MECOMARE, 12 (3) (2024) pp. 89-97

Published by: TRIGIN Publisher

International Journal of Mechanical Computational and Manufacturing Research

Journal homepage: www.trigin.pelnus.ac.id

Value Stream Mapping for Warehouse Process in Automotive Manufacturing Case

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ARTICLE INFO

Article history:

Received Oct 2, 2024
Revised Oct 22, 2024
Accepted Dec 5, 2024

Keywords:

KD Parts Warehouse;
Lean;
NVA & NNVA;
Process Mapping Analysis;
Value Stream Mapping.

ABSTRACT

KD parts warehouse is a transit and connection place before the KD parts (Knock Down) car's body and material from Automotive manufacturing, to export destination in several countries or destination. The faster the warehouse operation process will make the company's export performance better. This research aims to reduce NVA and NNVA activities' concern in warehouse KD operations in Japanese automotive manufacturers in Cikarang. The application of lean thinking with the VSM (Value Stream Mapping) approach eliminates the waste of activities and processes in the KD warehouse. From the CVSM and PMA (Process Mapping Analysis) results, the work efficiency is 63%, with NVA time of 244.5 minutes and an NNVA time of 471 minutes. In the future state map, the work efficiency becomes 82% due to kaizen improvement, re-layout, and process redesign in the warehouse, with the total NVA become zero and NNVA reduce to 177 minutes.

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1. INTRODUCTION

Competition in the Indonesian automotive industry is currently very high competitive. It forces for each automotive manufacturing companies to carry out effectiveness and efficiency in all their business processes, start from the production or manufacturing process, sales process until to the supply chain management process (Maryadi, 2021). Based on data from the Automotive Industry Association in Indonesia (Gaikindo 2015: 2019), there was an increase in the number of exported KD (Knock Down) parts or car components from 2015-2019 for four-wheeled vehicles and can be seen in the graphical figure 1. in the form of KD (Knock Down) parts, and it is undoubtedly a challenge to further increase profits for the company, by achieving better QCT (Quality, Cost and Time) levels continuously (Tamalika et al., 2022;Marwan et al., 2024:Maryadi et al., 2024).

KD (Knock Down) parts Warehouse is a select warehouse owned by one of the large automotive manufacturing companies from Japan-based in Cikarang, West Java, Indonesia. The company created the new warehouse in February 2019, which is devoted to goods to be sent abroad or export of parts in the form of WIP products for car production or after-sales spare parts in the destination country. The warehouse is one part of supply chain management in a company, especially automotive manufacturing. And it is imperative to do continuous improvement or continuous improvement to achieve a better level of productivity (Maryadi et al, 2023).

Implementing lean principles in a warehouse can significantly improve the material storage warehouse's performance by reducing stock losses and controlling the delivery process (Pereira et al., 2020) and (Guzmán et al., 2018). From (Oey & Nofrimurti, 2018) they found that the implementation of lean in traditional warehouses owned by SME's for drug distribution in Indonesia. It can increase the overall warehouse operation process flow, reduce process cycle time, and increase overall warehouse productivity. Lean tools significantly impact the warehouse work operation process by increasing warehouse performance by reducing process lead times and reducing inventory levels (Anđelković et al., 2017)(Pereira et al., 2020)(Prasetyawan et al., 2020).

Lean concept has first introduced in the Toyota production system (TPS) concept in 1988, introduced by Taiichi Ohno. The main objective is to reduce and eliminate waste from all processes and then increase speed and flow. Simultaneously, the desired output increases productivity, efficiency, and effectiveness in the process, which then impacts creating value for customers (Garza - Reyes et al.,2015)(Arturo, 2020). One of the lean approach's essential methods is identifying and classifying activities that can provide added value and not provide added value (Nyoman Pujawan., 2009)(Maulana, 2019)(Ridwan et al., 2020)(Maryadi et al, 2023). In this context, it can be classified into three, as follows: Non-Value Add activity (NVA): This is an activity that does not add value to a work process. Value Added activity (VA): Activities that provide value changes and additions to the product. Last is, Necessary but Non-Value Add activity (NNVA): An activity that does not provide added value but cannot eliminate.

Implementing lean thinking itself can be carried out systematically if it has followed several steps that compiled as follows (Nyoman Pujawan., 2009:Garza-reyes et al., 2015;Maryadi et al., 2024): Understands the occurrence of waste by sorting it into 3 classifications of NVA, VA, or NNVA. Next, setting the direction of improvement to be carried out, determining the target of improvement, selecting the measuring tool for success, determining which processes require detailed mapping. Understand the general picture (big picture). Perform mapping in detail using several existing mapping techniques. After that, we involve customers or suppliers. Last is check the goals and achievements.

Warehouse management has several essential parts in every logistics system and supply chain of a company, consisting of several processes: (Reis et al., 2017;A. Z. Abideen & Mohamad, 2019) develop improvement warehouse operations through KPI improvements with research subjects, namely traditional warehouses in Brazil and Malaysia. The results and findings of improved warehouse management performance improved the work environment better before improvement with lean.(A. Abideen & Mohamad, 2020) using value stream mapping by integrating it with DES (discrete event simulating) with a case study in a Malaysian pharmaceutical manufacturing company. With the research findings in the form of VSM future state with a reduction in cycle time and total lead time that is shorter than before the improvement.

Lean implementation improves the process and increases the process's overall performance, both internal and external (Alicke & Lösch, 2010; Pattanawasanporn, 2014;Maryadi, 2021;Dhinar et al., 2023:Azhari et al, 2024). Detail shows a summary of research potential using lean in a warehouse based on several previous research reviews as follows: Internal Warehouse: First, people: Increase efficiency and flexibility of labor (1-5 % Potential saving cost). Second process: Reduce handling steps and touches for each product between receiving and shipping (4-9% potential saving cost). Third performance Management: Ensure continuous improvement efficiency (2-5% potential saving cost). Last is Warehouse Layout: Optimize layout structure and align with local requirements and restrictions (3-4% Potential saving cost). For External Warehouse first is Interaction with 3rd parties: Interaction with 3rd parties (0-4 % Potential saving cost). And the second for Ownership: Optimize contract and service provider (0-4% Potential Saving Cost).

Based on the description above, this study take the application of Lean tools in operating a KD Parts warehouse in one of the large Japanese automotive car manufacturing companies in Indonesia with the objective in this research has an output in the form of work process improvement in the warehouse or logistic processing, lead time reduction, process, and activity waste elimination, reduction of process cycle time in KD Parts warehouse to achieve better efficiency and effectiveness (Muhali et al., 2019;Ekawati & Lestari, 2023;Nayak & Choudhary, 2022). Implementing Lean Warehouse practices in the KD (Knock Down) Part Warehouse of an automotive company more practical implications, enhancing operational efficiency and overall performance for the company.

2. RESEARCH METHOD

In this study, using a lean approach with the value stream mapping method to analyze the waste in the warehouse operation process is used to make improvements to achieve a better level of work effectiveness. This research began with a preliminary study, followed by an analysis to identify value-added and non-value-added processes using Value Stream Mapping (VSM) alongside Process Mapping Analysis. Subsequently, an improvement proposal was developed to eliminate non-value-adding activities within the operational system of the KD Parts warehouse.

3. RESULTS AND DISCUSSIONS

Current State Value Stream

Some of the KD warehouse work processes include receiving, marshaling, setting and sequence, shipping, and loading. Detailed activities for each function can see in Table 1 below:

Table 1. The detail and actual activity in KD Warehouse

Process	Sub Process	Detail Process	Process Code	Cycle Time (Min)
Receiving	Checking	Receive Delivery Notes from supplier	CR01	3'
		Checking 100% quantity confirmation	CR02	15'
		Waiting PO confirmation from administration logistic office	CR03	17'
		Validation Delivery Notes	CR04	22'
		Waiting QC Confirmation	CR05	10'
		Empty Packaging confirmation	CR06	12'
		Create Delivery notes for empty packaging	CR07	4'
	Unloading	Forklift preparation point	UR01	1,5'
		Forklift permit usage	UR02	2,5'
		Go to the truck docking area	UR03	3'
		Communication with Checker	UR04	3'
		Carrying out material from a truck	UR05	40'
		Put to the checking area	UR06	22'
		Go to the empty packaging area	UR07	8'
		Take empty packaging	UR08	17'
		Carrying in empty packaging to truck	UR09	13'
		Return to the forklift preparation area	UR010	4'
		Fill finish permit forklift usage	UR011	3'
	QC Point	Cheker calling QC team	UQC01	7'
		Waiting QC coming	UQC02	15'
		QC Checking 100%	UQC03	23'
		QC Label ("QC PASS")	UQC04	8'
Marshaling	Checking	Go to Checking Area	CM01	7'
		Waiting finish the checking process	CM02	34'
		Separating parts based on warehouse classification	CM03	42'
		Go to a Warehouse location	CM04	13'
	Posting	Waiting for confirmation from the administration process	MP01	23'
		Checking label and warehouse location	MP02	12'
		Posting parts to warehouse	MP03	39'
		Take Empty Pallet	MP04	31'
		Posting empty pallet to the empty packing area	MP05	15'
Setting and Sequence	Stock Control	Update stock amount in each warehouse	MS01	20'
		Fill amount in form stock report	MS02	12'
	Setting	Waiting confirmation for setting parts form from foreman	SS01	8'
		Walking to a warehouse location	SS02	7'
		Take dolly supply for setting parts	SS03	13'
		Searching part address	SS04	27'
		Take parts and put to dolly	SS05	49'
	Sequence	Waiting confirmation for sequence parts form from foreman	SQ01	9'
		Walking to the warehouse location	SQ02	6'

Picking	Picking	take dolly for sequence parts	SQ03	10'
		Searching part address	SQ04	31'
		Take parts and put to dolly	SQ05	43'
		Preparation empty case	PP01	28'
		Waiting for confirmation from foreman	PP02	6'
		Take list part for picking list in the logistic office	PP03	17'
		Manual wrapping plastics	PP04	102'
		Take parts and put in each case (follow picking list)	PP05	345'
		Waiting for QC coming to unpacking	PP06	13'
		QC Checking and QC pass	PP07	24'
		Put label tag in each case based on destination	PP08	61'
		Set a ready case to the finish area (use electric hand lift)	PP09	41'
Shipping and loading	Shipping	Forklift preparation point	SL01	1,5'
		Forklift permit usage	SL02	2'
		Go to the truck docking area	SL03	6'
		Waiting for QC coming to unpacking	SL04	13'
		QC PASS for loading and shipment to truck	SL05	24'
		Carrying in the case to truck	SL06	32'
		Return to the forklift preparation area	SL07	6'
		Fill finish permit forklift usage	SL08	1,5'
Administration	Good Receive	Take D/N from the unloading gate to the office	GR01	19'
		separating based on warehouse code	GR01	12'
		Posting PO material to the system	GR01	23'
		Fill in the database for each material coming	GR01	15'
		Confirmation material incoming to PPC team	GR01	12'
	Good Issue	Take D/N from loading gate to office	GI01	19'
		Posting PO material to the system	GI01	33'
		Fill in the database for each material outgoing	GI01	20'
		Confirmation material outgoing to PPC team	GI01	13'
Total Cycle Time			1593	

Furthermore, the researchers made a current state value stream mapping (CVSM) to describe the process of KD parts warehouse cycle time, starting from receiving, marshaling, picking, shipping, and administration functions. Total is 1593 minutes for all operations with a limit of 1 lot of KD part production (1 lot = 60 units) to produce finished products. From Figure 3 Current State Value Stream Mapping (CVSM) of the KD parts warehouse process, it can see that the cycle time of each process includes: Receiving a 253-minute process with a total inventory of 3 lots, a 248-minute marshaling process with a total inventory of 1 lot, setting and sequence processes for 203 minutes with a total inventory of 1 lot, picking process 537 minutes with inventory 1 lot, shipping and loading 86 minutes and the last administrative process with a cycle time of 166 minutes. The available working time for warehouse KD based on L/T shipment for export is 2 days with 2 shifts, 1 day is 960 minutes, total available time is 1920 minutes.

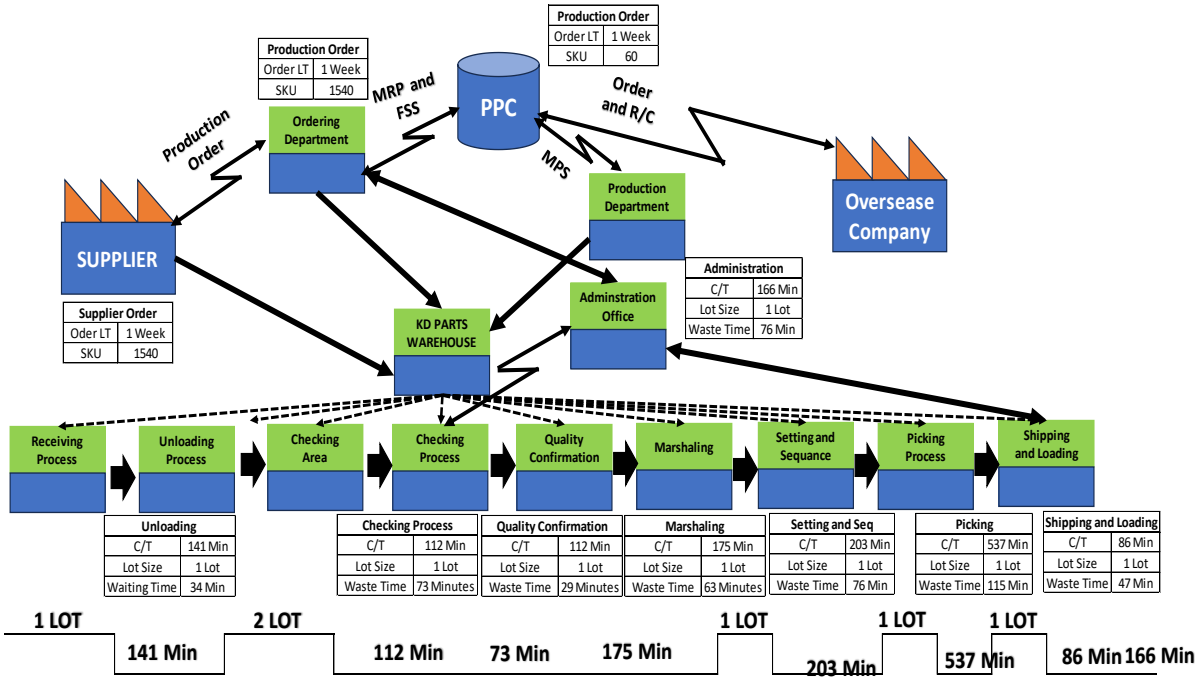

Figure 1. Current state value stream mapping (CVSM)

Process Activity Mapping (PMA)

Next, the researcher analyzes the waste that occurs with a classification based on non-value-added, value-added, and necessary but non-value-added using PMA (Process Mapping Activity) tools, which can see in Table 2 below.

Table 2. Process mapping activity

Job Code	Type								Identification			Job Code	Type								Identification		
	pe	ra	as	np	sp	ec	St	or	D	el	Dista	nce	V	A	N	V	N	V					
CR01	o										25		o						SS01							o					
CR02					o						3				o				SS02			o					17				o
CR03									o						o				SS03	o								o			
CR04	o										7		o						SS04				o				6				o
CR05									o						o				SS05	o								o			
CR06									o								o		SQ01							o	17				
CR07	o										25		o						SQ02			o									o
UR01	o										5		o						SQ03	o								o			
UR02					o										o				SQ04				o				10				o
UR03			o								17						o		SQ05	o								o			
UR04									o						o				PP01	o								o			
UR05	o										8		o						PP02							o				o	
UR06								o			24						o		PP03			o					13			o	
UR07			o														o		PP04	o											o
UR08								o									o		PP05	o								o			
UR09	o												o						PP06							o				o	
UR10			o								5						o		PP07				o								o
UR11					o										o				PP08	o								o			
UQC01									o						o				PP09			o					6				o
UQC02									o						o				SL01	o								o			
UQC03									o						o				SL02				o								o
UQC04									o								o		SL03			o									o
CM01			o								17				o				SL04							o	17			o	
CM02									o						o				SL05							o					o
CM03	o																o		SL06	o								o			
CM04			o								18						o		SL07			o									o

MP01				o			o		SL08		o				o	
MP02			o					o	GR01			o	17		o	
MP03	o				20	o			GR02		o					o
MP04				o	12	o			GR03	o				o		
MP05		o			5			o	GR04			o				o
MP06				o		o			GR05	o				o		
MS01			o			o			GI01			o	17		o	
MS02	o					o			GI02	o				o		
									GI03			o				o
									GI04	o				o		

The Yamazumi chart results show the non-value-added (NA) value of time waste for each warehouse process. So the current goal is to eliminate waste in the form of non-value added and reduce necessary but non-value added (NNVA). After that, the researchers analyzed the process efficiency using the results of the CVSM analysis and the PAM table. The form of the calculation formula is as follows.

$$Available\ working\ hour - (NVA + NNVA)time\ = Effective\ Working\ hour \ldots\ldots(1)$$

$$Work\ Efficiency\ = \frac{Effective\ Working\ Hour}{Available\ Working\ Hour} x\ 100\% \ldots\ldots\ldots\ldots(2)$$

Before applying lean:

Available working hour = (1 day (2 shift)) x 2 = (2x(8x60)) x 2 = 1920 Minutes
Effective working hour = 1920 – (244,5 +471) = 1204,5

$$Work\ Efficiency\ = \frac{1204,5}{1920} x\ 100\% = 63\%$$

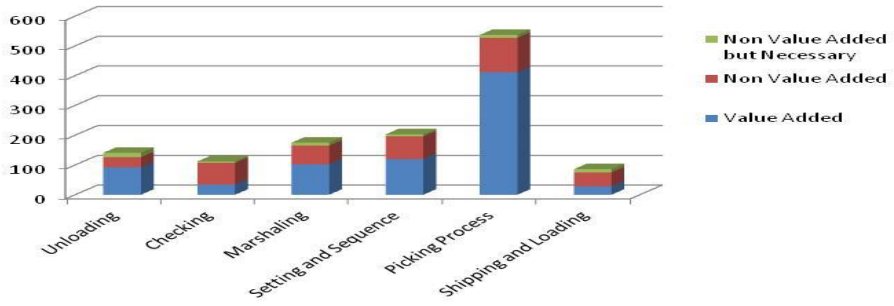

Figure 2. Yamazumi chart

Improvement

Re-layout warehouse

The proposed improvements to the warehouse layout include: a) Additional for picking area of 800 m2, to reduce waiting time for the picking process; b) Making a QC check area of 12 m2 to provide a particular area for the QC team, so there is no waiting process during checking activities in the receiving process near the loading dock area and shipping dock area; c) Addition of an office logistic team area adjacent to the loading dock area and shipping dock area with computer and internet equipment. Its purpose in eliminating the waiting process in warehouse administration activities.

Redesign process and kaizen

Several points of improvement for the redesign process in the KD warehouse, including: a) Making new SOPs (standard operating proceedings) related to several proposed activities, namely: QC Point checking stand by and administration logistic office near the warehouse's loading/unloading gate; b) Job and manpower balancing in the picking process. We are simplifying the administration process; c) Provision of handy talkies (HT) and cell phones for each leader to facilitate communication

between the warehouse processes; d) Packaging kaizen: quantity up and simplifying handling process. Do an expansion area (re-layout) for inspection and validation of delivery notes. Its purpose to reduce the waiting time for the checking and validation process; e) Picking improvement: Use of automatic wrapping machine auxiliary tools. Label and addressing improvement: use fruit names as a separator between unique parts, aimed at reducing searching time; f) Creation of a skid delivery module for each part, based on warehouse location/skid delivery. To eliminate the process of separating parts according to the warehouse location. Apart from that, it also aims to reduce the validation process and to check actual material.

Future State Mapping

After conducting simulations and trials related to improvement proposals, both warehouse re-layout, process redesign, and kaizen improvement, there was a significant change in the process cycle time by eliminating NVA, increasing the effectiveness of the VA process, but only reducing the time for NNVA. The total NVA time was successfully eliminated, and the NNVA become 177 minutes.

The last step is to calculate the work efficiency after the improvements are made using a lean approach, based on FVSM (future state value stream mapping). KD warehouse's productivity or working efficiency increased significantly far from the previous 63% to 90%.

Effective working hour = 1920 – (0 +177) = 1743

$$Work\ Efficiency\ = \frac{1743}{1920} x\ 100\%\ = 90\%.$$

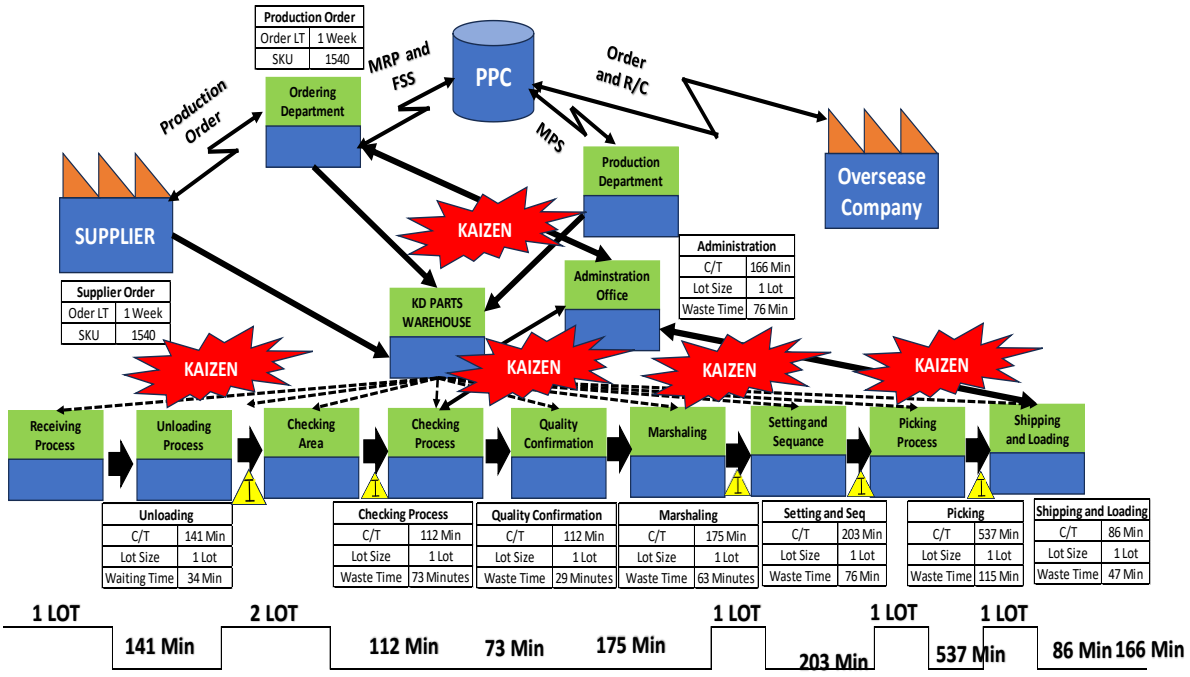

Figure 3. Future state value stream mapping (FSVSM)

4. CONCLUSION

Based on the analysis results above, it is proved that the lean approach with value stream mapping has a very significant and useful impact on the company in achieving even better production values, from 63% to 90%. However, there was no opportunity to apply more advanced technology in this study, such as using barcodes/scanners in the material code process, aiming to reduce the validation process and the searching time in the KD warehouse area. This research is limited to the research scope, which only focuses on reducing process waste in the KD warehouse area and does not touch

on optimizing warehouse inventory so, there's new opprtunity for future research improvoment related obejctive of the research. Meanwhile, for further research opportunities related to lean approaches, SIX SIGMA can be used or generally referred to as Lean Six Sigma to further research to optimize the KD warehouse process.

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