Improving the Efficiency of Repacking Process with Lean Technique The Study of Read With Me Group Company Limited

Jirayut Phetchuen and Jongkol Srithorn
System Engineering Program
The School of Industrial Engineering
Suranaree University of Technology
Nakhon Ratchasima, Thailand.
m6303198@g.sut.ac.th, jongkol@sut.ac.th

Abstract

The study examines the unloading and repacking process of Read With Me Group Company Limited. The research aims to improve the old work process and build a new efficient process with the Lean Technique and new machines for faster delivery without increasing the number of employees. Currently, two employees work based on five days on and off. However, workplace injuries have delayed the delivery time. When Value Stream Mapping was used to examine the data gathered, Non-Value Added was discovered, and a LEAN Manufacturing waste was identified in the working process. 37.20% of the total production time is Non-Value Added processing time found in the repacking process. The results of the new working process, improved plant layout, and cycle time before and after the adjustments are documented in the Flow Process Chart. By comparing the cycle time before and after modifications to the machinery and plant layout, the working day has been calculated in order to determine the Percentage of Efficiency. The improvements demonstrate a 25% increase in working space, a 42.82% decrease in process lead time, a 175.82% gain in work efficiency, and a zero percent injury rate at work.

Keywords
Lean Technique, Plant layout Design, U-Shaped Disassembly, Value Stream Mapping, Zero Injury

1. Introduction
READ WITH ME GROUP COMPANY LIMITED is a small enterprise that imports children's books from the United Kingdom and the United States and exports books to Southeast Asian countries such as Myanmar, Cambodia, and Laos.
The books are imported in cargo ships in 40ft and 45ft containers. Each container contains 44 large carton boxes weighing about 17-18 tons. The estimated number of books in each container is 60,000. The frequency of the import is 8-10 containers per year.

This paper focuses on the packing process, starting from unloading the large carton box and repacking it into a small box size 40x60x25 cm. weighing about 30-35 kilograms per box. 12 small boxes are equal to 1 large carton box.

This process used to be run by one staff. The carton box will be unloaded and repacked within one day. However, the speed of the operation will continuously reduce. After three days, only half of a carton box is unloaded and repacked, and after day five, the process has to be stopped due to work injury in the neck, the back, the wrist, the legs, and the arms of the staff. The staff must stop working for at least three days before beginning the process again. Therefore, the repacking process will be completed in about 8-9 weeks per container.

Currently, the company has increased the number of staff from one to two and the working hour is five-day work and five-day off.

The tools used in the repacking process are (1) a Semi-Automatic Strapping Machine, (2) a Hand-held Stretch Wrapping machine, (3) an Industrial weight scale, (4) Free rollers conveyor, (5) Electric Forklift, (6) Hand-lift

This time-consuming process delays delivery to customers, mainly the export to other countries, which will take an extended period, up to six weeks before the goods are ready to be shipped.

1.1 Objectives

The project aims to improve the working process and build a new effective process to reduce the unloading and repacking time.

The research questions are:

(1)Is the Plant layout for unloading and repacking, as well as the machinery, practical enough to meet customer demand?
(2)How can the company improve the speed of repacking process?

The Expected Benefits from the study are:

(1)The speed of the repacking process should be 100% faster.
(2)Low workplace injuries

2. Methods

The Delimitation of the study is divided into two phases.
The first phase will focus solely on the repacking process, and once this improves, the Delimitation will move on to the second phase, which is workers' injuries.

The conceptual framework and study duration is six months, from June to December 2022, using four containers that arrived in June, August, September, and November.

Phase 1: To build a new system for the repacking station to increase the number of repacking cartons on a two-people basis. Books from the June container are used to analyze the old system and workspace for process improvement and to prepare the new workspace for the August and September container. The first results are recorded.

Phase 2: To design a power-saving machine to minimize workplace injuries. The first experimental results are analyzed. The data is used to improve the unloading and repacking process for new machine designs and workflows

3. Data Collection and Analysis

Figure 1. The old Packing Process Area and Equipment. (Before Improvement)

3.1.3 GEN (GENBA, GENBUTSU, GENJITSU)

Only GENBA and GENJITSU were used in this study because the focus of the study was on the repacking process. The process is shown in Figure 1. (Paepoot, 2010; Pongsakasat, 2007). First, the workspace will be explored along

with employee interviews to collect data such as working steps, working methods, workspaces, unloading and repacking times, machine performance, and occupational workplace injuries. The results are recorded in Table 1.

Table 1. GENBA and GENJITSU Analysis

Survey	Effect
The process of working	Clear the working space for unloading the carton box. Unload half of a carton box and repack it into small boxes, then unload the rest and repack it into small boxes again.
Working Methods	No pattern; it depends on the working space
Working space	No design for proper working. The space is mixed up with other tools.
Duration of unloading	3.5 hours/a large carton box
Duration of repacking	4 hours/a large carton box
Used machine performance	Low performance, no power-saving machine
Work problems	Repetitive work injuries.
Frequent injury	Arms, shoulders, back, neck, and legs.
Cause of injury	The workflow between man and machine

3.2. Value Stream Mapping

Create a Value Stream Mapping using data gathered from workspace exploration and employee interviews. The analysis of workflow, production lead time, and processing time were used to identify the wates of the process and find the Non-Value Added (NVA), as shown in Figure 2. (Suksamarnvong 2013; Pakdeepunya, 2015; Ana and et al. 2014; Ikhsan and et al, 2017; Jafri and et al. 2015)

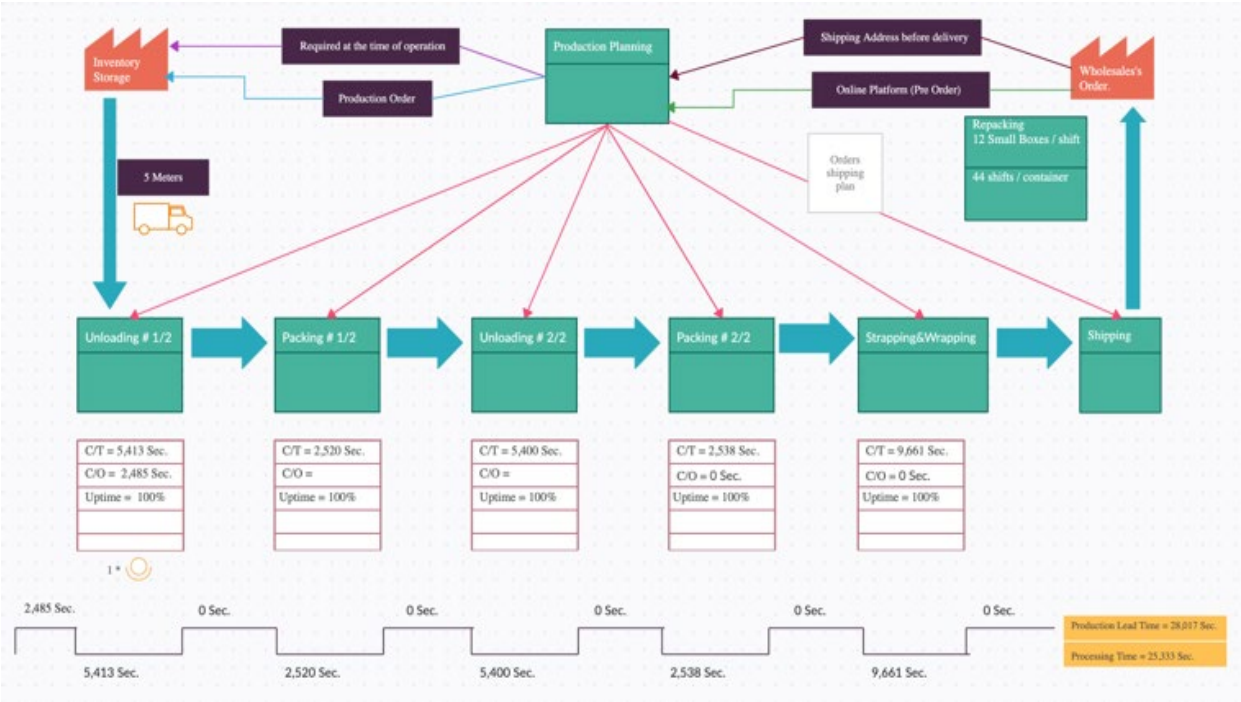


Figure 2. Value Stream Mapping. (Before Improvement)

Before the improvement, the Unloading and Repacking Process consumed up to 28,017 seconds, or 7.78 hours of Production Lead Time, according to the analysis of the Value Stream Mapping. As a result, the staff's productivity is down to just one pallet daily. Additionally, the examination of the working process in the Green Box shows that the preparation of the machine took up to 2,485 seconds, or 41.41 minutes, or about an hour of wasted time. Additionally,

two processes have redundant working. (Non-Value Added) The Production Lead Time should be greatly decreased if these two processes can be integrated.

3.3. Flow Process Chart Before Improvement

Record the old working steps in the Process Flowchart, as shown in Table 2. Determine the number of each step, cycle time, waiting time, and transportation distance. The time-consuming and unnecessary process has been detected. (Kajal, 2017; Valentino and Agus, 2022)

Table 2. Flow Process Chart before Improvement

Flow Process Chart						
Subject Charted.	Increasing Speed in the Packing Process				**Date**	1 July 2022
Method	(Before) After Improvement				**Recorder**	Mr.Jirayut P.
					Sheet No.	1 / 1
No.	**Process**	**Qt. (Bat.)**	**Distance. (m.)**	**Time (Second.)**	**Symbol**	**Note**
1	Searching for more working space	1	0	60		
2	Clear the unnecessary tools out of the working space	1	5	900		
3	Put the machine in the repacking station	1	0	1,500		
4	Use a hand-lift to move the large carton box to the unloading station	1	5	25		
5	Unbox the carton	1	0	10		
6	Take pictures of the books inside the carton	1	0	3		
7	Unloaded only half of a large carton box	30	0	4,500		
8	Put the books on the storage shelf, which will be sorted based on size and category	30	1	900		
9	Pack books in small, digitally scaled boxes	6	0	2,400		
10	Put the tag number on each box	6	0	36		
11	Take pictures of books in the small boxes	6	0	18		
12	Record the weight of the box	6	0	12		
13	Seal the box with clear tape	6	0	30		
14	Lift the box by hand and put it on the wooden pallet	6	1	24		
15	Take out the rest of the books from the large carton box	30	0	4,500		
16	Put the books on the storage shelf, which will be sorted based on size and category	30	1	900		
17	Pack books in small, digitally scaled boxes	6	0	2,400		
16	Put the tag number on each box	6	0	36		
17	Take pictures of books in the small boxes	6	0	36		
18	Record the weight of the box	6	0	12		
19	Seal the box with clear tape	6	0	30		
20	Lift the box by hand and put it on the wooden pallet	6	1	24		

21	Lift the box on the pallet by hand to the strapping station	12	1	48						
22	Band the box with a plastic strap	12	0	3,600						
23	Wrap the box on the wrapping machine	12	0	5,760						
24	Lift the wrapped box by hand and put it on a pallet	12	1	48						
25	Organize the boxes on the pallet	12	0	180						
26	Use a hand lift to move the pallet to the delivery station	1	5	25						
27	Inventory Storage	1	0	0						
Total		260	21	28,017	14	9	1	4	1	

3.4. Flow Process Chart After Improvement

After Improvement Phase 1: Data from a new experiment in Plant layout with two staff are presented in Table 3**.**

Table 3. Phase 1: Flow Process Chart after Improvement

Flow Process Chart						
Subject Charted.	Increasing Speed in the Packing Process			**Date**	1 Oct. 2022	
Method	Before (After) Improvement			**Recorder**	Mr.Jirayut P.	
				Sheet No.	1 / 1	
No.	**Process**	**Qt. (Bat.)**	**Distance. (m.)**	**Time (Second.)**	**Symbol**	**Note**
1	Prepare workspace and packing machine.	1	0	0		
2	Withdraw large carton boxes from the Inventory storage.	1	0	15		
3	Use the pallet hand-lift to move the large carton box to the unloading station.	1	3	15		
4	Unbox the carton.	1	0	10		
5	Take pictures of the books inside the carton.	1	0	3		
6	Unloading only half of a large carton box. Put the books on the storage shelf, which will be sorted based on size and category.	1	0	7,200		
7	Repacking staff waits for books to be unloaded by the unloading staff.	1	0	300		
8	Pack books in small, digitally scaled boxes.	12	0	3,600		
9	Put a tag number on each box.	12	0	36		
10	Move the box to the photo station.	12	0.5	36		
11	Take pictures of the book in the small boxes and the weight shown on a digital scale.	12	0	36		
12	Record the weight of the box.	12	0	24		
13	Recheck the weight photo taken from the digital scale with the weight recording book.	12	0	60		
14	Seal the boxes with clear tape.	12	0	60		
15	Slide the box to the strapping station.	12	1	36		

16	Band the box with plastic straps.	12	0	2,160		
17	Slide the box to the wrapping station.	12	1	36		
18	Wrap the box.	12	0	2,160		
19	Slide the box to the wooden pallet station.	12	1	36		
20	Organize the boxes on the pallet.	12	3	180		
21	Use the Pallet hand-lift to move the pallet to the delivery station.	1	3	15		
22	Inventory Storage	1	0	0		
Total		165	12.5	16,018	9 | 7 | 1 | 3 | 1	

After Improvement Phase 2: Data from a new experiment in Plant layout with two staff are presented in Table 4.

Table 4. Phase 2: Flow Process Chart after Improvement

Flow Process Chart						
Subject Charted.	Increasing Speed in the Packing Process				**Date**	1 Oct. 2022
Method	Before (After) Improvement				**Recorder**	Mr.Jirayut P.
					Sheet No.	1 / 1
No.	**Process**	**Qt. (Bat.)**	**Distance. (m.)**	**Time (Second.)**	**Symbol**	**Note**
1	Prepare workspace and packing machine.	1	0	0		
2	Withdraw large carton boxes from the Inventory storage.	1	0	15		
3	Use the pallet hand-lift to move the large carton box to the unloading station.	1	3	15		
4	Unbox the carton.	1	0	10		
5	Take pictures of the books inside the carton.	1	0	3		
6	Unloading only half of a large carton box. Put the books on the storage shelf, which will be sorted based on size and category.	1	0	7,200		
7	Repacking staff waits for books to be unloaded by the unloading staff.	1	0	300		
8	Pack books in small, digitally scaled boxes.	12	0	3,600		
9	Put a tag number on each box.	12	0	36		
10	Move the box to the photo station.	12	0.5	120		
11	Take pictures of the book in the small boxes and the weight shown on a digital scale.	12	0	36		
12	Record the weight of the box.	12	0	24		
13	Recheck the weight photo taken from the digital scale with the weight recording book.	12	0	60		
14	Seal the boxes with clear tape.	12	0	60		
15	Slide the box to the strapping station.	12	1	120		
16	Band the box with plastic straps.	12	0	2,160		

17	Slide the box to the wrapping station.	12	1	120						
18	Wrap the box.	12	0	2,160						
19	Slide the box to the wooden pallet station.	12	1	120						
20	Organize the boxes on the pallet.	12	3	180						
21	Use the Pallet hand-lift to move the pallet to the delivery station.	1	3	15						
22	Inventory Storage	1	0	0						
Total		165	12.5	16,354	9	7	1	3	1	

3.5. Cause and Effect Diagram

The summary of the problems established in the repacking process comes from the analysis of the Value Stream Mapping and Flow Process Chart. (Pakdeepunya, 2010)
The results show that there are four factors. (1) Method (2) Human (3) Machine (4) The Environment
All of the above have been plotted in the Figure 3.

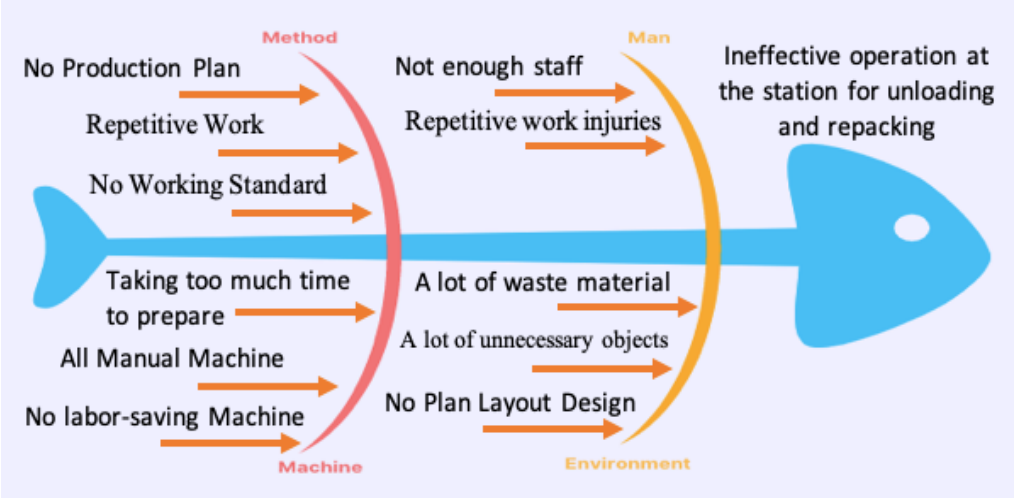


Figure 3. Cause and Effect Diagram. (Fish Bone Diagram)
Figure 4.

5S Analysis

Many unnecessary repacking objects, such as old wooden pallets, boxes of retailing books, and exhibition equipment, were found. (Mihalj, 2018)

SEIRI: organize the workspace by removing all unnecessary items for repacking.
SEITON: the current workplace is treated as a disassembly line. Therefore, the most suitable new design is the product layout model. The storage shelf has also been adapted for a faster and more convenient workstation.
SEISO: Define a policy for cleaning work areas, tools, machines, and other equipment to ensure everything is returned to "near-new" condition.
SEIKETSU: Hold a meeting to ensure employees fully understand and are ready to comply with the new work policy.
SHITSUKE: Create a commitment and self-discipline among employees to maintain the previous four 5S steps.

3.6. 8 Wastes

Only four wastes will be discussed in this study by focusing on the unloading and repacking process. (Amelia and et al 2013; Paepoot 2010)

Transportation: There is too much repetitive transportation in the process. The new plant layout is designed for one-way transportation to reduce work time.

Excess Processing: Reduce and Merge the steps of production to prevent over-processing.

Waiting: Unloading and repacking are partially synchronized, and the repacking must wait for the unloading process. The two employees swapped to work for five days and five days off. This was changed to two employees working simultaneously but being responsible at different stations. The repacking staff will help unload the carton to speed up the process. The less time spent on the unloading station, the faster the repacking station will be.

Motion: Too much movement of the employees leads to workplace injuries. Electric hoists have been introduced to reduce the risk of injury

3.7. Process Efficiency Equation

Process efficiency essentially measures the reduction in labor required during the working process. It can be computed by dividing the number of Finite Products and the Working Days in Process per container. It is the ratio of the output from the process and the input to the process. (Pongsakasat 2007).

The Efficiency Formula is written as follows:

$$Efficiency = Work\ Output / Work\ Input$$

With:
Efficiency = the efficiency of the process
Work Output = the output from the process (the finite Product)
Work Input = the input to the process (work days in process)

4. Results and Discussion

4.1. 5S improvement

It is shown in Figure 4 that after applying 5S techniques, the working space has increased by 25%. More than 50 items of dead stock and unidentified subjects found in the warehouse were organized for distribution.

Figure 5. Working Area After 5S Improvement

From Figure 5, the warehouse space has been divided into four sections (1) Inventory Storage 50% (2) Unloading and Repacking Area 35% (3) Tools and Equipment Area 10% (4) Space 5%.

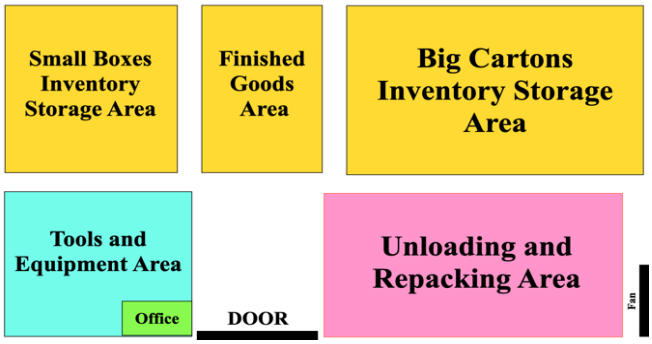


Figure 6. Plant Layout Design (After Improvement)

4.2. Machine Layout Design: Phase 1

The plant layout is designed as a U-shaped disassembly line, as shown in Figure 6. The unloading area is connected to the repacking area by Free Rollers Conveyor, using an electric hoist as an energy-saving machine for moving the boxes onto the wooden pallet without manual lifting.

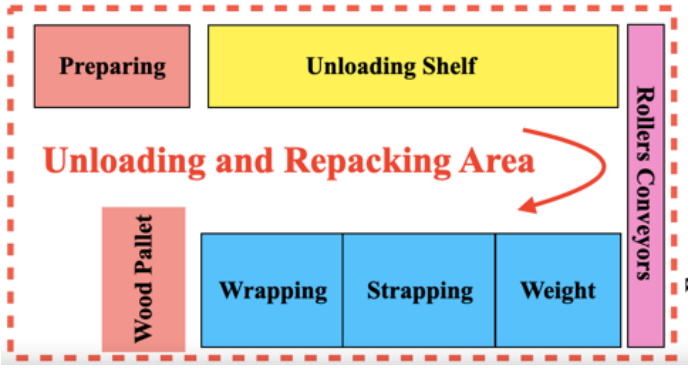


Figure 7. U-Shaped Disassembly Line

4.3. Machine Design: Phase 2

Figure 7 reveals that the heavy-lifting and moving machine has been designed based on Machine Layout Design in Topic 4.2. From Topic 4.2, the unboxing and unloading station is on the left-hand side, connected with Free Roller Conveyors, which help move the small box to the Packing, Strapping, and Wrapping station on the right.

Figure 8. Packing Machine. (After Improvement)

4.4. Cycle Time

Phase 1: Process Lead Time After Improvement is presented in Table 5.

Table 5. Phase 1: Cycle Time Improvement

No.	Process	Previous time	Current time	Changed	Percentage
1	Machine Preparing	2,485	30	2,455	↓98.79
2	Unloading	10,813	7,213	3,600	↓36.29
3	Packing	14,791	8,775	5,944	↓40.38
4	Work step	27	22	5	↓18.51
5	Work quantity	260	165	95	↓36.53
6	Distancing (m.)	21	12.5	8.5	↓40.4
7	Processing Lead Time (Second)	28,017	15,538	12,479	↓44.54
8	Processing Lead Time (Hour)	7.78	4.32	3.46	↓44.47
9	Large Carton / Day	1	1.85	0.85	↑85
10	Number of work days per Container	69	36	33	↓47.82
11	The working day before workplace injuries.	5	6	1	↑20

The repacking process can be completed in 36 days per container, a reduction of 47.83%

$$\textit{Efficiency (Phase 1)} = \textit{Output/Input} \quad (1)$$

Efficiency (Before Improvement) = 44/69 = 0.637

Efficiency (After Improvement) = 44/36 = 1.22

% Efficiency Increase = (1.22-0.637) x (100/0.637) = 91.52%

Despite the improvement of the workplace and work process in phase 1, with the staff having one more working day, the duration of reconditioning of the whole container cannot be increased to 100% because the staff still have to take a break during work.

Phase 2: Process Lead Time After Improvement is presented in Table 6.

Table 6. Phase 2: Cycle Time Improvement

No.	Process	Previous time	Current time	Changed	Percentage
1	Machine Preparing	2,485	30	2,455	↓98.79
2	Unloading	10,813	7,213	3,600	↓36.29
3	**Packing**	**14,791**	**8,093**	**6,626**	↓45.02
4	Work step	27	22	5	↓18.51
5	Work quantity	260	165	95	↓36.53
6	Distancing (m.)	21	12.5	8.5	↓40.4
7	Processing Lead Time (Second)	28,017	16,018	11,999	↓42.82
8	Processing Lead Time (Hour)	7.78	4.45	3.33	↓42.80
9	Large Carton / Day	1	1.79	0.79	↑ 79
10	Working day per Container	69	25	44	↓63.76
11	The working day before workplace injuries.	5	0	5	Zero Injury

The cycle time in the station with the electric hoist is increased due to the slower speed of the electric hoist compared to manual lifting.

The repacking process can be completed in 25 days per container, a reduction of 63.77%.

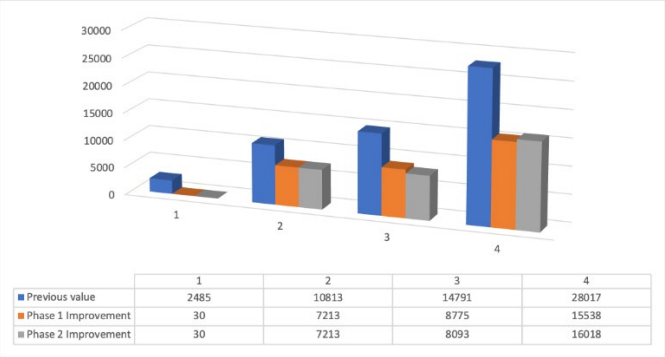
$$Efficiency\ (Phase\ 2)\ =\ Output/Input \qquad (2)$$

$$Efficiency\ (Before\ Improvement) = 44/69 = 0.637$$

$$Efficiency\ (After\ Improvement) = 44/25 = 1.76$$

$$\%\ Efficiency\ Increase = (1.76\text{-}0.637)\ x\ (100/0.637) = 175.82\%$$

The Phase 2 improvement reduced the processing time, as shown in Figure 8.



	1	2	3	4
Previous value	2485	10813	14791	28017
Phase 1 Improvement	30	7213	8775	15538
Phase 2 Improvement	30	7213	8093	16018

Figure 9. Packing Machine. (After Improvement)

with
1: Machine Preparing Time.
2: Unloading Time.
3: Packing Time.
4: Processing Lead Time. (Second)

In addition, work-related accidents are noticeably reduced, allowing employees to work without interruption while on the job.

5. Conclusion

The delay in the repacking process is the lack of proper plant layout and unclear work process. As a result, transportation waste is at a high level.
The indirect factor is work accidents related to manual lifting, which lead to poor work efficiency.
After the process improvement, the work efficiency increased by 175.82%, and the work injuries rate was reduced to zero.
The new work standard applies to the work process. Each member of staff must wear safety devices. Goods moving should only be done by an energy-saving machine. Manual lifting is prohibited.
The budget for improving the process line and working standard on a two-people basis is 57,500 Thai Baht.
Improving the system can reduce the cost and value of losses by 300,000 Thai Baht due to late delivery.

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Biography

Jirayut Phetchuen is a Master's Degree Student at the School of Industrial Engineering, Suranee University of Technology, Nakhon Ratchasima, Thailand. He received a Bachelor's Degree in Instrumentation Engineering from King Mongkut Institute of Technology Ladkrabang, Bangkok, Thailand. He currently owns a business selling imported books both wholesale and retail. In addition, he is a marketing, production, and warehouse manager. His research interests include Robotic Automation and Production Process Improvement.

Jongkol Srithorn received a B.E. (1999) from King Mongkut's University of Technology Thonburi, M.E. (2001) from Chulalongkorn University, and Ph.D. (2009) in Manufacturing Engineering and Operations Management from The University of Nottingham. She is currently a lecturer. School of Industrial engineering, Suranaree University of Technology.