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Implementation of Lean Warehouse to Improve The Performance of Warehouse Activities at PT. ABC

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Abstract

PT. ABC, a company operating in the cocoa product manufacturing industry, faces challenges related to waste during the reception of large spare parts, resulting in extended lead times for receiving goods. To address these issues, it is imperative to conduct an analysis of enhancements in the spare part receiving section within the maintenance warehouse to minimize or eradicate existing waste, thereby ensuring a shorter and more efficient process for receiving spare parts. Lean warehousing, which focuses on identifying and eliminating waste in warehouse operations or processes while reducing the time required to fulfill company requirements, serves as the guiding principle. The potential time reduction achievable by eliminating non-value-added activities is estimated at 26.56 minutes, representing a 23.8% decrease.

A. Introduction

The warehouse, an integral component of a production system, serves as a crucial support system [1]. It functions as a storage facility for materials, playing a pivotal role in the production process [2]. Despite not directly adding value and requiring substantial investment, the warehouse significantly enhances the performance of a company's production system [3]. Well-organized and maintained warehouses are essential for preventing losses, minimizing costs, and expediting operations and services [4][5][6]. Within daily operations, the spare parts warehouse holds particular importance, facilitating the servicing, sales, reception, storage, and distribution of spare parts to technicians [7][8]. Optimizing warehouse operations is essential for enhancing customer satisfaction, achieved by eliminating inefficiencies and ensuring reliability to minimize overall logistics costs [9][10].

PT. ABC, a cocoa product manufacturing company, operates on a Make To Stock (MTS) production system with a continuous production process. The company maintains several warehouses for storing various materials, including raw materials, machine spare parts, and finished goods. Among these warehouses is the spare parts warehouse, which consists of three sections: the maintenance warehouse, chemical warehouse, and store room. The maintenance warehouse accommodates large spare parts exceeding 3 meters in dimensions, while the chemical warehouse stores chemical spare parts such as oil and NaCl. The store room, or spare parts warehouse, caters to small to medium-sized spare parts measuring less than 2 meters. This section comprises both ground floor and first-floor areas, dedicated respectively to storing mechanical parts and electrical parts.

The process of receiving goods at PT. ABC's spare parts warehouse varies in duration, depending on the characteristics of the received items or spare parts. Receiving large items, such as bottom cone spare parts weighing 200 kg, typically takes longer, ranging from 10 to 70 minutes, as it necessitates ample transit space and material handling equipment for transportation. Conversely, receiving small to medium-sized goods generally takes around 15 to 20 minutes, contingent upon the quantity received. In practical conditions, warehouse staff often encounter delays while waiting for unloading areas and the availability of forklifts. They may also engage in multitasking, temporarily relocating large spare parts within the maintenance warehouse floor to facilitate access for material handling tools like stackers. However, such field conditions may still lead to waste in other activities.

The waiting time for forklifts and unloading areas, along with the repetitive movement of goods (spare parts) within the maintenance warehouse during receiving activities, constitutes waste [11]. These activities do not contribute value to the process or the handled goods (spare parts). Thus, it is crucial to implement lean concepts in goods receiving activities to reduce or eliminate existing waste, thereby optimizing processing time [12].

Therefore, this final project research conducted at PT. ABC endeavors to provide a solution by reducing waste in the process of receiving machine spare parts, thereby improving the efficiency and effectiveness of the goods receiving procedure. Lean warehousing embodies the principle of identifying and eradicating waste within warehouse operations or processes to expedite the fulfillment of customer requirements [13][14]. It entails the elimination of non-

value-added activities and waste throughout the material storage process within the warehouse [15]. Lean warehousing has been widely used in previous research and has been proven to effectively eliminate waste in the warehouse [16][17][18][19].

B. Research Method

Lean warehousing entails the principle of recognizing and eradicating inefficiencies within warehouse operations or processes to expedite the fulfillment of customer demands [20][21]. It involves the elimination of non-value-added activities and waste throughout the material storage process in the warehouse. In order to pinpoint the seven types of waste within the spare parts warehouse, researchers at PT. ABC employed various methodologies to uncover the underlying issues in warehouse activities. These methodologies included value stream mapping, assessment of warehouse activity values (value-added, non-value-added necessary, and non-value-added unnecessary), waste identification, 5W+1H analysis, and 5-Whys Analysis.

C. Result and Discussion

Data Collection

1. Data on Spare Part Receiving Activity Time in the Warehouse

To find out the activity time for receiving spare parts in the warehouse, use the stopwatch time study method. The stopwatch method used is repetitive timing where the number on the stopwatch returns to zero after each process is completed.

Table 1. Recap of Observation Results of Bottom Cone Spare Part Receiving Activity Time in the Maintenance Warehouse

No	Activity	Processing Time	Observations (Minutes)			Total Time	Average
			1	2	3		
1	Inspection	Waiting for unloading space to be available	5	5,5	5,2	15,7	5,23333
		Waiting for forklift availability	10	15	12	37	12,3333
		Go to the unloading area in the WCP area	3,5	4	3,7	11,2	3,73333
		Check the travel document with the attached purchase order	4	4,6	4,4	13	4,33333
		Unloading goods from suppliers	3,8	8,4	4,3	16,5	5,5
		Matching travel documents with the system	2	2,5	2,3	6,8	2,26667
		Check the quality and quantity of goods	5,2	6	5,4	16,6	5,53333
		Sign the travel document	1,8	2,1	2	5,9	1,96667
2	Placement of spare parts on shelves	Towards the maintenance warehouse spare parts warehouse	4	5,5	5,2	14,7	4,9
		Look for empty shelves	3,1	3,6	3,3	10	3,33333

No	Activity	Processing Time	Observations (Minutes)			Total Time	Average
			1	2	3		
		Pick up material handling tools	2,3	2,7	2,2	7,2	2,4
		Move spare parts in boxes to pallets using a stacker	13,14	24	15	52,14	17,38
		Temporarily move large spare parts to access the stacker road	8	10	9	27	9
		Place spare parts on shelves	15	30	20	65	21,6667
3	Labeling	Make spare part labels	1,25	1,5	1,3	4,05	1,35
		Attach spare part labels	2	2,6	2	6,6	2,2
4	Form Writing	Write stock card forms	1,2	2	1,5	4,7	1,56667
		Write a stock item form	1	2	1	4	1,33333
		Go to the computer desk in the store room	2,7	3	2,4	8,1	2,7
5	*Posting Receiving*	Post receiving	1,2	1,6	1,3	4,1	1,36667
		Keep a copy of the travel letter from the supplier for archiving	1	1,3	1,2	3,5	1,16667

2. Waste Weighting

The questionnaire for waste weighting contains a statement regarding the type of waste and a score table using a Likert scale with a minimum value of 1 and a maximum of 5. The questionnaires distributed to 3 respondents and the results and summary of the questionnaire were obtained as follows:

Table 2. Recap of Questionnaire Collection Results

No	Waste Type (Waste)	Respondent		
		R1	R2	R3
1	Excessive Transportation	4	3	3
2	Unnecessary Inventory	5	5	2
3	Unnecessary Movement	3	3	2
4	Waiting	5	5	2
5	Innapropriate Processing	5	3	3

Data Processing

1. Waste Rangking

Table 3 below is the outcomes derived from the process of documenting, computing, and organizing the survey findings concerning inefficiencies in spare parts reception procedures within the maintenance warehouse.

Table 3. Waste Questionnaire Calculation Results

No	Waste Type	Respondent			Average	Ranking
		R1	R2	R3		
1	Waiting	5	5	2	4	1
2	Unnecessary Inventory	5	5	2	4	2
3	Innapropriate Processing	5	3	3	3,67	3
4	Excessive Transportation	4	3	3	3,33	4
5	Unnecessary Movement	3	3	2	2,67	5

2. Value Stream Analysis Tools (VALSAT) analysis

Value Stream Analysis Tools (VALSAT) score calculation can be seen in Table 4 below.

Table 4. VALSAT Score Calculation

Waste	Average Score	PAM	SCRM	PVF	QFM	DAM	DPA	PS
Waiting	4	36	36	4	-	12	12	-
Excessive Transportation	3,33	29,97	-	-	-	-	-	3,33
Inappropriate processing	3,67	33,03	-	11,01	3,67	-	3,67	-
Unnecessary Inventory	4	12	36	12	-	36	12	4
Unnecessary movement	2,67	24,03	2,67	-	-	-	-	-
Total		135,03	74,67	27,01	3,67	48	27,67	7,33

From the results that can be seen in Table 4, The highest weight value will be selected for the VALSAT tool. Table 5 below is the VALSAT score ranking:

Table 5. Determination of VALSAT Tools

No	VALSAT	VALSAT Total Score	Ranking
1	Process Activity Mapping (PAM)	135,03	1
2	Supply Chain Response Matrix (SCRM)	74,67	2
3	Demand Amplification Mapping (DAM)	48	3
4	Decision Point Analysis (DPA)	27,67	4
5	Product Variety Funnel (PVF)	27,01	5
6	Physical Structure (PS)	7,33	6
7	Quality Filter Mapping (QFM)	3,67	7

3. Analysis of Selected VALSAT Tools

The choosen VALSAT tool, specifically Process Activity Mapping (PAM). As described by Hines and Rich (1997), as cited in Anggraeni et al. (2018), the Process Activity Mapping (PAM) approach involves meticulously mapping out the process step by step and categorizing it into distinct activity types, beginning with value-adding activities, followed by non-value-adding and necessary non-value-adding activities. These activity types encompass Operations, Transportation, Inspection, Storage, and Delay, as outlined in Table 6.

Table 6. Frequency Percentage and Time Results for Each Activity

No	Activity	Number of Activities	Percentage	Time (minutes)	Percentage
1	Operation	12	57 %	43,86	39 %
2	Transportation	3	14 %	11,33	10 %
3	Inspection	2	10 %	7,8	7 %
4	Storage	1	5 %	21,67	19 %
5	Delay	3	14 %	26,56	24 %
	Total	21	100 %	111,22	100 %

The next step is to grouped activities into types of activities, namely value added activity, non value added activity, and necessary non value added activity.

Table 7. Frequency Percentage and Time Results of Activity Types

No	Activity	Frequency	Percentage	Time (minutes)	Percentage
1	*Value Added Activity*	12	57 %	62,1	56 %
2	*Non Value Added Activity*	3	14 %	26,56	24 %
3	*Necessary Non Value Added Activity*	6	29 %	22,56	20 %
Total		**21**	**100 %**	**111,22**	**100 %**

4. Fishbone Diagram (Cause-Effect)

This analysis aims to generate recommendations for improvements. The following outlines the identification of causes and consequences of waste in spare part receiving activities at the maintenance warehouse, depicted through cause-and-effect diagrams illustrated in Figures 1 to 5 below:

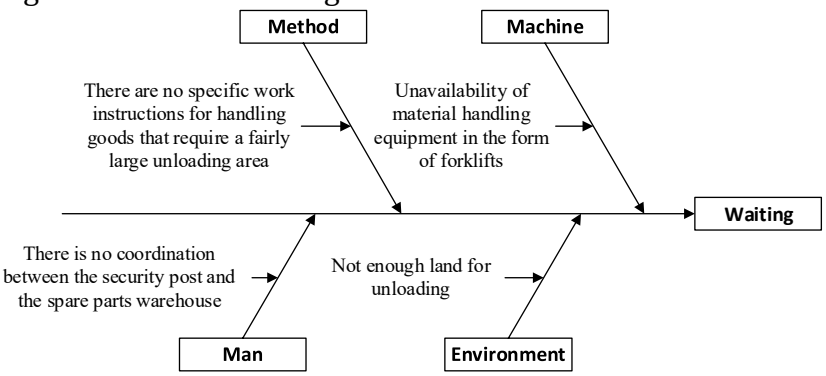

Figure 1. Types of Waiting Waste

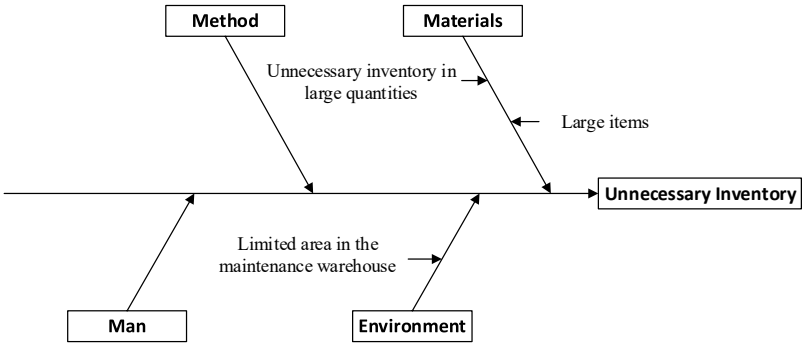

Figure 2. Types of Unnecessary Inventory Waste

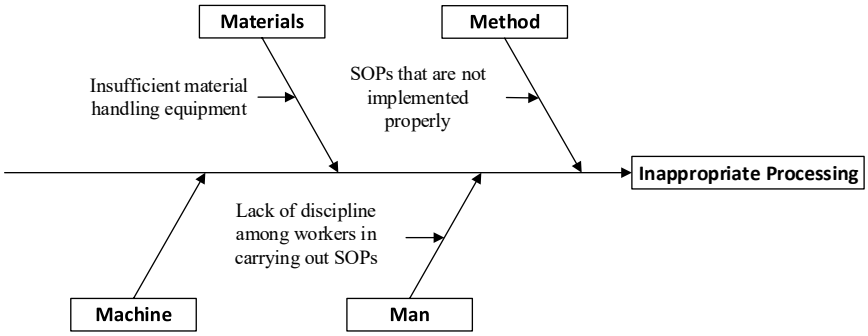

Figure 3. Types of Waste Inappropriate Processing

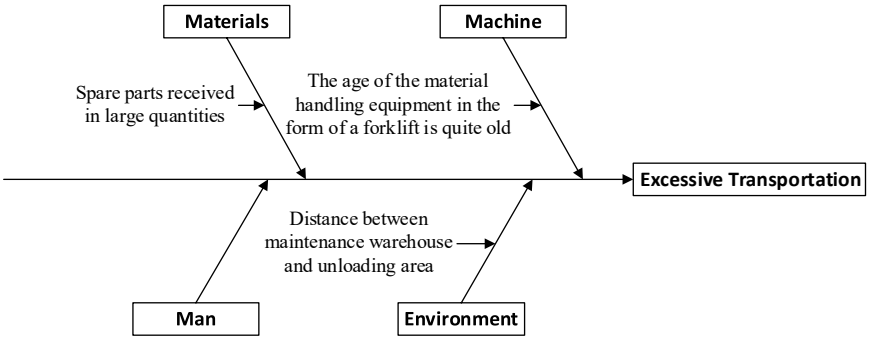

Figure 4. Types of Excessive Transportation Waste

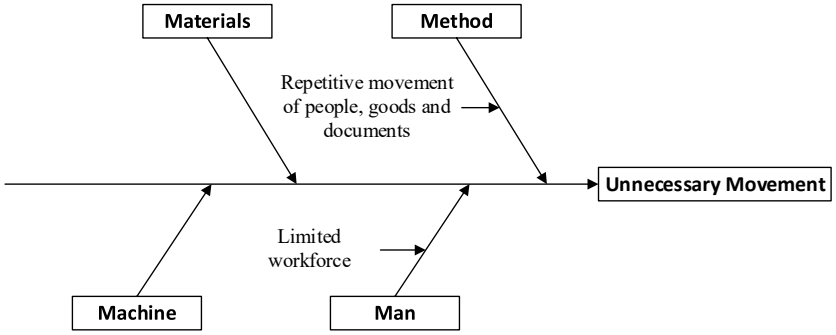

Figure 5. Types of Unnecessary Movement Waste

5. 5-Whys Analysis

This 5-whys analysis is based on the results of bainstorming with warehouse workers and the results of ranking the results of the waste identification

questionnaire. Below is a 5-whys analysis table regarding activities and causes of waste waiting, unnecessary inventory, and inappropriate processing.

a. Waste Waiting

Table 8. 5-Whys Analysis of the First Problem

First Problem:
Waiting for information regarding the availability of WCP (Waste Center Point) forklifts and the unloading area when warehousing activities are busy, specifically at the spare parts warehouse, so warehouse workers have to go back and forth from the WCP to the store room or spare parts warehouse to find out the availability of forklifts and the unloading area.
Why?
The limitation of material handling equipment is in the form of a forklift which is only intended for receiving spare parts in the maintenance warehouse.
Why?
There is no coordination between the security post (as the party that regulates the entry and exit of loaded trucks) and the warehouse which requires a large unloading area to receive large spare parts.
Why?
There are no specific work instructions for handling goods that require a large unloading area.

b. Waste Unnecessary Inventory

Table 9. 5-Whys Analysis of the Second Problem

Second Problem:
Warehouse workers, when placing newly arrived spare parts on the shelves, need to find an empty location first and move other spare parts to make it easier to access the material handling tool in the form of a stacker.
Why?
There is limited land available in the maintenance warehouse.
Why?
A large number of large spare parts which are non-moving goods are in the maintenance warehouse.

c. Waste Inappropriate Processing

Table 10. 5-Whys Analysis of the Third Problem

Third Problem:
Warehouse workers manually move spare parts from boxes to pallets in the maintenance warehouse, which can cause work accidents when moving spare parts from boxes to pallets in the maintenance warehouse.
Why?
Indiscipline of warehouse workers in carrying out SOPs when moving spare parts from boxes to pallets in the maintenance warehouse.
Why?
Lack of knowledge among warehouse workers about the risk of work accidents when lifting spare part loads exceeding 30 kg.
Why?
Insufficient material handling equipment is available to lift spare part loads of more than 30 kg.

6. Proposed Improvements Using the 5W+1H Method

This repair solution is based on actual conditions at the PT. ABC maintenance warehouse.

Table 11. 5W+1H First Solution

First Root Problem Solution: The limited number of forklifts, lack of coordination between the security guard and the warehouse which requires a large unloading area, and the absence of specific work instructions for receiving large spare parts.	
What	Procurement of material handling equipment in the form of forklifts specifically for warehouse maintenance warehouses as well as providing special forklift driver training for warehouse workers. Implementing the use of communication tools such as telephones, to facilitate coordination if there is a delivery of spare parts that requires a large unloading area. Determine specific work instructions for receiving large spare parts that require a fairly large unloading area.
When	When receiving large spare parts.
Where	In the maintenance warehouse.
Who	Store helper and security guard
Why	To speed up the flow of the process of receiving sent spare parts. So store helpers don't need to go back and forth to confirm item information and check the availability of forklifts and unloading areas.
How	When the supplier delivers goods, the security post will contact the store helper to immediately receive and unload the goods. After the store helper arrives at the security post, the store helper will contact the store keeper to confirm the quantity of goods written on the goods delivery document from the supplier (way document) with the Purchase Order (PO) document in the MAXIMO 7 system operated by the store keeper. If the goods are suitable, the store helper will receive the goods and unload the delivery truck. Apart from that, when goods receiving activities are carried out but there are no forklifts and unloading areas available, the store helper can contact the security guard to confirm the availability of forklifts and the unloading area and arrange traffic along the unloading area so that it does not interfere with spare part receiving activities.

Table 12. 5W+1H Second Solution

Second Root Solution to the Problem: Limited land and a large number of spare parts which are classified as non-moving goods are in the maintenance warehouse.	
What	Adding a special warehouse to store non-moving goods and prioritizing the release of non-moving spare parts (if the spare parts are suitable for the machine that is having trouble) so that there is no long accumulation of non-moving spare parts.
When	When receiving large spare parts.
Where	In the maintenance warehouse.
Who	Store helper.
Why	To reduce excessive movement of the store helper when placing large spare parts on the shelf, they must first move the spare parts on the floor to provide space for the material handling tool in the form of a stacker.
How	The store helper will place large spare parts on the shelf by first taking a material handling tool in the form of a stacker, then lifting the spare parts and then placing them on an empty shelf and arranged neatly.

Table 13. 5W+1H Third Solution

Third Root Problem Solution:	
The lack of complete material handling equipment available in the maintenance warehouse caused warehouse workers to move spare parts weighing 30 kg manually.	
What	Procurement of material handling equipment in the form of an engine crane to make it easier for warehouse workers to lift spare parts that weigh more than 30 kg. The following is a picture of a crane engine. 
When	During the activity of moving spare parts from boxes to pallets that weigh more than 30 kg.
Where	Warehouse from maintenance warehouse.
Who	Store helper.
Why	To make it easier for store helpers to lift spare parts weighing more than 30 kg and also to avoid work accidents, both light work accidents and heavy work accidents.
How	When the store helper wants to move spare parts from boxes to pallets weighing more than 30 Kg, the store helper uses the help of a material handling tool in the form of an engine crane by tying the goods with a webbing sling then the webbing sling is attached to the hook on the tool after that the spare Parts can be moved from boxes to pallets that are available in the maintenance warehouse.

7. Future State Mapping Analysis

From the explanation of the solution obtained using the 5W+1H method, activities classified as non-value added and necessary non-value added can be suppressed or reduced.

Table 14. Time Adjustment for Spare Part Receiving Activities at the Maintenance Warehouse

No	Process Description	Processing time before repair (Minutes)	Processing time after repair (Minutes)
1	Waiting for unloading space to be available	5,23	0
2	Waiting for forklift availability	12,33	0
3	Temporarily move large spare parts to access the stacker road	9	0
	Total	26,56	0

For more details, you can see in the picture below the future state mapping of spare part receiving activities at the maintenance warehouse as follows:

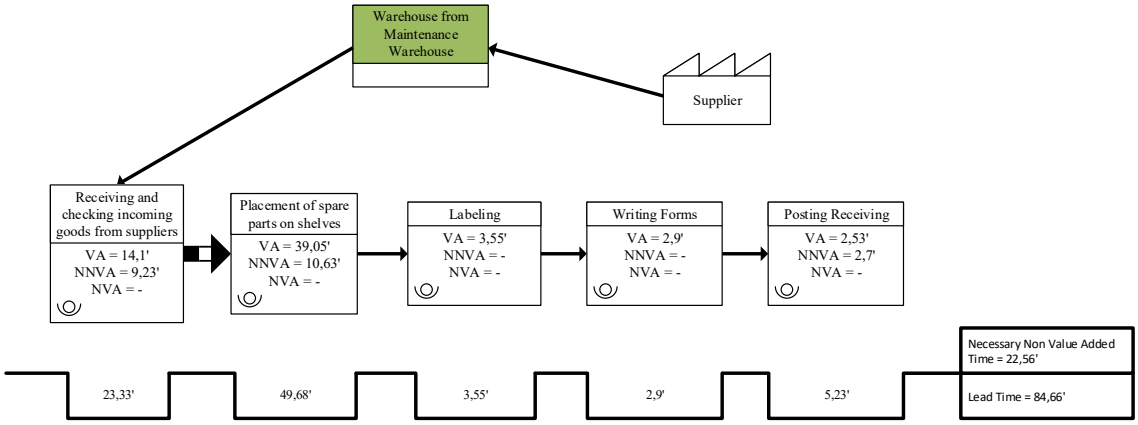

Figure 10. Future State Mapping

After obtaining the time calculation after repair, the next stage is to compare the initial time with the time after repair as follows:

Table 15. Proposed Activity Calculation

No	Activity	Frequency	Percentage	Time (minutes)	Percentage
1	*Value Added Activity*	12	67 %	62,1	73 %
2	*Non Value Added Activity*	0	0 %	0	0 %
3	*Necessary Non Value Added Activity*	6	33 %	22,56	27 %
Total		**18**	**100 %**	**84,66**	**100 %**

D. Conclusion

By using lean tools, namely Value Stream Mapping (VSM), lead time can be reduced for non-value added activities, namely the activities of waiting for the availability of an unloading place, waiting for the availability of a forklift and temporarily moving large spare parts to access the stacker road. Where the initial lead time of 111.22 minutes can be reduced to 84.66 minutes.

Based on the analysis of the 5-whys analysis method, it is known that the root cause of the problem in waste in spare part receiving activities in the maintenance warehouse is the first problem, namely the limited number of forklifts and lack of coordination between the security guard and the warehouse which requires a large unloading area for reception. large spare parts, the second problem is limited land and a large number of spare parts which are classified as non-moving goods in the maintenance warehouse, the third problem is the lack of complete material handling equipment available in the maintenance warehouse, causing warehouse workers to move spare parts from box onto a pallet weighing 30 kg manually.

Recommendations for improvements that can be proposed using the 5W+1H method are the solution to the first problem, namely procuring material handling equipment in the form of forklifts specifically for warehouse maintenance warehouses as well as providing special forklift driver training for warehouse workers, implementing the use of communication tools such as telephones, to make coordination easier. If there is a delivery of spare parts that requires a large unloading area, as well as establishing specific work instructions for receiving

large spare parts that require a fairly large unloading area, the solution to the second problem is to add a special warehouse to store non-moving goods and prioritize releasing spare parts. non-moving parts (if the spare parts are suitable for the troublesome machine) so that there is no long accumulation of non-moving spare parts, and the solution to the third problem is the provision of material handling equipment in the form of an engine crane to make it easier for warehouse workers to move spare parts from boxes to pallets weighing more than 30 kg to avoid work accidents.

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