

**REDESIGN LAYOUT OF PRODUCTION FACILITIES TO MINIMIZE
DISTANCE MOVEMENT
(STUDY CASE: CV. SALWA INDOBOGA)**

THESIS

**Submitted to the International Undergraduate Program in Industrial Engineering in
Partial Fulfillment of the Requirement for the Degree of Sarjana Teknik Industri –
Faculty of Industrial Technology**



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SURAT KETERANGAN

Dengan hormat,

Dengan ini CV. Salwa Indoboga, yang beralamat di Jl. Bakung V No. 108 RT.37 RW.15 Kel. Sialang Kec. Sako Palembang, dengan penuh tanggung jawab menyertakan dan menerangkan bahwa perusahaan kami telah memberi izin, fasilitas, serta kesempatan kepada mahasiswa yang namanya tercantum di bawah ini untuk melaksanakan kegiatan penelitian skripsi di lingkungan perusahaan kami sesuai dengan ketentuan dan jadwal yang telah disepakati, yaitu:

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Mahasiswa tersebut telah menyelesaikan seluruh rangkaian kegiatan penelitian skripsi di CV. Salwa Indoboga dengan baik sesuai ketentuan perusahaan.

Demikian surat keterangan ini dibuat dengan sebenarnya agar dapat dipergunakan sebagaimana mestinya

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DEDICATION PAGE

This undergraduate thesis is dedicated to my beloved parents, whose endless love, support, and sacrifices have been my greatest source of strength throughout my academic journey. Their unwavering encouragement and guidance have shaped me into the person I am today.

I also dedicate this work to my supervisor, whose invaluable guidance, insightful advice, and constant support have played a crucial role in the completion of this thesis. My deepest gratitude also goes to my family and close friends who have provided continuous motivation, understanding, and kindness during moments of challenge and achievement.

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PREFACE

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The author realizes this undergraduate thesis still has many shortcomings. Therefore, the author expects constructive criticism and suggestions from various parties that will be highly valuable for future improvements. This undergraduate thesis was prepared to fulfill one of the requirements for completing a bachelor's degree in the International Undergraduate Program in Industrial Engineering at the Faculty of Industrial Technology, Islamic University of Indonesia.

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Yogyakarta, 21 September 2025



Nyayu Salwa Shelomita

ABSTRACT

The production layout at CV. Salwa Indoboga required redesign to minimize production movement distances and improve workflow efficiency. This study aimed to optimize the layout by applying systematic facility planning approaches. The methods used included the Activity Relationship to analyze functional relationships, while Systematic Layout Planning (SLP) and rectilinear distance calculations were employed to evaluate alternative layouts. Five proposed layouts were generated and compared. The results showed that Layout 3 provided the most optimal performance. For grilled chicken, the distance decreased from 60 meters to 36 meters (a reduction of 24 meters or 40%), and for spicy beef, from 70 meters to 33 meters (a reduction of 37 meters or 52.9%). For the decoration sets process, the distance decreased from 44.5 meters to 22.5 meters (a reduction of 22 meters or 49.4%). In conclusion, the redesign successfully minimized material movement, improved safety, organization, and efficiency in the production area, with Layout 3 selected as the best option to support more efficient operations.

Keywords: Production layout, Layout redesign, Systematic Layout Planning, Activity Relationship, Food industry

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CHAPTER I

INTRODUCTION

1.1 Background

CV. Salwa Indoboga is a company that operating in the food and beverage sector, with its main products being various catering dishes and meal packages. CV. Salwa Indoboga aims to provide delicious meals and excellent service to its customers in Palembang and beyond. CV. Salwa Indoboga, located at Jl Bakung V No.108, Jl. Perumnas Raya, Sako, Kec. Sako, Kota Palembang, Sumatera Selatan 30163, Indonesia, operates with a team of 16 dedicated individuals. CV. Salwa Indoboga adjusts its production capacity daily to meet customer needs, whether it's for daily orders or special events.

In the current industrial scope, the success of a company is no longer determined only by the quality of its products. Nevertheless, a company that has the ability to implement proper operational standards, efficient production floor, utilize suitable equipment and employed skilled personnel will also be taken into account (Irianti, Afifah, Yuniar, Firmansyah, & Salsabila, 2022). In industrial sector, facility layout is an important aspect that must be carefully considered (Stefianti, Heryanto, & Suhada, 2022). An effective and efficient layout can contribute in reducing production cycle time, idle time, bottlenecks and material handling time while also improving the overall production output (Panrelli, Rexoprodjo, Safitri, & Lahay, 2024). The production layout refers to how company arranges its facility by utilizing the available space to keep the production process running smoothly and also supports the proper placement of facilities and equipment required for production activities (Sekarningtyas, Faza, Kafidzin, & Prasetyo, 2024).

The company adjusts its daily production capacity based on customer demand, whether for routine orders or special events. As a result, the volume of production varies. For example, the number of grilled chicken portions produced per cycle ranges from 150 to 2,500, while spicy beef ranges from 10 to 30 kilograms, and decorative sets range from 4 to 8 per day. The production area, which also serves as a warehouse, covers approximately 252 m². However, the current facility layout does not follow any clear guidelines for the placement of equipment and machines. This is due to insufficient planning during the initial layout design phase, as well as a lack of understanding regarding key layout considerations and priorities. An improper arrangement of the work area that does not follow the production flow leads to repeated

movements through sections of the production area that are not yet supposed to be accessed, resulting in unnecessary movement and wasted time (Hidayat, et al., 2023).

This issue significantly affects the operational process of producing various products. The repeated and back and forth movements within the workspace not only increase the physical burden on workers but also lead to inefficiencies in time and energy usage. This condition contributes to a rise in nonvalue added activities, such as unnecessary transportation and waiting time, which are classified as waste in lean manufacturing principles. Over time, these inefficiencies can accumulate and reduce overall productivity, delay order fulfillment, and compromise service quality, especially when handling large-scale or time-sensitive orders. Therefore, an immediate redesign of the layout is necessary to support smoother workflow, minimize waste, and optimize production performance.

To overcome the layout problems mentioned previously, it is necessary to redesign the facility layout as a solution. This redesign aims to align the arrangement of work areas, equipment, and material flow with the actual production process flow, thereby minimizing unnecessary movements and wasted time. Layout design using the Systematic Layout Planning (SLP) method is designed to solve problems involving various aspects, including production, transportation, warehousing, support services, assembly, and other office activities (Nurhidayat, 2021). Systematic Layout Planning (SLP) is a layout design method that considers the close relationships between departments based on the material flow that occurs during the production process (Anwar, Bakhtiar, S, & Riski Nanda, 2015). This method provides a clear framework for structuring work areas based on the degree of proximity of their functions to outcomes that align with actual conditions.

In previous research, Systematic Layout Planning (SLP) was used to design a production facility layout at PT DSS that minimizes material handling costs, reduces the distance between production areas, eliminates intersecting process flows, and results in a 32% improvement compared to the initial layout (Nurhidayat, 2021). Erdiansyah et al. (2024) used the Systematic Layout Planning method to redesign the production floor layout, addressing the misplacement of workstations that did not follow the production process sequence and caused backtracking, resulting in a 244-meter reduction in total distance between workstations compared to the initial layout. Dwi et al. (2022) used the SLP (Systematic Layout Planning) method to redesign its facility layout because the current arrangement did not align with the production flow and the

new layout reduced the travel distance from 40,073.55 meters to 23.6 meters which led to decreased operational expenses.

However, as the continuous step of using Systematic Layout Planning, Activity Relationship Chart (ARC) qualitative method is used to help identify and evaluate level of closeness between department or work area. ARC helps determine which areas should be located close together based on the frequency and importance of interactions between activities in the production process. This study used qualitative methods for data collection and analysis. A qualitative approach was chosen because it provides a deeper understanding of existing layout conditions, worker movement patterns, equipment placement, and the relationships between activities. Furthermore, this method allows for the interpretation of non-numerical data, such as workflow observations and employee input, which are essential for designing a layout that is functional and appropriate to field conditions.

Therefore, this research combines the Systematic Layout Planning and Activity Relationship Chart methods simultaneously to produce a more structured and efficient facility layout by aligning work areas according to the actual production flow and identifying the ideal proximity between departments, with the aim of minimizing unnecessary movement, reducing production time, and increasing overall operational efficiency.

1.2 Problem Formulations

Based on the background that has been described previously, it is necessary to provide appropriate recommendations and solutions. To achieve this, the following problem statements have been formulated:

1. What are the changes in production layout required by CV. Salwa Indoboga to improve the smoothness of the production process?
2. How big is the difference in the distance of movement that occurs between the initial layout and the proposed layout?

1.3 Research Objectives

Based on the problem formulations, the research objectives are as follows:

1. To establish required proposed layout of production floor CV. Salwa Indoboga by changing it to improve the smoothness of the production process.

2. To know the difference in the distance of movement that occurs between the initial layout and the proposed layout,

1.4 Reserach Benefit

This research offers benefits to various aspects specifically to the academic aspect and practical aspect. The benefits obtained from this research are:

1. Academic Aspect

This research contributes to the development of science in the field of industrial engineering, particularly in facility layout planning. By integrating the Systematic Layout Planning (SLP) and Activity Relationship Chart (ARC) methods, this research can be used as a reference in further academic studies that discuss layout efficiency based on production flow and proximity between departments.

2. Practical Aspect

For CV. Salwa Indoboga, this research provides practical recommendations regarding redesigning the production facility layout to be more efficient and align with actual workflows. Implementation of the proposed layout is expected to reduce unnecessary material movements, minimize production time, and improve operational performance. Furthermore, the new layout also supports more optimal space utilization, increases labor productivity, and has the potential to lower operational costs.

1.5 Limitation and Assumption

This research presents several limitations and assumptions to narrow the scope of discussion. The limitations and assumptions applied in this study are as follows:

1. This research was conducted within the Faculty of Industrial Technology at the Islamic University of Indonesia.
2. This research only focuses on the internal production floor area of CV. Salwa Indoboga.
3. The analysis carried out is quantitative and based only on distance.
4. This research only applies the Systematic Layout Planning (SLP) method in combination with the Activity Relationship approach to redesign the layout.
5. The data used were estimates and observations from the general production cycle, and therefore may not represent conditions during peak loads or unexpected events.

CHAPTER II

LITERATURE REVIEW

2.1 Research Position

Research position can be described with the state of the art, are taken from several previous research as the guide to support this research, which will then serve as a reference and comparison. State of the art includes several journals that are on the same position with this research from the objects and methods.

Table 2. 1 Research Position

Author	Case in Food Industry	Production Facility	Systematic Layout Planning	Activity Relationship	Distance Optimization
Sekarningtyas et al. (2024)	✓	✓	✓	✓	✓
Panrelli et al. (2024)	✓	✓	✓	✓	✓
Wiati et al. (2021)		✓	✓	✓	✓
Tiara et al. (2024)	✓	✓		✓	✓
Deesamer et al. (2025)			✓		✓
Pamungkas et al. (2025)		✓	✓	✓	✓
Suhardi et al. (2021)		✓	✓	✓	✓
Bisri and Cahyana (2022)		✓	✓	✓	✓
Shiddiqi et al. (2025)		✓		✓	✓
Proposed	✓	✓	✓	✓	✓

Facility layout issues have long been a critical concern in various industries, particularly in food-based micro, small, and medium enterprises (MSMEs) which often operate with limited space and resources. Numerous studies have revealed that poor layout design can lead to various forms of waste, including excessive worker movement, redundant transportation of materials, and increased production time. For instance, Wiati, Zaman, and Kautsar (2021) investigated the case of Fandy's Cake Mold Home Industry and identified inefficient, back and forth movements

between workstations due to a layout that failed to follow the logical flow of the production process. This significantly increased production time and reduced labor efficiency. A similar problem was found by Deesamer, Phudee, and Pooprang (2025), who stated that the initial layout in their case study was inefficient due to a disrupted process flow and limited space, which led to excessive material movement. Pamungkas et al. (2025), in the research of UD Cantenan, aimed to reorganize the layout to shorten the distances between workstations and streamline the production process, resulting in a more efficient workflow. These issues are not isolated cases but are commonly found across various food industry MSMEs. In the case of MSME Bill Bakerykoe, Sekarningtyas et al. (2024) observed that the arrangement of work areas did not align with the sequence of production activities, leading to repeated movements and inefficiencies. A's Bakery faced similar challenges on production floor, it has non-ideal layout hindered the smooth flow of operations and limited workers' mobility, as noted by Tiara, Perdana, and Atikah (2024). Furthermore, Panrelli et al. (2024), in their study of a food business producing various fried products, identified a layout that was disorganized and not aligned with the production sequence, causing back and forth movement that slowed down operations. These studies highlight the widespread issue of inefficient layouts in the food production sector and reinforce the need for systematic redesigns to improve operational performance.

To overcome the challenges related to inefficient production layouts, Systematic Layout Planning (SLP) has emerged as a widely used method due to its structured approach in designing optimal facility arrangements. Systematic Layout Planning systematically considers the relationship between activities, space requirements, and production sequences to generate layouts that are efficient and practical. Numerous studies have demonstrated the effectiveness of this method. For example, Deesamer et al. (2025) implemented Systematic Layout Planning combined with the Analytic Hierarchy Process (AHP) to solve layout issues in a space-constrained facility, successfully reducing material movement distance by 40%. The integration of decision-making tools such as Analytic Hierarchy Process allows for more objective prioritization in layout design. Pamungkas et al. (2025), in their study of UD Cantenan, applied a combination of Systematic Layout Planning, the kanban system, and work sampling to improve the production layout. The result was a reduction in material movement distance from 41 m² to 37 m², demonstrating that a well-planned layout can significantly improve production efficiency. Meanwhile, Bisri and Cahyana (2022) applied Systematic Layout Planning along with the Blocplan method to address problems of suboptimal layout and excessive

interdepartmental distances at CV. Jaya Rubber Industry. These inefficiencies led to frequent backtracking and reduced process flow. By applying Systematic Layout Planning, the researchers successfully reduced material movement by 23.75 meters and achieved a 34% increase in efficiency. These studies confirm That Systematic Layout Planning is not only capable of improving physical arrangement and minimizing waste but also facilitates better process flow, space utilization, and time management. For MSMEs with limited resources and dynamic production volumes, Systematic Layout Planning offers a flexible and data-driven framework to improve layout design. Its successful applications across various industrial settings make it a valuable methodological tool for production facility improvement.

Combining Systematic Layout Planning (SLP) with the Activity Relationship (AR) method can yield even more optimal facility layouts by incorporating both spatial efficiency and process logic. The Activity relationship method, which includes tools such as the Activity Relationship Chart (ARC) and Activity Relationship Diagram (ARD), focuses on identifying the close relationships between different activities or departments. When integrated with Systematic Layout Planning, it provides a deeper understanding of workflow dynamics and helps create layouts that reflect both operational requirements and proximity needs. Shiddiqi et al. (2025) demonstrated the effectiveness of this approach in the Aurora Home Industry, which produces baby pillows and mattresses. The facility faced problems such as inefficient layout and wasted space. By applying Activity Relationship, those were able to reduce total displacement distance from 940 meters in the initial layout to 310 meters in the proposed layout. This significant improvement shows how combined methods can reduce unnecessary travel time and enhance production flow. Another notable case was presented by Suhardi, Elvira, and Astuti (2021) at PT Pilar Kekar Plasindo, where the production facility suffered from long material movement distances, cross-traffic, and the presence of non-operational machines in the workspace. By generating three alternative layouts through the Systematic Layout Planning method and incorporating Activity Relationship principles, the selected layout reduced material handling costs by 68.3% and material movement distance by 59.6%. Similarly, Wiati et al. (2021) applied both Systematic Layout Planning and Activity Relationship to improve the layout at Fandy's Cake Mold Home Industry. The revised layout successfully addressed the problems of wasteful motion and inefficient workstation placement, reducing total material movement from 1,981.8 meters to 1,732.05 meters. These findings confirm that combining Systematic Layout Planning with Activity Relationship methods not only enhances layout

structure but also aligns physical arrangements with production logic. This synergy is especially beneficial in MSMEs where space is limited, and production workflows need to be tightly organized.

In the food industry, the integration of Systematic Layout Planning (SLP) and Activity Relationship Chart (ARC) has proven effective in redesigning production facilities for greater efficiency and reduced waste. Several studies have applied this combined approach to tackle layout issues in MSMEs and small food businesses. For instance, Sekarningtyas et al. (2024) conducted a redesign of the layout in MSME Bill Bakerykoe and achieved a significant reduction in total material movement by 16.4 meters through a rearrangement of seven work areas. The study demonstrated how aligning workstations based on Activity Relationship Chart generated closeness ratings can streamline production and improve workflow continuity. Panrelli et al. (2024), working with a food business that produces various fried snacks, encountered similar inefficiencies caused by a disorganized layout. Their use of Systematic Layout Planning and Activity Relationship Chart led to the development of an alternative layout that was 23.4 meters in total length which is 20.41% shorter than the original 29.4 meters. This reduction directly contributed to faster production cycles and minimized fatigue among workers by eliminating unnecessary movements. Another case study involving a bakery referred to as Toko Roti A revealed the same issue. The original layout led to material travel distances of 1,398 meters. After applying to the Activity Relationship Chart, the redesigned layout reduced this to just 840.1 meters proved a clear indication of improved work effectiveness and production efficiency. These studies show that Activity Relationship Chart helps enhance spatial logic and proximity between activities, while Systematic Layout Planning offers a structured layout planning framework.

Although many studies emphasize the advantages of this combination method, most have not been applied in depth to the food sector, particularly the catering MSME. CV. Salwa Indoboga, as a catering business, faces similar problems such as inefficient movement of personnel and materials due to a layout that does not follow the workflow. For catering MSMEs such as CV. Salwa Indoboga, which face frequent backtracking and repetitive movement due to disorganized layouts, adopting this combined approach can lead to substantial improvements in space utilization, reduced movement, and better overall efficiency. Beyond practical benefits, such studies contribute to developing theoretical and methodological knowledge in applying layout planning in the context of food processing and small-scale manufacturing environments.

Therefore, this research positions itself in a relevant but largely unexplored position by applying the Systematic Layout Planning and Activity Relationship Chart methods simultaneously in the context of the food industry, specifically catering MSMEs. By implementing this approach, it is hoped that a new, more efficient layout can be created, shortening travel distances and reducing operational costs. In addition to providing practical solutions, this research also contributes to the development of theory and practice in implementing systematic layouts in the food industry and MSMEs.

2.2 Theoretical Background

2.2.1 Redesign

Redesign is an important concept in the development of systems, processes, and organizational structures. In general, redesign is defined as the process of redesigning existing elements with the aim of increasing the efficiency, effectiveness, and quality of a system's performance (Hammer & Champy, 1993). In an industrial context, redesign is carried out to adapt systems to environmental changes, increasing demand, technological developments, and to address various operational inefficiencies.

Redesign includes processes, structures, and systems that aim for continuous adaptation and improvement with the support of technology and customer needs (Davenport, 1993). Redesigning service procedures can speed up processing times, reduce bureaucracy, and increase user satisfaction. These findings reinforce the view that redesign is relevant across various sectors, not just the private sector.

2.2.2 Layout

Layout is a fundamental element in production and operations systems, determining how facilities, equipment, and activities are arranged within a workspace. A good layout plays a crucial role in achieving operational efficiency, reducing waste, and supporting the smooth flow of materials and information within the work environment (Tompkins, White, Bozer, & Tanchoco, 2010). Layout is not only a physical aspect, but also a management strategy to maximize the utilization of space, labor, and time.

According to Singh and Sharma (2006), facility layout is the process of arranging physical facilities such as machines, work stations and storage areas in a work space with the aim of minimizing production costs and supporting effective work processes. The selection of layout

type depends on product characteristics, production volume, process flexibility, and the size and shape of the work area (Chase, Aquilano, & Jacobs, 2005).

Factory layout is a crucial aspect of running a business efficiently and cost-effectively. Every work area, production line, and material storage facility must be designed to operate at maximum speed and minimize cycle times. When designing a factory layout, it's crucial to consider all functions within the company. (Kadane & Bhatwadekar, 2011).

2.2.3 Production Facility

Production facilities are a vital component of manufacturing and service systems, serving as the primary location where the transformation of inputs into outputs takes place. Production facilities include buildings, machinery, equipment, labor, support systems, and other infrastructure used to produce goods or services according to specified quality and quantity standards. (Tompkins, White, Bozer, & Tanchoco, 2010). According to Heragu (Heragu, 2008), the primary goal of production facility management is to support the smooth, efficient, and safe production process. This involves various aspects, including site selection, layout design, equipment selection, capacity planning, and ergonomics and occupational safety. Proper and efficient placement of facility components will impact workflow, reduce downtime, and lower production costs.

2.2.4 Systematic Layout Planning (SLP)

The Systematic Layout Planning (SLP) method can be used to address various problems such as production, transportation, warehousing, and other activities. According to Wicaksana and Setyawan (2014), Systematic Layout Planning (SLP) is a structured approach to layout planning, commonly used to address issues in production, transportation, and warehousing. The process begins with collecting data on both current and projected production activities. This is followed by a material flow analysis and an activity relationship analysis to develop an activity relationship diagram. By considering the required and available space, a space relationship diagram is created, which then serves as the basis for designing and evaluating alternative layout options.

According to Purnomo (2004), the SLP method consists of three main stages. The first stage is analysis, which includes identifying material flow, activity relationships, preparing diagrams of relationships between activities, and reviewing space requirements and availability.

The second stage is the design stage, starting from preparing diagrams of relationships between rooms to developing several layout alternatives. The final stage is the selection process, namely assessing and determining the best layout alternative.

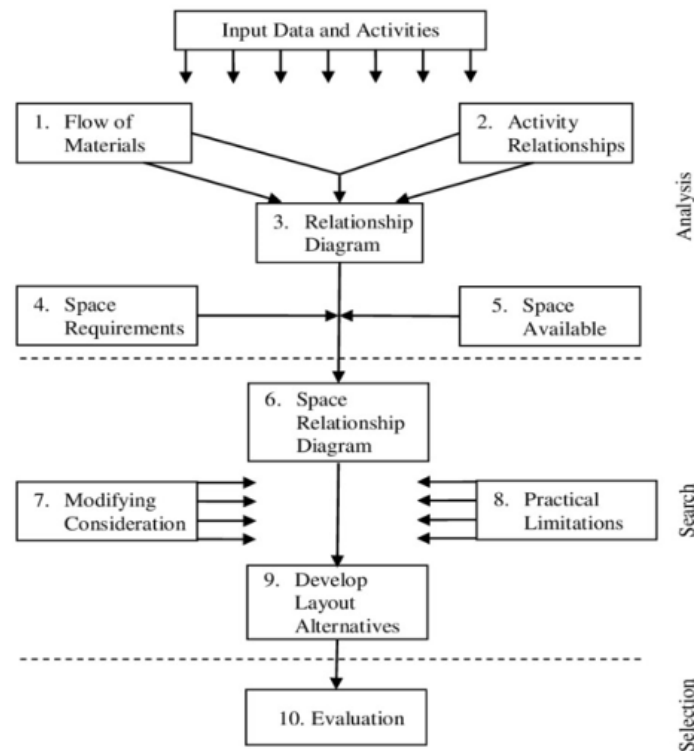


Figure 2. 1 Systematic Layout Planning Framework

Source: Heragu, 2016

For the selection phase was done by evaluating alternatives designed layout: (Heragu, 2016)

2.2.4.1 Data Input

The input data required to implement the SLP technique includes five categories:

- P (Product): The type of product being produced.
- Q (Quantity): The production volume for each part.
- R (Routing): The sequence of operations for each part.
- S (Supporting Services): Supporting services, locker rooms, inspection stations, and so on.
- T (Timing): When each part will be produced and which machines will be used.

2.2.4.2 Flow of Materials

The flow of material can be illustrated using a flow process chart. A flow process chart is a combination of an operation chart and a process chart. The operation chart uses circles to represent each operation that involves the fabrication of components, which are then assembled into the final product and finally packaged into a finished good.

2.2.4.3 Activity Relationship

The redesign of the facility layout should consider the degree of closeness between each workstation using the arrival degree method through the Activity Relationship Chart (ARC), Activity Relationship Diagram (ARD), and Activity Allocation Diagram (AAD), which take into account both qualitative and quantitative proximity values to achieve greater effectiveness and efficiency; this method is also easy to understand as it avoids complex mathematical formulas (Hadiguna & Setiawan, 2008).

The Activity Relationship Chart (ARC) is a method used to plan facility or department layouts by evaluating how closely related the activities of each facility or department (Samudra, 2023). Activity Relationship Chart (ARC) is a planning technique used to map the relationships between different groups of activities within a company or production floor. In addition to Activity Relationship Chart, Area Relationship Diagram (ARD) is created to show the placement of workstations based on their proximity to each other. Activity Allocation Diagram (AAD) is used to indicate the specific areas for each workstation. Finally, a proposed layout is developed with the help of floorplan software (Azizah N. F., Apriani, Pradana, & Azzam, 2023).

Activity Relationship Chart is qualitative, using letter codes to indicate the degree of activity relationship and also number codes to explain the reasons for determining the choice of letter code. The letters A (Absolutely Necessary): Red, E (Especially Necessary): Orange, I (Important): Green, O (Ordinary): Blue, U (Unimportant): White, X (indesirable): Brown represented by color at the top, while the number code defines the reason for choosing the letter. The Activity Relationship Chart (ARC) was developed to determine the degree of closeness between activities or departments. The degree of closeness indicates whether certain areas need to be placed near each other, depending on the strength of their relationship.

Activity Relationship Chart was introduced by Robert Muther to visualize the closeness relationships among all activities or departments. The steps for creating this chart are as follows:

- Identify all existing activities.
- List all the activities in a chart, placing the main production area at the top of the chart.
- Analyze the activity relationship map, which will illustrate the degree of relationship between each activity.

Below are the reasonable desire closeness and closeness rating of activity relationship diagram

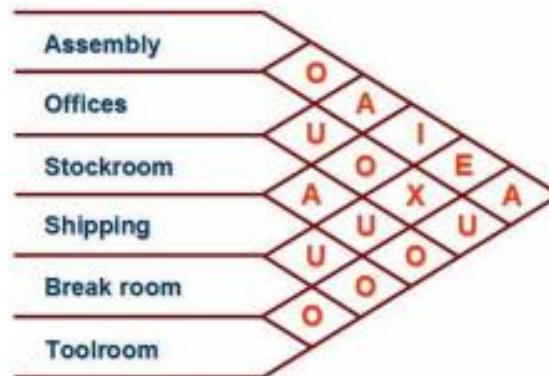


Figure 2. 2 Activity Relationship Chart

Table 2. 2 Closeness Rating

Code	Definition
A (Red)	Absolutely necessary that these two departments be next to each other
E (Orange)	Especially important
I (Green)	Important
O (Blue)	Ordinary importance
U (No. Color)	Unimportant
X (Brown)	Closeness undesirable

Table 2. 3 Reasonable Desire Closeness

No	Reason
1	Same area material flow sequence
2	Workforce sequence
3	Dirty & dusty
4	Has no functional relationship

2.2.4.4 Activity Relationship Diagram

As described by Muther & Hales (2015), the Activity Relationship Diagram (ARD) is a diagram that illustrates the interrelationships between departments. The construction of this diagram follows specific rules, as outlined below.

Process Chart Symbols & Action*	Symbols Extended to Identify Equipment & Space	Color Ident.	Black & White**
* ○ Operation	○ Forming or Treating Equipment & Space	Green**	
	○ Assembly, Sub-Assembly, Dis-Assembly	Red**	
* ➡ Transportation	➡ Transport-related Equipment & Space	Orange Yellow**	
* ◇ Handling	◇ Handling Areas -- Pick-up & Set-Down	Orange Yellow**	
* ▼ Storage	▼ Storage Equipment and Space	Orange Yellow**	
* D Delay	D Set-down or Hold Areas	Orange Yellow**	
* □ Inspection	□ Inspect, Test, Check Equipment & Space	Blue**	
* A.N.S.I. Standard ** MHMS (IMMS) Standard (Adopted as basic to SLP procedure)	□ Service & Support Equipment & Space	Blue**	
	⬆ Office or Planning Areas, or Building Features	Brown** (Gray)	

Vowel Letter	No. Value	No. of Lines	Closeness Rating	Color Code
A	4	////	Absolutely Necessary	Red**
E	3	///	Especially Important	Orange Yellow**
I	2	//	Important	Green**
O	1	/	Ordinary	Blue**
U	0		Unimportant	Uncolored**
X	-1	W	Not Desirable	Brown**
XX	-2,-3,-4,?	W	Extremely Undesirable	Black

Figure 2. 3 Activity Relationship Diagram Construction

Source: (Muther & Hales, 2015)

2.2.4.5 Space Requirements & Space Available

In the space requirement stage, an analysis is conducted to determine the amount of space needed. According to Muther & Hales (2015), there are at least five methods to determine space requirements:

a. Calculation

This method involves determining the total area needed for each space element and multiplying it by the number of elements required for a particular task, while also adding additional space that generally cannot be assigned to any specific element.

b. Conversion

A practical approach that starts by asking “what do we currently have?” and then moves toward “what adjustments are needed to meet future needs?” The existing space is adjusted to match current requirements and then converted for each individual area.

c. Space standard

This involves using pre-established space standards that are commonly applied across many projects.

d. Roughed-out layout

This method is used when calculation or conversion is impractical and no standards are available. If scaled area plans, templates, or equipment models are available especially for critical activities or those involving high investment, it may be advisable to draft a rough layout for specific areas and use it as a basis for determining space needs.

e. Ratio trend and projection

This method uses ratios of space (in square meters or square feet) to other factors, such as space per shipment or space per labor-hour per year. Among the five methods, this one is generally the least accurate. However, it may still be sufficient for long-term planning, especially in areas like offices and general warehouses where equipment is mobile, fixed investments are relatively low, and properties can be repurposed.

2.2.4.6 Space Relationship Diagram

The space relationship diagram is a diagram that shows the interrelationships between one department and another, while also presenting the dimensions of each department according to the scale used.

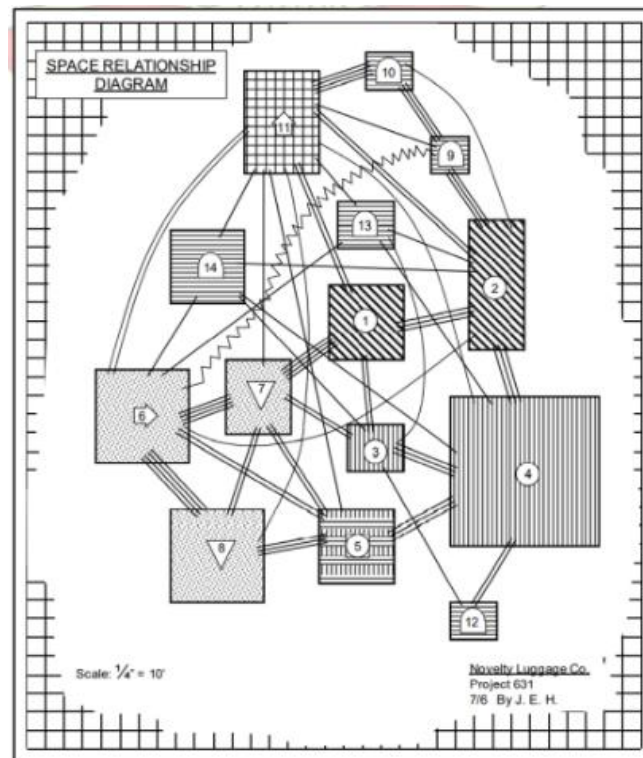


Figure 2. 4 Example of Space Relationship Diagram

Source: (Muther & Hales, 2015)

The proposed layout design phase involves the Activity Relationship Chart (ARC), Worksheet, Activity Relationship Diagram (ARD), calculation of space requirements, calculation of space requirements taking into account the size of machines and equipment, and space for workers (Naganingrum, Jauhari, & Herdiman, 2013). The information needed in this layout planning includes product design data, production processes, and production schedules.

1. Determination of Production Capacity

In fulfilling production orders received by the company, it must be known whether they can be fulfilled according to the capabilities of the company's installed production capacity. If there is an excess of production orders, it can be done through overtime or sub-contracting by transferring it to another company. In determining production capacity, use data on products that are frequently ordered and produced in large quantities (reference products) within 3 months of research.

2. Determining the Distance Between Production Facilities

In the initial layout, the distance between work stations can be determined by determining the center between the work stations. Next is calculating the distance using a rectilinear

distance system, namely the distance measured between the center of one work station and the center of another work station. Look for the center point for each work station, namely 0 of x and y. The reason for using this method is the flow path/transportation route that the material and semi-finished products pass through. The formula used is as follows:

$$d_{ij} = |x_i - x_j| + |y_i - y_j| \quad (2.1)$$

where:

$x_{i,j}$ = x coordinate at the center of facility i, j

$y_{i,j}$ = y coordinate at the center of facility i, j

d_{ij} = distance between the centers of facilities i and j

2.2.5 Distance Measurement

In facility layout planning and evaluation, measuring the distance between points is crucial for calculating the efficiency of material handling, worker movement, or equipment transfer. Several methods are commonly used to measure the distance between two points, including euclidean distance, rectilinear (Manhattan) distance, tchebyshev distance, and the centroid formula. The choice of distance metric depends on the characteristics of the workspace, movement patterns, and physical constraints within the working environment.

2.2.5.1 Euclidean Distance

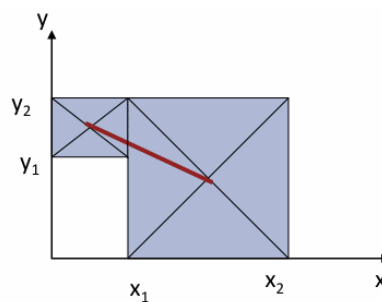


Figure 2. 5 Euclidean Distance

Euclidean distance is one of the most widely used distance measurement methods across multiple disciplines, including facility layout planning, image processing, and spatial data analysis. This metric represents the shortest straight-line distance between two points in two, or multi dimensional space. Mathematically, euclidean distance is calculated as the square root of

the sum of the squared differences between corresponding coordinates. In two dimensional space, the formula is:

$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \quad (2.2)$$

where:

$x_{i,j}$ = x coordinate at the center of facility i, j

$y_{i,j}$ = y coordinate at the center of facility i, j

d_{ij} = distance between the centers of facilities i and j

Euclidean distance is commonly applied in clustering algorithms, classification, and minimum-distance optimization problems.

2.2.5.2 Rectilinear Distance

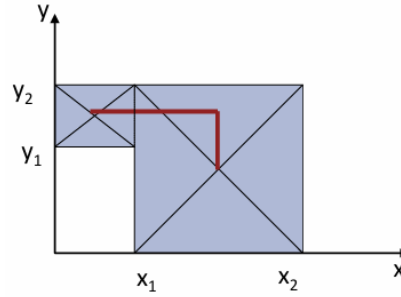


Figure 2. 6 Rectilinear Distance

Rectilinear distance, also known as Manhattan distance or L1 norm, calculates distance based on total horizontal and vertical movement between two points. The term “Manhattan” refers to the grid-like street pattern of Manhattan city, where movements are limited to right-angle turns. The formula for this distance is:

$$d_{ij} = |x_i - x_j| + |y_i - y_j| \quad (2.3)$$

where:

$x_{i,j}$ = x coordinate at the center of facility i, j

$y_{i,j}$ = y coordinate at the center of facility i, j

d_{ij} = distance between the centers of facilities i and j

This method is particularly suitable in facility layouts or urban routing problems where movements occur only along horizontal and vertical paths. In industrial facility settings,

rectilinear distance reflects actual material or worker movement along fixed aisles, making it a practical choice for layout efficiency analysis.

2.2.5.3 Tchebyshev Distance

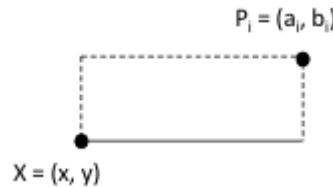


Figure 2. 7 Tchebyshev Distance

Tchebyshev distance, also known as chebyshev distance or L_∞ norm, considers the greatest difference between corresponding coordinates of two points. It is calculated by taking the maximum absolute difference between any of the dimensions:

$$d_{ij} = \max(|x_i - x_j|, |y_i - y_j|) \quad (2.4)$$

where:

$x_{i,j}$ = x coordinate at the center of facility i, j

$y_{i,j}$ = y coordinate at the center of facility i, j

d_{ij} = distance between the centers of facilities i and j

This method is applicable in scenarios where movement can occur freely in all directions, including diagonally, and the cost or speed of movement is equal in every direction. A common analogy is the movement of a king in chess, which can move one square in any direction. Tchebyshev Distance is useful in grid-based systems, robotic movement, and situations where the time or effort to move is based on the largest coordinate difference.

2.2.5.4 Centroid Formula

The centroid represents the geometric center or the average position of a group of points and is commonly used in layout problems, cluster analysis, or when calculating distances from a central reference. In two-dimensional space, the centroid (x_c, y_c) of n points is calculated as the average of the x and y coordinates:

$$x_c = \frac{1}{n} \sum_{i=1}^n x_i, \quad y_c = \frac{1}{n} \sum_{i=1}^n y_i \quad (2.5)$$

where:

x_c = x-coordinate of the centroid

y_c = y-coordinate of the centroid

x_i = x-coordinate of the i-th point

y_i = y-coordinate of the i-th point

n = total number of points

This formula is useful when determining the center of gravity of a group of departments, machines, or data points. Once the centroid is obtained, distances from the centroid to each point can be calculated using any of the distance metrics, depending on the context and layout characteristics.

CHAPTER III

RESEARCH METHODOLOGY

3.1 Research Object

This research focuses on the production layout of CV. Salwa Indoboga as the object to be observed. The company runs in the food and beverage sector and focuses on daily catering services. The main issue being looked at in this research is how the work areas are arranged, which may affect how efficient the production process is. The goal of this research is to redesign the production layout so that it becomes more organized, efficient, and in line with the actual flow of the production process. By doing a detailed analysis and rearranging the layout, this research aims to reduce unnecessary movement of materials, shorten the distance of movement, and make better use of the available space. That way, the daily food production activities can run more smoothly and meet hygiene standards more easily.

3.2 Research Method

This research applies a quantitative approach to analyze and redesign the production facility layout at CV. Salwa Indoboga. The quantitative method is chosen because the study focuses on measuring, calculating, and evaluating numerical data related to production flow distances and material movement. Data collection includes measuring the dimensions of each department and calculating the distance traveled in the material flow. This research uses a quantitative approach combined with the Systematic Layout Planning (SLP) method and the Activity Relationship Chart (ARC) to redesign the production facility layout at CV. The final outcome of this research is a proposed facility layout that minimizes the total material handling distance, aligns with production flow, and improves overall operational efficiency based on measurable data.

3.3 Data Source

The data used in this research consists of both primary and secondary data, which are essential for solving the research problem. Primary data were obtained directly from field investigations, including interviews with key personnel such as staff, supervisors, and managers from the operations and maintenance divisions of CV. Salwa Indoboga. The data collected includes the current production layout, dimensions of each work area, material flow patterns, equipment placements, and the overall production space (18 x 14 meters). Secondary data were collected

through supporting documents, records, and reports provided by the company, as well as relevant references from books, journals, and other literature sources that support the analysis and design stages of this research.

3.4 Data Collecting Method

Several methods were employed to collect the necessary data for this research, ensuring the accuracy and relevance of the findings. The data collection methods in this research include the following:

1. **Field Observation**

Observation was conducted directly in the production area of CV. Salwa Indoboga to understand the current layout, workflow, and equipment arrangement. The researcher observed how materials, tools, and workers moved throughout the kitchen, particularly during peak production hours. This method allowed the identification of critical issues such as inefficient layout patterns, excessive movement, bottlenecks in food preparation, and safety risks. The equipment observed includes cooking stations, preparation tables, washing sinks, food storage units, and serving areas.

2. **Interviews**

Interviews were conducted with employees directly involved in the food production process, including kitchen staff, team leaders, and operational supervisors. The purpose of these interviews was to gather deeper insights into their daily routines, the challenges faced in executing tasks, and suggestions for improving layout efficiency. Topics covered include workflow logic, equipment placement, space adequacy, material flow direction, time management, and potential obstacles in the current setup.

3. **Literature study**

To support the theoretical framework of this research, a literature review was conducted by analyzing relevant sources such as academic journals, textbooks, industry standards, and online references related to facility layout planning, production efficiency, kitchen design, and layout redesign methodologies. This method serves to provide a foundation for understanding the concepts used in Systematic Layout Planning (SLP) and Activity Relationship Chart (ARC). It also helps identify best practices in production layout design, especially for small to medium sized food businesses.

3.5 Research Framework

The research framework serves as a structured overview of the steps taken throughout the study. It outlines the methodology used to identify the existing problems, collect relevant data, perform analysis, and propose solutions through layout redesign. The research methodology outlines the activities carried out throughout the study, starting from the initial observation to the conclusion of the problem. Each step describes the overall process and provides general information related to it. The steps are illustrated in Figure 3.1.

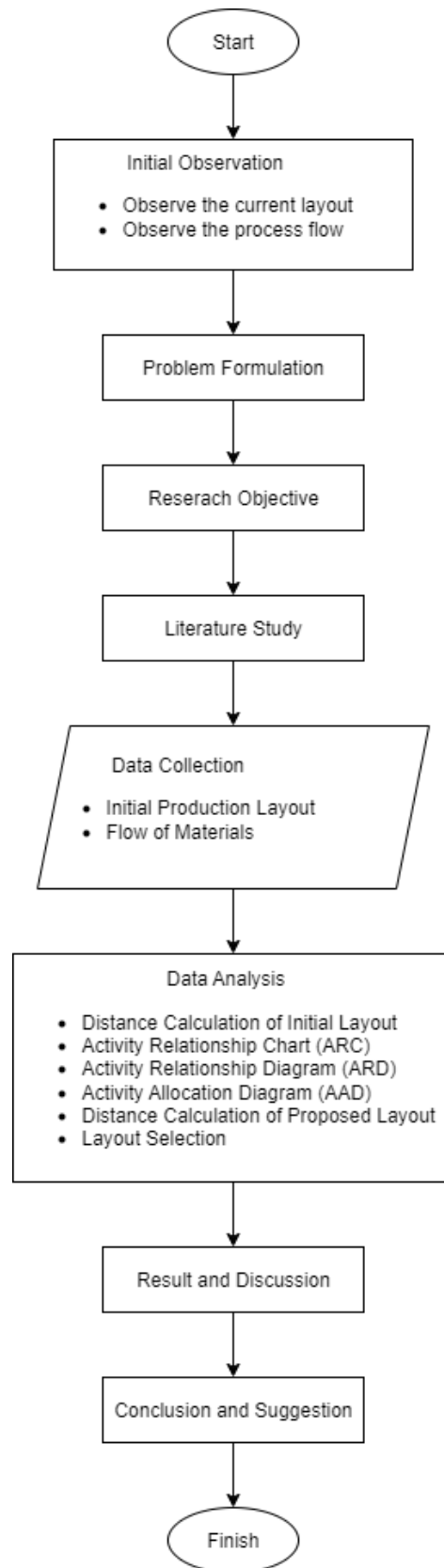


Figure 3. 1 Research Framework

3.5.1 Initial Observation

The first step was conducting an early observation in the production area of CV. Salwa Indoboga. At this stage, the researcher focused on observing the existing layout and understanding the flow of the production process. This helped the researcher get a clear picture of how raw materials, equipment, and workers move during daily operations.

3.5.2 Problem Formulation

After the observation was conducted, the next step was to formulate the problems identified in the field. The issues found were related to inefficiencies in the production flow, such as excessive material movement, poorly organized work areas, and potential obstacles in daily production processes. These problem statements were then used as the foundation for determining the direction and specific focus of the research.

3.5.3 Research Objective

Based on the formulated problem statements, the objective of this research is to improve the layout of the production facilities at CV. Salwa Indoboga. This improvement is expected to result in a more efficient and structured layout by rearranging the work areas according to the actual sequence of the production process. With this objective, it is anticipated that the daily production process will run more smoothly, material movement time will be reduced, and space utilization will become more optimal.

3.5.4 Literature Study

Before conducting further analysis, a literature review was carried out to strengthen the theoretical foundation of this research. The reviewed literature covered the research position of previous studies, theoretical background related to redesign, layout, production facilities, Systematic Layout Planning (SLP) and Activity Relationship Chart (ARC). Several previous research discussing the redesign of production layouts, particularly in food and beverage MSMEs, were also examined. This literature review helped in understanding the appropriate approach to be applied in the research and provided insights into best practices for organizing production layouts.

3.5.5 Data Collection

Data collection was carried out using several methods, including direct field observation, interviews with relevant parties, and documentation. The data collection in this research includes:

3.5.5.1 Initial Production Layout

In the initial stage of the research, the researcher collected primary data regarding the existing layout of the production facility. The production area had dimensions of 18 meters in length and 14 meters in width. Within this area, several key work sections were identified, including preparation, cooking, washing, and packaging. Each section was observed in terms of its function, physical dimensions, and the equipment or furniture placed in it. This step helped the researcher understand the current space utilization and identify potential inefficiencies or constraints within the workflow.

3.5.5.2 Flow of Materials

Following this, the researcher analyzed the flow of materials throughout the facility, starting from the receipt of raw materials to the distribution of finished products. The flow included processes such as receiving, storage, preparation, cooking, packaging, and distribution. A material flow diagram was created to visualize the movement between these areas. Through this analysis, the researcher identified any backtracking, overlapping paths, or irregular movements that could cause delays or compromise hygiene standards, factors that are especially critical in a food production setting.

3.5.6 Data Analysis

After the data was collected, the next step was to conduct an analysis to obtain a more detailed picture of the current layout's efficiency and its potential improvements. The following are the data analysis:

3.5.6.1 Distance Calculation of Initial Layout

To evaluate the efficiency of the current layout, the researcher measured the travel distances between key workstations. This was done by calculating the total material handling distance

based on the sequence of operations and the physical distance between departments. The results provided a quantitative baseline to compare with the proposed layout.

3.5.6.2 Activity Relationship Chart (ARC)

The researcher developed an Activity Relationship Chart (ARC) to assess the degree of closeness required between each pair of departments. This chart categorized relationships using closeness ratings such as A (Absolutely Necessary), E (Especially Important), I (Important), O (Ordinary), U (Unimportant), and X (Undesirable), along with corresponding justifications. This step was critical in determining which departments should be located near each other to enhance workflow and communication.

3.5.6.3 Activity Relationship Diagram (ARD)

Based on the Activity Relationship Chart, an Activity Relationship Diagram (ARD) was created. This diagram visually represented the closeness relationships identified in the ARC by connecting departments with lines indicating the level of interaction required. The ARD served as a guide in conceptualizing the new layout and aligning it with the functional needs of the production process.

3.5.6.4 Activity Allocation Diagram (AAD)

An Area Allocation Diagram (AAD) was then constructed to allocate space proportionally based on the area requirements of each department. The researcher calculated the space needs of each work area and positioned them according to the relationships outlined in the ARD. This stage allowed the researcher to simulate several alternative layouts and evaluate the feasibility.

3.5.6.5 Distance Calculation of Proposed Layout

The next step involved calculating the total distance of material movement in the proposed layout. By applying the same method as in the initial layout analysis, the researcher assessed whether the redesign achieved a reduction in travel distance. A decrease in total material handling distance would indicate improved efficiency and better space utilization.

3.5.6.6 Layout Selection

Finally, among the proposed layout alternatives developed through the AAD, the researcher selected the optimal layout using a set of criteria, including minimal material handling distance, compliance with ARC/ARD recommendations, and suitability for the dimensions of the available space. The chosen layout was expected to improve workflow efficiency, reduce congestion, and enhance hygiene and safety standards in accordance with food production regulations.

3.5.7 Results and Discussion

After the data was collected, the next stage was to perform an analysis to obtain a more detailed overview of the current layout efficiency and its potential improvement. The total material handling distance was calculated to determine how far materials moved from one process to another. Subsequently, an Activity Relationship Chart (ARC) was constructed to identify the closeness between activities, which was then transformed into an Activity Relationship Diagram (ARD) for visualization. Based on this, an Activity Allocation Diagram was developed as the foundation for the new layout design. Several layout alternatives were then generated, compared, and analyzed through a simple simulation to evaluate their effectiveness in comparison to the initial layout.

3.5.8 Conclusion and Suggestion

In the final part of this research, the main findings were concluded and the previously stated objectives were addressed. Recommendations were also provided for CV. Salwa Indoboga to consider the implementation of the proposed new layout. In addition, suggestions for future research were given, such as the use of more advanced simulation software or the application of alternative layout methods to compare the results.

CHAPTER IV

DATA COLLECTION AND ANALYSIS

4.1 Data Collection

Data collection in this research consists of two main components which are the initial production layout and the flow of materials. The initial production layout describes the current arrangement of departments, equipment, and work areas within the facility, including their dimensions, and functions. The flow of materials illustrates the movement of raw materials and products throughout the production process.

4.1.1 Initial Production Layout (Floor Plan)

The existing production layout at CV. Salwa Indoboga was documented by photographing the actual conditions in each section and converting these observations into a scaled floor plan. As shown below.



Figure 4. 1 Initial Production Floor 1



Figure 4. 2 Initial Production Floor 2



Figure 4. 4 Initial Production Floor 3



Figure 4. 3 Initial Production Floor 4



Figure 4. 5 Initial Production Floor 5

Based on the data collecting, it is known that the production area is of 18m x 14m area, within the total production area measures approximately 252 m² and also functions as a warehouse to store raw materials and finished products. The arrangement was made without specific layout planning guidelines, resulting in a workflow that is not fully aligned with the production process. The initial layout as shown on Figure 4.6.

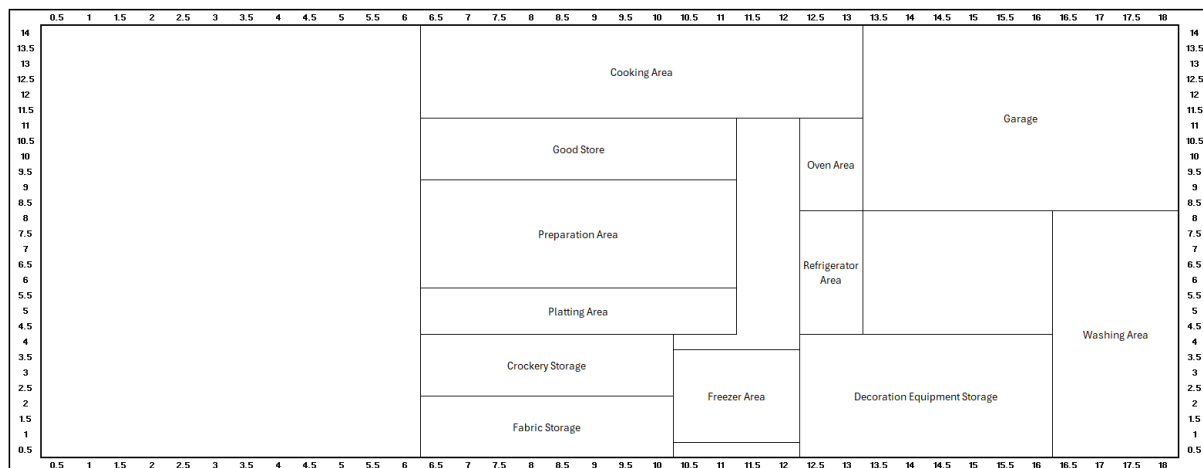


Figure 4. 6 Initial Production Layout

In figure 4.6, it is known that there are 12 work area or work stations available on CV. Salwa Indoboga production layout which include:

A. Garage

This area serves as a parking space for vehicles and a loading/unloading zone for goods and equipment within the dimensions of 5 x 6 m. It functions as the main entry point for raw material deliveries and the dispatch area for catering orders.

B. Freezer Area

This area sized 2 x 2 m is designated for storing frozen raw materials such as meat, poultry, and seafood to maintain freshness and prevent spoilage.

C. Refrigerator Area

This area, measured 1 x 4 m is used to store chilled ingredients including vegetables, dairy products, sauces, and other perishable items that require refrigeration.

D. Goods Store

This area functions as storage for dry goods, packaging materials, and non-perishable supplies such as rice, flour, sugar, and canned products. This area has dimensions of 5 × 2 m.

E. Washing Area

This area is used for washing raw materials, utensils, and kitchen equipment, ensuring cleanliness before further processing within 5 x 3.5 m dimensions.

F. Preparation Area

This area has a size of 5 × 3.5 m and is where raw materials are prepared before cooking, including cutting, slicing, seasoning, and portioning for the cooking or baking process.

G. Cooking Area

This area serves as the main cooking workspace, equipped for frying, steaming, boiling, and sautéing to transform raw ingredients into finished dishes. This area has the biggest dimensions which is 7 x 3 m.

H. Oven Area

This area measures 1 × 3 m and is specifically used for baking and roasting, particularly for bakery products, bread, pastries, and roasted meats.

I. Plating Area

This area is for decorating, portioning, and arranging semi-finished food into serving dishes before delivery, sized at 5 x 1.5 m.

J. Crockery Storage

This area measures 4 × 2 m and is used to store tableware and serving equipment such as plates, bowls, chafing dishes, and serving utensils.

K. Decoration Equipment Storage

This area, with dimensions of 4 × 4 m, stores decorative tools and equipment for catering events, including tables, ornaments, and accessories for venue setup.

L. Fabric Storage

This area measures 4×2 m and stores fabrics and linens such as tablecloths, aprons, chef hats, uniforms, and decorative cloths for catering and events.

The initial floor plan (Figure 4.6) illustrates the actual positioning of these departments and the existing workflow. This documentation serves as the baseline for identifying inefficiencies and developing an improved layout in the following stages of analysis.

4.1.2 Flow of Materials

In this study, the analysis of the production flow focuses on the three products with the highest production volume over the past year: grilled chicken, spicy beef, and decorative sets. The number of grilled chicken portions produced per cycle ranges from 150 to 2,500 portions, depending on order size and event requirements. For spicy beef, the production volume ranges from 10 to 30 kilograms per cycle, while decorative sets are produced in quantities of 4 to 8 sets per day, primarily for event and buffet table arrangements.

The material flow for each product is mapped and analyzed using a process chart, which visually represents the sequence of activities from raw material preparation to the final output. This approach helps to identify potential bottlenecks, unnecessary movements, and areas for improvement in the production process. The Operation Process Chart (OPC) is used to describe the sequence of operations and transportation activities involved in the production process. Each operation is represented by a circle symbol, indicating a step where a specific task or process is performed. Transportation activities, such as moving materials from one department to another, are represented by a horizontal arrow symbol.

In this research, the OPC was developed for the three main products: grilled chicken, spicy beef, and decorative sets. The chart visually presents the workflow from the initial stage of retrieving raw materials to the final stage of delivering the finished product. The left column shows the process sequence for each product, while the middle column lists the corresponding departments or work areas. The right column indicates the time required for each activity, recorded in minutes (').

The detailed process flow of each product is presented in Figure 4, illustrating the specific stages, work areas involved, and the order of operations for grilled chicken, spicy beef, and decorative sets.

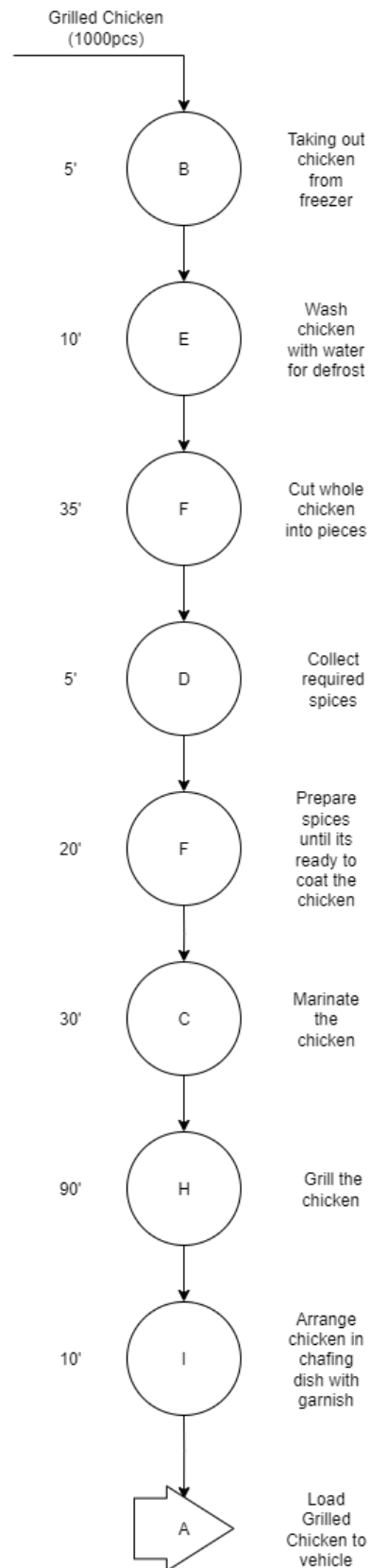


Figure 4. 7 Operation Process Chart of Grilled Chicken

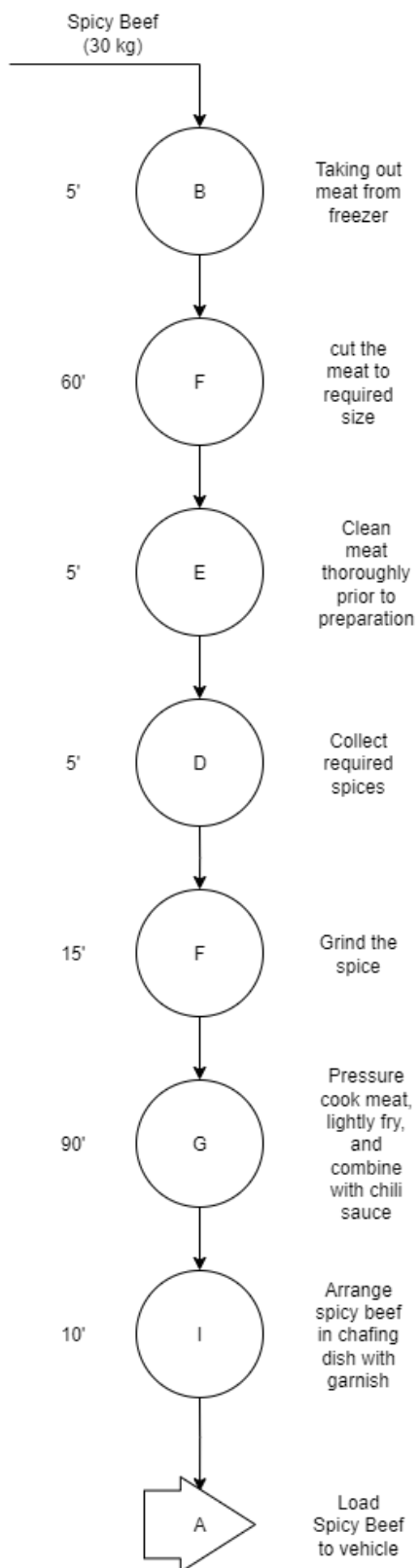


Figure 4. 8 Operation Process Chart of Spicy Beef

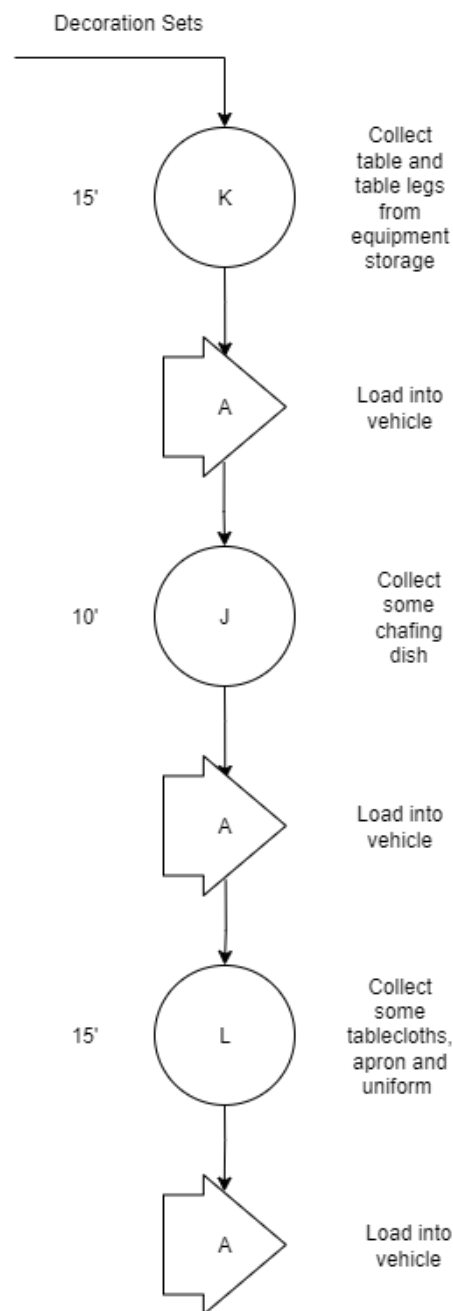


Figure 4. 9 Operation Prosess Chart Decoration Sets

To produce 1,000 pieces of grilled chicken, a total time of 205 minutes or approximately 3.42 hours is required, assuming that four workers are involved in handling the production process. The production flow begins in area B (freezer), where the chicken is removed in 5 minutes. Next, the frozen chicken is brought to area E (washing area) to be rinsed with water to defrost. The process then continues in area F (preparation), where the whole chicken is cut

into several portions, requiring 35 minutes. Once the cutting process is completed, the worker proceeds to area D (goods store) to collect the necessary spices, taking 5 minutes, and then returns to area F (preparation) to prepare the seasoning mixture for marinating, which takes 20 minutes. The next step is coating the chicken with the seasoning and marinating it in the refrigerator (area C) for 30 minutes. After marination, the chicken is moved to area H (oven) for roasting. By using three ovens simultaneously, the roasting process can be completed in 90 minutes. The final stage takes place in area I (plating), where the chicken is arranged neatly on a chafing dish for 10 minutes before being loaded into the vehicle for distribution to the designated location.

The production process of Product 2, Spicy Beef, with a total quantity of 30 kg, requires 190 minutes or approximately 3.17 hours, assuming three workers are involved. The process begins in area B (freezer), where the frozen beef is removed. The beef is then transferred to area F (preparation) to be cut according to the standard size, which takes 60 minutes. After cutting, the beef is brought to the washing area (E) for cleaning. The next stage involves spice preparation, starting with retrieving and weighing the required spices in the goods store (D) for 5 minutes, followed by preparing the chili seasoning in area F (preparation) for 15 minutes. Once ready, the cleaned beef is brought to area G (cooking), where it is first pressure-cooked using a presto machine, then lightly fried, and finally cooked together with the prepared chili seasoning. The final stage takes place in area I (plating), where the spicy beef is arranged neatly in a chafing dish for 10 minutes before being loaded into the vehicle in the garage area for distribution to the designated destination.

The production process of Product 3, Decoration Sets, requires a total time of 40 minutes or approximately 0.67 hours, assuming two workers are involved. The process begins in area K (equipment area), where items such as tables, stalls, flowers, and decorative ornaments are prepared, which takes 15 minutes, before being transported to the garage for vehicle loading. The next stage is carried out in the crockery area (J), where workers collect chafing dishes, tiered cake stands, serving spoons, cutlery, plates, glasses, and other tableware, requiring 10 minutes, followed by transporting them to the garage for loading. The final step takes place in the fabric area (L), where tablecloths, table skirts, aprons, tissues, and other fabric-related items are collected within 15 minutes, and then brought to the garage to be loaded into the vehicle. At this point, all decoration sets are ready for distribution to the designated event location.

4.2 Data Analysis

Data analysis in this research was conducted to assess the effectiveness of the current production layout and design an improved one that reduces material handling distance and increases efficiency. The process includes calculating the initial layout distance as a baseline, developing the Activity Relationship Chart (ARC) and Activity Relationship Diagram (ARD) to identify and visualize departmental relationships, and preparing the Activity Allocation Diagram (AAD) to allocate space accordingly. The proposed layout is then evaluated through distance calculation and compared with the initial layout, followed by selecting the most efficient and feasible arrangement for the production facilities.

4.2.1 Center Point of Initial Layout

Distance calculation of the initial layout is conducted to measure the movement distance within the existing production facilities for three different products, each having its own production process. The calculation is based on the production flow of each product, which involves several work areas. To determine the distance, the rectilinear distance formula is applied by using the centroid point of each area as a reference. The movement distances between all related areas throughout the whole production process are then summed up to obtain the total distance value. This result serves as a baseline for evaluating the efficiency of the current layout and as a comparison for the proposed layout design.

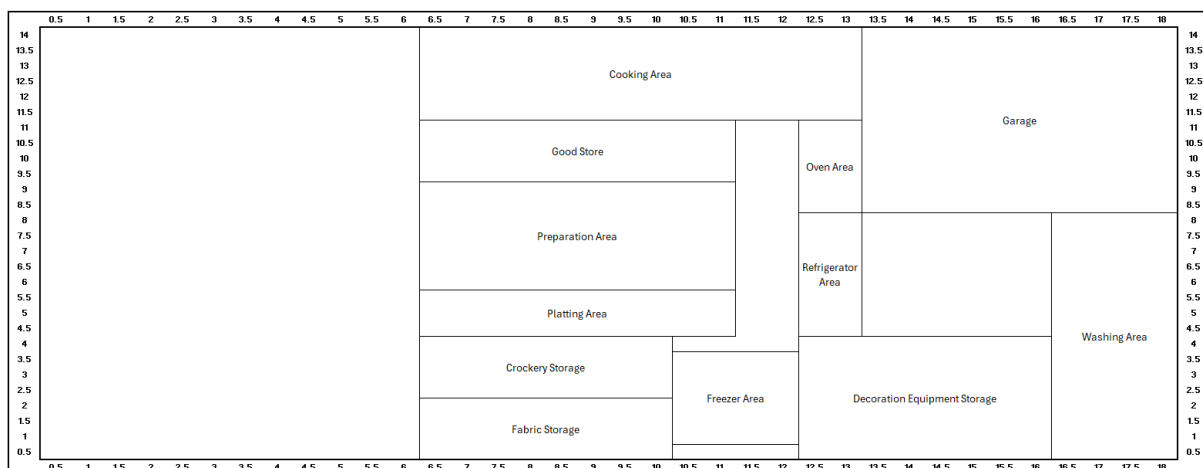


Figure 4. 10 Initial Production Layout

Based on the initial production layout in Figure 4.10, the calculation of distance movement requires the center point of each area. This center point can be determined using the centroid point formula, which is expressed as follows.

$$x_c = \frac{1}{n} \sum_{i=1}^n x_i, \quad y_c = \frac{1}{n} \sum_{i=1}^n y_i \quad (4.1)$$

where:

x_c = x-coordinate of the centroid

y_c = y-coordinate of the centroid

x_i = x-coordinate of the i-th point

y_i = y-coordinate of the i-th point

n = total number of points

Based on the formula above, the center point of each area was obtained as shown in Table 4.1, which then serves as the reference for calculating the rectilinear distance in the subsequent analysis.

Table 4. 1 Initial Layout Center Point

Code	Workstation	Initial	
		x	y
A	Garage	16	11.5
B	Freezer	11	2
C	Refrigerator	12.5	6
D	Good Store	8.5	12.5
E	Washing Area	17	4
F	Preparation Area	8.5	7.25
G	Cooking Area	9.5	13
H	Oven	12.5	9.5
I	Plating Area	8.5	5.75
J	Crockery Storage	8	3
K	Decoration Equipment Storage	14	2
L	Fabric Storage	8	1

4.2.2 Activity Relationship Chart (ARC)

Activity Relationship Chart (ARC) is used to determine the degree of closeness between departments or work areas in the production process. Each department is compared with another, and the relationship is rated using a closeness rating scale. The closeness rating shows how important it is for two departments to be located near each other. In addition, the reasons for the closeness are also listed to provide a clear justification for the relationship.

Table 4. 2 Closeness Rating

Code	Definition
A (Red)	Absolutely necessary that these two departments be next to each other
E (Orange)	Especially important
I (Green)	Important
O (Blue)	Ordinary importance
U (No. Color)	Unimportant
X (Brown)	Closeness undesirable

Table 4. 3 Reasonable Desire Closeness

No	Reason
1	Same area material flow sequence
2	Workforce sequence
3	Dirty & dusty
4	Has no functional relationship

Based on the closeness rating and reasonable desire for closeness determined earlier, the Activity Relationship Chart (ARC) can be developed to illustrate the relationships between departments in the production process. In this study, there are 12 workstations under consideration, namely Garage, Freezer, Refrigerator, Goods Store, Washing Area, Preparation Area, Cooking Area, Oven, Plating Area, Crockery Storage, Decoration Equipment Storage, and Fabric Storage. Each workstation has its own level of closeness, which shows how much interaction is needed between areas, whether it's because of material flow, process efficiency, or ease of supervision.

Based on interviews conducted with the company, the relationships between departments were analyzed using the closeness rating and reasonable desire closeness to determine the level of proximity between processing areas and storage areas. At CV. Salwa Indoboga, the processing areas include Garage, Preparation Area, Cooking Area, Oven, Plating Area, and Washing Area, while the storage areas consist of Freezer, Refrigerator, Goods Store, Crockery Storage, Decoration Equipment Storage, and Fabric Storage. This analysis is important because determining the correct placement of departments directly impacts production efficiency, material handling time, and the maintenance of food hygiene standards.

The analysis results show that the Garage plays a central role as the entry and exit point for goods, including both raw materials and finished products. Therefore, the Garage has an ordinary (O) relationship with the Freezer, Refrigerator, and Goods Store, as raw materials purchased from suppliers are immediately directed to the corresponding storage areas: frozen

products to the Freezer, fresh products to the Refrigerator, and dry goods to the Goods Store. The Garage also has an absolute (A) relationship with the Plating Area, because finished products must be loaded directly into distribution vehicles without passing through irrelevant areas. On the other hand, the Garage should not be placed adjacent (undesirable, X) to the Washing, Preparation, Cooking, and Oven areas. Vehicle activity in the Garage can generate dust and dirt that may contaminate food or equipment, while the Washing Area is often wet, posing a safety hazard. Meanwhile, for heavy items stored in the Crockery Storage, Equipment Storage, and Fabric Storage, the Garage has an especially important (E) relationship to facilitate the mobilization of large and heavy items for direct loading or unloading.

Next, the Freezer and Refrigerator serve as the main food storage units under different conditions, and both have an important (I) relationship with the Preparation Area. This connection is critical, as raw materials taken from storage must be immediately processed to maintain freshness, especially for frozen and perishable products. The Freezer and Refrigerator also have an ordinary (O) relationship with the Washing Area, since many products such as vegetables and fresh meat require cleaning before processing. However, both should not be placed adjacent (undesirable, X) to Crockery, Equipment, and Fabric Storage, as those areas may generate dust that could compromise food hygiene.

The Goods Store also plays a vital role, particularly for dry raw materials. Its relationship with the Preparation Area is categorized as absolute (A) because nearly all stored goods must pass through the preparation stage before cooking. The Goods Store also has an especially important (E) relationship with the Washing Area, as some items must undergo cleaning first. This arrangement supports a smoother material flow, ensuring efficiency and better control of the production process.

In the processing areas, the Preparation Area functions as the core of production activities. It has an absolute (A) relationship with the Cooking Area and Oven, as ingredients move directly from preparation to cooking or baking. This close proximity ensures faster movement, reduces handling distances, and maintains the quality of pre-processed items. The Preparation Area also has an ordinary (O) relationship with the Plating Area, since some finishing or garnish steps may occur after preparation. The Cooking Area and Oven in turn have an absolute (A) relationship with the Plating Area, as cooked products must immediately be transferred for plating before serving or packaging. Cooking and Oven also share an important (I) relationship with the Washing Area, because cooking utensils need to be cleaned quickly for reuse.

The Washing Area serves a dual purpose: cleaning raw materials as well as kitchen utensils. Thus, it has an ordinary (O) relationship with the Preparation Area, though the wet floor condition must be managed to avoid interfering with food preparation. With the Cooking and Oven, Washing has an important (I) relationship, as it supports the hygiene cycle of equipment. However, Washing has an undesirable (X) relationship with areas such as Plating, Crockery Storage, Equipment Storage, and Fabric Storage, since water splashes and wet conditions could damage items or compromise food quality.

Lastly, the equipment storage areas which are Crockery Storage, Equipment Storage, and Fabric Storage have an especially important (E) relationship with one another and with the Garage, since the stored items are often large, heavy, and transported together. This requirement is more about ease of mobilization than production flow. However, these three storage areas should be placed away from the processing areas such as Freezer, Refrigerator, Goods Store, Preparation, Cooking, Oven, and Plating, because they lack direct process interaction and could generate dust that threatens food hygiene standards.

Overall, the analysis highlights that interdepartmental relationships at CV. Salwa Indoboga are influenced by three main factors: material flow sequence, hygiene requirements, and ease of mobilization. Absolute (A) relationships generally occur along the main production flow, such as Preparation, Cooking, Plating, Garage. Especially important (E) and important (I) relationships appear in supporting areas, such as Washing with Goods Store or Cooking, while undesirable (X) relationships are assigned to prevent contamination risks and maintain food safety. With this understanding, the facility layout can be better directed toward reducing material handling distances, ensuring smooth workflow, and upholding food hygiene standards in production. The Activity Relationship Diagram as shown on Figure 4.14.

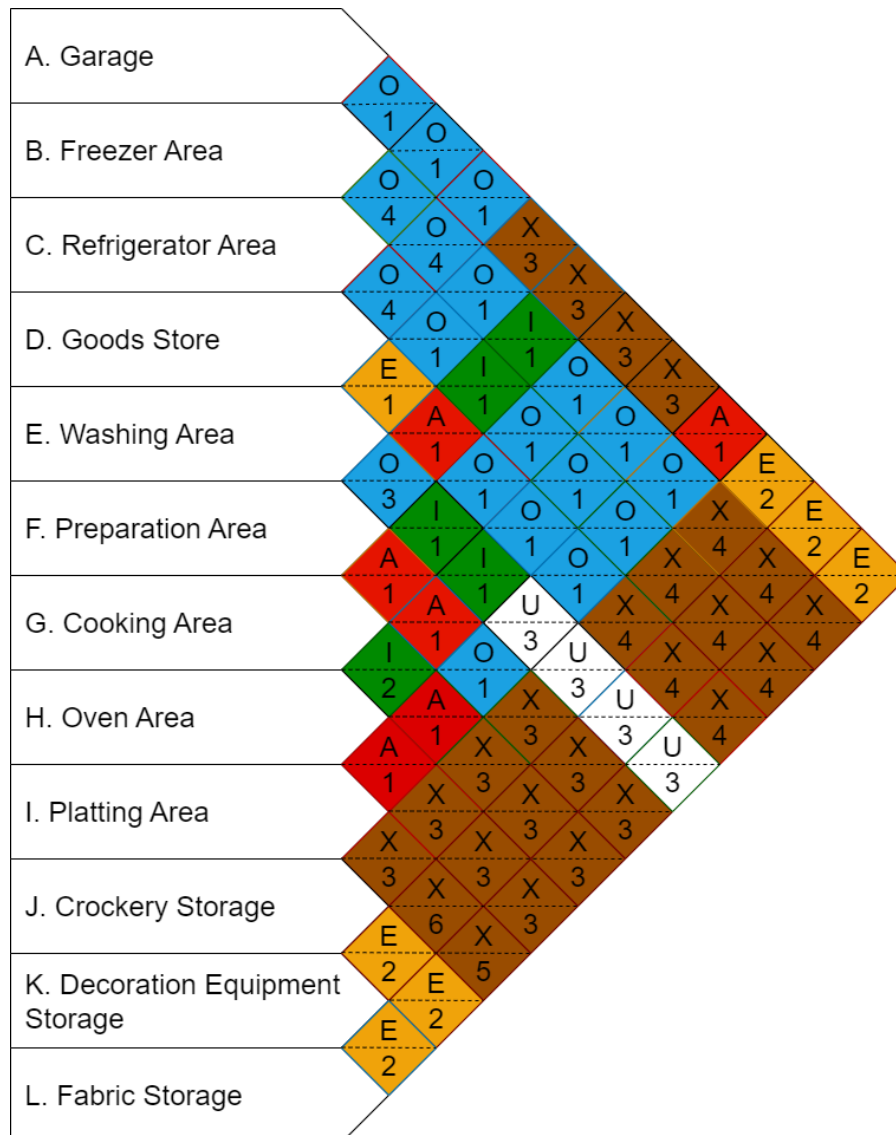


Figure 4. 11 Activity Relationship Chart

Based on the closeness rating and reasonable desire closeness, the relationships between the twelve workstations can be mapped more clearly. The Garage has an ordinary relationship with the Freezer, Refrigerator, and Goods Store because after shopping, raw materials are first placed into these areas. However, its relationship with Washing, Preparation, Cooking, and Oven areas is undesirable, since vehicle activity may create dust or wet conditions that can contaminate food. On the other hand, Garage has a very close relationship with Plating, since finished products need to be immediately transferred into vehicles. It is also especially important for Garage to be close to Crockery Storage, Decoration Equipment Storage, and Fabric Storage due to the worker flow and the heavy or bulky items that must be carried.

For the Freezer and Refrigerator, their relationship with each other and with Goods Store is ordinary since their functions differ, while with Washing and Preparation areas the connection is stronger, as materials usually go through cleaning and preparation after storage. Links to Cooking, Oven, and Plating are ordinary because the flow may occur but not frequently. Meanwhile, connections to Crockery, Equipment, and Fabric storage are undesirable to avoid contamination from dust.

The Goods Store is especially important to be close to Washing and absolutely necessary to be close to Preparation because of the direct material flow sequence. Its relationship with Cooking, Oven, and Plating remains ordinary, while with Crockery, Equipment, and Fabric Storage is undesirable due to no functional link.

The Washing Area has an ordinary relationship with Preparation, though risks of wet and slippery conditions exist. Its relationship with Cooking and Oven is important, as washing of tools or raw materials links directly to these processes. However, closeness with Plating and all storage areas (Crockery, Equipment, Fabric) is unimportant or undesirable due to risks of water damage or contamination.

The Preparation Area has an absolutely necessary link with Cooking and Oven because of the production sequence, while its connection with Plating is ordinary as some garnishing or final touches may be done before serving. However, its relationship with Crockery, Equipment, and Fabric Storage is undesirable to prevent dust exposure.

The Cooking Area has an important relationship with Oven, since some products may require both cooking and baking in sequence, and both are considered hot areas. It has an absolutely necessary connection with Plating, as products must be served right after cooking. Conversely, its relationship with Crockery, Equipment, and Fabric Storage is undesirable for cleanliness reasons.

The Oven also has an absolutely necessary connection with Plating, while its closeness with the three storage areas is undesirable. The Plating Area connects absolutely with Garage as well as Cooking and Oven, but with Crockery, Equipment, and Fabric Storage, its closeness is undesirable to avoid contamination risks. Among the storage-related areas, Crockery Storage, Decoration Equipment Storage, and Fabric Storage are especially important to be close to each other since they share similar worker flow and often involve handling heavy or related items.

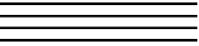
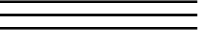
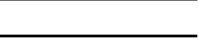
4.2.3 Activity Relationship Diagram (ARD)

The Activity Relationship Diagram (ARD) is made based on the Activity Relationship Chart (ARC) and shows how different work areas are connected, taking into account the closeness ratings determined earlier. Each workstation is placed according to how much interaction and material flow it needs, making it easier to understand visually. The ARD helps to see the relationships clearly and supports designing more efficient layout alternatives later on.

Some key relationships are also highlighted. The Preparation area is close to Cooking because ingredients need to be processed right away to save time and keep quality. Washing is near Plating so clean utensils are easy to access during plating. Freezer and Refrigerator are next to Preparation to make it quick to get ingredients and move them to processing. The Goods Store is close to all preparation areas so extra ingredients can be reached quickly, while the Garage is placed a bit apart since vehicle activity isn't part of production and could cause disturbance. This setup makes the workflow smoother, reduces unnecessary movement, and keeps everything organized logically.

Area Relationship Diagram (ARD) is determined based on the proximity levels obtained from the Activity Relationship Worksheet (ARW). The ARD is created by depicting block diagrams connected by specific lines to represent the relationships between different areas (Azizah N. F., Apriani, Pratama, & Alfietta, 2023).

Table 4. 4 ARD Relationship Line

Relationship Line	
A	
E	
I	
O	
U	
X	

In an ARD, lines are used to show how close or important the relationship is between work areas. The more lines there are between two areas, the stronger their connection. For example, four lines mean the areas really need to be close, three lines show an important but not critical connection, two lines represent a normal relationship, and one line means the areas don't need to be close or should even be kept apart. Using lines this way makes it easy to see

which workstations should be near each other and which can be separated, helping to plan a layout that's more efficient and organized. The ARD for the CV. Salwa Indoboga production floor layout is shown in Figure 4.15.

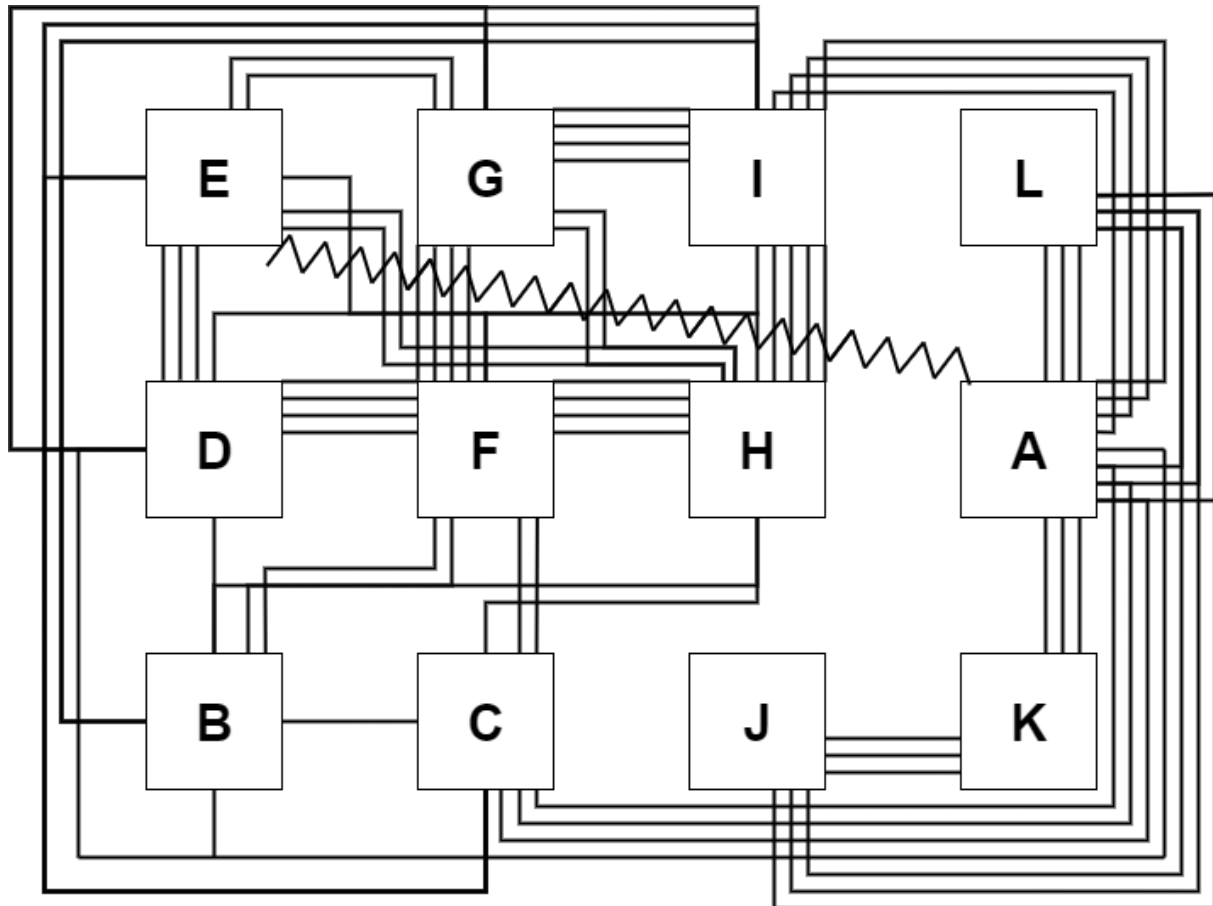


Figure 4. 12 Activity Relationship Diagram

4.2.4 Activity Allocation Diagram (AAD)

The Activity Allocation Diagram (AAD) is a step beyond the Activity Relationship Diagram (ARD) and helps decide the best spots for each work area on the floor. While the Activity Relationship Diagram (ARD) shows how close or connected activities are, the AAD focuses on placing workstations in a way that makes the workflow smoother and reduces unnecessary movement. In this research, five different Activity Allocation Diagram (AAD) were made to show recommended layout options for the production floor, each offering a way to make the production process more efficient and organized.

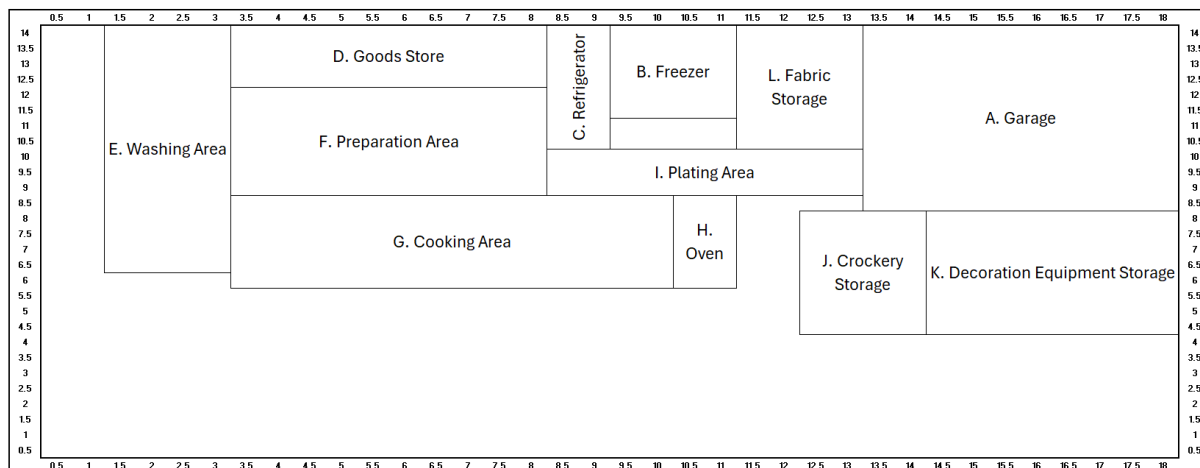


Figure 4. 13 Propose Layout 1

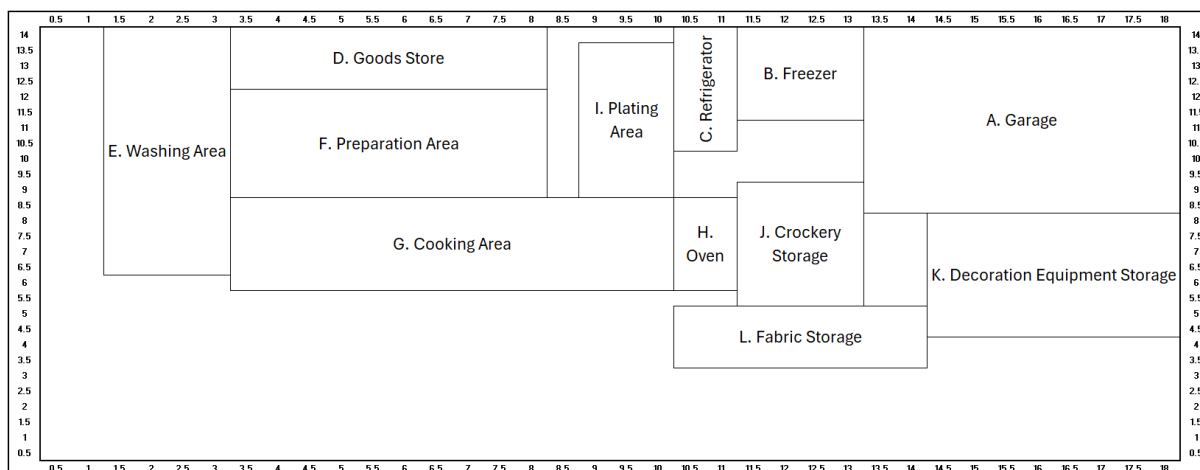


Figure 4. 14 Propose Layout 2

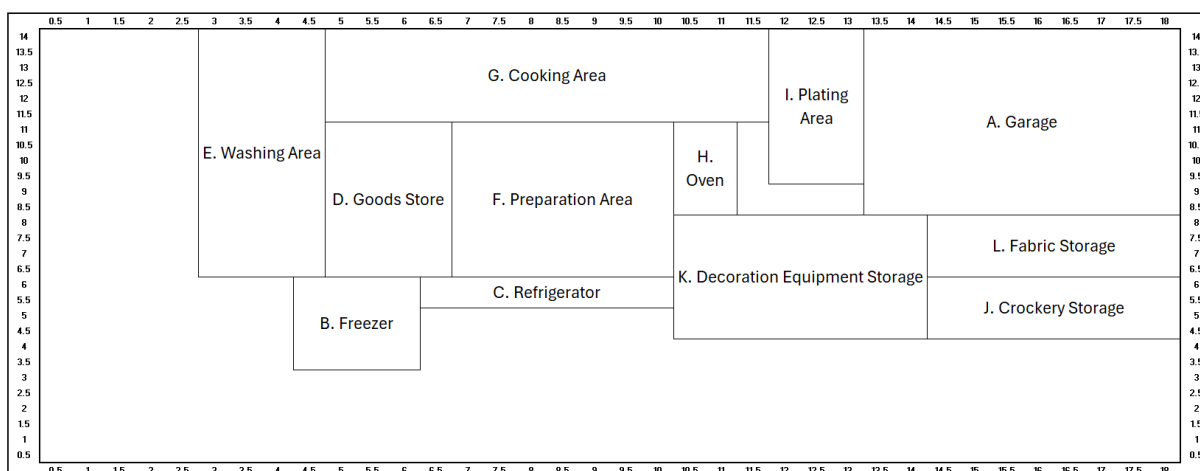


Figure 4. 15 Proposed Layout 3

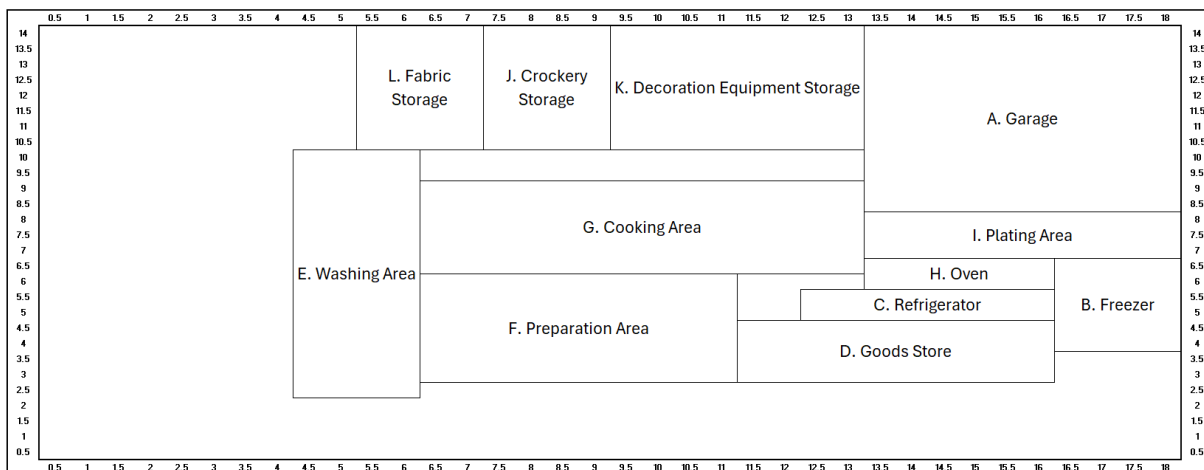


Figure 4. 16 Proposed Layout 4

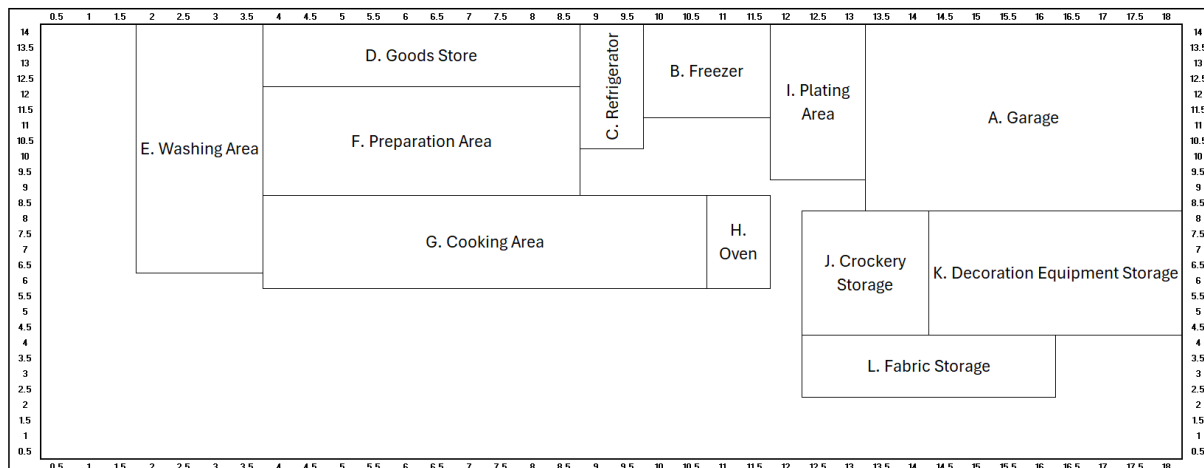


Figure 4. 17 Proposed Layout 5

Figure 4.16, 4.17, 4.18, 4.19 and 4.20, shows the Activity Allocation Diagram (AAD) for the recommended layout. There are five different layout alternatives as possible solutions for the production floor. Each diagram shows how the workstations are arranged to make the workflow smoother and cut down on unnecessary movement. The layouts are based on the closeness and relationships from the ARD, so areas that interact a lot are placed near each other, while less connected areas are farther apart. These five options make it easy to compare layouts and pick the one that works best, helping the production process run more efficiently and keeping materials and staff moving more smoothly.

4.2.5 Center Point of Proposed Layout

Among the five alternatives, the layout with the shortest movement distance was selected. This layout places workstations with the most interactions closest to each other, reducing unnecessary travel and making the workflow more efficient. By minimizing movement, materials and personnel can be handled faster, which helps the production process run more smoothly and increases overall operational efficiency.

To calculate the distance, the rectilinear distance formula is used, taking the centroid of each area as a reference point. The distances for all movements between related areas across the entire production process are added together to get the total distance. This total serves as a baseline to assess the efficiency of the current layout and to compare it with the proposed layout designs. Using the proposed production layout, the movement distances are calculated based on the center point of each area. These center points are determined using the centroid formula, which is expressed as follows.

$$x_c = \frac{1}{n} \sum_{i=1}^n x_i, \quad y_c = \frac{1}{n} \sum_{i=1}^n y_i \quad (4.3)$$

where:

x_c = x-coordinate of the centroid

y_c = y-coordinate of the centroid

x_i = x-coordinate of the i-th point

y_i = y-coordinate of the i-th point

n = total number of points

By applying the formula described above, the center point of each work area was calculated and is presented in Table 4.8. These center points serve as the reference locations for each area and are essential for determining the movement distances between workstations. In the following analysis, the rectilinear distance between these points is calculated for all related areas throughout the production process. Summing these distances provides a total movement value, which will be used to evaluate the efficiency of the current layout and to compare it with the proposed layout alternatives. This method ensures that the layout assessment is based on precise measurements and reflects the actual flow of materials and personnel within the production floor.

Table 4. 5 Proposed Layout Center Point

Co de	Workstation	Proposed 1		Proposed 2		Proposed 3		Proposed 4		Proposed 5	
		<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>
A	Garage	16	11.5	16	11.5	16	11.5	16	11.5	16	11.5
B	Freezer	10	12.5	12	12.5	5	4.5	17	5	10.5	12.5
C	Refrigerator	8.5	12	10.5	12	8	5.5	14	5	9	12
D	Good Store	5.5	13	5.5	13	5.5	8.5	13.5	3.5	6	13
E	Washing Area	2	10	2	10	3.5	10	5	6	2.5	10
F	Preparation Area	5.5	10.25	5.5	10.25	8.25	8.5	8.5	4.25	6	10.25
G	Cooking Area	6.5	7	6.5	7	8	12.5	9.5	7.5	7	7
H	Oven	10.5	7	10.5	7	10.5	9.5	14.5	6	11	7
I	Plating Area	10.5	9.25	9.25	11	12.25	11.5	15.5	7.25	12.25	11.5
J	Crockery Storage	13	6	12	7	16	5	8	12	13	6
K	Decoration Equipment Storage	16	6	16	6	12.0	6.0	11	12	16	6
L	Fabric Storage	12	12	12	4	16	7	6	12	14	3

Based on the movement distance calculations, it was found that each proposed layout produced different results because the center points of the workstations vary. This affects how far workers and materials need to move during each production process.

CHAPTER V

RESULT AND DISCUSSION

5.1 Distance Movement Comparison Between Initial Layout and Proposed Layout

After determining the center points, the next step is to calculate the movement distance of each product based on the production process sequence using the rectilinear distance formula, as follows.

$$d_{ij} = |x_i - x_j| + |y_i - y_j| \quad (5.1)$$

where:

$x_{i,j}$ = x coordinate at the center of facility i, j

$y_{i,j}$ = y coordinate at the center of facility i, j

d_{ij} = distance between the centers of facilities i and j

The table below shows the comparison of production movement distances between the initial layout and the five proposed layouts. The distances were calculated using the rectilinear formula, measured from the center point of each workstation to keep it consistent. Each proposed layout was designed to shorten movement and make the workflow smoother. From the comparison, it can be seen how much the distance for grilled chicken, spicy beef, and decoration sets changed in each layout. This makes it easier to see which layout gives the biggest improvement.

Table 5. 1 Distance Movement Comparison Between Initial Layout and Proposed Layout of Grilled Chicken

From Workstation	To Workstation	Distance (m)						
		Initial	Proposed					
			1	2	3	4	5	
B	E	8	10.5	12.5	7	13	10.5	
E	F	11.75	3.75	3.75	6.25	5.25	3.75	
F	D	5.25	2.75	2.75	2.75	5.75	2.75	
D	F	5.25	2.75	2.75	2.75	5.75	2.75	
F	C	5.25	4.75	6.75	3.25	6.25	4.75	
C	H	3.5	7	5	6.5	1.5	7	
H	I	7.75	2.25	5.25	3.75	2.25	5.75	
I	A	13.25	7.75	7.25	3.75	4.75	3.75	
Total		60	41.5	46	36	44.5	41	

For the grilled chicken production process, which passes through Freezer, Washing Area, Preparation Area, Goods Store, Preparation Area, Refrigerator, Oven, Plating Area, and Garage, it was found that the total distance movement in the production process of grilled chicken is 60 meters for the initial layout. From the calculation results for proposed layouts, the total movement distances for each layout show clear differences. Layout 1 has a total distance of 41.5 meters, indicating a moderate flow of materials and workers. Layout 2 has the longest distance, which is 46 meters, suggesting that some workstations are placed farther apart, causing more movement and potentially slowing down the workflow. Layout 3 has the shortest distance at 36 meters, making it the most efficient layout because it minimizes unnecessary movement and keeps the most interacting areas close together. Layout 4 is 44.5 meters, slightly better than Layout 2 but still higher than Layout 1, while Layout 5 has a total distance of 41 meters, almost the same as Layout 1, showing a fairly balanced arrangement. From these results, Layout 3 clearly offers the most efficient workflow, while Layout 2 results in the highest total distance.

Table 5. 2 Distance Movement Comparison Between Initial Layout and Proposed Layout of Spicy Beef

From Workstation	To Workstation	Distance (m)						
		Initial	Proposed					
			1	2	3	4	5	
B	F	7.75	6.75	8.75	7.25	9.25	6.75	
F	E	11.75	3.75	3.75	6.25	5.25	3.75	
E	D	17	6.5	6.5	3.5	11	6.5	
D	F	5.25	2.75	2.75	2.75	5.75	2.75	
F	G	6.75	4.25	4.25	4.25	4.25	4.25	
G	I	8.25	6.25	6.75	5.25	6.25	9.75	
I	A	13.25	7.75	7.25	3.75	4.75	3.75	
Total		70	38	40	33	46.5	37.5	

For the spicy beef production process, which follows Freezer, Preparation Area, Washing Area, Goods Store, Preparation Area, Cooking Area, Plating Area, and Garage, the total distance movement in the production process of spicy beef reaches 70 meters for the initial layout. Meanwhile the movement distances of proposed layouts also vary. Layout 1 has a total distance of 38 meters, offering a moderate level of efficiency. Layout 2 is slightly longer at 40 meters, while Layout 3 again has the shortest distance at 33 meters, making it the most efficient layout. Layout 4 shows the longest distance at 46 meters, indicating that workstation placement in this layout requires more movement for workers and materials. Layout 5 has a distance of 37.5

meters, slightly better than Layouts 1 and 2. These results highlight that Layout 3 is consistently the most efficient for minimizing movement in the spicy beef process, while Layout 4 is the least efficient.

Table 5. 3 Distance Movement Comparison Between Initial Layout and Proposed Layout of Decoration Sets

From Workstation	To Workstation	Distance (m)						
		Initial	Proposed					
			1	2	3	4	5	
K	A	11.5	5.5	5.5	5.5	5.5	9.5	
A	J	16.5	8.5	8.5	8.5	8.5	6.5	
J	A	16.5	8.5	8.5	8.5	8.5	6.5	
A	L	18.5	4.5	11.5	10.5	10.5	4.5	
L	A	18.5	4.5	11.5	10.5	10.5	4.5	
Total		44.5	22.5	22.5	22.5	22.5	22.5	

For the decoration sets process, which passes through Decoration Equipment Storage, Garage, Cookery Storage, Garage, and Fabric Storage, the total distance movement in the production process of decoration sets is 44.5 meters. By contrast, all proposed layouts produce the same total movement distance of 22.5 meters. This indicates that the layout changes do not affect the movement distance for this process, since the sequence of workstations and their relative positions remain the same across all alternatives. In other words, regardless of how the layout is arranged, the workflow for the decoration sets process stays consistent, and there is no advantage in terms of movement distance from choosing one layout over another.

Overall, the comparison of these processes shows that some production processes, like grilled chicken and spicy beef, are highly sensitive to workstation placement, while others, like decoration sets, are not affected. By analyzing these distances, it is possible to identify which proposed layouts reduce unnecessary movement and improve workflow efficiency, helping to choose the most effective layout for each production process.

5.2 Layout Selection

After looking at the movement distances for all the proposed layouts, it's easy to see that some layouts make it easier for workers and materials to move around, while others require more travel. Comparing the total distances for each production process helps to figure out which layout works best overall.

Comparing the total distances for each production process shows that proposed layout 3 consistently has the shortest movement distances for grilled chicken and spicy beef, at 36 meters and 33 meters, respectively. Even though the decoration sets process has the same distance in all proposed layouts, proposed layout 3 is still the best choice overall. It cuts down unnecessary walking, helps workers move more easily, and keeps the production process running smoothly. The way workstations are arranged in proposed layout 3 also puts related areas close together and keeps less connected areas apart, making everything more organized and practical. Proposed layout 3 is chosen as the recommended layout for the production floor that would makes work faster, easier, and more efficient. Below is the work sequence for each product in Proposed layout 3. These sequences show the order in which tasks and materials move through the workstations. Below is an overview of the production process sequence for each product in Proposed Layout 3.

The comparison between the initial layout and the chosen Proposed Layout 3 shows significant reductions in movement distances across products. For grilled chicken, the distance decreases from 60 meters to 36 meters, a reduction of 24 meters or 40%. Spicy beef shows the largest improvement, dropping from 70 meters to 33 meters, which is a decrease of 37 meters or 52.9%. Meanwhile, the decoration sets process decreases from 44.5 meters to 22.5 meters, cutting 22 meters or 49.4%. These reductions demonstrate that Proposed Layout 3 effectively minimizes unnecessary movement, streamlines the workflow, and supports a more efficient production process overall.

For the first product, grilled chicken, the production process follows a specific sequence of work areas, starting from the freezer, followed by the washing area, preparation area, goods store, preparation area (second step), refrigerator, oven, plating, and finally the garage. The production process moves back and forth between workstations, which makes workers and materials travel longer distances. This crossing between areas can slow things down and make the workflow less smooth. In the Grilled Chicken proposed flow, it can be seen that there's no back-and-forth or crossing between workstations. Therefore, workers and materials can move more smoothly along the production line, which helps speed up the process, reduces unnecessary movement, and makes the workflow more efficient overall. The detailed illustration of the production flow for grilled chicken can be seen in Figure 5.1 for initial layout and Figure 5.2 for proposed layout.

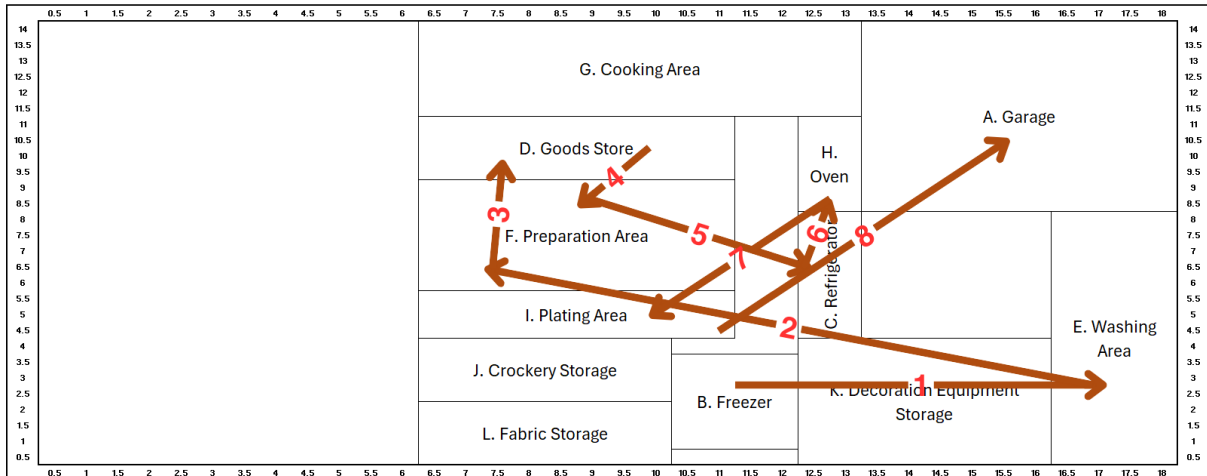


Figure 5. 2 Grilled Chicken Initial Flow

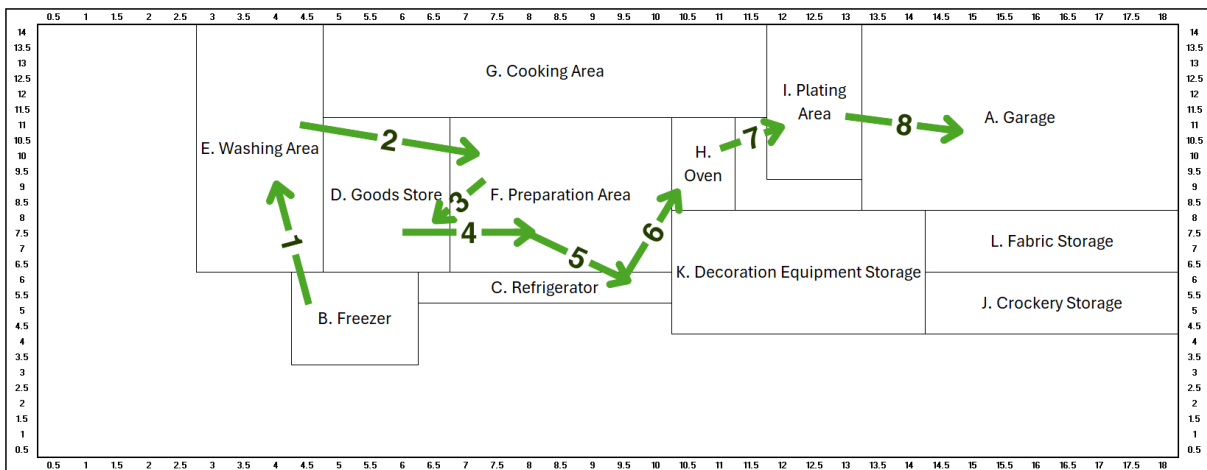


Figure 5. 1 Grilled Chicken Proposed Flow

For the second product, spicy beef, the production process also involves several sequential stages across different work areas. The process begins in the freezer, then continues to the preparation area, followed by the washing area, goods store, preparation area (second step), cooking area, plating area, and finally ends in the garage. The production process has workstations that are pretty far apart, which means workers and materials have to move a lot. This makes the workflow slower, less efficient, and takes more time and effort to get things done. In the spicy beef process for proposed layout, the distance between workstations is no longer far, and the production sequence follows the correct order without back-and-forth movement. As a result, the workflow becomes smoother, materials and workers move more efficiently, and the overall production process can be completed faster with fewer delays. The

detailed production flow for spicy beef is illustrated in Figure 5.3 for initial layout and Figure 5.4 for proposed layout.

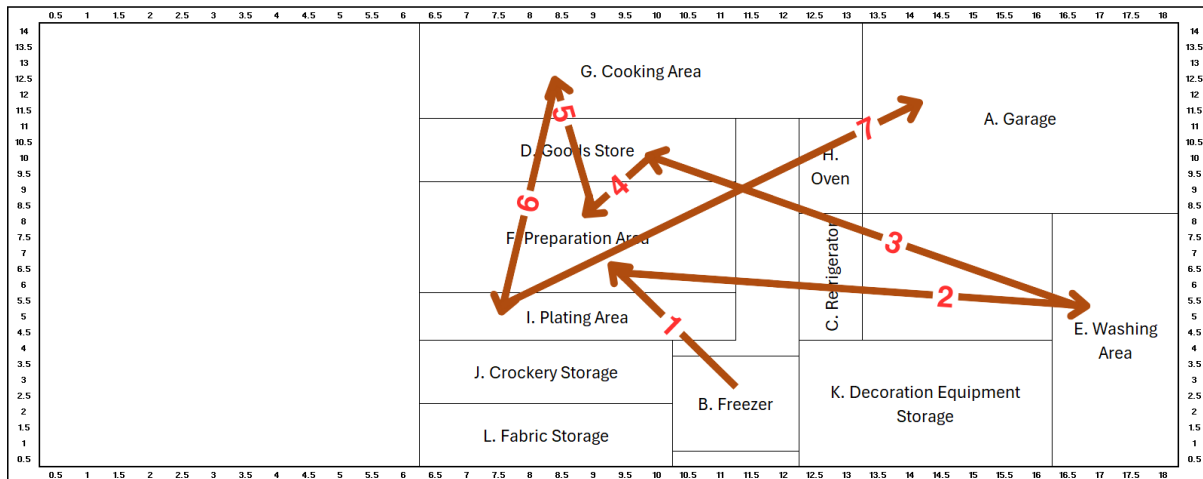


Figure 5. 3 Spicy Beef Initial Flow

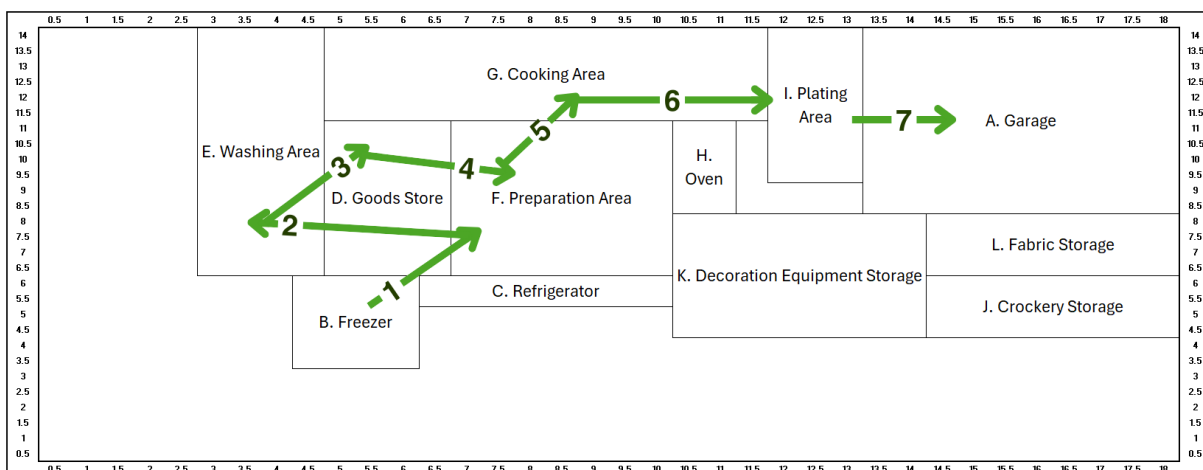


Figure 5. 4 Spicy Beef Proposed Flow

For the third product, decoration sets, the production flow involves movements between several specific storage and working areas. The process begins in the Decoration Equipment Storage, continues to the Garage, then proceeds to the Crockery Storage, followed again by the Garage, then moves to the Fabric Storage, and finally returns to the Garage. This sequence highlights the multiple back-and-forth movements that occur between the storage areas and the garage, which indicates a relatively inefficient material flow compared to food production processes. The production process for decoration sets has workstations that are pretty far apart. Since some of the items being moved are quite heavy, this makes it harder and more tiring for

workers, slows down the workflow, and increases the risk of delays or mistakes. In the decoration sets process sequence, the distance between workstations is manageable, making it easier for workers since the items being moved are large and heavy. As a result, the workflow is smoother, workers can handle materials more safely and efficiently, and the overall production process becomes less tiring and more organized. The flow of operations for the decoration sets is presented in Figure 5.5 for initial layout and Figure 5.6 for proposed layout.

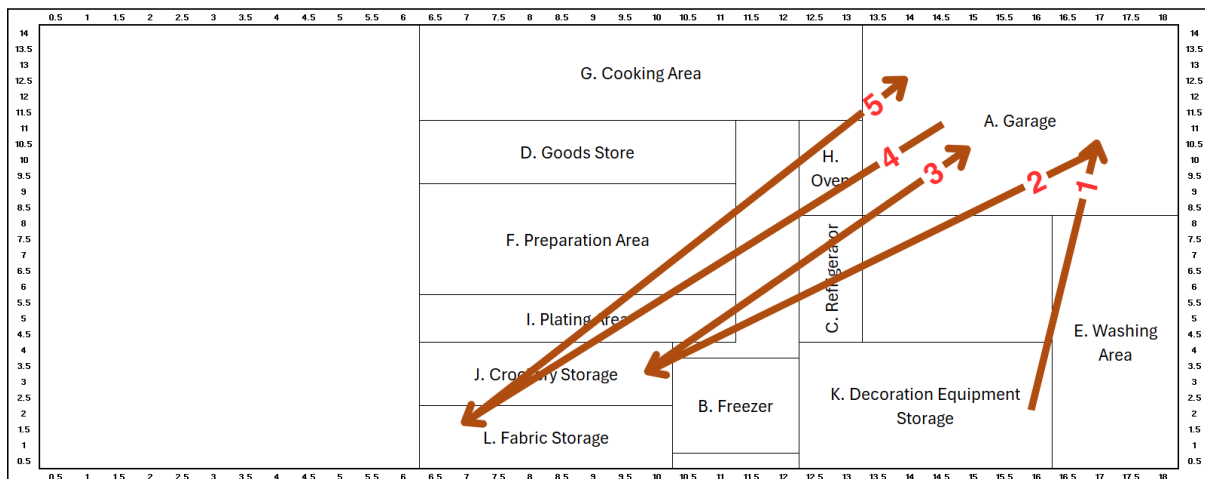


Figure 5. 5 Decoration Sets Initial Flow

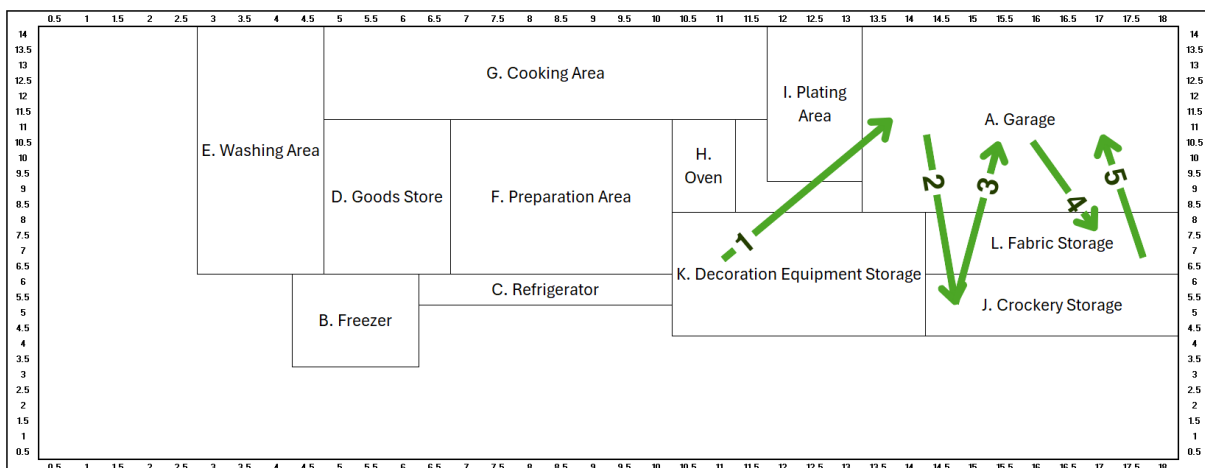


Figure 5. 6 Decoration Sets Proposed Flow

In short, after looking at the movement distances and production sequences for all three products, Proposed Layout 3 clearly comes out on top. For grilled chicken, there's no back-and-forth or crossing between workstations, so materials and workers can move more smoothly and with less effort. For spicy beef, the workstations are closer together, and the production

sequence follows the right order without any backtracking, making the workflow faster and more efficient. For decoration sets, the workstations are close enough to handle the large and heavy items more easily, which makes the process less tiring and safer for workers. Taking all of this into account, Proposed Layout 3 not only reduces total movement distances but also keeps the workflow organized, practical, and easier to manage.

5.3 Result

In this chapter, the results are presented from the production layout analysis at CV. Salwa Indoboga are presented. The initial layout had several issues that made the production process less smooth. Workers and materials had to move back and forth a lot, cross paths between workstations, and cover long distances, which slowed things down and made work more tiring. To fix these problems, five alternative layouts were designed using the Activity Relationship Chart (ARC), Activity Relationship Diagram (ARD), and Activity Allocation Diagram (AAD).

From these, five proposed layouts were developed as possible ways to improve the workflow. The layouts were created based on how workstations relate to each other in the ARC and ARD, and the AAD helped place each workstation in a way that minimized movement and made operations smoother. Out of the five options, Proposed Layout 3 turned out to be the best. This choice came after calculating the movement distances for each product's production process using Systematic Layout Planning (SLP) with the rectilinear distance formula, which made it easy to compare how far workers and materials would travel in each layout.

Proposed Layout 3 had the smallest total movement distances for the main production processes, meaning materials and workers could move more efficiently and with less effort. For grilled chicken and spicy beef, unnecessary back-and-forth and crossing movements were eliminated, and for decoration sets, the workstations were close enough to handle heavy items safely. The layout also made sure that areas that needed to be close were near each other, while less connected areas were farther apart, creating a more logical and organized flow.

5.4 Discussion

A detailed analysis of the results shows that proposed layout 3 clearly improved the workflow, but a few minor issues remain. For example, workers still have to move quite a bit when handling heavy items in the decoration sets process. The main point is that rearranging workstations using Activity Relationship Diagram and Activity Allocation Diagram helps

reduce unnecessary movement and makes production smoother. For instance, the total distance for grilled chicken decreased from 46 meters in the initial layout to 36 meters in Layout 3, and for spicy beef it dropped from 46 meters to 33 meters. This demonstrates that careful workstation planning can make work easier, reduce fatigue, and save time moving materials.

Additionally, the facility's comfort and functionality could be further improved by making use of the remaining empty areas in the suggested arrangement. These spaces could be set aside for auxiliary amenities like a small staff room, more storage spaces, better workstations, a staircase for vertical access if necessary, or basic conveniences like restrooms and toilets. Future increases in production capacity or the addition of additional equipment may also be accommodated by enlarging specific workstations, such as the preparation or plating sections.

However, this study was conducted only based on Systematic Layout Planning (SLP) and Activity Relationship methods and was applied solely to the production floor, without considering factors such as worker skills, equipment availability, or unexpected workflow interruptions. In the future, combining layout planning with simulation tools, time-motion studies, or ergonomic analysis could provide even greater improvements in workflow efficiency. Overall, this discussion highlights what worked, what still needs attention, and how future research can further enhance production layout design.

CHAPTER VI

CONCLUSION AND SUGGESTION

6.1 Conclusion

Based on the research conducted, the conclusions are:

1. The production layout at CV. Salwa Indoboga needed to be rearranged to make the workflow smoother and more practical. By applying the ARD and AAD methods, five alternative layouts were evaluated, and Layout 3 was identified as the most efficient option. In this layout, the positions of 12 departments were adjusted to improve material flow and reduce unnecessary movement, with calculations carried out using Systematic Layout Planning (SLP) and the rectilinear distance formula.
2. The total movement distances were reduced noticeably when comparing the initial layout with proposed layout 3 considering all three products, grilled chicken, spicy beef, and decoration sets. For the grilled chicken process, the distance decreased from 60 meters to 36 meters, which is a reduction of approximately 40%. For spicy beef, it went down from 70 meters to 33 meters, representing a decrease of about 52.9%. For the decoration sets, the distance decreased from 44.5 meters to 22.5 meters, which is a reduction of approximately 49.4%. The new layout made the workflow more organized, safer, and easier for workers to handle materials efficiently.

6.2 Suggestion

Several directions for future research may be considered to further develop this study. One potential avenue is the integration of production flow simulations to evaluate how the proposed layout performs under actual operating conditions. It would also be valuable to incorporate ergonomic factors and variations in worker skills, ensuring that the layout is not only efficient but also safe and adaptable for operators. Future research may also address facility-related constraints, such as equipment availability, storage capacity, or unplanned process disruptions, which were not fully explored in this study. Furthermore, applying alternative methods or specialized software for layout optimization could provide additional improvements in minimizing movement distances and enhancing workflow. These recommendations are drawn from the findings and limitations identified in this research and are intended to guide further enhancements in production layout design at CV. Salwa Indoboga.

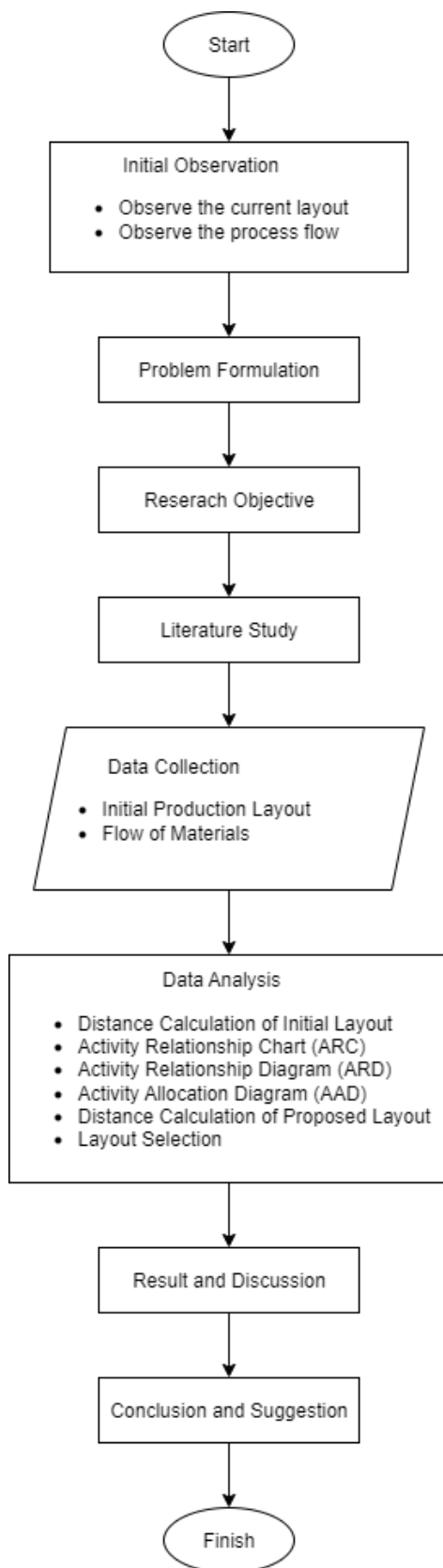
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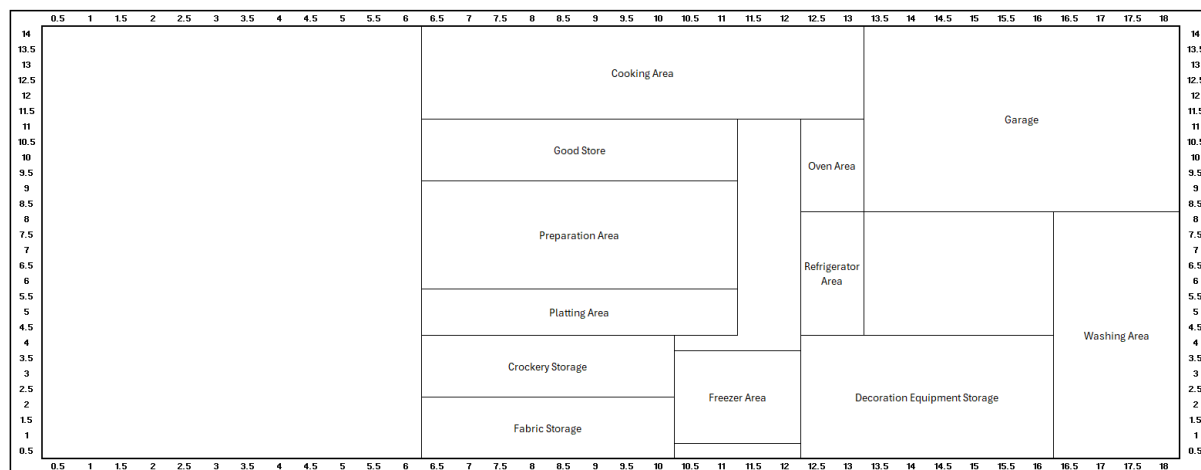
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ATTACHMENT

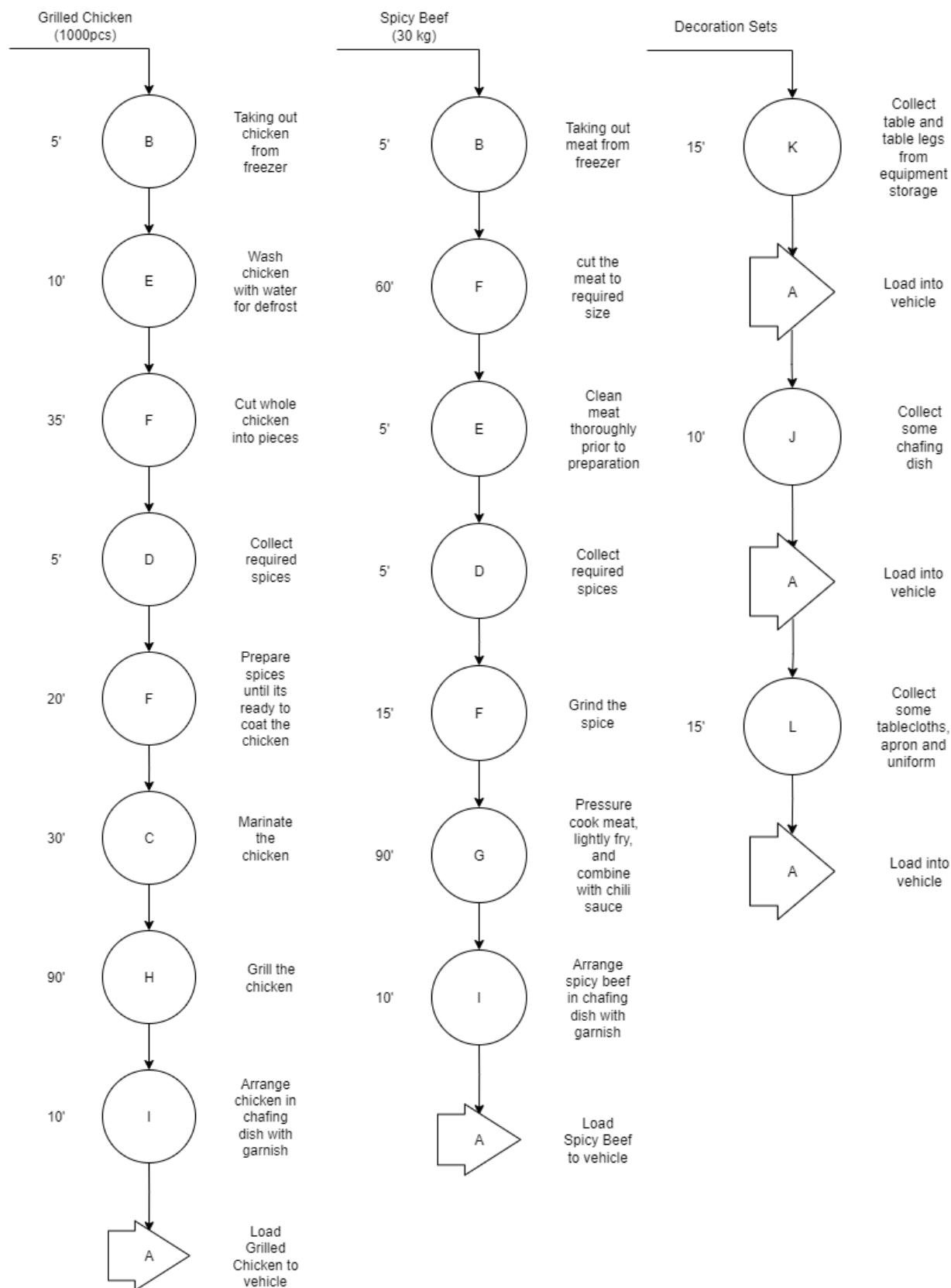




Initial Production Floor



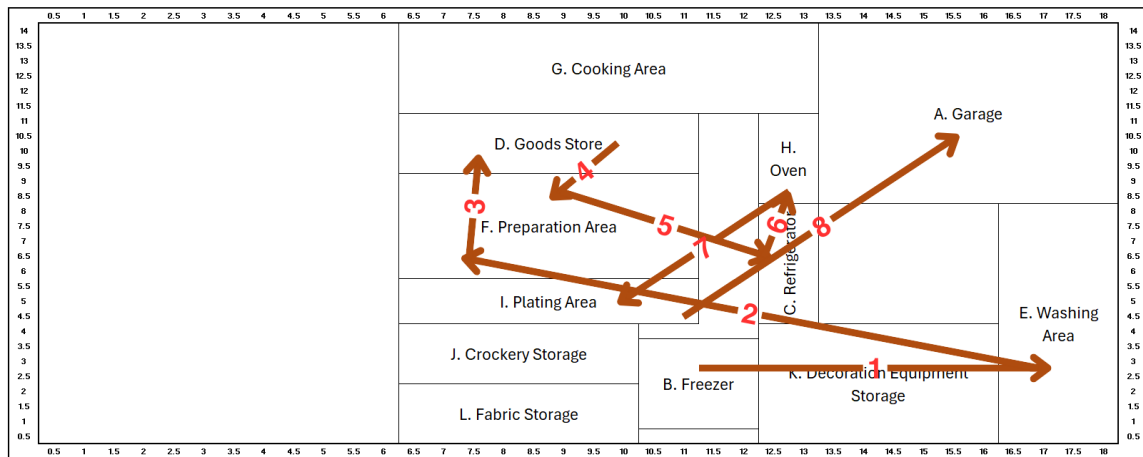
Initial Production Layout



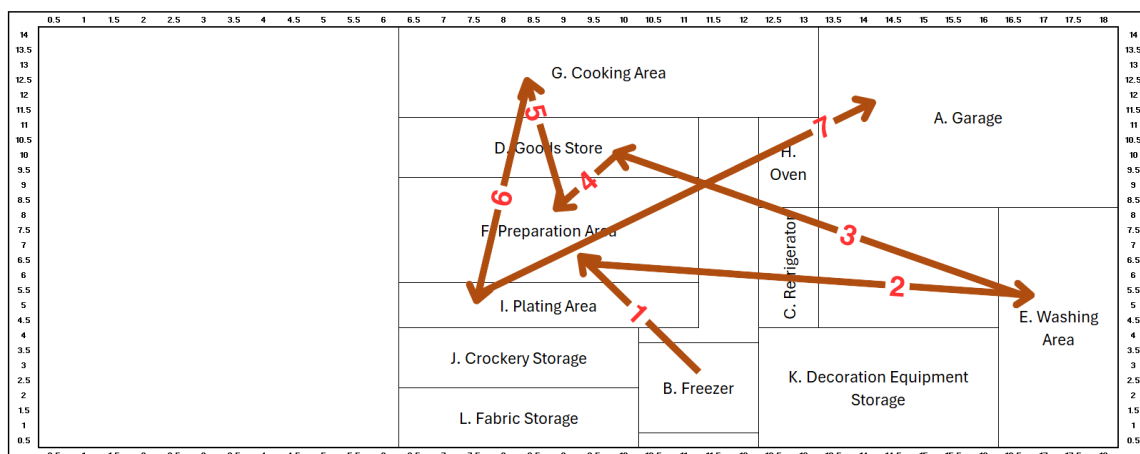
Operation Prossess Chart

Initial Layout Center Point

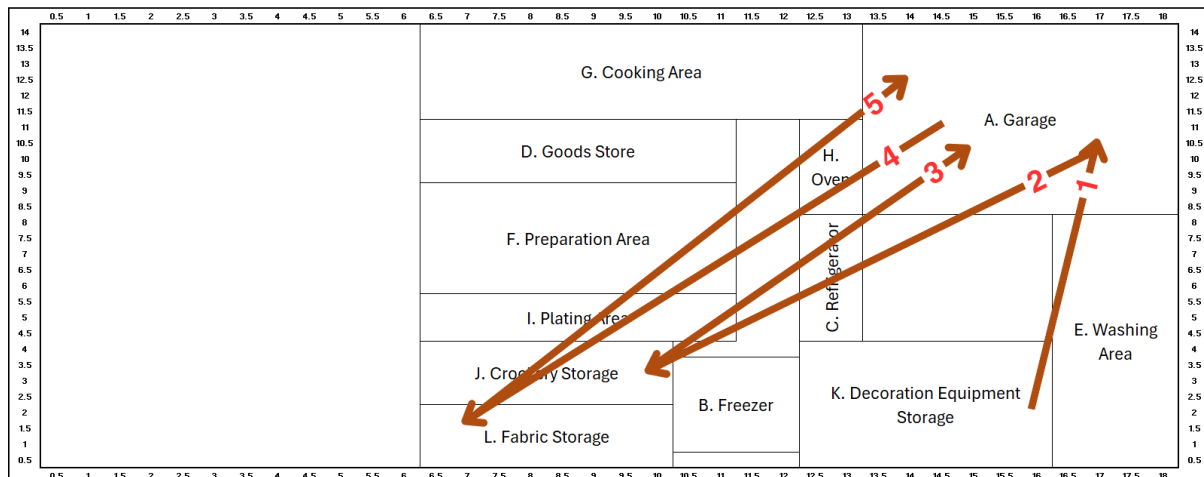
Code	Workstation	Initial	
		x	y
A	Garage	16	11.5
B	Freezer	11	2
C	Refrigerator	12.5	6
D	Good Store	8.5	12.5
E	Washing Area	17	4
F	Preparation Area	8.5	7.25
G	Cooking Area	9.5	13
H	Oven	12.5	9.5
I	Plating Area	8.5	5.75
J	Crockery Storage	8	3
K	Decoration Equipment Storage	14	2
L	Fabric Storage	8	1



Grilled Chicken Initial Flow



Spicy Beef Initial Flow



Decoration Sets Initial Flow

Grilled Chicken Distance Movement

From Workstation	To Workstation	Distance (m)
B	E	8
E	F	11.75
F	D	5.25
D	F	5.25
F	C	5.25
C	H	3.5
H	I	7.75
I	A	13.25
Total		60

Spicy Beef Distance Movement

From Workstation	To Workstation	Distance (m)
B	F	7.75
F	E	11.75
E	D	17
D	F	5.25
F	G	6.75
G	I	8.25
I	A	13.25
Total		70

Decoration Sets Distance Movement

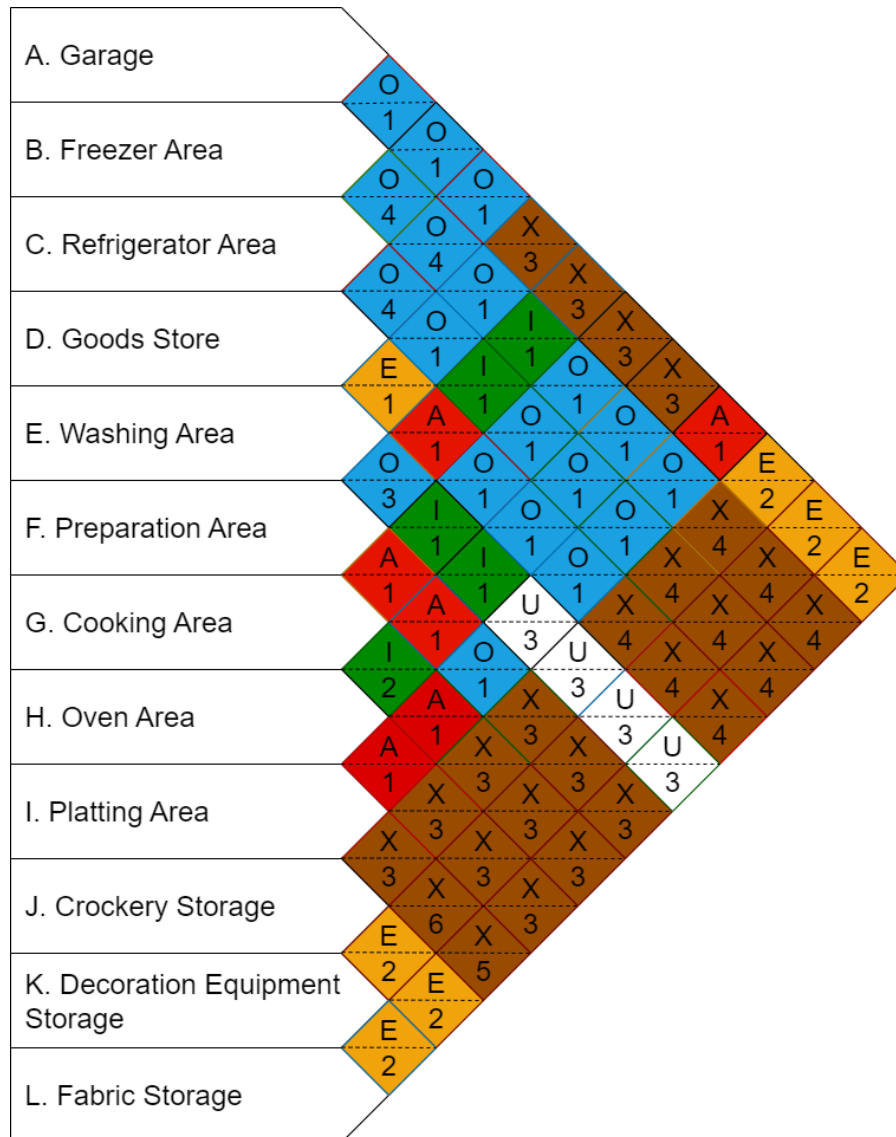
From Workstation	To Workstation	Distance (m)
K	A	11.5
A	J	16.5
J	A	16.5
A	L	18.5
L	A	18.5
Total		44.5

Closeness Rating

Code	Definition
A (Red)	Absolutely necessary that these two departments be next to each other
E (Orange)	Especially important
I (Green)	Important
O (Blue)	Ordinary importance
U (No. Color)	Unimportant
X (Brown)	Closeness undesirable

Reasonable Desire Closeness

No	Reason
1	Same area material flow sequence
2	Workforce sequence
3	Dirty & dusty
4	Has no functional relationship



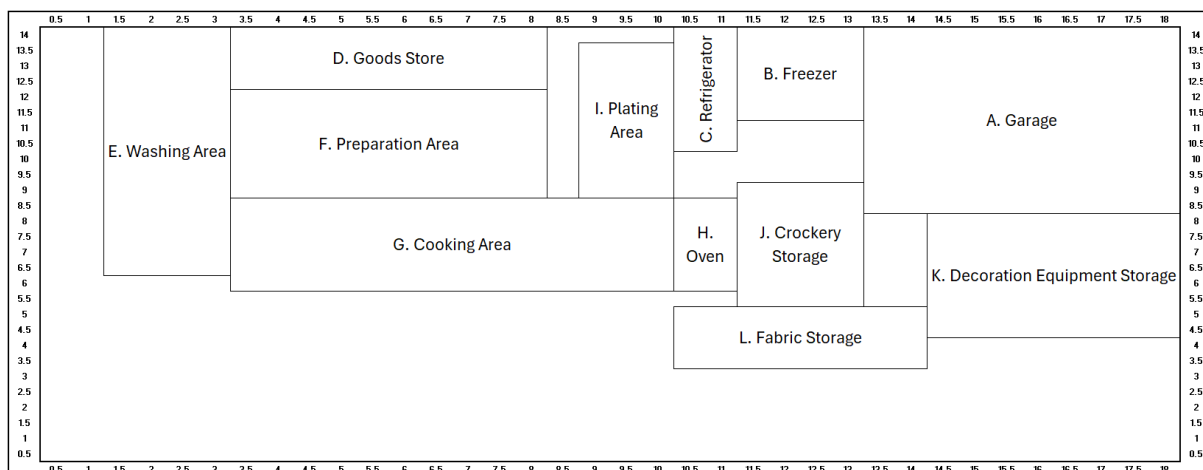
Activity Relationship Chart

ARD Relationship Line

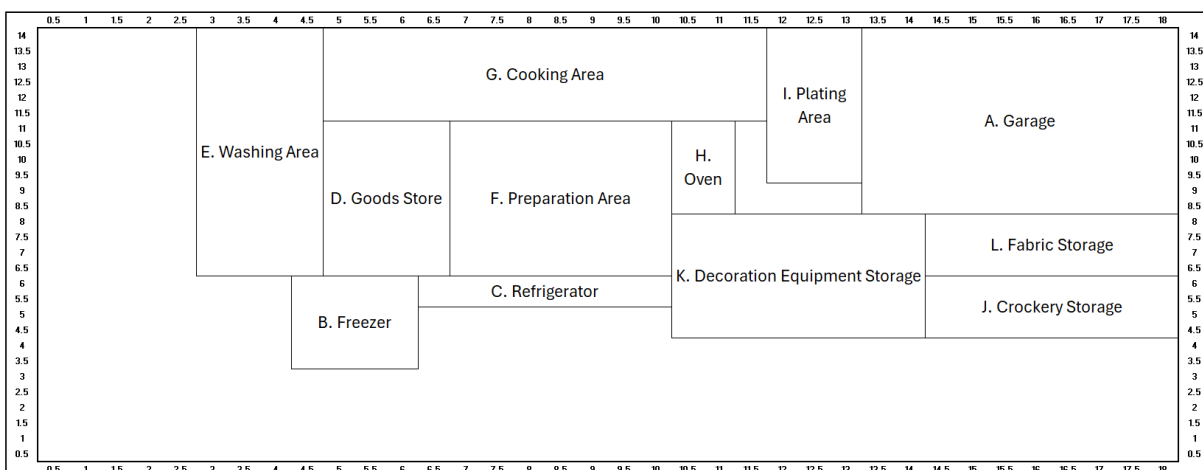
Relationship Line	
A	=====
E	=====
I	=====
O	=====
U	=====
X	~~~~~

14	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	14
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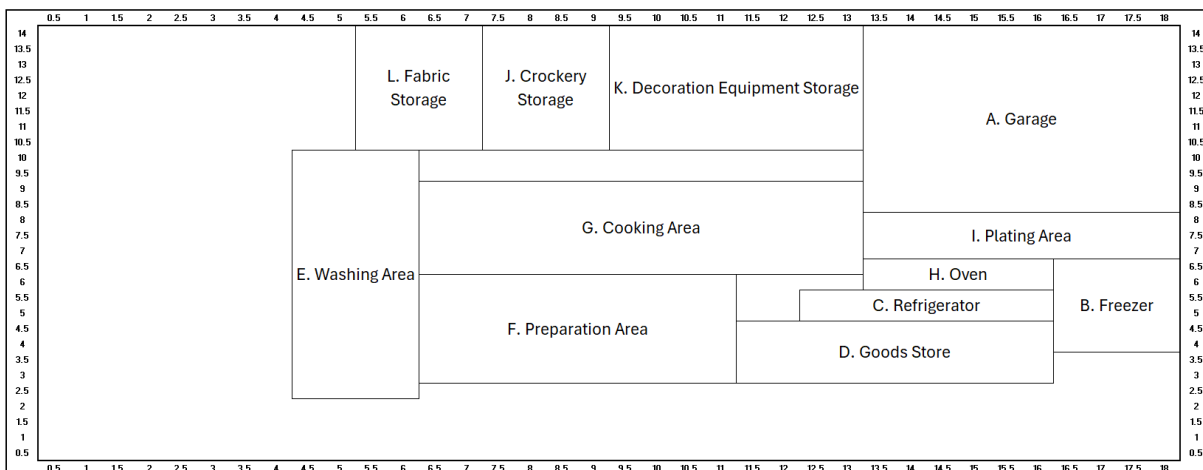
Propose Layout 1



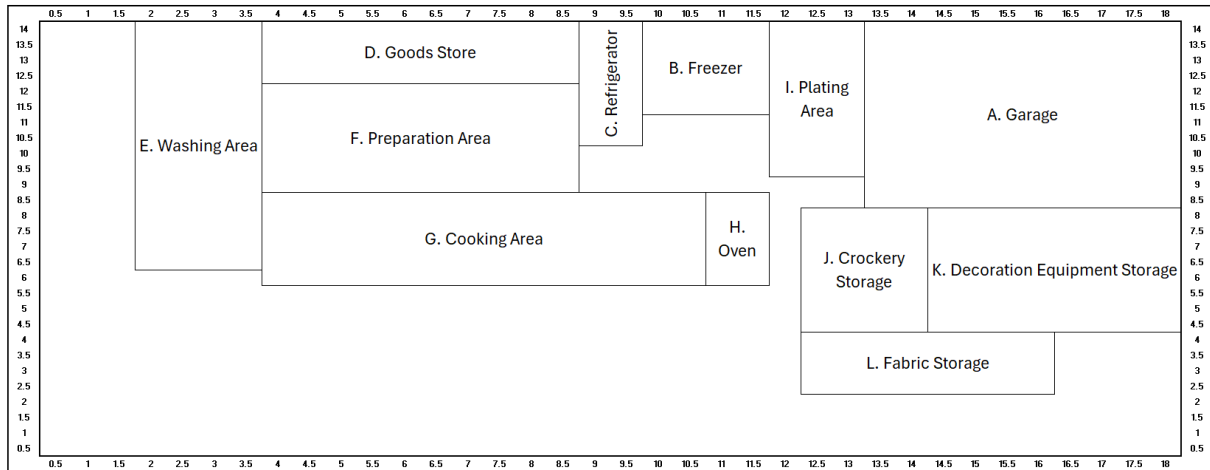
Propose Layout 2



Proposed Layout 3



Proposed Layout 4



Proposed Layout 5

Proposed Layout Center Point

Co de	Workstation	Proposed 1		Proposed 2		Proposed 3		Proposed 4		Proposed 5	
		<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>
A	Garage	16	11.5	16	11.5	16	11.5	16	11.5	16	11.5
B	Freezer	10	12.5	12	12.5	5	4.5	17	5	10.5	12.5
C	Refrigerator	8.5	12	10.5	12	8	5.5	14	5	9	12
D	Good Store	5.5	13	5.5	13	5.5	8.5	13.5	3.5	6	13
E	Washing Area	2	10	2	10	3.5	10	5	6	2.5	10
F	Preparation Area	5.5	10.25	5.5	10.25	8.25	8.5	8.5	4.25	6	10.25
G	Cooking Area	6.5	7	6.5	7	8	12.5	9.5	7.5	7	7
H	Oven	10.5	7	10.5	7	10.5	9.5	14.5	6	11	7
I	Plating Area	10.5	9.25	9.25	11	12.25	11.5	15.5	7.25	12.25	11.5
J	Crockery Storage	13	6	12	7	16	5	8	12	13	6

Co de	Workstation	Proposed 1		Proposed 2		Proposed 3		Proposed 4		Proposed 5	
		<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>	<i>x</i>	<i>y</i>
K	Decoration Equipment Storage	16	6	16	6	12.0	6.0	11	12	16	6
L	Fabric Storage	12	12	12	4	16	7	6	12	14	3

Distance Movement of Grilled Chicken for Proposed Layout

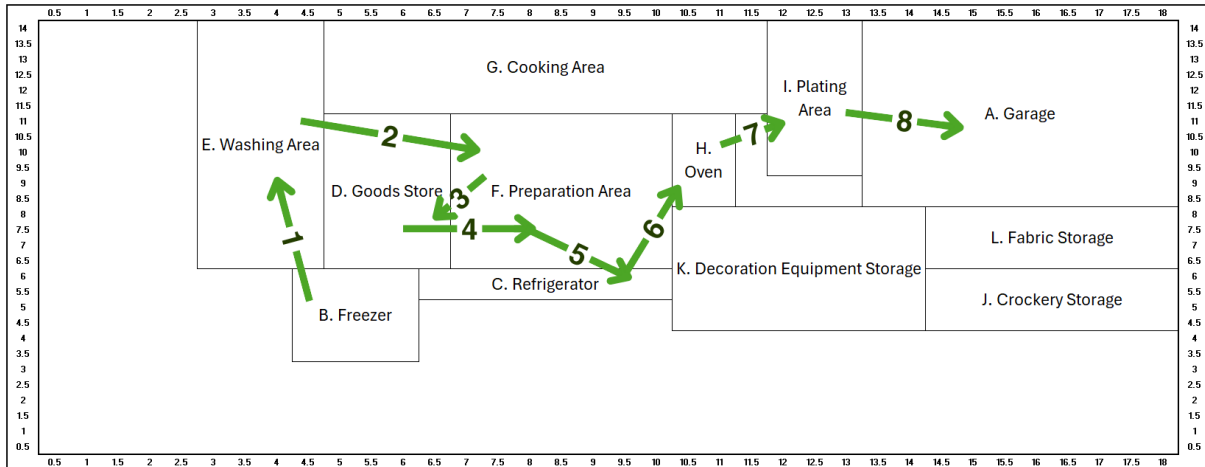
From Workstation	To Workstation	Distance (m)				
		1	2	3	4	5
B	E	10.5	12.5	7	13	10.5
E	F	3.75	3.75	6.25	5.25	3.75
F	D	2.75	2.75	2.75	5.75	2.75
D	F	2.75	2.75	2.75	5.75	2.75
F	C	4.75	6.75	3.25	6.25	4.75
C	H	7	5	6.5	1.5	7
H	I	2.25	5.25	3.75	2.25	5.75
I	A	7.75	7.25	3.75	4.75	3.75
Total		41.5	46	36	44.5	41

Distance Movement of Spicy Beef for Proposed Layout

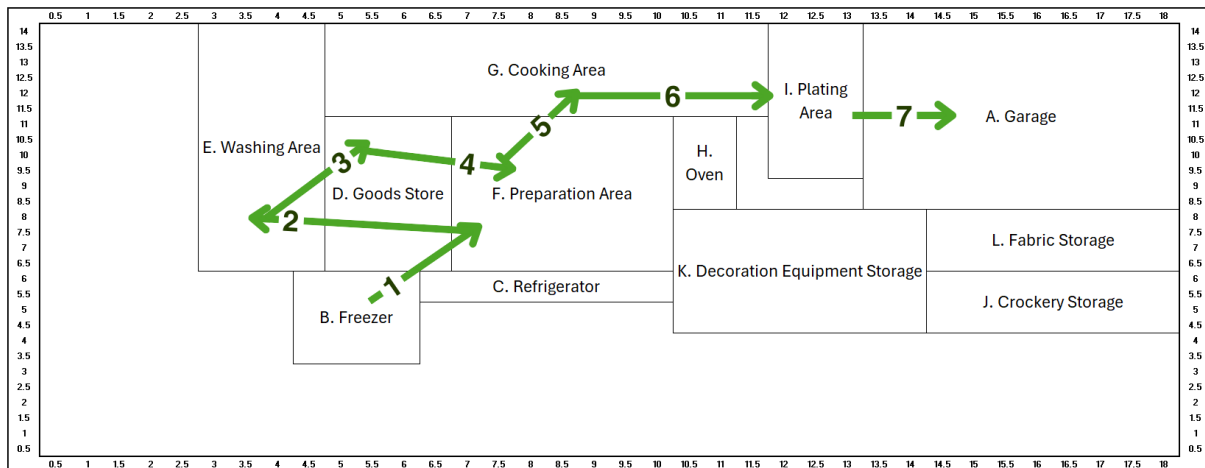
From Workstation	To Workstation	Distance (m)				
		1	2	3	4	5
B	F	6.75	8.75	7.25	9.25	6.75
F	E	3.75	3.75	6.25	5.25	3.75
E	D	6.5	6.5	3.5	11	6.5
D	F	2.75	2.75	2.75	5.75	2.75
F	G	4.25	4.25	4.25	4.25	4.25
G	I	6.25	6.75	5.25	6.25	9.75
I	A	7.75	7.25	3.75	4.75	3.75
Total		38	40	33	46.5	37.5

Distance Movement of Decoration Sets for Proposed Layout

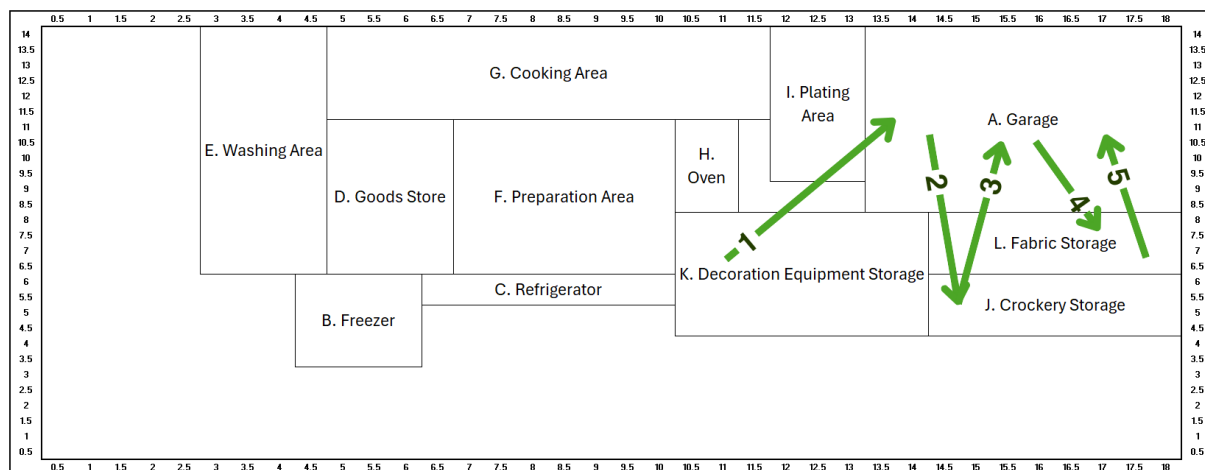
From Workstation	To Workstation	Distance (m)				
		1	2	3	4	5
K	A	5.5	5.5	5.5	5.5	9.5
A	J	8.5	8.5	8.5	8.5	6.5
J	A	8.5	8.5	8.5	8.5	6.5
A	L	4.5	11.5	10.5	10.5	4.5
L	A	4.5	11.5	10.5	10.5	4.5
Total		22.5	22.5	22.5	22.5	22.5



Grilled Chicken Proposed Flow



Spicy Beef Proposed Flow



Decoration Sets Proposed Flow