



Evaluation and Proposed Improvements to The Packaging Room Layout of PT. X Using the Activity Relationship Chart Method

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ARTICLE INFO	ABSTRACT
Published Online: 24 July 2026	PT. X is a food industry that produces various types of products, including ready-to-eat products. The products are packaged in a 6.5×5 m ² packaging room used for two types of packaging: small and large. Ideally, these two packaging processes should not be carried out simultaneously, but during peak season conditions, both must be implemented, leading to waste motion, cross-flow of work, and potential workplace accidents. This research aims to redesign the packaging space layout so that both packages can be in line and increase labour productivity. The method used is the Activity Relationship Chart (ARC) to design the new layout. Subsequently, cycle time and Euclidean distance were measured before and after the proposed improvements. The research results show that reducing the average time brought the 30 kg bulk WIP from 7.43 seconds to 4.54 seconds and decreased the transfer time from the small packaging machine to the metal detector from 8.90 seconds to 3.15 seconds. The Euclidean distance calculation also shows a decrease in worker travel distance at the small packaging (250 grams) and large packaging (1 kg) production stages. For small packaging, the distance decreased by 7% from the Bulk WIP Pallet to the Small Packaging Machine Platform and by 62% from the Small Packaging Machine to the Metal Detector, while one transfer path remained unchanged. For large packaging, all transfer paths experienced a decrease in distance, with percentages of 50%, 39%, and 23% respectively. Additionally, productivity increased from 22 kg/man hour before improvement to 28 kg/man hour after improvement.
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KEYWORDS: facility layout, Activity Relationship Chart, productivity	

I. INTRODUCTION

Layout is one of the most crucial operational strategic decisions in determining the long-term efficiency of a company. Optimal layout will significantly contribute to increased productivity (Ramdan et al., 2021). Layout is an important basic element in industry. Plant layout design serves as a production planning and flow to achieve an effective and efficient reciprocal relationship between operators, equipment, and the material transformation process from the receiving area to the finishing area (Gozali et al., 2020). Facility layout guides the arrangement of various existing facilities within the factory to support the smooth production process (Firmansyah & Lukmandono, 2020). Therefore, increasing productivity thru the determination of the right layout strategy is essential for a company to survive amidst the intense industry competition today (Azizah et al., 2023).

PT. X is a food industry that produces various types of products and has established numerous

collaborations with major food industries, exporting to most countries in Asia, Africa, and Europe. This research focuses on ready-to-eat products with a packaging area of 6.5×5 m² and two types of product packaging: small (250 grams) and large (1 kg). Small packaging is done with an automatic machine that weighs, fills, and seals the product. In contrast, large packaging is still done manually.

Ideally, the packaging process for these two types of packaging is not recommended to be done simultaneously. However, during the peak season, demand for both types of packaging increases dramatically, requiring the packaging process to be carried out simultaneously. In the packaging area, there are six pallets placed in the center of the room. This condition creates an obstacle when two types of packaging are running simultaneously. Therefore, the placement of pallets is an important aspect of smooth operations, particularly in material handling processes. This is also in line with the opinion of Maulana et al. (2024).

Limited space caused one of the packaging processes to not run in line, resulting in a cross-flow production line. Both packaging processes must pass thru a metal detector, which functions to detect the presence of metal in the product before distribution. This situation has the potential to cause collisions between workers and inefficient back-and-forth movement. As a result, the production flow is hindered and productivity decreases. Additionally, the placement of workstations far apart increases transportation time between stations. Therefore, layout improvements and adjustments are needed to reduce cycle time and increase workflow efficiency (Wahid & Munir, 2021).

Based on these problems, redesigning the layout becomes highly necessary. This redesign aims to create an optimal production process, making the movement of materials and workers from one station to another more effective and efficient (Hartari & Herwanto, 2021). When designing or improving production layouts, a structured method is needed that considers space efficiency, process flow patterns, and the placement of machines and equipment to achieve optimal results (Zaeni et al., 2025). Thus, the company can minimize obstacles and maximize its productivity potential.

The focus of this study is to evaluate and propose a layout that can eliminate back-and-forth processes, make the entire packaging process in-line, eliminate production flow crossings, and increase productivity. The method used in this study is the Activity Relationship Chart (ARC) to identify the relationships between machines. The interconnectedness of this equipment/machinery is generally interpreted as the need for close proximity (Nurmutia, 2024).

The purpose of this research is to evaluate the existing packaging layout and design a proposed layout improvement to enable the in-line packaging of both small and large packages when they must be done simultaneously, as well as to analyse the impact on cycle time, material handling distance, and labor productivity.

II. LITERATURE REVIEW

Productivity

Some studies prove that the layout of the production room plays a major role in increasing productivity. The placement of equipment, machinery, and furniture arrangements in the work environment is a fundamental aspect that directly influences productivity and the success of the company (Bučko et al., 2024). Additionally, layout is an important component in manufacturing and has a significant impact on reducing costs and distances to improve operational efficiency (Chemim et al., 2021). In the context of warehousing, an optimal layout design can create more efficient material flow, shorter travel distances, faster transportation times,

and minimal handling costs (Ernawati et al., 2023). Rearranging the workspace is very important to consider in small/large industries, as it can affect the sustainability of the company both in terms of worker health and company revenue (Suarjana et al., 2022). Furthermore, in the field of logistics, distribution centres (DCs) that still rely on manual order picking can lead to dependence on labor, requiring warehouse layouts to be adjusted according to worker movement to optimize the warehousing process flow (Ariyanti & Paramaputra, 2023).

Activity Relationship Chart (ARC)

The Activity Relationship Chart (ARC) is one method that can be used to design the layout of departmental facilities based on the level of activity relationships, to support increased productivity. The use of this method has been proven to create a positive impact, especially in terms of the effectiveness and efficiency of movement (Lubis et al., 2022). RC can be used to identify the level of importance between facilities and activities, allowing decisions to be made about whether an element needs to be placed nearby or kept separate (Basuki & Satrio, 2023). This method can determine deeply interconnected actions, thus requiring an ideal layout arrangement (Putra & Kirono, 2025).

III. RESEARCH METHODOLOGY

The method used in this research is a qualitative method with data collection techniques consisting of interviews conducted with operators and foremen, as well as direct observation in the ready-to-eat product packaging room to understand the real conditions that occur. The observation aimed to examine the production process flow, machine positions, and the relationships between activities in the area. Based on the observation results, identified problems included overlapping process flows, inefficient travel distances between machines, and potential waste of time and energy. Further analysis steps include:

1. Create a layout design for the packaging room before proposing improvements.
2. Data collection includes cycle time using a stopwatch, performed 5 times to obtain an average result.
3. Recording the area dimensions of each machine using a measuring tape.
4. Collecting output data before and after the implementation of the layout improvement.
5. Analyzing the data using the ARC to evaluate the degree of closeness among activities (Hartari & Herwanto, 2021). The degree of closeness relationships in the ARC was defined as follows:

A	= Absolutely necessary to be adjacent.
E	= Especially important to be adjacent.
I	= Important to be adjacent.
O	= Ordinary / sufficient.
U	= Unimportant to be adjacent.

X = Undesirable to be adjacent.

Based on these closeness values, specific justification criteria were assigned to explain the rationale for each rating (A, E, I, O, U, and X).

- 6. Developing a proposed layout redesign based on the results obtained from the ARC analysis.
- 7. Comparing Euclidean distances before and after the proposed layout improvement using the Shape Sheet feature in Microsoft Visio. The PinX and PinY columns represent the horizontal and vertical coordinates of the object center points (Jordan et al., 2025). The Euclidean distance was calculated using the following formula:

$$d = \sqrt{(x2 - x1)^2 + (y2 - y1)^2}$$

d =Euclidean distance between two points

x1 = x-axis coordinate of the first point

x2 = y-axis coordinate of the first point

y1 = x-axis coordinate of the second point

y2 = y-axis coordinate of the second point

- 8. Calculating labor productivity to verify that the proposed layout redesign resulted in improved performance and a positive impact on work efficiency, using the following equation:

$$\frac{Output\ (kg)}{Number\ of\ workers \times Working\ hours}$$

IV. RESULT AND DISSCUSSION

Packaging Area Layout Design Before Improvement

The packaging room area is 6.5 × 5 m². Figure 1 uses a scale of 1:100. This packaging process requires 5 workers: 2 for the packaging machine, 1 for manual weighing (large packages), 1 for the sealer, and 1 for the metal detector.

The dashed arrow line represents the flow of the small-package packaging process, while the solid arrow line represents the flow of the large-package packaging process. The process flow for small-package packaging (dashed arrow line) is described as follows:

- 1. G – B : Transporting 30 kg of bulk work-in-process (WIP) to the packaging machine.
- 2. A – E : Transporting boxes containing small-packaged products to the metal detector.

The process flow for large-package packaging (solid arrow line) is described as follows:

- 1. G – C : Transporting 30 kg of bulk work-in-process (WIP) to the weighing station for large-package packaging.
- 2. C – D : Sealing the finished large-package products.
- 3. D – E : Conducting metal detection inspection for

finished large-package products.

As can be seen in the Figure 1, there is a crossing in the process flow of the two packaging lines, and the distance that needs to be covered from the packaging machine to the metal detector is quite far, with the burden of a stack of small packaged products being carried along the way. For details on the code and area of the equipment/machines used in the packaging process, please refer to Table 1.

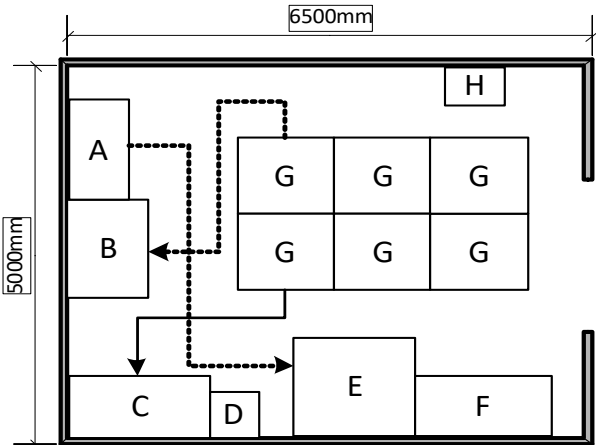


Figure 1. Existing Packaging Area Layout for Ready-to-Eat Products

Table 1. Description of Equipment Codes and Space Requirements

Code	Equipment/Machine	Length (mm)	Width (mm)
A	Small packaging machine	1,320	760
B	Small Packaging Machine Feeder	1,300	1,000
C	Manual Weighing Station	800	1,750
D	Sealer	600	600
E	Metal Detector	1,300	1,500
F	Table	800	1,750
G	Pallet Bulk Work in Process	2,020	3,600
H	Air Conditioner	500	650

Analysis of Activity Relationship Closeness

Figure 2 is an activity relationship chart showing the relationship between the machines/equipment used in the small and large packaging processes. The reasons for each code given are explained in Table 2.

Based on the ARC analysis shown in Figure 2, several key points require primary attention:

- 1. The large packaging scale, sealer, metal detector, small packaging machine, small packaging platform, and WIP

- pallet facilities are marked with an A (absolutely adjacent) because of the workflow sequence, ease of material transfer, and labor efficiency.
2. Other facilities are marked with an O (fair/good) to be placed closer because they can improve labor efficiency, but do not significantly affect the smoothness of the process.
 3. The large packaging scale, small packaging machine, and small packaging platform are marked with an A (absolutely adjacent) to the WIP pallet because they can smooth the workflow, improve labor efficiency, facilitate material transfer, and increase labor efficiency.

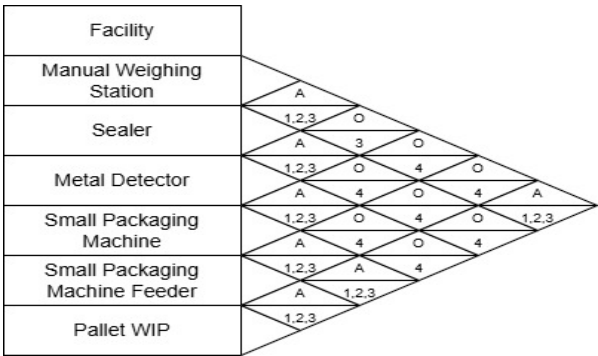


Figure 2. Activity Relationship Chart of the Packaging Area at PT X

Table 2. Justification Codes for the Activity Relationship Chart (ARC)

Justification Code	Description
1	Workflow sequence
2	Ease of material handling
3	Labor efficiency
4	No direct relationship

Proposed Layout of the Packaging Area

Based on the results of the redesign and testing using the new (proposed) layout in the packaging area, it was proven that the changes were able to eliminate cross-flow processes without the need to increase or decrease the number of workers. Figure 3 shows that the position of the work-in-process pallets is arranged in an L shape, making space utilization more effective. The entire packaging process can now be directly connected (in-line) to the metal detector. The packaging process for small packages, which previously required products to be collected in a box before being taken to the metal detector, is now more efficient because each package can be moved directly to the metal detector without going thru the collection process.

This improvement not only accelerates the workflow but also enhances the effectiveness of the metal detection process. In the event of metal contamination in a product, identification can be performed more rapidly. In

contrast, the previous system required unpacking and re-inspection of each item individually when metal contamination was detected, resulting in additional time and labor consumption.

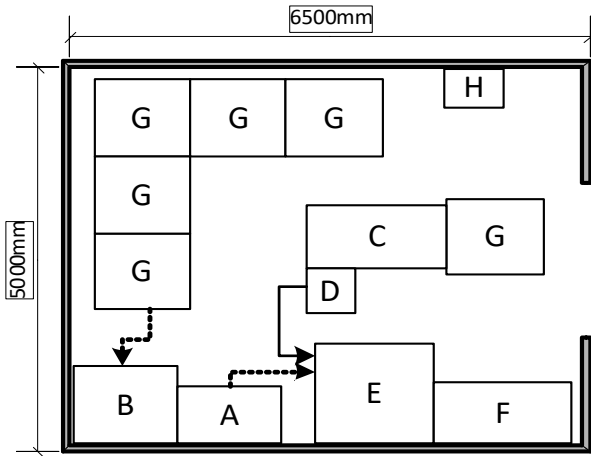


Figure 3. Proposed Layout of the Ready-to-Eat Product Packaging Area at PT X

Comparison of Cycle Time Data Before and After Layout Improvement

Tables 3 and 4 show the cycle time data for small packaging before and after the proposed layout improvement, obtained thru direct observation by monitoring the work cycle of each station using a stopwatch. The results of the cycle time observation show that the average time to carry 30kg of bulk WIP can be reduced from 7.43 seconds to 4.54 seconds, and the transfer from the small packaging machine to the metal detector can be reduced from 8.90 seconds to 3.15 seconds.

Table 3. Cycle Time of Small-Packaging Process Before Layout Improvement

Number of Work Element		Cycle Time (seconds)					Average Workers
Small Packaging Machine (250 g)	Transporting 30 kg Bulk WIP	7.31	7.41	7.33	7.50	7.47	7.43
	Picking Material	1.66	1.68	1.47	1.57	1.52	1.56
	Loading Material into Machine	1.62	1.40	1.51	1.44	1.54	1.47
	Weight Cross-Check	0.38	0.41	0.42	0.44	0.47	0.44
Transfer	Placing products into boxes for transfer to the metal detector	0.32	0.37	0.33	0.31	0.33	0.34
	Transfer from Packaging Machine to Metal Detector	8.76	8.94	8.92	8.78	8.96	8.90
Metal Detector	Metal Detector	3.00	3.00	3.00	3.00	3.00	3.00

Table 4. Cycle Time of Small-Packaging Process After Layout Improvement

Number of Workers	Work Element	Cycle Time (seconds)							Average
Small Packaging Machine (250 g)	Transporting 30 kg Bulk WIP	3.53	3.40	3.12	4.17	7.47	4.54		
	Picking Material	1.69	1.61	1.63	1.53	1.52	1.57		
	Loading Material into Machine	1.71	1.18	1.24	1.28	1.54	1.31		
	Weight Check	0.53	0.47	0.44	0.42	0.47	0.45		
	Placing products into boxes for transfer to the metal detector	0.39	0.35	0.34	0.37	0.33	0.35		
Transfer	Transfer from Packaging Machine to Metal Detector	1.24	1.21	1.22	1.20	8.96	3.15		
Metal Detector	Metal Detector	3.00	3.00	3.00	3.00	3.00	3.00		

The results of the inter-station distance calculations before and after the layout change can be seen in Tables 7, 8, 9, and 10, which show a comparison of the total distance and the efficiency gained from reducing the inter-process distance in the new layout.

Table 5. Cycle Time of Large-Packaging Process Before Layout Improvement

Number of Workers	Work Element	Cycle Time (seconds)							Average
Weighing	Transporting Bulk WIP to Weighing Station	5.22	5.31	5.30	5.32	5.29	5.31		
	Loading Product into Package	0.39	0.77	0.59	0.19	0.47	0.51		
	Weighing Process	4.43	4.73	4.37	6.15	7.39	5.66		
Sealing	Picking Product	1.39	1.28	1.24	2.01	1.12	1.41		
	Packaging Sealing	3.24	3.31	3.25	3.22	3.17	3.24		
Transfer	Transfer from Sealer to Metal Detector	0.82	0.78	0.59	0.66	0.71	0.71		
Metal Detector	Metal Detector	3.00	3.00	3.00	3.00	3.00	3.00		

Table 6. Cycle Time of Large-Packaging Process After Layout Improvement

Number of Workers	Work Element	Cycle Time (seconds)							Average
Weighing	Transporting Bulk WIP to Weighing Station	4.31	4.12	4.40	4.28	4.53	4.33		
	Loading Product into Package	0.81	0.75	0.70	0.81	0.84	0.78		
	Weighing Process	5.49	5.51	5.88	5.41	5.46	5.57		
Sealing	Picking Product	1.29	1.32	1.18	1.13	1.00	1.16		
	Packaging Sealing	3.02	3.21	3.12	3.23	3.11	3.15		
Transfer	Transfer from Sealer to Metal Detector	0.73	0.72	0.72	0.65	0.88	0.74		
Metal Detector	Metal Detector	3.00	3.00	3.00	3.00	3.00	3.00		

Comparison of Euclidean Distances Before and After Layout Improvement

The results of the distance calculations between stations before and after the layout change can be seen in Tables 7, 8, 9, and 10, which show a comparison of the total distance and the efficiency gained from reducing the distance between processes in the new layout.

Table 7. Euclidean Distance of Small-Packaging Process (Before Layout Improvement)
Small Packaging Process (250 g)

From	To	X1	Y1	X2	Y2	Euclidean
Bulk WIP Pallet	Small Packaging Machine Feeder	8.40	15.90	5.00	15.40	3.44
Small Packaging Machine Feeder	Small Packaging Machine	5.00	15.40	4.90	16.80	1.40
Small Packaging Machine	Metal Detector	4.90	16.80	8.30	13.40	4.81

Table 8. Euclidean Distance of Small-Packaging Process (After Layout Improvement)
Small Packaging Process (250 g)

From	To	X1	Y1	X2	Y2	Euclidean
Bulk WIP Pallet	Small Packaging Machine Feeder	6.20	6.53	4.70	3.70	3.20
Small Packaging Machine Feeder	Small Packaging Machine	5.00	15.40	4.90	16.80	1.40
Small Packaging Machine	Metal Detector	6.00	3.50	7.80	3.70	1.81

Table 9. Euclidean Distance of Large-Packaging Process (Before Layout Improvement)
Large Packaging Process (1 kg)

From	To	X1	Y1	X2	Y2	Euclidean
Bulk WIP Pallet	Manual Weighing Station	8.40	15.90	5.40	13.30	3.97
Manual Weighing Station	Sealer	5.40	13.30	6.80	13.20	1.40
Sealer	Metal Detector	6.80	13.20	8.30	13.40	1.51

Table 10. Euclidean Distance of Large-Packaging Process (After Layout Improvement)
Large Packaging Process (1 kg)

From	To	X1	Y1	X2	Y2	Euclidean
Bulk WIP Pallet	Manual Weighing Station	6.20	6.53	7.90	5.50	1.99
Manual Weighing Station	Sealer	7.90	5.50	7.40	4.80	0.86
Sealer	Metal Detector	7.40	4.80	7.80	3.70	1.17

By comparing the results in the four tables, it can be seen that most of the distances between stations decreased after the layout improvement. This has a positive

impact on the comfort of the workforce in performing their jobs and saves time by using the proposed layout because the distance travelled is shorter compared to the initial layout. This is consistent with the research by Jamalludin et al. (2020).

Table 11. Comparison of Euclidean Distances for the Small-Packaging Process

From	To	Euclidean Distance (m)		Reduction Percentage	Remarks
		Before	After		
Bulk Pallet	WIP Small Packaging Machine Feeder	3.44	3.20	7%	Reduced
Small Packaging Machine Feeder	Small Packaging Machine	1.40	1.40	0%	Unchanged
Small Packaging Machine	Metal Detector	4.81	1.81	62%	Reduced

Table 12. Comparison of Euclidean Distances for the Large-Packaging Process

From	To	Euclidean Distance (m)		Reduction Percentage	Remarks
		Before	After		
Bulk Pallet	WIP Manual Weighing Station	3.97	1.99	50%	Reduced
Manual Weighing Station	Sealer	1.40	0.86	39%	Reduced
Sealer	Metal Detector	1.51	1.17	23%	Reduced

Labor Productivity Calculation

Observations were conducted using the same number of workers and the same operators under both pre-observations were made using the same number of personnel and by the same individuals under the same conditions before and after the layout changes, allowing for a balanced and objective comparison of the calculation results. Observations to calculate labor productivity were conducted over 6 days while both packaging lines were running simultaneously. The Table 13 shows an increase in productivity from an average of 21.6 kg/mh to 27.5 kg/mh.

Table 13. Labor Productivity Comparison

Before				After			
Observation	I	II	III	Observation	I	II	III
Number of Cartons Produced	70	71	75	Number of Cartons Produced	94	91	90
Weight per Carton (kg)	6	6	6	Weight per Carton (kg)	6	6	6
Number of	5	5	5	Number of	5	5	5

Workers				Workers			
Working Time (hours)	4	4	4	Working Time (hours)	4	4	4
Man-Hours	20	20	20	Man-Hours	20	20	20
Total Output Weight (kg)	420	426	450	Total Output Weight (kg)	564	546	540
Productivity	21	21,3	22,5	Productivity	28,2	27,3	27
Average	22			Average	28		

V. CONCLUSION

Based on the analysis of the proposed packaging area layout redesign, which was evaluated through cycle time measurements, Euclidean distance calculations, and labor productivity assessment, this study provides empirical evidence of the effectiveness of layout optimization in improving operational performance. The main conclusions of this study are as follows:

- 1. The cycle time analysis shows that the average time required to transport 30 kg of bulk work-in-process (WIP) was reduced from 7.43 seconds to 4.54 seconds, while the transfer time from the small-packaging machine to the metal detector decreased from 8.90 seconds to 3.15 seconds.
- 2. The implementation of the improved packaging area layout successfully eliminated intersecting production flows and enhanced overall operational efficiency.
- 3. Labor productivity for both packaging types increased from an average of 21.6 kg/man-hour to 27.5 kg/man-hour.

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