Optimizing Efficiency, Flow of Serving, and Layout of DIPS Indonesia using Systematic Layout Planning (SLP) Method

Claresta Yasmine, Gloria Fenny Delavina Simanjuntak, Rizki Estu Rahmaisyraq and Siti Lubna Nazihah
Department of Industrial Engineering
Universitas Indonesia
Depok, 16424, Indonesia
claresta.yasmine@ui.ac.id, gloria.fenny@ui.ac.id, rizki.estu@ui.ac.id, siti.lubna@ui.ac.id

Ardhy Lazuardy
Assistant Professorof Department of Industrial Engineering
Universitas Indonesia
Depok, 16424, Indonesia
ardhy.lazuardy@ui.ac.id

Abstract

Dips Ice Cream is engaged in the beverage and food industry with a focus on ice cream and to-go snacks production. It is located in the Library of the University of Indonesia and is always busy with students during their peak hours. In meeting material needs, they use manual estimates and have not used a systematic calculation of facility planning. Besides that, Dips' flow of workers and material handling are not optimal due to limited space. Researchers conducted observations in the field and processed the data using Systematic Layout Planning (SLP) methods to redesign the facility layout and minimize workers' movement on the production floor. The data are selected to be processed through OPC with the number of operations. Data processing uses OPC, ARC, ARD, and flow process materials for alternative layouts and adjustment on customer's flow to maximize efficiency during the service. From the given four layout recommendations, the proposed layout is chosen because it is the most effective and efficient layout to minimize workers', ease material movement, and improve customer flow so that Dips ice cream could increase its productivity.

Keywords
Material Handling, Facility Planning and Layout.

1. Introduction

In various industries, whether in the production department or in the warehouse department, we need to work effectively and efficiently. The company must be able to produce products with minimum needs, including workers. Plant layout is an optimal arrangement and placement of factory facilities including labor, production equipment, storage space, material handling equipment and all other supporting services with the best structural design to accommodate all these facilities. The production process can start from taking raw materials, assembling, and then sending the finished product that has been assembled. Then we need to check the material, pack it, and send it. Every company will continue to do this whenever there is a request for production. Each time this is done, the costs incurred will also be greater. Likewise with the possibility of errors in doing the work, so that it will incur even greater costs.

The main key that companies can do to make their production activities effective and efficient is to simplify the process, which means reducing unnecessary activities, but with the same results. This is important because the company needs to ensure that all activities carried out by workers do add value to the production process. If possible, we can make a value mapping so that we can find out which processes provide added value and which do not. If the company can estimate the value of our business growth in the future, then make sure that this growth is not the same as the costs we need. Companies need to think about how to ensure our business can grow without

significant cost increases. Companies must ensure that what we do adds value to production activities. It is hoped that if an economic recession occurs, the company's position will still be better because of the good level of productivity they have.

Dips Ice Cream is engaged in the beverage and food industry with a focus on ice cream and to-go snacks production. Dips Ice Cream is located in the Library of the University of Indonesia and is always busy with students during their peak hours. In meeting material needs they use manual estimates and have not used a systematic calculation. So far, they need to place orders once every two days considering there are a lot of orders and the location is not too big so they can't load a lot of raw goods. Dips Ice Cream in its procurement of materials always orders goods related to the manufacture of ice cream such as cones, premix ice cream, toppings, cups, to spoons and tissues. Considering that the store tends to be always crowded and the location is not big, it is very important that Dips Ice Cream is able to use every part of the store properly and carry out material handling in an orderly manner so that it can bring long term benefits to Dips Ice Cream. In an effort to get good and valid calculation results, researchers use the systematic layout planning (SLP) method to remodel the facility layout in DIPS Ice Cream.

1.1 Background of the Problem

The research that will be conducted focuses on restaurants that sell food products. The purpose of this research is to optimize the service process of the object under study. This form of optimization can include adjusting capacity and working time efficiency, handling production materials, as well as adjusting the needs of service areas and supporting large areas.

1.2 Objectives

The objective of our research on Facility Planning and Design is Dips Ice Cream which is located at the Central Library of University of Indonesia. Dips ice cream is popular among University of Indonesia's students because of their unique way of selling ice cream. Randomly, Dips will change their three ice cream flavors every day to surprise their customers. Apart from selling ice cream, Dips also sells other menus, such as coffee and ice blended drinks.

Following is the details of Dips Ice Cream menu:

- Ice Cream
  a. Small cone ice cream
  b. Large cone ice cream
  c. Large cup ice cream
  d. Large cup with cone ice cream
  e. Sundae

- Cold Drinks
  a. Thai tea
  b. Chocolate
  c. Yuzu orange
  d. Pink lemonade

- Coffee
  a. Americano
  b. Americano float
  c. Brown sugar coffee

- Ice Blended Drinks
  a. Shortbread matcha frappe
  b. Oreo madness
  c. Choco bellagio

This research will discuss the optimization of facility planning and layout with ice cream production as the main focus. Moreover, Dips Ice Cream has different areas for ice cream and non ice cream production, including the ordering section. In other words, this problem scoping is felt to be very appropriate and relevant.

2. Literature Review

2.1 Facility Planning

The process of physically organizing all the production variables that make up the production system in order for it to appropriately and effectively comply with the organization's strategic objectives is known as facility layout planning (FLP) (Pablo et al 2021). Transitioning from held technologies to donned scanners offers the chance to further increase material handling productivity, just as the switch from pencil and paper to handheld computers and feature changes like interface improvements from mechanical keys to a virtual keypad have shown productivity enhancements (Eboni et al 2022).

2.2 Layout Design

Layout design (layout) is one factor that is very influential on the performance of an organization. This is because the layout is related to the flow of materials and product movement, information, labor convenience and customer response. Layout efficiency and effectiveness will help companies achieve goals and adapt to various changes (Sarihati and Lazaref 2021). For service businesses that prioritize services such as coffee shops, layout not only facilitates the company's operational performance, but also has an impact on customer satisfaction and loyalty (Ibrahim et al. 2018).

Layout is a plan that involves decisions regarding the preparation and arrangement of the layout of an economic activity center needed by each facility that has various processes (Krajewski et al. 2015). According to Heizer & Render (2015) layout is a meaningful decision that determines long-term operating efficiency. The layout has many strategic effects because the layout determines the competitiveness of the company in terms of capacity, process, flexibility, pay, quality of work area, contact with customers and corporate image.

The main purpose of the layout is to optimize the arrangement of production equipment so that its position can maximize production operations (Slack et al. 2013). One of the methods to improve layout is using systematic layout planning. With this method, the new plant layout significantly decreased the distance of material flow and will directly affect the overall productivity (Potadar and Kadam 2018).

2.3 System Efficiency

Placement of production machines and equipment, space for material handling placement, space for storing materials and assembled components, space for human labor, and other spaces to support the service process must be properly designed from the start of the business (Pérez-Gosende et al. 2021). This is to anticipate the disassembly of production equipment and supplies, cost efficiency and changing customer tastes.

3. Methods

3.1 Stages of the Research

a. Perform the necessary data collection. The data collected is needed as input in the analysis process which will later be carried out in designing the factory layout.
b. Identify the places and layouts prior to the improvement process by looking at its room allocation, product arrangement, and equipment.
c. Identify the material flow of the production process in each activity and generate a process chart to describe the production process flow.
d. Identify the material handling needed throughout the production process to analyze the efficiency of its production process.
e. Perform an Activity Relationship Chart (ARC) analysis to determine the level of relationship between activities that occur in each area one with another in pairs.
f. Create an Activity Relationship Diagram (ARD) which is described by connecting lines according to the degree of closeness of each area in accordance with the ARC that has been made.
g. Create a consideration of modifications and practical limitations in making the proposed alternative layouts.
h. Formulate alternative proposed layouts in accordance with the overall analysis that has been done previously.
i. Evaluating and selecting the best proposed alternative layouts to be applied to research objects so as to increase their productivity.

4. Data Collection

The analysis will use primary data obtained through direct visit and interviews with the head and employees of Dips Ice Cream. In result, facilities and equipment details at Dips Ice Cream will be attached in here Dips Ice Cream_Data Collection.

4.1 Operation Process Chart (OPC)

The following Figure 1 is the Operation Process Chart of making the ice cream until it's served to the customer.

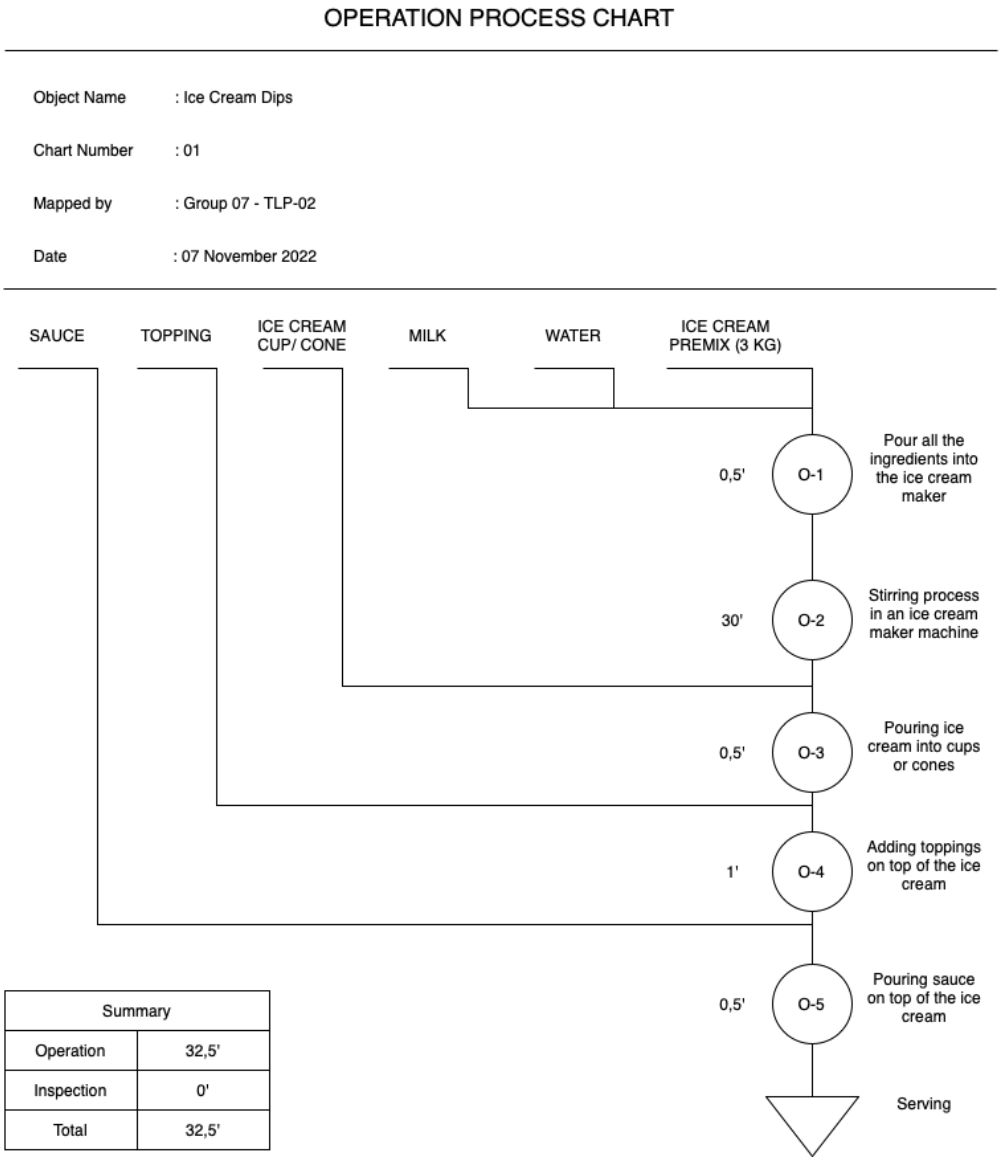

Figure 1. Operation Process Chart

Based on the Operational Process Chart for making ice cream in Dips Ice Cream, there are five stages of operation. While the total operating time to produce 1 cup or cone ice cream product is 32.5 minutes.

4.2 Material Flow

Dips material flow represents the shipment of materials from the supplier to the Dips' storage every two days due to space limitation. Meanwhile the material for toppings (crumble and sauce) will be sent every week. The raw materials needed for Dips will be sent directly from the house of Dips Head, as a warehouse, by a car. The warehouse is located in Kalibata which will take around 40 minutes to arrive at Dips in the Central Library of University of Indonesia area. Upon arrival, the car will park in the Central Library's dock area to unload the raw materials which will be brought to the store location by using a trolley (Table 1).

Table 1. Collected Data from DIPS Ice Cream

	Material Supply	Total Supply
Ice Cream and Toppings	Ice cream premix	10 cartons x 1,5 kg = 15 kg
	Matcha crumble	3 bags x 1 kg = 3 kg
	Oreo crumble	3 bags x 1 kg = 3 kg
	Biscoff crumble	1 bag x 1,5 kg = 1,5 kg
	Red velvet crumble	1 bag x 1,5 kg = 1,5 kg
	Caramel sauce	3 bottles x 600 ml = 1800 ml
Packaging	Ice cream cone	4 bags x 100 cones = 400 cones
	Ice cream paper cup	4 bags x 100 cups = 400 paper cups
	Ice cream spoon	400 spoon

In addition to quantitative data, to get a clearer picture, we describe the current layout in the following Figure 2.

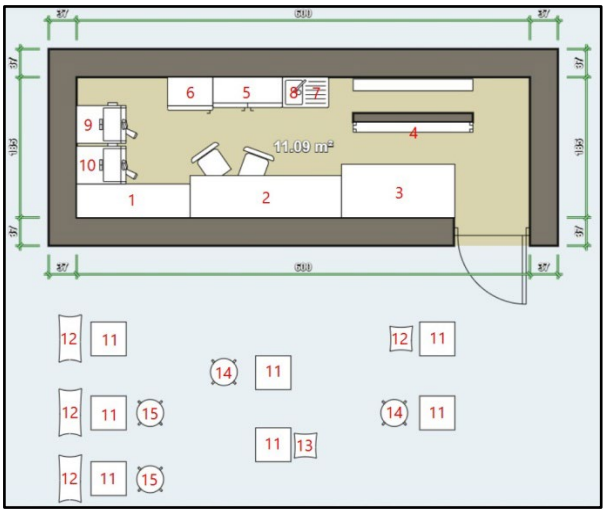

Figure 2. Existing Layout of DIPS Ice Cream (November 2022)

With further information in the following Table 2.

Table 2. Addition Information about the Existing Layout

Facility	No	Description	Quantity	Size (cm)		
				Length	Width	Height
Service	1	Ice cream display counter	1	150	55	105
	2	Waiting, cashier, and serving table	1	200	55	105
Material Inventory	3	Materials storage	1	150	70	90
	4	White cabinet for topping	1	118	34	162
	5	Cabinet for pre-mix storage	3	60	30	100
	6	Refrigerator	1	60	40	90
	7	Freezer	1	100	45	40
	8	Mix table	1	105	30	60
	9	Ice cream maker (1 flavor)	1	55	35	70
	10	Ice cream maker (2 flavors)	1	40	35	70
Dining Area	11	Customers table	7	60	60	77
	12	Customer Chair Type 1	3	120	30	50
	13	Customer Chair Type 2	2	30	30	50
	14	Customer Chair Type 3	1	45	30	82
	15	Customer Chair Type 4	3	45	45	82

4.3 Material Handling

Material handling is the movement, protection, storage, and control of materials by using special tools or manual handling throughout the production process. However, Dips' area can be considered as small for the movement of workers which leads Dips to set their production quantity as low. With that in mind, Dips only need a trolley as a tool to move materials from the loading dock, in the parking lot, to their storage. Meanwhile, the workers use manual material handling during the ice cream making process.

4.4 Workers

4.4.1 Job Distribution among Workers

For the overall operation of Dips, five workers are hired in which 3 of them are responsible for the ice cream serving as well as the cashier and the remaining 2 workers are responsible for making other dishes besides ice cream. As the research will be focused on the ice cream menu, the total number of workers that would be taken into consideration are only those 3 workers. Each of the 3 workers has a more detailed job description in serving the ice cream. The first worker is the cashier and is responsible for doing the payments, starting from calculating the customers' purchases, receiving money, and giving change for them. Then, the second worker is serving the ice cream, starting from pouring ice cream into cones/cups, adding toppings, and giving the ice cream to customers. Lastly, the third worker is the stock controller and assists either in purchasing or serving areas.

4.4.2 Working Shift Schedule

Dips doesn't have certain scheduling for working shifts since all of the workers need to work from early of the store opening until it closes. In this case, the workers' working time is the same as the operational time for the store. On Monday to Thursday and on Saturday, the working time started at 09.30 and ended at 18.00 with only workers shuffling in the break time. On Friday, the working time began at 09.00 and ended at 18.00, but there would be a resting time at 11.45-13.00 and the store would be in a full close order state during this interval time.

5. Results and Discussion

5.1 Activity Relationship Chart

Table 3 represents the ARC Closeness Rating Description and Figure 3 shows the activity relationship chart of dips ice cream.

Table 3. ARC Closeness Rating Description

Closeness Rating	Description
A	Absolutely necessary
E	Especially Important
I	Important
O	Ordinary closeness
U	Unnecessary
X	Avoid closeness

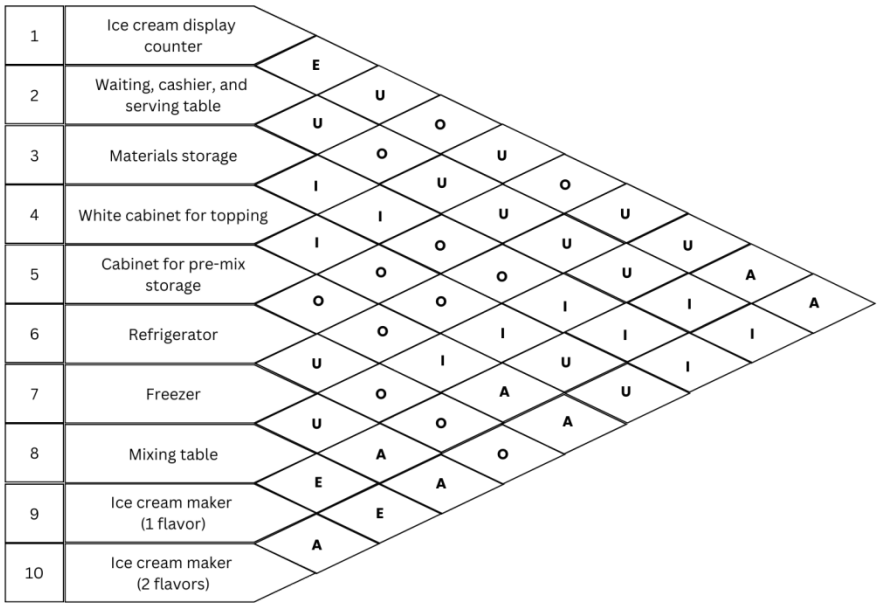

Figure 3. Activity Relationship Chart of Dips Ice Cream

5.2 Activity Relationship Diagram

Table 4 represents the Closeness Rating Result of ARC and Figure 4 shows the activity relationship diagram of dips ice cream.

Table 4. Closeness Rating Result of ARC

No. Dept	Department	Closeness Rating Code					
		A	E	I	O	U	X
1.	Ice cream display counter	9, 10	2	-	4, 6	3, 5, 7, 8	-
2.	Waiting, cashier, and serving table	-	1	9, 10	4	3, 5, 6, 7, 8	-
3.	Materials storage	-	-	4, 5, 8, 9, 10	6, 7	1, 2	-
4.	White cabiner for topping	-	-	3, 5, 8	1, 2, 6, 7	9, 10	-
5.	Cabiner for premix storage	9, 10	-	3, 4, 8	1, 2, 6, 7	-	-
6.	Refrigerator	-	-	-	1, 3, 4, 5, 8, 9, 10	2, 7	-
7.	Freezer	9, 10	-	-	3, 4, 5	1, 2, 6, 8	-
8.	Mixing table	-	9, 10	3, 4, 5	6	1, 2, 7	-

9.	Ice cream maker (1 flavor)	1, 5, 7, 10	8	2, 3	6	4	-
10.	Ice cream maker (2 flavors)	1, 5, 7, 9	8	2, 3	6	4	-

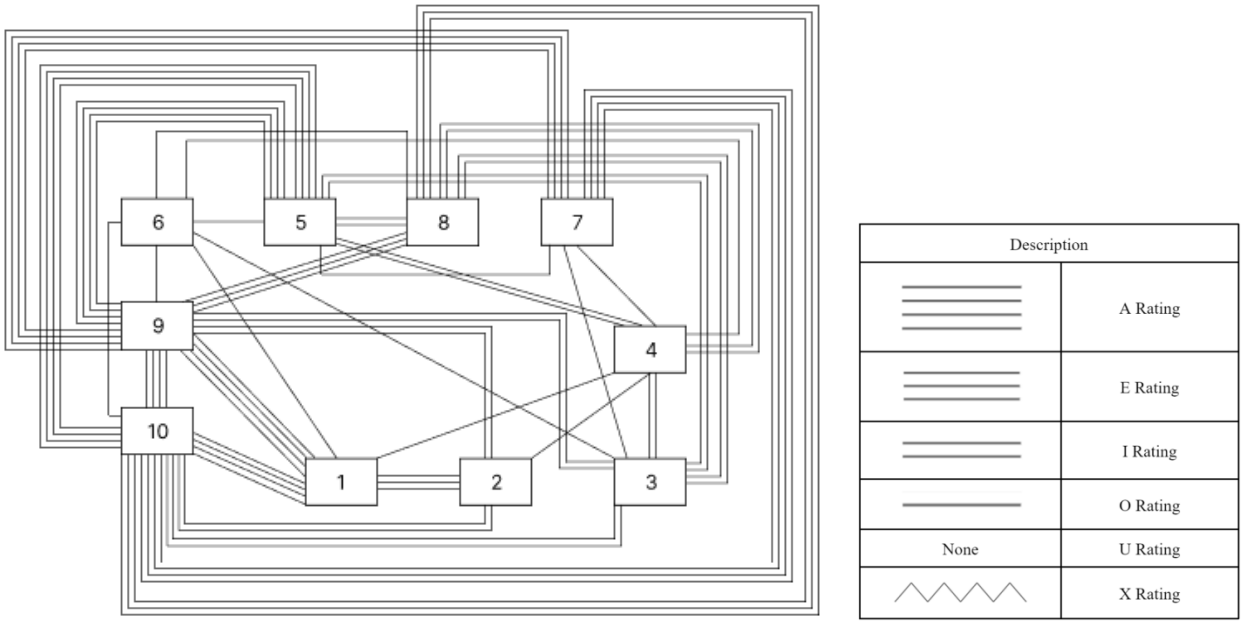

Figure 4. Activity Relationship Diagram of Dips Ice Cream

5.4 Material Flow

Figure 5 shows the flow of material.

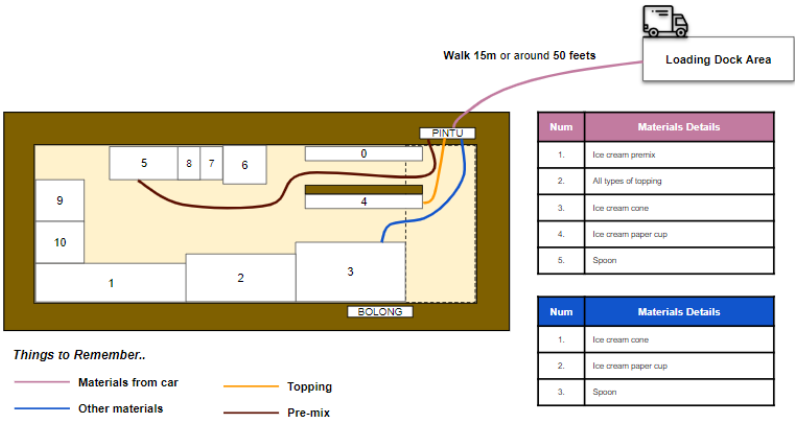

Figure 5. The Flow of Material

5.5 Customer Flow

Figure 6 shows the flow of customer.

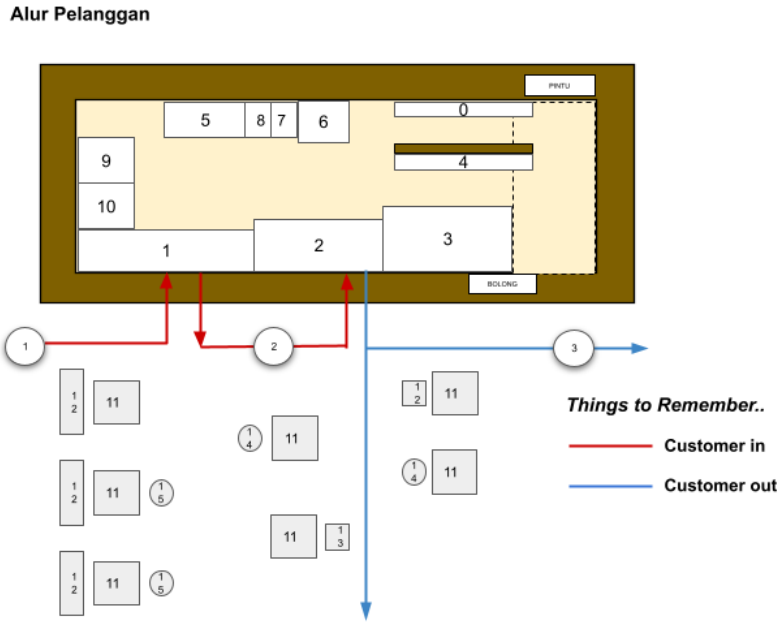

Figure 6. The Flow of Customer

5.6 Recommendation

Option A

Based on the analysis using ARC and ARD method, it is absolutely necessary for Dips Ice Cream to have a freezer in a close distance to 2 ice cream maker machines, beside that it is important to have the storage close to the ice cream machine (Figure 7).

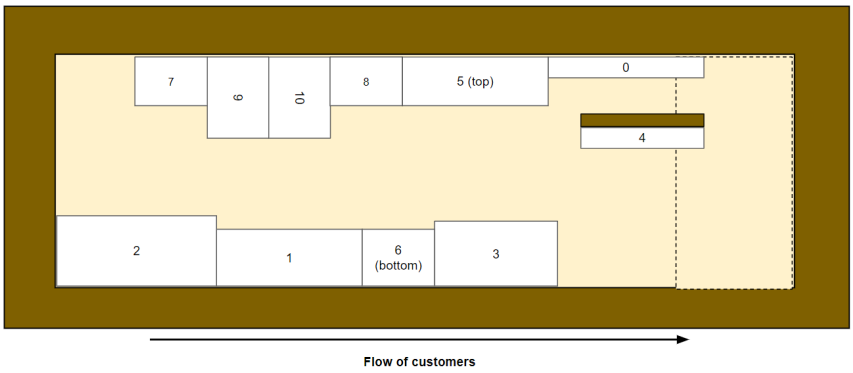

Figure 7. Recommendation (Option A)

Option B

Considering the existing processes through the operation process chart and all calculation results using activity relationship charts, activity relationship diagrams, material flows, to customer flows, by compiling a layout of the items in materials like this, we are able to get better effectiveness compared to existing layouts. This layout wouldn't

confuse the customers since they need to go through the ice cream-making process before ordering and purchasing the ice cream (Figure 8).

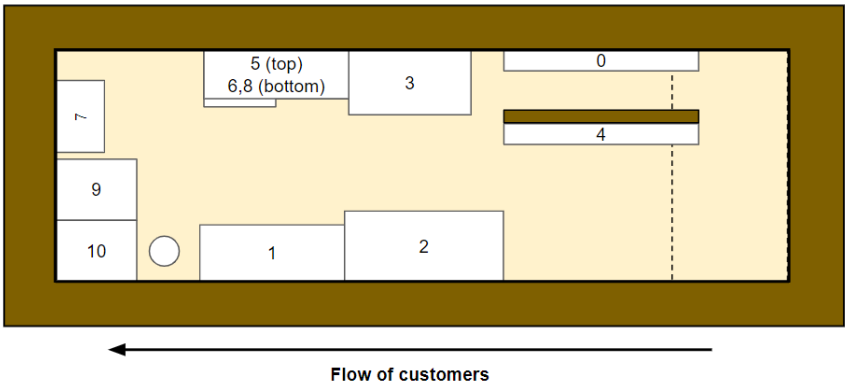

Figure 11. Recommendation (Option E)

Option C

This layout recommendation is based on the analysis of ARC and ARD which stated that the ice cream maker should be put close to the display counter, cabinet for premix storage, and freezer. In this layout, the ice cream maker worker can do his job easily and the movement is also efficient in order to put the ice cream whether on a display or in a freezer. Customers' flow will be from the left side so they would choose the ice cream and topping first before getting them purchased. But, this layout would probably confuse the customers since they need to go through the ice cream-making process before ordering and purchasing the ice cream (Figure 9).

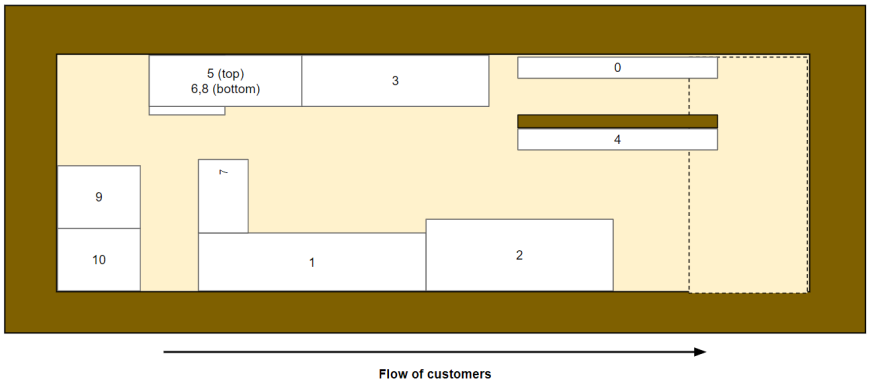

Figure 9. Recommendation (Option C)

Option D

Based on the analysis using ARC and ARD method, storage needs to be close to the ice cream machine area in order to minimize the movement during the ice cream making process. It will also help the workers to move the ice cream premix without any special tools. However, this layout changes the customer's flow with the cashier as the first service they will meet. As a result, it is expected to reduce queue lines during their peak hours. It will also provide customers with a waiting area on facility number 1, after the cashier (Figure 10).

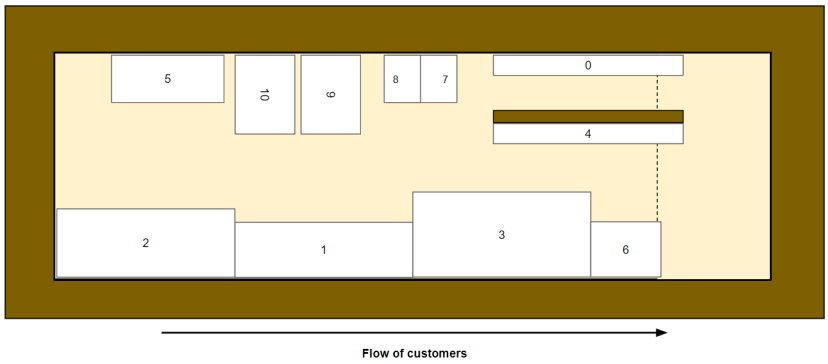

Figure 10. Recommendation (Option D)

5.5 Proposed Layout

After considering each of the measurements and calculation, we chose the following layout in Figures 11 and 12 (layout B) because it aligns the calculation that has been done.

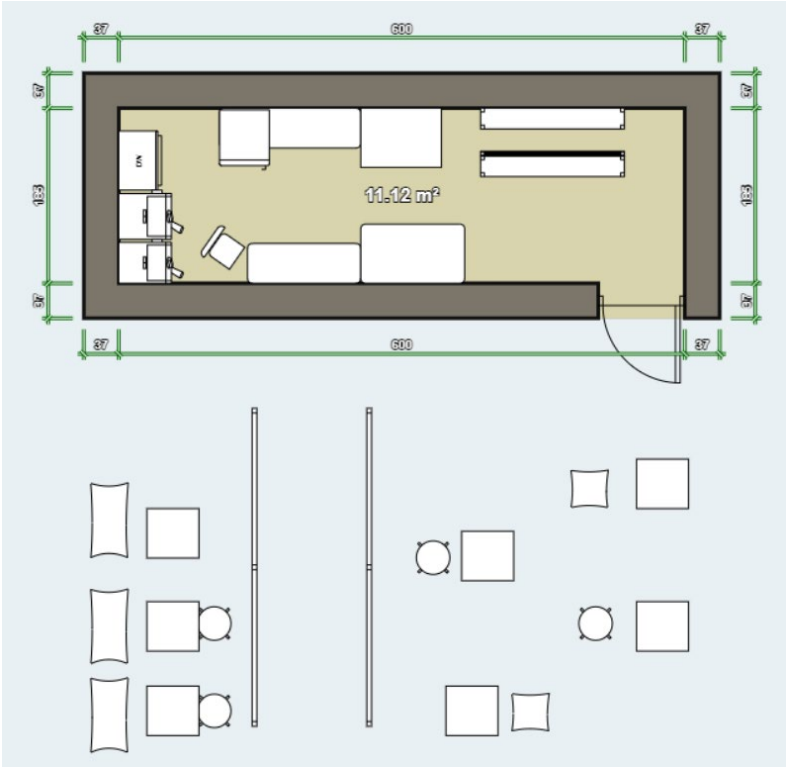

Figure 11. The Proposed Layout

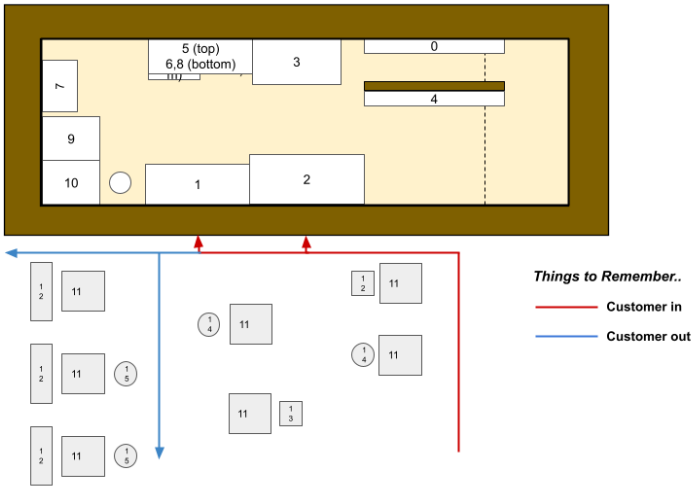

Figure 12. The Proposed Layout

5.5.1 Service

Based on the results of ARC and ARD method, the storage must be placed in one area nearby to the ice cream maker. It aims to reduce the movement of workers due to limited space during material preparation to make Dips' ice cream. The ice cream maker will be on the left following the display counter on the right as a table to add toppings which will allow the workers to serve ice creams and toppings easily according to the customers' requests. Meanwhile the cashier table will be on the right as the first service customers encountered. With this in mind, it is also necessary to change the dimensions of the storage facility to fit in with the mixing table at the storage area. The storage's length will shorten to 120 cm and align with the cashier table at the front.

5.5.2 Customer Flow

Based on the layout recommendation below, Dips' customers will experience a change in customer's flow due to the change in the location between cashier table and display counter. Customers will have to order and pay first on the cashier table at the right side of Dips. As a result, it is expected to reduce queue lines during their peak hours. It will also provide customers with a waiting area on facility number 1, after the cashier.

5.5.3 Job Distribution among Workers

With the improvement of recommendation layout, it is expected that the job distribution among workers would also be better. Given that the ice cream-making worker only focuses on the ice cream making and putting the ice cream on the display, the second worker can also focus on adding toppings, spoon, and tissue for the customers. Then, the third worker will also do his job as the cashier man and is responsible for doing the purchasing activity. With a more focused job distribution, the production flow would be more streamlined and more productive.

6. Conclusion

Dips ice cream is one of the food and beverage stalls in the Library of University of Indonesia which focuses on ice cream menu with other additional servings such as snacks and various drinks. Being famous by its delicacy and affordable prices, Dips ice cream is always crowded during peak hours. Therefore, Dips ice cream needs to optimize its efficiency as well as its flow of serving to reduce nonproductive time and movement in serving its customers. The analysis is conducted using systematic layout planning (SLP) method to remodel the facility layout of Dips ice cream. After doing some data collection and identification of the existing layout using Activity Relationship Chart (ARC) and Activity Relationship Diagram (ARD), four recommendation layout are given based on the analysis. By doing some additional research and consideration, the proposed layout is chosen. The proposed layout performs the most effective and efficient layout to minimize workers', ease material movement, and improve customer flow so that Dips ice cream could increase its productivity.

References

Casban, C., and Nelfiyanti, N, Analisis Tata Letak Fasilitas Produksi Dengan Metode FTC dan ARC untuk Mengurangi Biaya Material Handling. *Jurnal Penelitian dan Aplikasi Sistem & Teknik Industri*, vol. *13*, no. 3, pp. 262-274, 2019.

Nelfiyanti, P., Mula, J., & Díaz-Madroñero, M., Facility Layout Planning. an extended literature review. *International Journal of Production Research*, vol. *59*, no. 12, pp. 3777–3816, 2021.

Gaddis, E. S., Burch V, R. F., Strawderman, L., Chander, H., Smith, B. K., Freeman, C., and Taylor, C., The impact of using wearable devices on the operator during manual material handling tasks. *International Journal of Industrial Ergonomics*, vol. *89*, no. 103294., 2022.

Pérez-Gosende, P., Mula, J., and Díaz-Madroñero, M., Facility Layout Planning. an extended literature review. *International Journal of Production Research*, vol. *59*, no. 12, pp. 3777–3816, 2021.

Potadar, O. V., and Kadam, G. S., Development of Facility Layout for Medium-Scale Industry Using Systematic Layout Planning. *Lecture Notes in Mechanical Engineering*, pp. 473–48, 2018.

Susie Suryani, Rani Rahima Septiani, Analisis Efektivitas Tata Letak (Layout) Pada Starbucks Coffee Mal Ska Pekanbaru, 2022.

Biographies

Claresta Yasmine Putri Pribadyo is a sophomore undergraduate Industrial Engineering student at Universitas Indonesia. She was born in Jakarta, September 8th 2003. In addition to her academic obligations, she is currently entrusted with the responsibility of being one of the Laboratory Assistant in Ergonomics Centre 2022 and a Board of Director of the Social in IMTI FT UI 2022. Her research interests are mostly related to Quality of a System, Management of a Project, System Optimization, and Economics.

Gloria Fenny Delavina Simanjuntak is a sophomore undergraduate Industrial Engineering student at Universitas Indonesia. She was born in Semarang, October 10h 2002. In addition to her academic obligations, she is currently entrusted with the responsibility of being one of the Board of Directors in IISE UI 2022 Student Chapter and a Member of the Financial and Funding Commission MPM FT UI 2022. Her research interests are mostly related to Quality of a System, Management of a Project, System Optimization, and Economics.

Rizki Estu Rahmaisyraq is a sophomore undergraduate Industrial Engineering student at Universitas Indonesia. She was born in Tuban, June 18th, 2002. In addition to her academic obligations, she is currently entrusted with the responsibility of being one of the Board of Directors in Science and Technology in IMTI FTUI 2022. Her research interests are mostly related to Quality of a System, Management of a Project, System Optimization, and Economics.

Siti Lubna Nazihah is a sophomore undergraduate Industrial Engineering student at Universitas Indonesia. She was born in Jakarta, October 21st, 2002. In addition to her academic obligations, she is currently entrusted with the responsibility of being one of the Expert Staff IMTI FTUI 2022. Her research interests are mostly related to Quality of a System, Management of a Project, System Optimization, and Economics.