Tibuana
Journal of Applied Industrial Engineering-University of PGRI Adi Buana

p-ISSN 2622-2027
e-ISSN 2622-2035

The application of Lean Manufacturing at PT XYZ Packaging Unit with the Value Stream Mapping (VSM) Approach

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***Abstract*— The challenges of manufacturing companies in facing global market competition must be able to maintain the effectiveness and efficiency of operational processes that take place, including one strategy in getting good work productivity by focusing on eliminating waste that occurs in the operational process. In the packaging process, there are 14 activities classified into 9 operation activities, 3 transportation activities, 1 inspection activity, and 1 storage activity. Of all these activities are categorized as 50% value added activity with a time percentage of 62%, non-value-added activity, necessary activity of 36% with a time percentage of 29%, while 14% of activities are non-value-added activity with 9% percentage of 9%. Improvements are made by adding transfer conveyors from raw materials to the hopper, categorizing activities outside packaging as external activities, changing the number of operators and work schedules, and eliminating activities with pallet investment. The impact of the improvement is achieved by eliminating 14 activities and reducing them to 12 activities.**

Keywords: Lean Manufacturing, Non-Value-Added Activity, Value Added Activity, Value Stream Mapping

I. INTRODUCTION

The challenges faced in a manufacturing business are getting higher as economic and environmental pressures increase (Siti Zaenab Nur Hasanah dkk., 2023) .In competing in the global market, manufacturing companies must be able to properly maintain process efficiency and work effectiveness, especially in efforts to eliminate waste. The purpose of ensuring the process runs effectively and efficiently is to be able to produce products of good quality that satisfy customers. In addition to good quality, customer satisfaction is also determined by fast and on-time delivery. The demand for high productivity is one of the activities to maintain the continuity of meeting customer needs. Companies can focus on improving cycle time as a measure of work productivity, which can result in reducing processing and delivery times and improving product quality so that customer satisfaction can be met and even increased (Puji Priyono & Yuamita, 2022). Lean manufacturing is one of the company's strategic approaches in identifying and eliminating non-value-added activities so that the value of a product can be increased (Hafizh Alim & Suseno, 2022). Lean manufacturing, in addition to reducing waste, also aims to satisfy customers and improve operational performance (Firdaus & Wahyudin, 2023). Classify lean manufacturing methods into two categories. The first is an activity to identify all waste and eliminate the most significant ones that have a direct impact on the operational process. The goal is to improve quality and reduce costs. The second is to focus on leaner operational processes to eliminate constraints in operations (Reza & Santoso, 2022).

PT. XYZ is one of the "ID FOOD" companies that has a core business in 2 divisions, namely the production of raw material salt, commonly referred to as krosok salt, and the salt industry, which focuses on producing processed salt, both in the classification of consumer salt products and food industry salt products. PT XYZ has one plant in Sampang Regency that operates in the packaging of consumer salt products.

p-ISSN 2622-2027
e-ISSN 2622-2035

From Table 1, it can be seen that the low annual production achievement is in fine packaging products. As an effort to achieve the target, this study conducted an evaluation of the identification process and eliminated waste in order to obtain improvements in the operational process. This is being done in order to provide a lean operational process and have an impact on increasing productivity, so that production results can increase

.

Table 1. Annual production targets and achievements

Product	Annual Target	Realization 2023	Realization 2024
Rough Packaging	5.906	5.505	6.032
Smooth Packaging	10.424	9.565	6.770

Figure 1: Production achievement graph

II. VALUE STREAM MAPPING

VSM can visualize the process flow in a packaging operation, which can then identify each activity included in value-added (VA) and non-value-added (NVA) that adds costs, processing time, and other time required to deliver products to customer. The VSM method is used to identify problems in the packaging process flow, as well as information based on direct observation of the production process (Meckel Rifaldo & Abryandoko, 2023). The data collected includes the production process flow, number of operators, production capacity, cycle time, and takt time. PAM is used in the process of identifying value-added and non-value-added in the production process (Ponda et al., 2022) . Furthermore, NVA will be categorized into two, namely necessary non-value-added activity (NNVA) and unnecessary non-value-added (NVA) (Rohani & Zahraee, 2015). To identify process activities, start by classifying each activity in the process into each activity category, namely operation, inspection, transportation, storage, and delay

Current state mapping is made based on the results of VSM and PAM. Current state mapping is used to analyze products and information flows comprehensively to find waste in each process. Waste is classified into seven types, namely over-production, transportation, motion, over-processing, defect, waiting time, and over-inventory (Agustin & Widjajati, 2024). The next step is to determine the most significant waste

p-ISSN 2622-2027
e-ISSN 2622-2035

using the Pareto concept as the focus of improvement, then analyze the cause of the problem and design improvement activities to eliminate or reduce the waste, describe the proposed improvements in the future state mapping, and draw conclusions. (Prambudi & Giyanti, 2021).

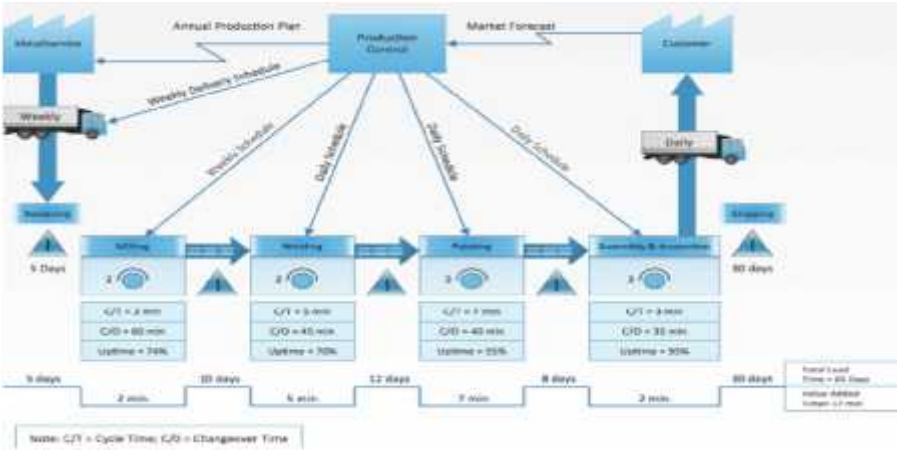

Figure 2. Value stream mapping process flow image

III. RESEARCH METHODS

This study focuses on improving the packaging process of the packaging machine, due to the low achievement of smooth packaging products processed through the packaging machine. The production process is carried out during one work shift with working hours of 07.00-16.00, eight working hours and one hour of rest. The initial step is to collect data related to the operation of the packaging machine, to calculate theoretically whether the capacity owned can have the potential to meet the annual target.

Table 2. Operational information on packaging machines.

Component	Magnitude	Unit
1 year working days	365	Day
Sunday	54	Day
National Holiday	16	Day
Machine Speed	35	ppm
Number of Machines	11	machine
Product Weight	200	gr
Effective working days	295	Day
Effective working hours	2.360	Hours

In theory, the calculation of engine capacity is obtained using the formula below:
Machine capacity = Effective working hours * Machine speed * Number of machines * Product weight
= 2.360 hours * 60 minute* 30 ppm * 11 machine * 200 gr
= 11.894.400.000 gr
= 11.894,4 ton

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e-ISSN 2622-2035

Based on the theoretical calculations above, there is a non-achievement of 43.08%. Furthermore, process activity mapping is carried out on the packaging activity, which is then identified regarding the classification of VA and NVA.

IV. RESULTS AND DISCUSSION

The first step in the waste identification process is to observe the process flow and identify the details of the sequence of activities and the time needed to carry out these activities, including observing the number of workers in each activity. The approach from observation is to observe the material flow. The following is an example of a packaging activity table 3 Before carrying out mapping, it is necessary to calculate the takt time, which is the time needed to produce a product in certain units according to customer fulfillment needs (Perdana dkk., 2018). Takt time can be calculated using the equation below

:

Table 3 Packaging Activity

Activity	Time	Unit	Information	Operator	Activity Category	Activity category
Arrange raw materials sacks on pallets	600	second	Each 1 ton	A1, A2, A3	*Operation*	NNVA
Transfer to the hopper area	300	second	Each 1 ton	A1, A2, A3	*Transportation*	VA
Tear the sack seams	30	second	Each 50 kg	A1	*Operation*	NNVA
Pour into hopper	40	second	Each 50 kg	A2, A3	*Operation*	NNVA
Transfer screw conveyor	300	second	Each 50 kg	-	*Transportation*	VA
Product packaging	1,7	second	Each 200 gr	B1, B2, B3, B4, B5, B6, B7, B8	*Operation*	VA
Transfer conveyor machine output	4	second	Each 2.200 gr	-	*Operation*	VA
Extrabag packaging	30	second	Each 4 kg	C1, C2, C3, C4, C5, C6, C7, C8, C9	*Operation*	VA
Tape the extra bags	7	second	Each 4 kg	C1, C2, C3, C4, C5, C6, C7, C8, C9	*Operation*	VA
Arrange extra bags on the inner pallets.	5	second	Each 4 kg	C1, C2, C3, C4, C5, C6, C7, C8, C9	*Operation*	NVA
Arrange results from inner pallets to outer pallets.		second	Each 2,5 ton			
Quality check (sampling)	1200	second	Each 2,5 ton	D1	*Operation*	NVA
Transfer to the warehouse.	600	second	Each 2,5 ton	E1	*Inspection*	VA
Arrange in the warehouse	600	second	Each 2,5 ton	F2	*Transportation*	NNVA

Before carrying out mapping, it is necessary to calculate the takt time, which is the time needed to produce a product in certain units according to customer fulfillment needs (Otsuka dkk., 2018).

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e-ISSN 2622-2035

Takt time can be calculated using the equation below (Cagnetti dkk., 2021)

Takt time = Available working time / Demand
= (295-day x 8 hours x 60 minutes) / 10.424 ton
= 13.58 minutes.

Based on the process activity mapping above, the classification of activity categories and value-added categories is depicted in Figures 3 and 4.

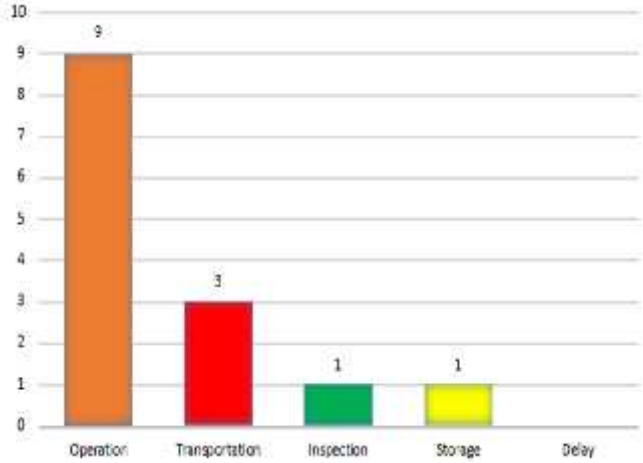

Figure 3. Activity Category Graph

In the Figure, it can be seen that 64.29% of the activities are in the operation category, the remaining 35.71% are outside the operation category, namely in the transportation, inspection, and storage categories. Of the 14 activities as illustrated in Figure 4, it is known that 50% are included in the value-added activity (VA), 36% are included in the necessary non-value-added activity (NNVA), and 14% are in the non-value-added activity (NVA) category.

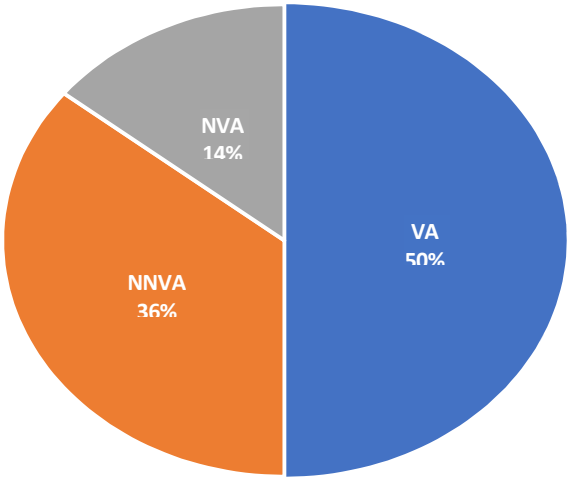

Figure 4. Graph of value-added activity categories

The next step is to calculate the cycle time of the natural packaging process in the same tonnage unit in the calculation of takt time. The goal is to compare the same work productivity assumptions based on current conditions and determine whether it can meet the takt time according to the calculations above.The following is information about cycle time in the packaging process in table 4.

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Table 4. Cycle time in the packaging process

Activity	Time	Unit	Information	Per unit tonnage	Activity category
Arrange raw materials sacks on pallets	600	second	Each 1 ton	600 second	NNVA
Transfer to the hopper area	300	second	Each 1 ton	300 second	VA
Tear the sack seams	30	second	Each 50 kg	600 second	NNVA
Pour into hopper	40	second	Each 50 kg	800 second	NNVA
Transfer screw conveyor	300	second	Each 50 kg	300 second	VA
Product packaging	1,7	second	Each 200 gr	773 second	VA
Transfer conveyor machine output	4	second	Each 2.200 gr	1.818 second	VA
Extrabag packaging	30	second	Each 4 kg	833 second	VA
Tape the extra bags	7	second	Each 4 kg	194 second	VA
Arrange extra bags on the inner pallets.	5	second	Each 4 kg	139 second	NVA
Arrange results from inner pallets to outer pallets.	1200	second	Each 2,5 ton	480 second	NVA
Quality check (sampling)	600	second	Each 2,5 ton	240 second	VA
Transfer to the warehouse.	600	second	Each 2,5 ton	480 second	NNVA
Arrange in the warehouse				7798 second	
				130 minutes	

Refereing to table 4 and the calculation of takt time in meeting the production target of 13.58 minutes. While in the mapping, the cycle time depicted is 130 minutes. It can be interpreted that there is still potential for not reaching the target fulfillment. So it is necessary to analyze in eliminating waste that occurs in the operational process by using current state mapping.

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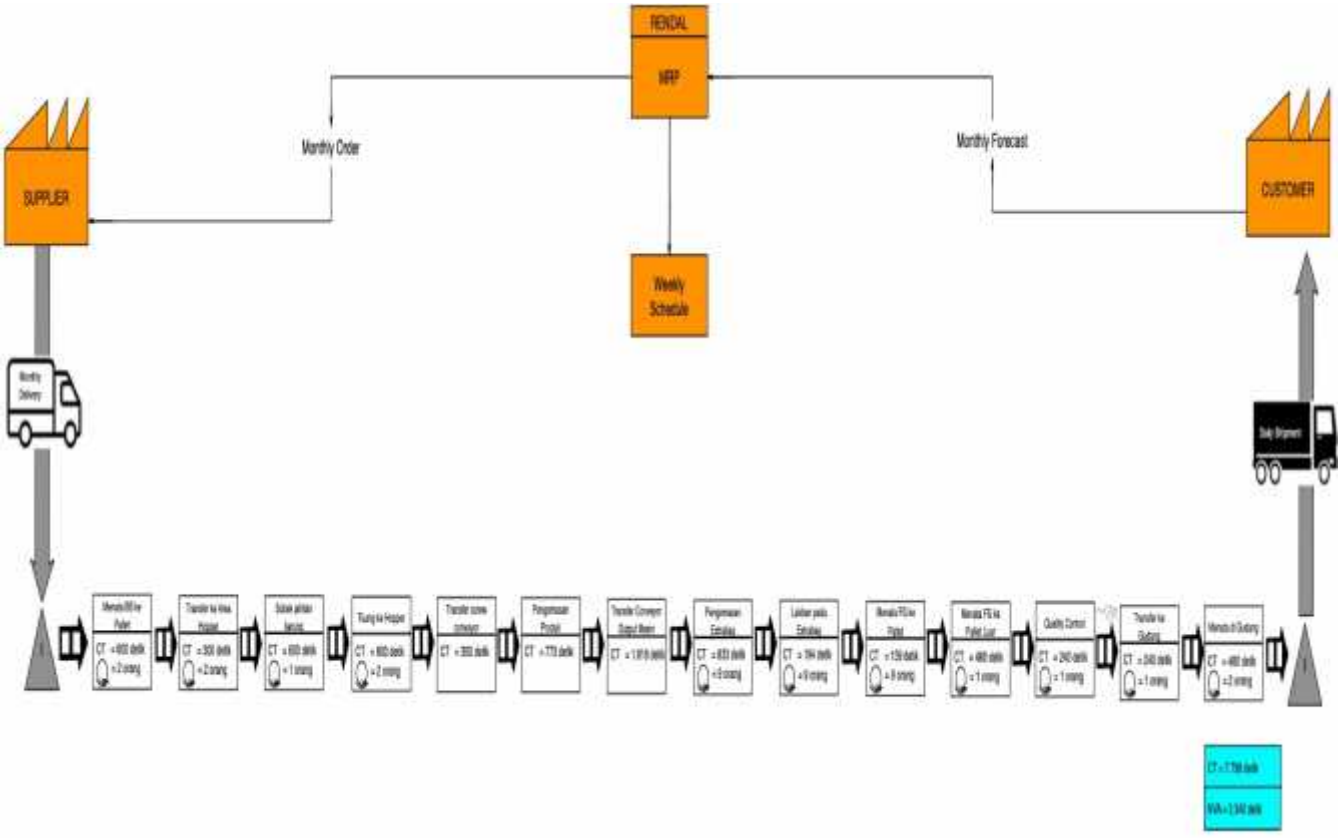

Figure 5. Current State Mapping

Referring to Table 4 and the calculation of takt time in meeting the production target of 13.58 minutes. While in the mapping, the cycle time depicted is 130 minutes. It can be interpreted that there is still potential for not re

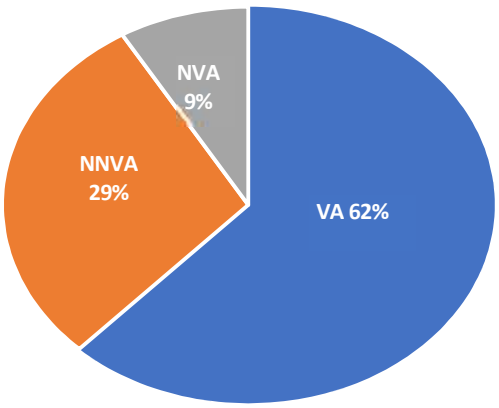

Figure 6. Time category graph of value-added

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Proposed Improvements

In the waste elimination process, based on the activity categories obtained in the previous process, efforts are Picture 5. Current State Mapping

Proposed Improvements

In the waste elimination process, based on the activity categories obtained in the previous process, efforts are made to eliminate activities related to NVA. If, in practice, there are obstacles, the next focus is on efforts to reduce time. Meanwhile, NNVA activities focus on reducing activities or time related to the process. It does not rule out the possibility of process improvement in activities in the VA category with the aim of getting faster process times. Based on the current time mapping, the percentage of activity category time is obtained in Figure 6.

For the figure 6, Proposed improvements for efforts to eliminate, reduce, and improve the process of packaging activities are carried out through a brainstorming process with respondents being teams related to operational processes, ranging from the operator position level to the general manager.

Table 5. Improvement porposal beased onactivity group

Activity	Activity Group	Improvement
Arrange raw materials on pallets	manual raw material transfer	
Transfer to the hopper area	manual raw material transfer	
Tear off sack seams	manual raw material transfer	
Pour into the hopper	manual raw material transfer	
Transfer screw conveyor	automatic raw material transfer	
		1. Adding a transfer conveyor from the raw material to the hopper
Product packaging	Primary packaging	2. Categorizing activities outside of packaging as external activities
Transfer conveyor output machine	Primary packaging	3. Remapping operators according to workload
Extrabag packaging	Secondary packaging	4. Elimination of activities with a pallet investment
Duct tape on the extra bag	Secondary packaging	
Inner pallet Secondary packaging: Arrange results from inner pallet to outer pallet	Secondary packaging	
Transfer to the warehouse, Storage of Finished	Secondary packaging	
Quality checking (sampling)	Quality Control	
Transfer to the warehouse.	Storage of Finished Goods in Warehouse	
Arranging in the warehouse	Storage of Finished Goods in Warehouse	

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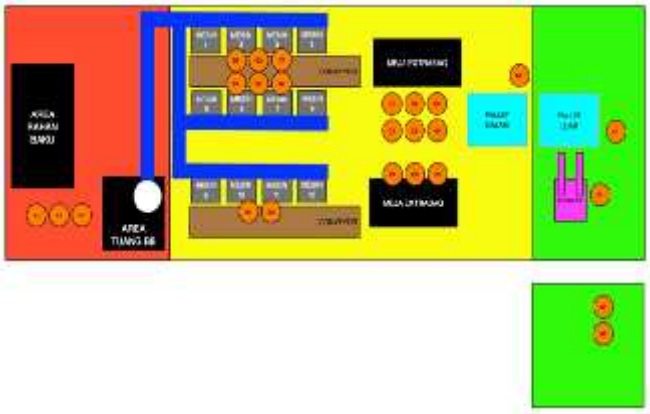

Figure 7. Layout and mapping of workers before improvement

After Improvement

Based on the proposed improvements in the next process, the first improvement is related to re-mapping the number of workers based on the results of the packaging machine. The goal is that the entire output of the packaging machine can be absorbed directly into the extrabag packaging process.

Table 6. Calculation of manpower in the secondary packaging process

Number of Machines	11	Machine
Machine Speed	35	Ppm
Product Weight	200	gr
Extrabag Packaging	30	Second/4 kg
Extrabag Tape	7	Second/4 kg
Machine Output per Hour	4.620	Kg
Manpower Planning	12	people

After the re-mapping process and the proposed addition of conveyors as a tool in the transfer process, and the addition of pallet investment in the warehouse, the classification of activities into two categories, namely external activity and internal activity, will have an impact on managing employee working hours. Below is a remapping process that illustrates future state mapping on Figure 8.

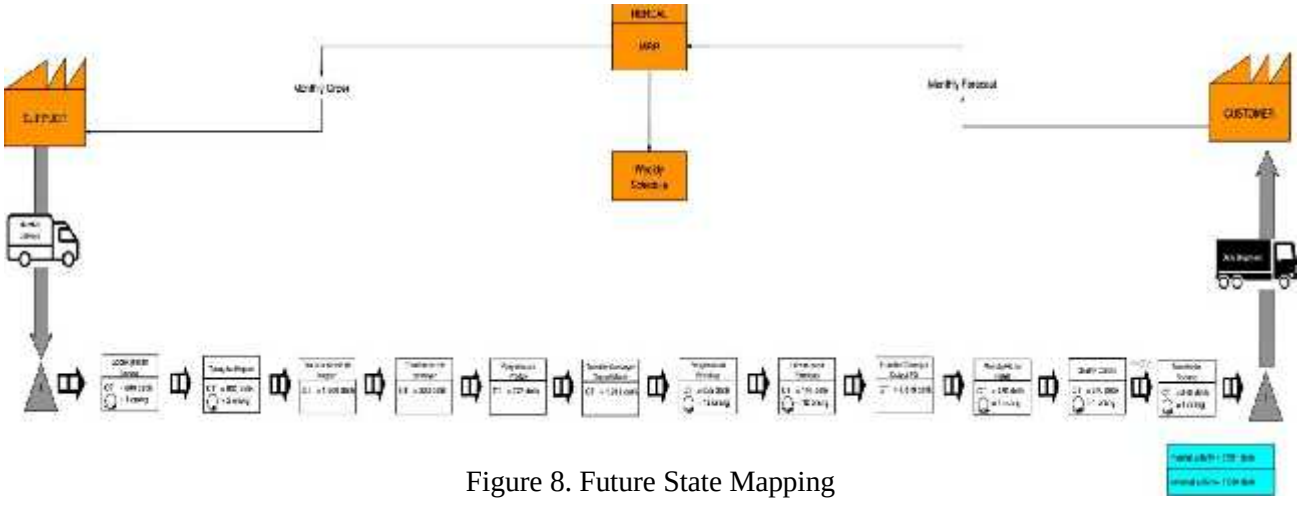

Figure 8. Future State Mapping

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Table 7. Calculation of manpower in the secondary packaging process

Activity	Group Activity	Activity External	Activity Internal	Unit
Tear the sack seam	Manual Raw Material Transfer	600		se
Pour into screw conveyor	Manual Raw Material Transfer	800		se
Transfer screw conveyor to hopper	Manual Raw material	1.800		se
Transfer screw conveyor	Manual Raw material	300		se
Product packaging	Primary Packaging		773	second
Transfer conveyor output machine	Primary Packaging		1.818	second
Extrabag packaging	Secondary packaging	625		second
Tape the extra bag	Secondary packaging	146		second
Transfer the conveyor to the outer pallet	Secondary packaging	1.818		second
Arrange finished goods on a pallet	Secondary packaging	480		second
Quality check (sampling)	Quality Control	240		second
Transfer to the warehouse	Storage of Finished Goods in Warehouse	240		second
		7.049	2.591	second

Based on Table 7, improvements were made to the arrangement of employee working hours based on activity groups from the packaging process depicted in Figure 8 and improvements to the layout in Figure 9.

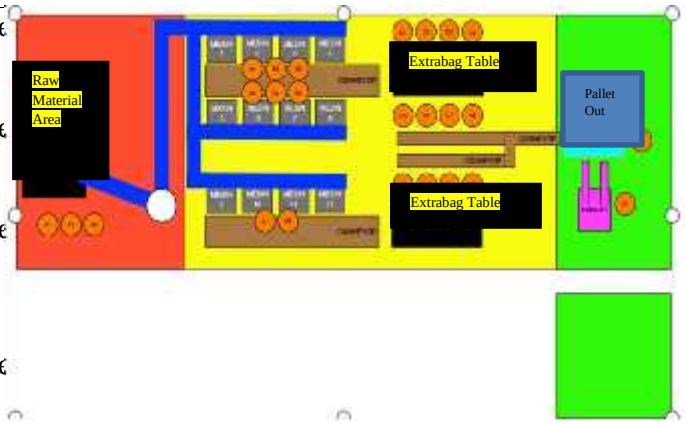

Figure 9. Layout and mapping of workers after improvement

The number of workers in the extrabag packaging process can be adjusted proportionally to the production capacity of the packaging machine. The production flow becomes more efficient and balanced, thus minimizing the waiting time between processes by replacing the forklift position. Potential congestion in the extrabag packaging area can be avoided. Labor productivity can be maximized, with a more targeted division of labor by replacing the forklift and pillet in position (Osho et al., 2024). Furthermore, by optimizing the layout and workflow, the reliance on manual handling and equipment repositioning is reduced. This not only enhances safety in the workplace but also contributes to a smoother and more continuous packaging operation (Attaqwa et al., 2021). The elimination of unnecessary movement and idle time leads to better synchronization between the packaging machine and the extrabag process, ensuring that materials are handled just in time.

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Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-V
PER UNIT TONNAGE	9	1390319	154480	1.90	0
Error	2	162450	81225		
Total	11	1552769			

In the ANOVA results F-Value = 1.90: This indicates the ratio of between-group variation to within-group variation (error) is low. P-Value = 0.392: This is well above the general thresold of significance (0.05), which means there is not enough statistical evidence to suggest that there is a real difference between groups. M Meaning of "Variation Caused by Random Factors or Measurement Error". (Gomaa, 2025). Since there is no significant difference:It is likely that the variation in per unit tonnage between groups is not due to differences in process conditions, equipment, labor, or work methods. Instead, the variation may be due to things such as: Natural fluctuations in the production process (e.g. slightly different raw material conditions). (Allo & Bhaskara, 2022). Measurement or recording errors during data collection. Uncontrolled factors (such as temperature, humidity, shift times, etc.). The sample size is too small, so the statistics are not robust enough to detect real differences. Mismatch of :

a) VSM Method with Real Field ConditionsVSM assumes a fairly stable and measurable process flow. If the production conditions in the field are very volatile or the process is not standardized, then the VSM results are not optimal or do not provide significant insight.

b) b) Resistance to Change Lean implementation usually involves changes in work culture and processes. c) If there is strong resistance from employees or management to change, the improvement process is difficult to run optimally.

d) Limited Scale of Implementation
If Lean and VSM are only applied to a small part of the process without involving the entire value chain, ththe impact can be small and insignificant. Improvements must be comprehensive for the results to be felt.

e)Lack of Training and Capacity Building
The team conducting VSM and Lean implementation needs to have adequate knowledge and skills.
Without sufficient training, the results obtained can be less than optimal.

f) No Follow-up and Monitoring After VSM
Mapping and analysis must be followed by concrete corrective actions and continuous monitoring. If it only stops at the mapping stage without real implementation, then there is no significant change.

g) External Factors and Changing Operational Conditions, Raw material supply disruptions, changes in market demand, or technical machine problems can also make Lean results less significant because these factors are difficult to control.

Contribution to sustainability for that case: Reducing NVA activities means lowering energy, fuel, and labor time consumption, which supports resource efficiency and lowers the carbon footprint of operations. And Appropriate and Efficient Use of Labor The table shows the number of operators per activity, for example: 8 operators (B1-B8) on “Product packaging”, 9 operators (C1-C9) on the activity “Tape on extrabags” This process observation and mapping allows for a more equitable and appropriate redistribution of workload. Improved labor welfare with a more balanced workload. Avoid excess labor, which impacts cost efficiency and long-term operational sustainability.Then, Material Flow Optimization Activities such as: "Transfer to hopper area", "Transfer screw conveyor" , "Transfer to warehouse" are identified as VA or NNVA, meaning they can be reviewed to see if they can be Automated. Simplified with a more efficient layoutBy classifying each activity into categories: Unnecessary activities, Excess transportation, Stacking of goods , Duplication of . operator tasks, Reducing NVA activities means lowering energy, fuel, and labor time consumption, which supports resource efficiency and lowers the carbon footprint of operations. This process observation and mapping allows for a more equitable and appropriate redistribution of workload. Encourages a lean and kaizen culture, which is at the core of operational sustainability. Reduces the risk of long-term waste due to decisions based on observation and analysis.

p-ISSN 2622-2027
e-ISSN 2622-2035

Implementation Testing Based on Before & After Changes

A. Comparison of Total Process Time

From the Future State Mapping (Figure 8), we can compare the total time of Internal vs. External Activities:

Activity Type Total Time (seconds) : Internal 2,591, External 7,049 and Total 9,640 seconds. Then, Analysis Internal activities are activities that are actually performed during the main process. External activities are activities that can be performed outside of the core process time. By classifying activities and moving external activities outside of the core process time, total internal time can be minimized, thereby reducing effective lead time.

B. Layout Changes and Worker Mapping (Figure 9)

Previous: Many manual activities & material movement using forklifts After Improvement: Additional conveyors, Elimination of forklifts, Repositioning workers according to machine workload

Then, Implementation Results is Avoiding bottlenecks in the extrabag area, Reduced waiting time between processes, Reduced non-value-added activities (e.g., repetitive manual movements), Labor productivity increased due to clearer and more specific workflows

C. Workforce Planning

From Table 6: Machine output: 4,620 kg/hour, The extrabag process takes a total time (Tape + Packaging) of 37 seconds per 4 kg, Designed human capacity: 12 people → adjusted to accommodate machine output to prevent backlog. In Workforce planning based on actual machine capacity → prevents idle time or overload. Personnel efficiency achieved through a balanced division of labor.

Specifications Before Implementation and After Implementation Total process time: Not directly stated: 9,640 seconds total (with 2,591 seconds internal)

Manual activity: High (manual transfer, forklift) Reduced (conveyor, worker repositioning), Bottleneck: Existing in the extrabag process. Minimized through layout and labor. Human resource efficiency: Not optimal (12 people according to machine capacity). Occupational safety: Not optimal. Improved (minimized manual movement). Waste: High (movement, waiting time). Reduced through elimination of NVA and NNVA.

The solution to improve this research is Add a transfer conveyor from raw materials to the hopper. Manually transporting materials is time-consuming, causing bottlenecks and waste in transportation and waiting. Solution : Install an automatic conveyor with a level sensor to prevent empty or overflowing hoppers. Use a JIT system with small batches to ensure hoppers are always filled on time and reduce overstock (7 wastes: transportation & waiting). Trial the soft-launch conveyor, monitor OEE and cycle time for 2–4 weeks, then adjust the layout if necessary. Many activities are classified as "internal" because tey occur when the line is stopped, increasing downtime.

Solution: Perform Value Stream Mapping to identify internal vs. external activities, such as Move non-packaging activities—such as pallet preparation or material movement—to be performed while the line is running. Train staff cross-functionally to be ready to perform these tasks during non-stop packaging. Re-mapping operators according to workload.

This study describes the implementation of lean manufacturing in a salt packaging industry and derives some proposed improvements as a follow-up to efforts to eliminate process time. Some of the proposed improvements are described as follows:

1. Adding a transfer conveyor from raw materials to the hopper
2. Categorizing activities outside of packaging as external activities
3. Re-mapping operators according to the workload
4. Elimination of activities with a pallet investment
5. Change the number of operators and work schedule with details:

a. Raw material preparation operators: remaining 3 operators with working hours 07.00 - 16.00

b. Packer labor: from 9 people to 12 people with working hours 07.30 - 16.30

c. QC labor remains 1 person with working hours 07.50 - 16.50

d. Fixed forklift operator 1 person with working hours 08.00-17.00

e. Shift the function of the 1 operator from the work of arranging the results from the inner pallet to the outer pallet to the work of arranging the products from the output conveyor to the pallet.

f. Eliminate the function of arranging work in the warehouse with the number of operators, 2 people

p-ISSN 2622-2027
e-ISSN 2622-2035

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