread in Indonesia, with this situation there have been many changes in the industrial sector in Indonesia. In this situation, industry players should make adjustments to their production processes so they can continue and run safely. According to information from the Ministry of Health and the Task Force for the Acceleration of Handling Covid-19, one of the health protocols to prevent the spread of Covid-19 is physical distancing, where the minimum distance between workers is 1 meter. So to deal with this condition, of course, it is necessary to redesign the layout of the factory facilities. Layout is an important decision that determines the efficiency of long-term operations. PT ABC is a company engaged in the processing of metal goods. In addition to implementing health protocols, PT ABC also has problems in structuring work facilities that are not quite right. This can lead to less effective and efficient workers for moving the material, thus causing a lot of work in process. The analysis method to these problems uses the ARC (Activity Relationship Chart), ARD (Activity Relationship Diagram), and Flexsim 6.0 simulation method to determine the Material Handling Cost and production output. Layout changes that have been made, can minimize material handling costs which were previously $ 28,847.16 reduced to $ 22,717.76 to get $ 6129.4 or about 21%.
**Keywords:** ARC, ARD, Facility Layout, Material Handling Cost, Simulation.
**Abbreviations:** ARC (Activity Relationship Chart), ARD (Activity Relationship Diagram).
**Running title:** Redesign Facility Layout in Pandemic Era.

## INTRODUCTION

According to Kumar, et al. (2015) the industrial sector plays an important role in economic growth in Indonesia. In the current market scenario, the demand and product specifications from customers have changed a lot. So, it is very important for companies to meet customer desires in order to compete in the market. Based on data from the Central Statistics Agency (BPS), the number of small industrial companies engaged in the manufacture of metal goods is 13990. This figure is ranked sixth out of 34 company categories and it is under the food, tobacco processing, textile, apparel, leather, wood and cork industries. The number of companies engaged in the metal goods industry makes competition even tighter. To deal with this condition, where product variations are high, companies are competing to produce the best products to meet market demand. Therefore, to produce quality products, a good production system is needed, and a good production system is of course related to a good layout as well.

Since March 2020 the news of Covid 19 has spread in Indonesia, with this situation there have been many changes in the industrial sector in Indonesia. This pandemic state demands industry players to make adjustments to their production processes so that they can continue to run safely. According to information from the Ministry of Health and the Task Force for the Acceleration of Handling Covid-19, one of the health protocols to prevent the spread of Covid is physical distancing, where the minimum distance between workers is 1 meter. According to Apple (1990) layout definition as analyzing, forming a concept, compiling, and realizing a system for making goods or services. Layout is an important decision that determines the efficiency of operations in the long run. Layout has many strategic impacts as it determines the competitiveness of a company in terms of capacity, process, flexibility, cost, quality of work environment, customer contact and company image. An effective layout will be able to support the implementation of business strategies that have been determined by the company, whether differentiation, low cost, or fast response. (Heizer and Render, 2014). In addition, according to Hadiguna, in 2008, less systematic material handling was a big problem and disrupted the smooth production process, thus affecting the overall system, while Purnomo (2004) stated that a well-designed facility layout would generally make a positive contribution in optimizing the operation process. the company and will ultimately maintain the company's survival and company's success.

One of the companies engaged in the processing of metal goods is PT ABC. Items produced include wok, tembor, cake molds and cake mold covers made of aluminum. The type of production used is make to stock, so that every buyer who wants to buy the goods is always ready. Within a day the company can produce up to approximately 300 items. However, the problem that occurs in this company is the number of lathes that are idle due to a lack of labor. This is due to the inaccurate arrangement of work facilities, such as the location of the filing process in a narrow lane which is the path between the semi-finished goods storage and the lathe for the process polishing.

This problem causes the goods into storage (work-in-process) to accumulate, this of course affects the production process because the output production is not maximal. This will disappoint customers and hurt themselves. Therefore, a simulation is needed to solve this problem. The use of simulation in solving this problem is to save costs and does not interfere with the production

process of the company because there is no need to make direct changes to the real system. The software used in this study is Flexsim version 6.0.

## MATERIALS AND METHODS

### Study area

This study uses two data, namely primary data and secondary data. Primary data is taken from direct observation and interviews with informants. Furthermore, secondary data collection was carried out in two ways, namely literature studies and the company's data. The literature studies carried out were obtained from journals, books, and articles related to facility layout design. Meanwhile, the company's data obtained by researchers is in the form of company profiles and company historical data.

Based on the research flow, in the first stage the researcher determines the location of the company that will be used as a research location. After that, the researcher identifies the problems that occur in the company and serves as a problem formulation to achieve the goal. Because not all problems in the system can be handled all, the researchers limit the problem so that research is more focused. Then collect and process data related to research. After that, create a model which is then simulated from the real system. The results of the model will be tested for the level of validation whether they are valid with the real system, which is then analyzed for the model. Researchers also carry out experimental designs to make improvements to the system. Then choose an alternative from the various experiments that have been carried out. Finally, the researchers analyzed the experimental results and made conclusions.

### The Research Location

The object of this research is the production floor of PT ABC, which is a company engaged in the processing of metal goods, the goods produced include tembor, wok, cake molds and cake mold covers made of aluminum. With the company layout and flow chart production process as shown below:

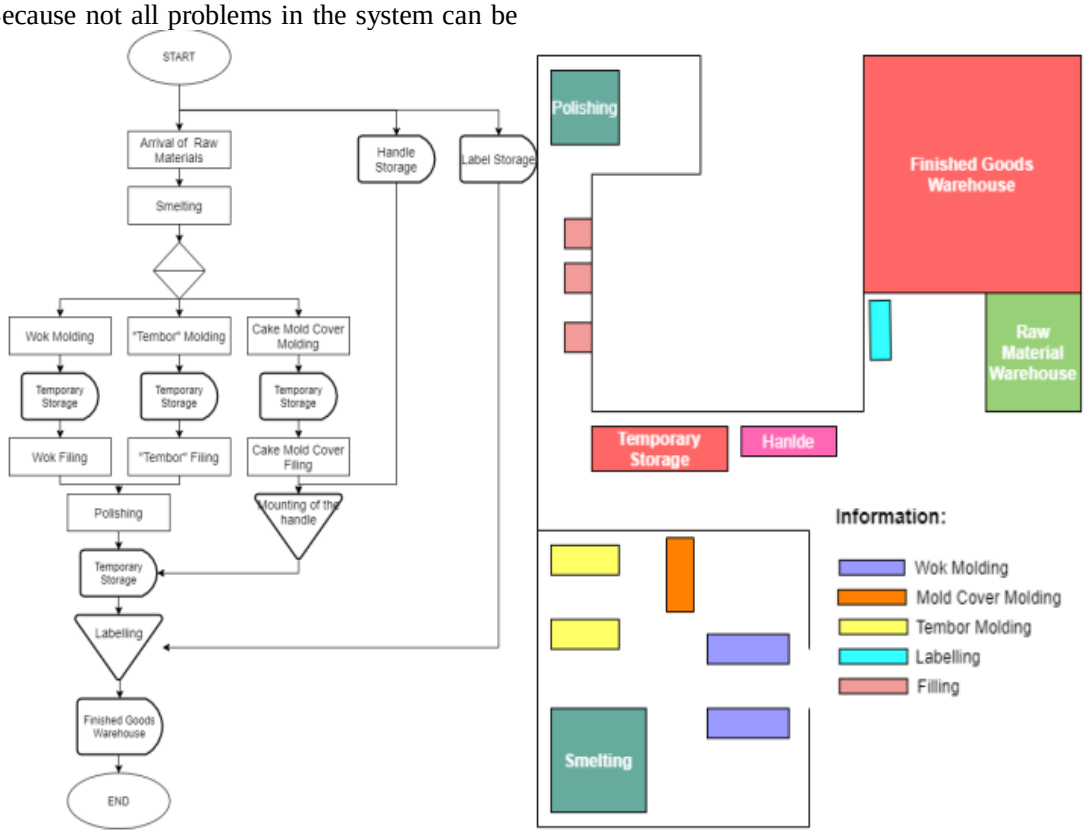


**Figure 1.** Flowchart production process and the company layout.

Apart from that, as a reference for analyzing ARC, the location area of each department is also needed. The following is the location area data:

**Table 1.** The location area data.

| No | Location | Area |
|---|---|---|
| 1 | Finished Goods Warehouse | 50 $m^2$ |
| 2 | Smelting and Molding | 70 $m^2$ |
| 3 | Polishing | 28 $m^2$ |
| 4 | Filing Storage of Semi-finished | 7 $m^2$ |
| 5 | Goods | 9 $m^2$ |
| 6 | Storage of Raw Materials | 11 $m^2$ |

### Procedures

*Activity Relationships Chart*

ARC is a simple method or technique in planning the

layout of facilities based on the degree of "qualitative" and subjective activity relationships from each facility (Iskandar & Fahin, 2015).

*Activity Relationships Diagram*

According to Apple (1990), ARD is depicted in diagrammatic form blocks that show the activity linkage approach, hich shows each activity as a single activity model that does not emphasize the meaning of space. ARD is formed by referring to the ARC analysis that has been made previously (Iskandar & Fahin, 2015).

## RESULTS AND DISCUSSION

Based on the data that has been collected is modeled using software Flexsim 6.0, the following is company's initial layout model:

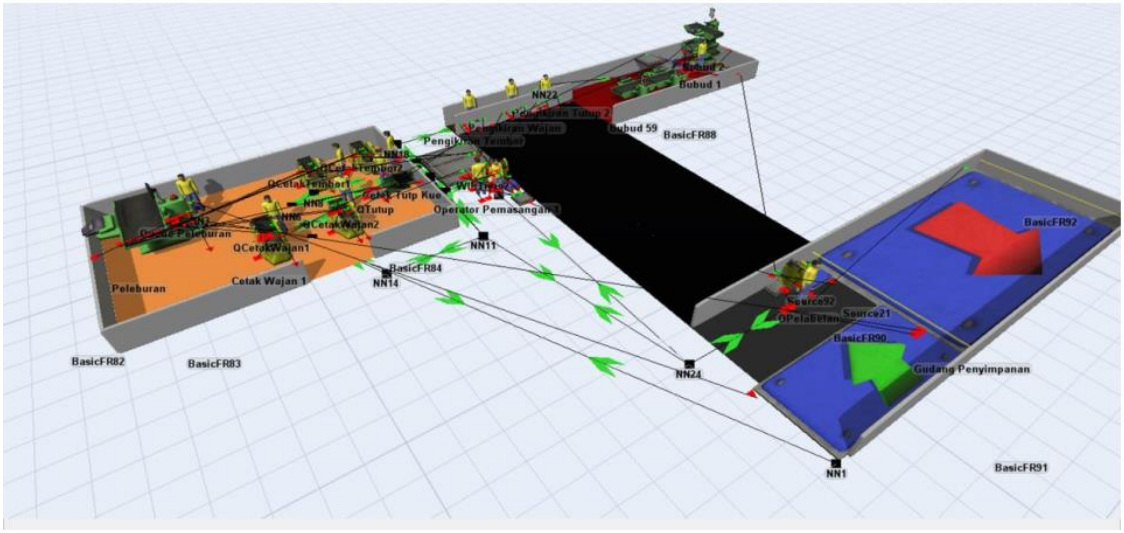


**Figure 2.** Company's initial layout model by author.

Then, to ensure that the model is in accordance with real conditions, we need to perform the validation. Validation is done by comparing the output historical and output simulations. The method used is validation output using a statistical approach through the two mean similarity test, variance test, and chi-square test. The following is historical data and simulation result data:

**Table 2.** Historical data and simulation result data of tembor, wok, and cake mold cover.

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tembor | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Historical | 75 | 76 | 79 | 75 | 87 | 71 | 76 | 88 | 85 | 80 | 86 | 75 | 74 | 85 | 82 | 85 | 80 | 84 | 92 | 88 | 80 | 86 | 67 | 85 | 88 | 88 | 84 | 90 | 92 | 85 |
| Simulation | 86 | 87 | 87 | 87 | 88 | 87 | 88 | 86 | 88 | 86 | 88 | 87 | 88 | 87 | 88 | 87 | 87 | 87 | 88 | 87 | 88 | 86 | 87 | 87 | 87 | 87 | 86 | 88 | 87 | 86 |
| Wok | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Historical | 79 | 85 | 85 | 70 | 66 | 76 | 66 | 80 | 71 | 65 | 70 | 84 | 66 | 64 | 80 | 85 | 75 | 79 | 67 | 70 | 83 | 80 | 57 | 55 | 57 | 64 | 68 | 60 | 82 | 69 |
| Simulation | 71 | 71 | 71 | 70 | 70 | 71 | 70 | 71 | 70 | 71 | 70 | 70 | 70 | 71 | 70 | 71 | 71 | 71 | 70 | 71 | 70 | 71 | 70 | 71 | 71 | 71 | 71 | 70 | 70 | 71 |
| Cake Mold Cover | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Historical | 92 | 93 | 93 | 82 | 88 | 98 | 93 | 82 | 81 | 90 | 86 | 85 | 73 | 72 | 91 | 95 | 84 | 88 | 94 | 94 | 75 | 81 | 85 | 80 | 80 | 80 | 94 | 86 | 80 | 87 |
| Simulation | 90 | 90 | 90 | 90 | 91 | 92 | 90 | 92 | 90 | 90 | 90 | 92 | 90 | 91 | 92 | 92 | 92 | 92 | 90 | 90 | 92 | 90 | 90 | 90 | 90 | 92 | 90 | 91 | 90 | 90 |

The steps in testing the suitability of the simulation model using the Chi-Square are test as follows:

a. Determining the hypothesis
   H0: Simulation data is in accordance with the real system.
   H1: Simulation data does not match the real system data.
b. Determine the level of significance

The real rate ($\alpha$) = 0.05.

c. Calculating the statistical test

   Using the excel formula, the calculated Chi Square and Chi Square table values can be found.
   Chi Square Count => "= SUM (Calculated Data)"
   Chi Square Table => "= CHIINV (Probability Alpha, number of class-1)
d. Chi Square Test Results Chi Square
   Count = 31.69
   Chi Square Table = 42.5569678

In this case, the Chi-Square test stands alone if the 2 other tests are found to be invalid, but if the Chi-Square test is valid (f count > t table) then the model is declared in accordance with the reality. So, based on the above results, it is found that H0 is accepted, so it means that the simulation results data can be accepted or in accordance with the results of the existing real system.

After the model is declared valid, the material handling costs of the operators who deliver and ship goods from one process to another are carried out. The

following is the calculation result of material handling costs using Flexsim 6.0 software.

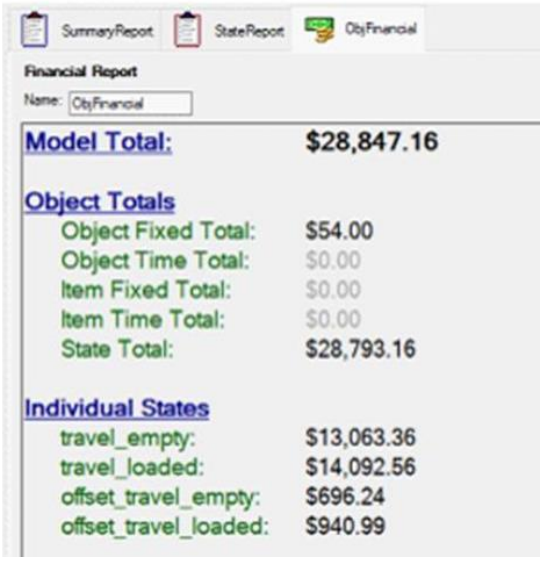


**Figure 3.** The calculation result of prefix material handling costs using Flexsim 6.0 software.

According to the picture above, it is known that the material handling costs are $28,847.16 with a total output production are 248.

## Activity Relationship Chart

Next, the design is carried out in a layout proposed by analyzing it using ARC. ARC is a simple technique in planning the layout of the facility. This method combines activities that will determine the level of relationship. Here is the result of the ARC:

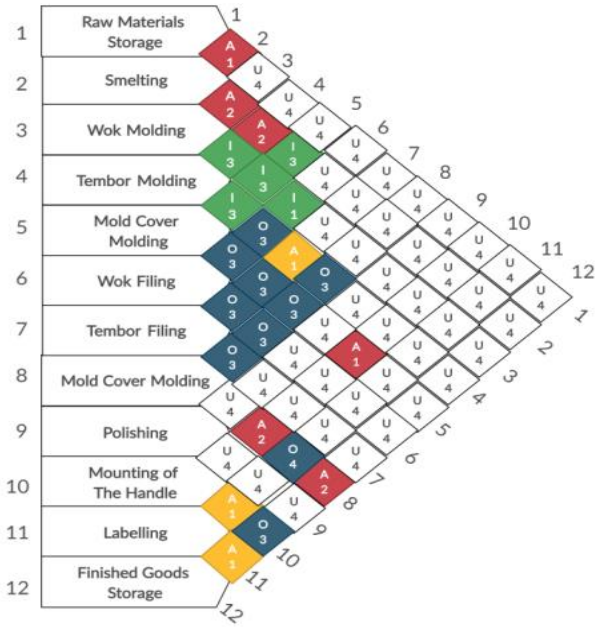


**Figure 5.** The result of the ARD.

**Table 4.** Information of ARC.

| No | Rate of Interest | Code | Color |
|---|---|---|---|
| 1 | Absolutely Essential | A | Red |
| 2 | Very Important | E | Yellow |
| 3 | Key | I | Green |
| 4 | Ordinary | O | Blue |
| 5 | Unimportant | U | White |
| 6 | Unwanted | X | Chocolate |

**Table 5.** Description of Reasons.

| Code of Reasons | Description Reason |
|---|---|
| 1 | Smooth Flow of Materials |
| 2 | Magnitude of Risk |
| 3 | Material Similarity |
| 4 | Has No Functional Relationship |

Some of the layout changes here are moving the raw material reservoir to the smelting and molding floor to shorten the pick-up distance by the smelter operator. In addition to rearranging printing machines on the printing and smelting production floors. The rearrangement is in accordance with the health protocol set by the government, the processes are given a distance of 1.5 meters and the machines are not facing each other. Moving the filing process to a semi-finished goods storage location, this is done in order to facilitate the process of moving the material. As for the semi-finished goods storage, it is shifted slightly to the left. For the machine polishing itself, it remains in the previous room, only the machine is slightly moved close to the door. The lathe was not moved to a different room due to the waste from the process polishing which might later disturb other workers and the reason for bringing it closer to the door so that the dust can immediately leave the room and not disturb the operator polishing.

## Activity Relationship Diagram

Based on the relationships that have been analyzed using ARC, then make a layout is proposed which is represented by ARD.

**Figure 4.** The result of the ARC.

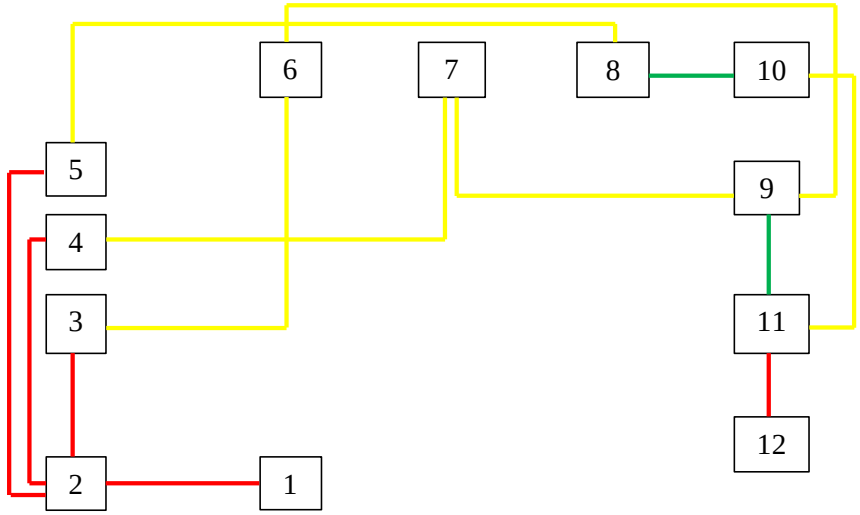


**Table 6.** Explanation of line and color in ARD.

| Line | Code |
|---|---|
| | A |
| | E |
| | I |
| | O |
| | U |
| | X |

## The Proposal Layout

The following is the proposed layout that has been analyzed using ARD and ARC.

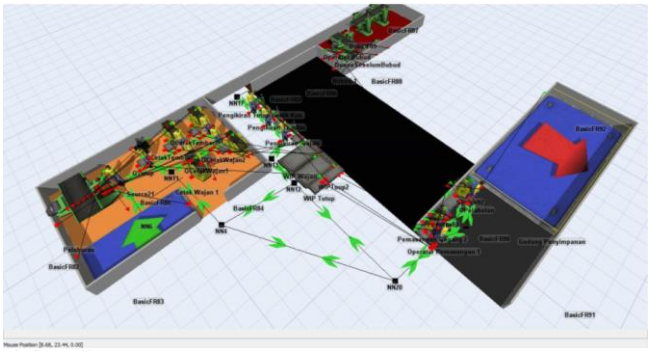

**Figure 6.** The result of proposal layout.

From the proposed layout, the costs are obtained by material handling which is smaller than the initial layout. It can be seen from the image below:


**Figure 7.** The calculation result of proposal material handling costs using Flexsim 6.0 software.

Based on Figure 7, it can be seen that there was a decrease in material handling costs, which was initially reduced by $ 28,847.16 to $ 22,717.76 so that the decrease was $ 6129.4 or about 21%. This change layout has an effect on output the resulting which increases by 4%. And when viewed from the level of safety and comfort of the workers,
this layout is worth applying.

The changes layout that have been made, by moving the filing locations and storage of raw materials, can minimize costs material handling which previously reduced $ 28,847.16 to $ 22,717.76, resulting in a decrease of $ 6129.4 or about 21%. This change layout also made the output increase from an average of 248 to 256, which means an increase of approximately 4%. This change layout is also feasible when viewed from the level of safety, worker comfort, and health protocols.

## CONCLUSIONS

Based on the research results, it can be concluded that there was a decrease in material handling costs by 21%. This layout change has an effect on the resulting output which increases by 4%. seen from the level of safety and comfort of the workers, this layout is worth implementing. Layout changes made by moving filing locations and storing raw materials can minimize material handling costs by 21%. This layout change also made the output increase by about 4%.

## REFERENCES

Apple, J. M. 1990. Tata Letak Pabrik dan Pemindahan Bahan. Edisi ketiga.Bandung: Institut Teknologi Bandung.

Hadiguna, R. A. dan Setiawan, H. 2008. Tata Letak Pabrik. Yogyakarta: Andi Offset.

Heizer dan Render. 2014. Manajemen Operasi. Jakarta: Salemba Empat.

Iskandar, N. M., & Fahin, I. S. 2015. Perancangan Tata Letak Fasilitas Ulang (Relayout) untuk Produksi Truk di Gedung Commercial Vehicle.

Purnomo, H. 2004. Perencanaan dan Perancangan Fasilitas. Cetakan Pertama. Yogyakarta: Graha Ilmu.