# Design Improvements to Inbound Logistics and Outbound Logistics Process Groups using the Plan-Do-Check-Act (PDCA) and Multi-Moment Analysis (MMA) Approaches

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***Abstract***
*The object of this research is a company engaged in services and fabrications of sheet metal-based products. The management wants to increase the profits. One of the divisions that management wants to improve is the Logistics Division. Over the past few months, there has been an increasing trend of overtime in the Logistics Division that indicates an increase in operational costs for workers. The occurrence of overtime indicates that there are worker activities that are not adding value or so-called waste. In the lean concept, waste is something that must be eliminated. Thus, this study aims to reduce waste in order to reduce costs so that the company obtains an increase in profits. The Plan-Do-Check-Act (PDCA) was used as an improvement framework for this research. Then, Multi Moment Analysis (MMA) methodology will be used to document the process and measure the level of waste. The outputs from this research are process mapping, dashboards, and proposed solutions for improvement. Proposed improvements are designed for each inbound and outbound logistics process group in Logistics Division in line with the management concern. The proposed improvement for inbound logistics estimates a reduction in overtime of 43% or equivalent to cost savings of up to Rp23,948,597.8 per year. Meanwhile, proposed improvements for outbound logistics can potentially reduce overtime by up to 47.55% which is equivalent to cost savings reaching Rp36,315,157.5 per year.*

***Keywords***: *Inbound Logistics, Outbound Logistics, Waste, PDCA, Multi-Moment Analysis*

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## 1. Introduction

The metal industry in Indonesia experienced good growth during the pandemic Covid-19. In the first quarter of 2022, the performance of the base metal industry grew 7.9%, followed by the second quarter growing by 15.79% (Kemenperin, 2022). The growth of the metal

industry can lead to increased competition between companies so that the company concerned must be able to improve their performance thus they can remain competitive with their competitors (Porter, 1985).

The company of this research is engaged in the service and fabrication of sheet metal or plate-based products. The company's production activities are based on orders received from various industries. Therefore, the company implements a job-shop production system to fulfill orders with high variations.

Internal consultant manager of the company wanted to increase company's profits. To support this desire, the company planned to evaluate the level of waste and established improvements from non-production divisions. The company wanted to review the Logistics Division. This decision was based on the high cost emerged by logistics overtime. During July 1, 2022, to January 26, 2023, it was known that there was an increasing trend of overtime hours in the Logistics Division as shown in Figure 1.

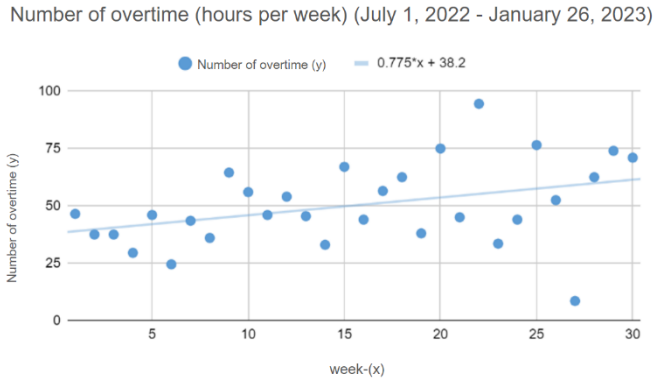



**Figure 1.** Overtime trends at Logistics Division

High overtime indicated the possibility of waste in the form of non-value-added activities carried out during working hours that indirectly contribute to operational costs. Therefore, these wastes need to be eliminated or minimized in order to reduce operational costs and support the company in achieving increased profits.

This research focused on evaluating the waste levels and creating proposed improvements in the inbound and outbound logistics process group performed by the Logistics Division of this research company. The level of waste was evaluated by conducting Multi-Moment-Analysis (MMA). MMA is a work sampling technique that is carried out to assess the level of productive and non-productive activities that took place on the research object. This approach was chosen by considering the job-shop production system used by the company.

Previous study about MMA was conducted by Reifenrath et al. (2012) at the radiology center. The study was purposed to analyze and evaluate whether MMA is the appropriate method for analyzing and measuring the flow process of the work without equipped with the following actions to improve the process. Another similar study to evaluate bottlenecks and propose improvement was conducted using other approaches such as the study conducted by Ferdiansyah et al. (2013). The study used Process Activity Map (PAM) to map the activity, distance, time, person, and type of value. Then Value Stream Mapping (VSM) was used to map the process flow and identify bottlenecks.

In this research, VSM was less suitable to use because of the sporadic flow made by the workers and the process cycle time could not be gained using time study because the company

produce various products based on customer orders which impacted on the various time needed for handling each type of the product. Therefore, MMA was used to obtain the estimated average time to complete the process in a certain period of time. To conduct MMA, an activity map of inbound and outbound logistics performed by Logistics Division is needed as the list of activities from which data will be taken. Because the company did not yet have logistics activity maps, this research began by mapping the activity of inbound and outbound logistics, followed by evaluating waste using MMA, and making suggestions for improvements.

## 2. Methods

This research was intended to provide an evaluation of the waste and create suggestions for improvement. To monitor the result of the waste evaluation, dashboards are created. Furthermore, the dashboard could be used for the next evaluation to support the company in establishing continuous improvement. This research was oriented towards efforts to support continuous improvement, so that the main framework of this research was built using the PDCA cycle. In addition, MMA was the main method used to evaluate waste so that the do stage in the PDCA cycle was developed using the MMA stages proposed by Planje (2015).

### 2.1 PDCA Cycle

PDCA cycle is one method that could be used to perform continuous improvement. As the name suggests, PDCA forms a cycle with plan-d0-check-act stages. The following explains the PDCA stages according to Imai (2012) along with the details of the method implemented at each stage in this study.

The plan stage is the planning stage. At the do stage, a plan was made with the main objective to evaluate waste using the MMA method and to provide suggestions for improvements. Planning was made using the A3 project plan. The do stage is the stage of implementing the plan. At this stage, MMA was conducted according to the stages described in subsection 2.2. The check stage is a stage to determine the suitability of the implementation of the plan carried out against the target plan made. In this research, the check stage was carried out by carrying out a value-added assessment, sample adequacy test, and Pareto analysis. Value added assessment will be carried out using the procedure proposed by Nicholas (2018) as shown in Figure 2. Furthermore, the act stage is the stage of making adjustments or changes needed based on the results of the analysis at the check stage. In this research, the act stage was carried out by analyzing the causes of bottlenecks, creating suggestions for improvements to the inbound logistics and outbound logistics process groups.

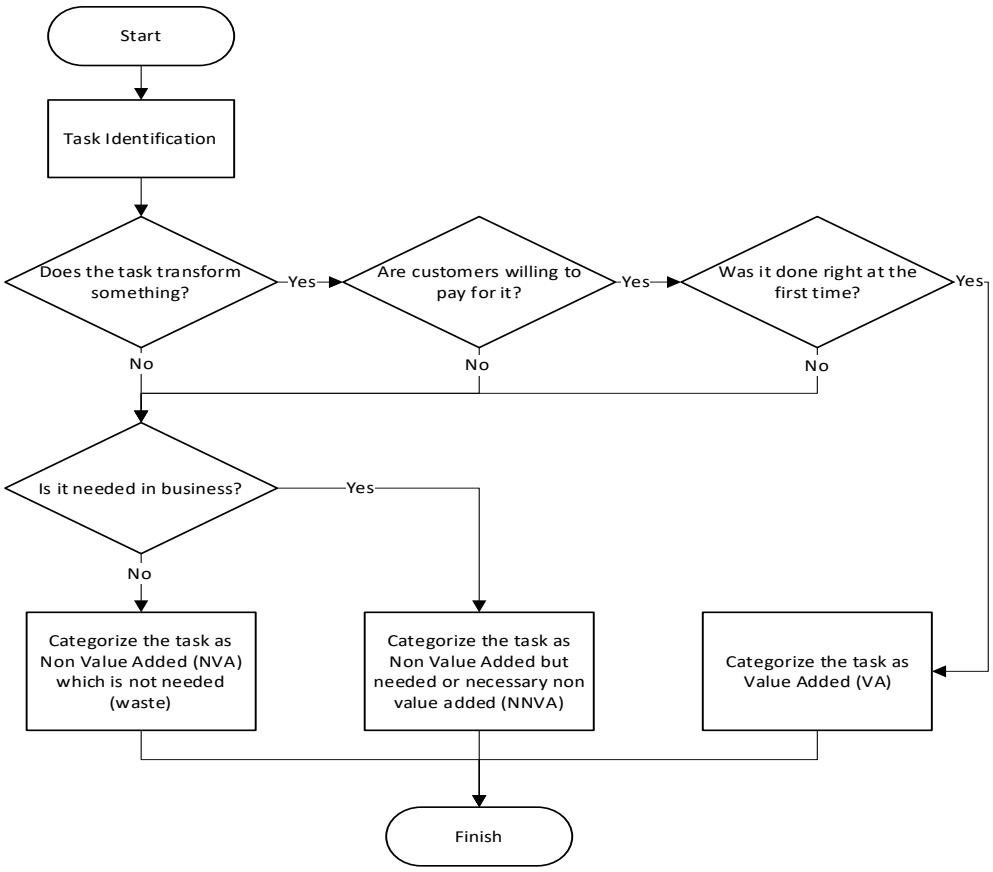



**Figure 2.** Value-added assessment procedure (Source: Nicholas, 2018)

## 2.2 *Multi-Moment Analysis* (MMA)

MMA is a work sampling technique that allows researchers to obtain information about a work procedure (Planje, 2015). In its implementation, MMA is used to measure value-added activities and waste that occurs in the field (Etges, 2018). MMA is also used to examine and evaluate processes in industry where activities are clearly defined from the results of comprehensive observations (Reifenrath et al., 2012). By using MMA, distribution of data related to work or activities carried out by Logistics Division workers can be obtained so that value-added and non-value-added activities can be reviewed. MMA is carried out by observing ongoing activities at random times determined before data collection is carried out. In this study, MMA was carried out in accordance with the MMA procedure proposed by Planje (2015).

1) Setting a goal
   MMA goals were set based on the reasons for conducting MMA. The objectives also provide the boundaries and parameters needed in the study.
2) Preparation and prerequisites
   Before conducting MMA, preparations were made to ensure that everything needed could be provided and used. Therefore, we first reviewed the organizational structure, mapped the process and listed activities, conveyed the objectives of the MMA to stakeholders involved, and created a project team.
3) Planning, organization, and start MMA

At this stage, several things need to be prepared were the MMA master data which basically contains data of the list of activities to be observed, prepared and built instruments that support data recording. The MMA trials was carried out to ensure that the master data created represented the real conditions.

4) Measurements (data collection)
   MMA data were collected by observing and recording the activities that were performed by the workers at certain random times.
5) Analysis and reporting
   In this study, this stage was equivalent to the check stage of the PDCA cycle.

## 3. Results and Discussion

### 3.1 Plan

The purpose of this research was to evaluate waste using MMA and provide suggestions for improvements to reduce waste. Planning is made using tha A3 project plan as shown in Figure 3.

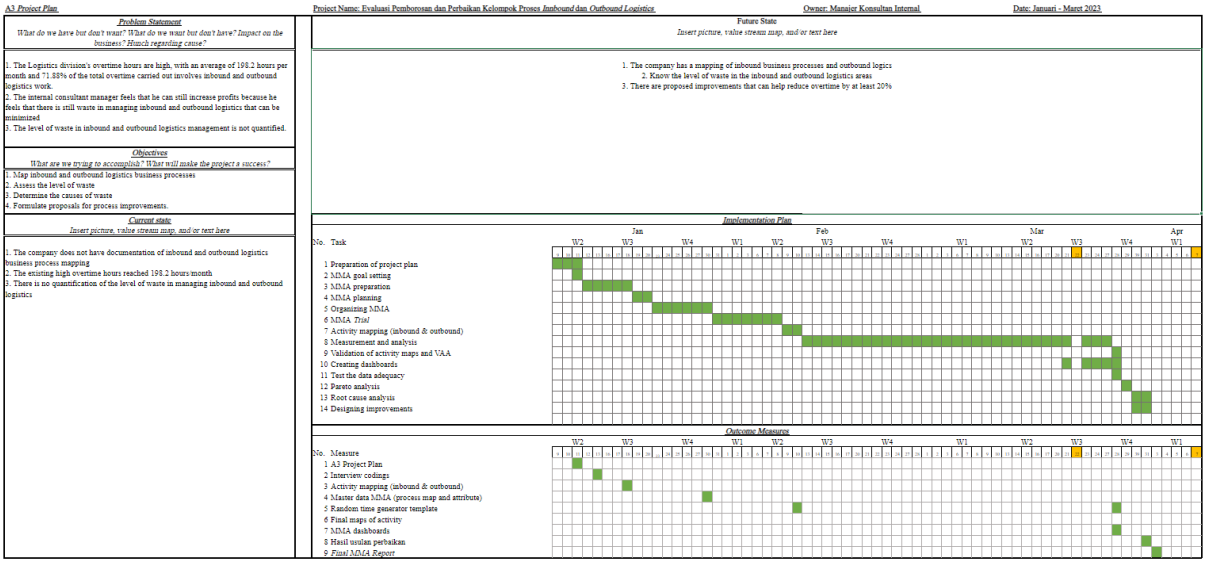



**Figure 3.** A3 *project plan*

### 3.2 Do

The do stage was carried out by doing MMA as the main method used to evaluate waste.

1) Setting a goal
   The goal of conducting MMA was to evaluate the waste.
2) MMA Preparation
   At this stage, stakeholder analysis was carried out and an overview of the inbound and outbound logistics process flow were mapped. There were 9 workers from the logistics division who were observed, consisting of 1 leader and 8 staff. Figure 4 and Figure 5 are images of the process flow that will be observed.

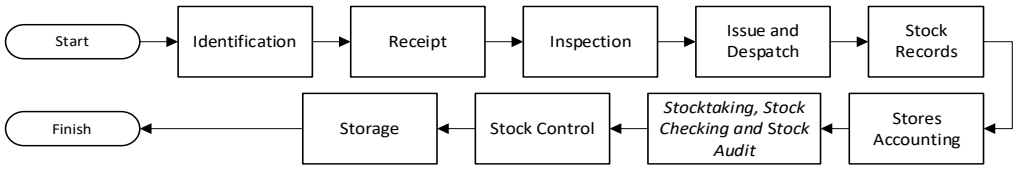



**Figure 4**. Inbound logistics process flow (Source: Crocker et al., 2012)

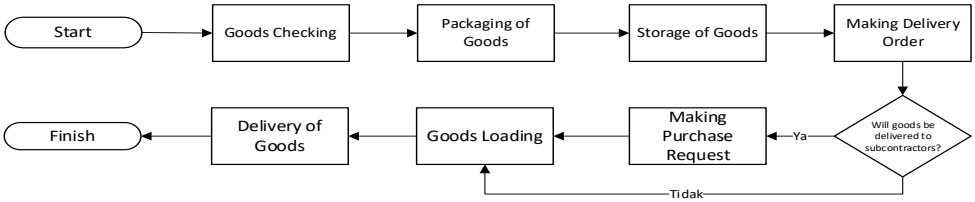



**Figure 5.** Outbound logistics process flow based on empirical data

3) Planning, organizing, and start MMA
MMA master data were organized using entity-relationship modelling. Figure 6 shows the model of the master data that was also used in Power BI dashboards.

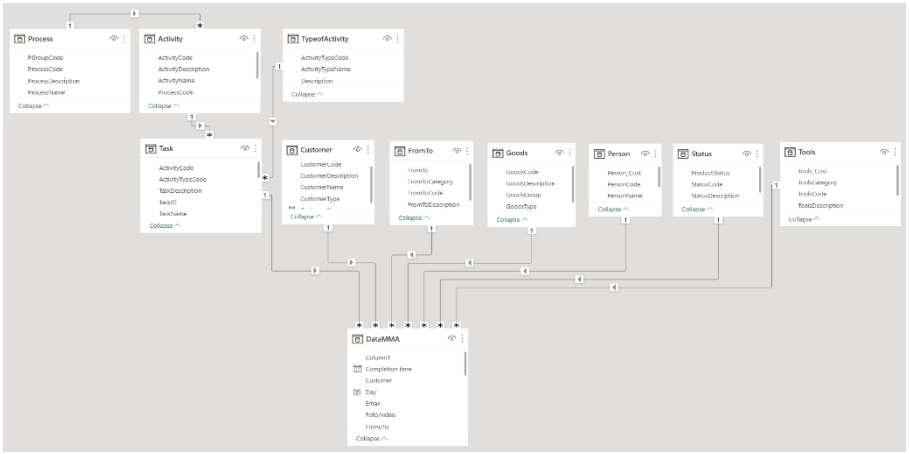



**Figure 6.** Data model of the MMA master data and Power BI dashboards

Sampling was carried out by observing 3 work areas of the Logistics Division: inbound warehouse, outbound warehouse, and administration room.

4) Measurements
Data collection was carried out at random times during working days and hours. Data were collected for 21 working days from 07.00 WIB to 16.00 WIB on Monday-Thursday and until 16.30 WIB on Friday.

5) Analysis and Reporting
From the MMA conducted, the following results were obtained as shown in Table 1. The data distribution for each process is as follows on the Figure 7.

**Table 1.** MMA data results

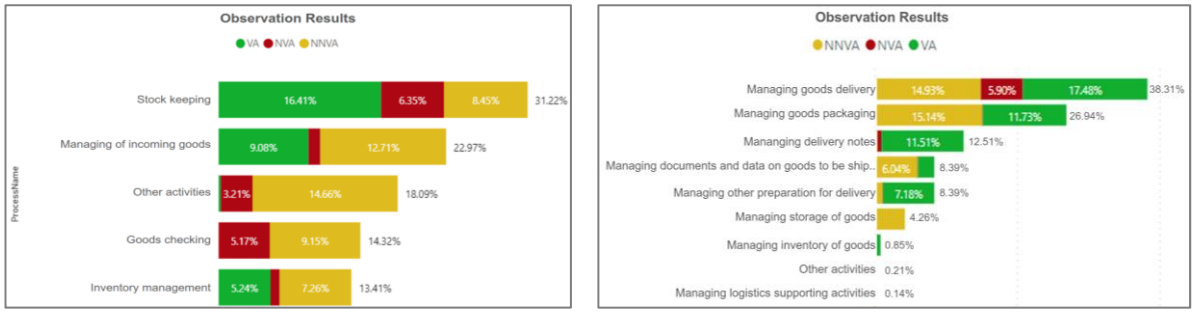
| | *Inbound Logistics* | *Outbound Logistics* | **Total** |
|---|---|---|---|
| **Number of data** | 1432 | 3317 | 4749 |
| **Percentage** | 30,15% | 69,85 | 100% |
| **Hours/day/worker** | 2,41 | 5,59 | 8 |
| **Hours/day** | 21,71 | 50,29 | 72 |

### 3.3 *Check*

At this stage, an analysis of existing processes was carried out from the MMA results by carrying out a value-added assessment. Value-added assessment divided activities into 3 categories: value-added (VA), non-value-added (NVA), and necessary but non-value-added (NNVA). The results of value-added assessment are shown in Table 2 and the distribution of each process is shown in Figure 7.

**Table 2.** Value-added assessment results

| | *Inbound Logistics* | | *Outbound Logistics* | |
|---|---|---|---|---|
| | *%* | *Minutes/person/day* | *%* | *Minutes/person/day* |
| **VA** | 30,94% | 44,77 | 32,83% | 110,07 |
| **NVA** | 16,83% | 24,36 | 15,10% | 50,63 |
| **NNVA** | 52,23% | 75,59 | 52,07% | 174,58 |




(a) (b)

**Figure 7.** Value-added assessment results per process (a) *inbound logistics;* (b) *outbound logistics*

In these results there was still waste in the form of NVA that needs to be eliminated. Therefore, the focus of the improvement was to eliminate the NVA. In inbound logistics, 16.83% of NVA comes from 83 tasks spread across each process. Figure 8 shows the value-added assessment results for each inbound logistics and outbound logistics process. The task levels of these processes were evaluated using Pareto analysis and it was found that 12 tasks contributed to 78.84% of the tasks that had no added value in the inbound logistics process group. Meanwhile, in the outbound logistics process group, 40 tasks were found which contributed to 79.95% of the total tasks. The tasks included in the pareto area were then analyzed using the 5-whys method and obtained 10 root causes of bottlenecks in the inbound logistics process group and 26 root causes of bottlenecks in the outbound logistics process group which were then resolved with proposed improvements.

### 3.4 Act

At this stage, recommendations for improvements are created based on the root cause analysis.

**1) Inbound Logistics**

The proposed improvements were created based on the root cause of the bottleneck found using a 5-whys analysis. The root cause analysis was carried out on non-value-added tasks. The proposed improvements for inbound logistics process are as follows.

a) Application for digitizing checking sheets

This digitization was proposed to speed up the checking process which previously used paper. This suggestion estimates the elimination for 6 tasks with a total savings of up to 7.92 minutes per person per day.

b) Checklist for 5S activities
This checklist potentially caused the 5S agenda in the company could be implemented properly and speed up certain processes. The estimated savings obtained are up to 4,346 minutes per person per day.

c) Making daily targets or work lists
This target potentially made the workers know what must be done that day so as to minimize wasted time from non-working activities due to waiting for orders. This suggestion estimates savings of up to 4,548 minutes per person per day.

d) Peer computer training
This computer training was intended for workers to be able to use computers for their duties, without disturbing other workers by ordering other workers to do their work. This suggestion could save up to 1.819 minutes per person per day.

e) Standard Operating Procedures (SOP) for reporting discrepancies in the use of materials with instructions from the system
This SOP was made with purpose to faster process of adjusting stock in the system because time wasted to find out the cause of the system error would be faster. This suggestion estimates savings of up to 0.758 minutes per person per day.

f) Merging the raw material identity on the pallet with the identity on the raw material
This merger reduces the work of workers from taking care of three identity labels in one pallet to only two identity labels. This fix estimates savings of up to 1,364 minutes per person per day.

**2) Outbound Logistics**

Proposed improvements to outbound logistics are made based on the root problems found using the 5 whys analysis. The proposed solutions made for the outbound logistics process group are as follows.

a) Confirm delivery schedule with consignee
Confirmation of the delivery schedule is carried out by contacting the consignee to ensure that there are no long unloading queues within a certain time period so that the Logistics Division can determine the correct delivery time. This suggestion has the potential to save time, but the amount of time saved could not be determined because it came from the value-added activities but the time to perform them could be minimized.

b) Making daily work targets in a week
Work targets are set by the Logistics Division leader at the beginning of every week. Work targets are made on a whiteboard in the logistics administration room. This improvement has the potential to save up to 21,122 minutes of work time per person per day.

c) Use of the split screen feature when transferring stock systemically
The split screen feature is done by pressing the WIN button + the "<" or ">" button on the item master data and purchase request tabs. This improvement has the potential to save time, but the amount of time saved cannot be determined.

d) Write the delivery and pickup schedule for goods
   This suggestion is proposed to be carried out on a spreadsheet by the Logistics Division leader. This improvement has the potential to save up to 10,156 minutes per person per day.
e) Peer computer training for workers
   Computer training can be carried out between workers by observing that there are 3 workers who are considered more trained than the other 6 workers. This improvement has the potential to save time, but the amount of time saved cannot be determined.
f) Reduction of pallet identity
   Pallet identity reduction is proposed because there are 2 pallet identities with similar information. Deductions can be made on palette identities created by handwriting. This improvement has the potential to save time, but the amount of time saved cannot be determined.

## 4. Conclusion

Based on the value analysis of existing processes in the Logistics Division, in the inbound logistics process group, NVA waste was obtained at 24.36 minutes/person/day and waste in NNVA was 75.59 minutes/person/day, while in the outbound logistics section, NVA was obtained at 50.63 minutes/person/day.

The proposed improvements for the inbound logistics process group estimate savings of 19.91 minutes per person per day or 81.74% of NVA and 0.81 minutes per person per day or 1.07% of NNVA. The total savings in inbound logistics is 20.72 minutes/person/day or the equivalent of 21.75 hours/week (with 7 days a week). With the previous average overtime being 50,167 hours/week, the proposed improvements to inbound logistics estimate savings of up to 43%.

The proposed improvements for the outbound logistics process group can provide an estimated savings of 31.28 minutes per person per day or the equivalent of eliminating 62.05% of the total NVA. These savings also have the potential to reduce overtime by up to 47.6%. However, these savings do not include savings obtained from improvements in NNVA activities which cannot be quantified.

Based on the estimated time savings above, savings in labor costs can be estimated as well. For estimating the labor cost savings, it is referring to the minimum wage value in 2023 at Cikarang, West Java, Indonesia as this observation takes place, which is Rp 5.137.575 per month and equivalent of Rp. 32.109,8 per hour. So, labor cost savings comes from inbound logistics time savings is up to Rp. 23.948.597,8 per year and outbound logistics is up to Rp 36.315.157,5 per year.

For succession of this research, the industry should be applying the proposed improvements. But, in applying those improvements have a cost and other variable that could be considered. The cost must be below the estimated labor cost savings for getting the effective benefits. The other variable that should be considered is the people that maybe cannot change their behavior directly, so the industry must make a strategy for this change of the systems. The strategy can be like training, workshop, etc. Then, after the industry makes the improvements, the results of the improvements still need to be reviewed. The MMA methods in the next PDCA cycle still be recommended for continuous improvements. The result of MMA tells what is actually happen so that design improvements can be made effectively.

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