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Storage rack design to minimize Customer Claims at PT Rekadaya Multi Adiprima Using DMAIC, FMEA, and NIDA methods

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PT Rekadaya Multi Adiprima is a manufacturing industry that produces automotive components, especially for four-wheeled vehicles. PT Rekadaya Multi Adiprima is divided into four production divisions, namely the metal division, non-woven division, plastic division (service hole), and interior division. During the implementation of production at PT Rekadaya Multi Adiprima, there was still a customer claims process which was very detrimental to PT Rekadaya Multi Adiprima. Based on the results of interviews with quality staff, it was found that the number of claims occurring in 2022 at plant 1 of PT Rekadaya Multi Adiprima exceeded the tolerance set by the company, namely 0.05%. Based on these problems, further observations need to be made to resolve existing problems. The method used to solve this problem is the DMAIC (Define, Measure, Analyze, Improve, control) method with the help of the FMEA (Failure Mode and Effects Analysis) method based on customer claim data from July 2022- December 2022. The defining stage is carried out by analysis to determine product with the highest level of claims, the measurement stage involves calculating the DPMO value and Sigma Level, the analysis stage aims to find out the cause of the claim using the help of a fishbone diagram and the FMEA Table, in the improv stage the aim is to find and make improvements with the help of the 5W+1H Table based on the diagram fishbone and FMEA tables that have been made previously. As well as carrying out design using the NIDA method, the final stage of control is monitoring the expected improvement results. The results before the improvement, the DPMO value was 77,000 units with a sigma level of 2.925 and after the improvement the DPMO value decreased to 17,400 units with a sigma level of 3.611. The results of the improvements made reduced the level of customer claims by 61.93%.

1. Introduction

The world of manufacturing industry is now developing very rapidly. Every company must always make gradual and continuous improvements in order to be able to compete in the era of globalization (Al-kautsar et al., 2022). One of the things that can be improved is the quality produced by the industry. Often the quality produced becomes a benchmark for customers to cooperate with industry, therefore not a few manufacturing industries that always maintain the quality they provide (Miranda, 2002).

At the time of its implementation, the processes that occur in the industry do not always run smoothly, there are times when problems occur that can hinder the development of the industry (Eldrin & Sarvia, 2021). One of the problems that is often found in the industrial world, especially the automotive component manufacturing industry, is the occurrence of customer claims (Gaspersz, 2002). Customer claim is a process carried out by customers to suppliers by making claims or asking for responsibility due to non-conformities with specifications or provisions on a product. In the manufacturing industry, this customer claim process is quite detrimental to the company because it needs to be replaced or replaced products that are not in accordance with standards with new products according to existing standards (Hanifah & Iftadi, 2022; Hidayat & Rochmoeljati, 2020; Izzah & Rozi, 2019).

PT Rekadaya Multi Adiprima is one of the companies that produces automotive components that focuses on producing automotive components for four-wheeled vehicles. PT Rekadaya Multi Adiprima is divided into four production divisions, namely the metal division, non-woven division, plastic division (service hole), and interior division. Based on the results of interviews with quality staff, it was found that in 2022 the claims made at plant 1 of PT Rekadaya Multi Adiprima exceeded the tolerance set by the company, which was 0.05%. Based on the data collected, claims occurred in several parts produced at PT Rekadaya Multi Adiprima in the metal division.

This customer claim process is quite detrimental for PT Rekadaya Multi Adiprima because it needs to be replaced or replaced products according to the number of products claimed. Therefore, it is necessary to conduct research to find the cause of this claim process and then improvements can be made that can reduce or even solve this problem.

2. Research Method

In this study, a six sigma approach was used with the DMAIC method (Define, Measure, Analyze, Improve, Control). Here are five stages that will be carried out in the DMAIC method.

1. The Define stage is the stage of finding and determining the main problem to be solved at PT Rekadaya Multi Adiprima. At this stage using the help of tools, namely pareto diagrams and SIPOC diagrams.

2. The Measure stage is the second step in the DMAIC method, at this stage the determination of Critical to Quality (CTQ) is carried out which is then continued with the calculation of Defects per Million Opportunities (DPMO) and the determination of the Sigma Level.

3. Analyze stage at this stage analysis is carried out using Fishbone diagrams and FMEA (Failure Mode and Effect Analysis) tables to find causes and determine priorities for improvements that must be made to solve existing problems.

4. The Improve stage at this stage is improved according to the analysis carried out in the previous stage and using the help of the 5W + 1H Table. And make a repair design in the form of shelves using the help of the NIDA method.

5. Control stage where at this stage control will be carried out on repairs that have been carried out in the previous stage to ensure that the repair process remains stable and defects do not reappear.

The problem-solving framework used in this study is as follows:

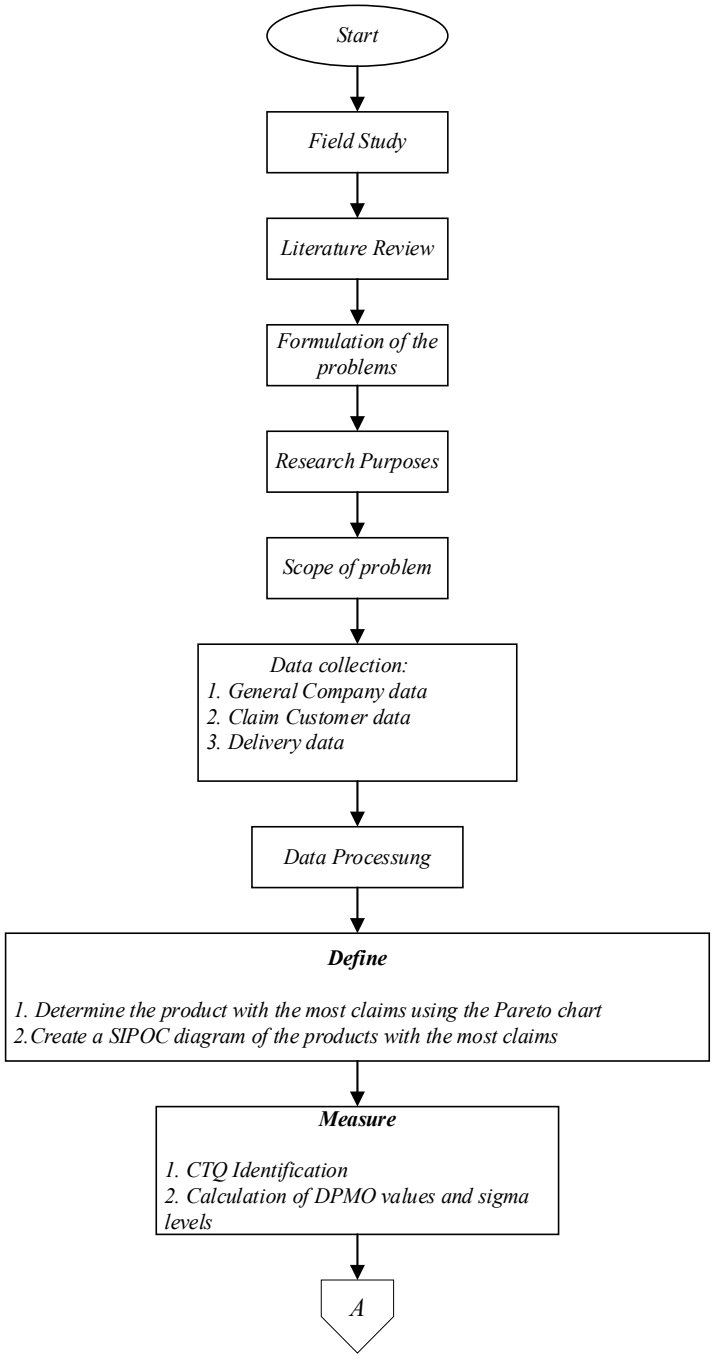


Figure 1. Troubleshooting Framework

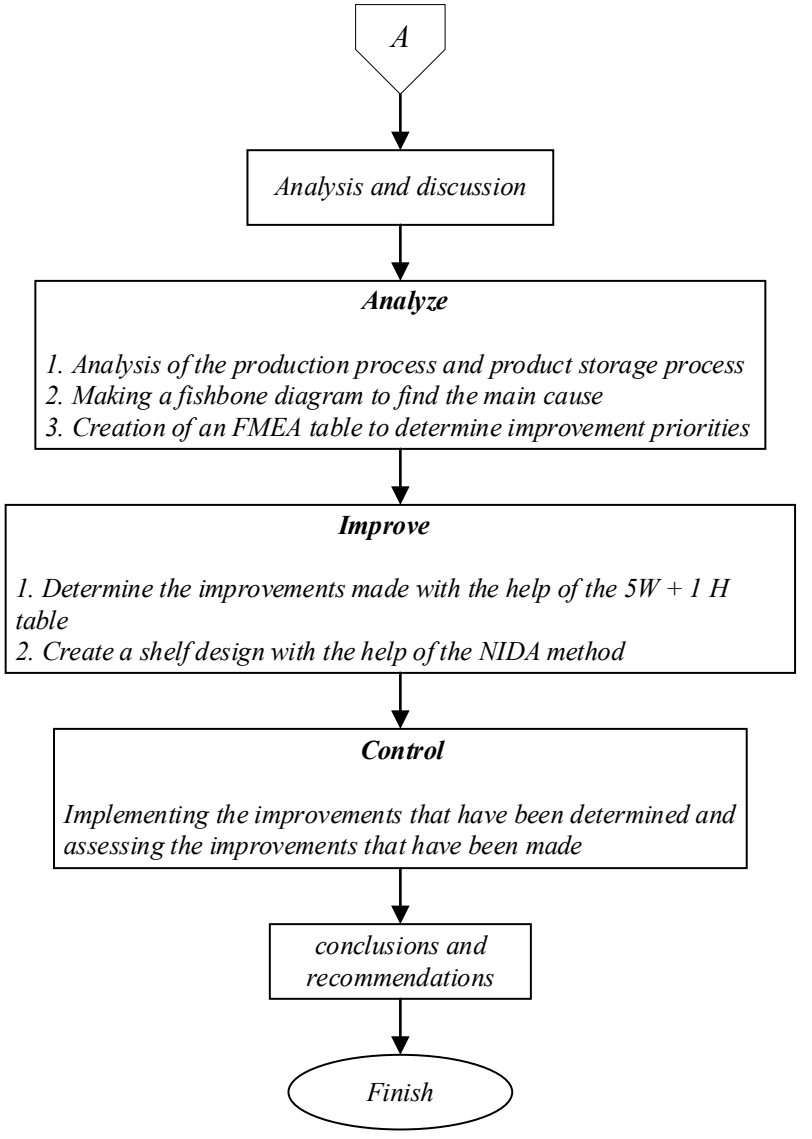


Figure 2. Troubleshooting Framework (Advanced)

3. Result and Discussion

3.1 Tahap *Define*

Define is the first stage in the DMAIC method, in this research the define stage starts from identifying problems, then identifying problematic products and determining the priority of products used as research material.

1. Identify the problem

PT Rekadaya Multi Adiprima is one of the companies that produces automotive components that focuses on producing automotive components for four-wheeled vehicles. Based on the data found, there are several products that experience *customer* claims, especially at plant 1 of the metal division of PT Rekadaya Multi Adiprima, therefore it is necessary to find what products experience *claims* and determine the products with the highest claim *rates and find solutions to minimize products with the highest customer* claim *rates* at plant 1 *of* PT Rekadaya Multi Adiprima.

Table 1. Data for July-December 2022

Product Name	*Product Image*	*Total Delivey (Pcs)*		*Claim customer*		
				Date	*Qty (Pcs)*	*Explanation*
Stay L		July	1.000	14/7/2022	90	*Rusty*
		August	1.000	24/8/2022	80	*Rusty*
		September	1.000	20/9/2022	70	*Rusty*
		October	1.000	18/10/2022	85	*Rusty*
		November	1.000	24/11/2022	65	*Rusty*
		December	1.000	21/12/2022	72	*Rusty*
Stay S		Juli	1.500	24/7/2022	60	*Rusty*
		September	1.500	20/9/2022	75	*Rusty*
		Desember	1.500	18/11/2022	78	*Rusty*
Rubber Sus (Plate IP-207224)		July	1.200	13/8/2022	125	*Thread Minus*
		August	1.000			
		September	1.325			
		October	1.900	21/10/2022	50	*Over bending*
		November	1.400			
		December	1.000			
Metal Stopper Bumper RR		July	1.200	10/10/2022	200	*Not Center*
		August	1.400			
		September	1.000			
		October	1.200			
		November	1.300			
		December	1.000			

2. Determine the product with the *highest* claim rate

Based on the data that has been obtained, it was found that there are several products that have *a fairly high number of customer claims*, along with some of these products.

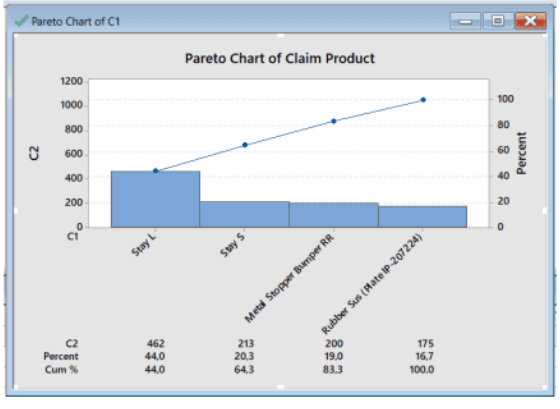


Figure 3. Diagram Pareto *Claim Product*

Based on the pareto diagram shown in Figure 3, it was found that the largest *customer claim* value was in the *Stay L* product with a total of 462 pcs returned because there was rust on the product.

3. SIPOC diagramming

After obtaining the product with the highest claim rate , namely *the Stay L* product, it is then necessary to make a SIPOC diagram. SIPOC diagrams are a useful tool in process improvement to determine the flow of work (Erni & Wijaya, n.d.). The following SIPOC diagram explains the production process of *Stay L products*.

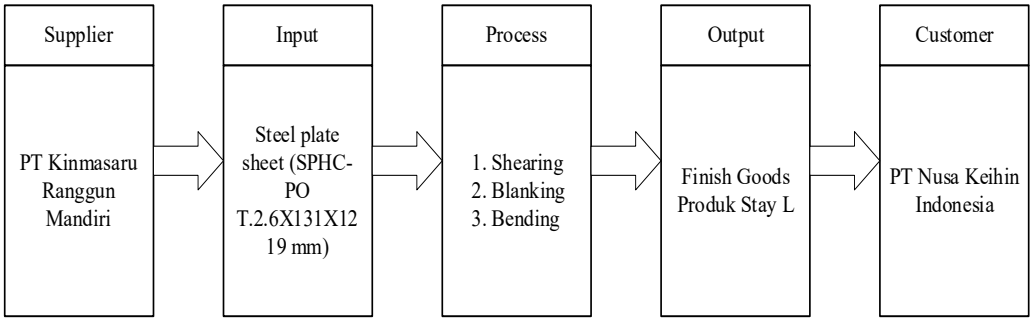


Figure 4. SIPOC Diagram *of Stay L Products*

3.2 Tahap *Measure*

The *Measure* stage is the second step in the DMAIC method, at this stage a P control map is made, *Critical To Quality (*CTQ) determination is then continued with the calculation *of Defects per Million Opportunities (DPMO)* and the determination of Sigma Level (Meidiarti, 2020).

1. Control Map P

The creation of the control map is based on monthly production data and compared to the number of *claims* that occurred in that month, the data used is July 2022 – December 2022.

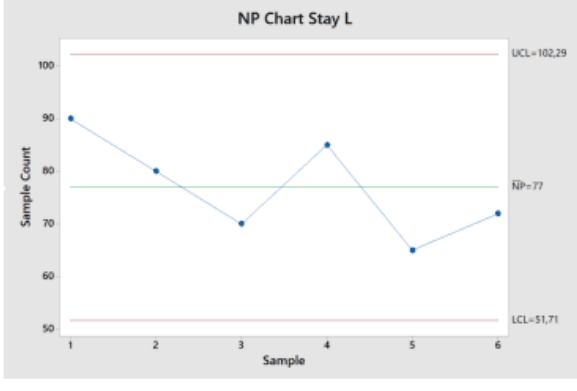


Figure 5. Data Control Map July 2022 – December 2022

2. CTQ Identification

When viewed from the SIPOC diagram above, PT Nusa Keihin Indonesia is a *customer* who makes a *claim* to PT Rekadaya Multi Adiprima. Based on observations made, the *claim process* occurs because there is a discrepancy with the provisions that have been agreed upon by both parties (Prawirosentono, 2001; Sepriandini & Ngatilah, 2021). From the data collected, it can be determined *Critical To Quality* (CTQ) or in other words, the most influential aspect of customer *claims* is the discovery of rust on products received by PT Nusa Keihin Indonesia.

3. DPMO and sigma level calculation

DPMO (*Defect per Million Opportunities*) is a measure of failure that shows failure per million opportunities. Sigma levels are obtained by converting the DPMO values obtained into the existing Sigma Level Table.

Table 2. Calculation of DPMO Value and *Sigma Level* before repair

ble for calculating the DPMO value of customer claims for Stay L products for the period July – December 2022	
erage Number of Units (Pcs)	1.000
erage Number of Claims (Pcs)	77
pportunities (Unit)	1
fect Per Unit (Unit)	0,077
tal Opportunity (Unit)	1.000
fect Per Oppurtunity (Unit)	0,077
fect Per Million Oppurtunity (Unit)	77.000
vel Sigma	2,925

3.3 Tahap Analyze

The analysis phase is the phase of finding and determining the root of the problem. At this stage, an analysis of the data that has been obtained is carried out (Siregar et al., 2019). Analysis of this data needs to be done to find out the sources and root causes *of claims against existing product specifications then an analysis of the factors that cause claims to occur.*

Table 3. Stay L *Product Specifications*

Product Name	*Stay L*
Material	Steel Plate Sheet SPHC-PO T.2.6X131X1219 mm
Customer	PT Nusa Keihin Indonesia
Dimension (PxLxT)	5 cm x 2 cm x 2 cm
Tolerance	± 0.2 cm
Weight	25 gram

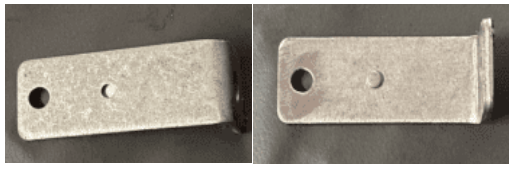


Figure 6. Stay L *Products*

In the production process*, Stay L* goes through several production processes, namely:

1. Shearing

Shearing is the process of cutting sheet iron plates into smaller parts with a *shear cutting machine*. This process has the aim of cutting iron plate sheets according to the required size so that they can be processed at the next stage (Sumasto et al., 2022).

2. Blanking

After the shearing *process is carried out*, it continues to the next production process, namely the *blanking process. Blanking* is the process of cutting or printing material by pressing or pounding using a stamping machine according to the shape of the dies used (Ulrich, 2003).

3. Bending

The final process for producing *Stay L* is the bending process. *Bending* is a process aimed at bending the workpiece according to a predetermined size (Tjiptono & Diana, 2001).

After completion of production, the product is stored in the warehouse, but before being stored, the product will be put first into *plastic packing*. The packing specifications are in plastic packing containing 100 pcs, with the following conditions

Figure 7. Storage conditions of Stay L products

After being packaged using plastic packing, the product is placed on the shelf and stored in the warehouse.

3.3.1 Analysis of the Cause of the Claim

The claim process *that occurs at PT Rekdaya Multi Adiprima has various cases, but based on the pareto diagram in Figure 4.12, it is found that the product* with the highest claim is *Stay L* with a total claim of 462 pcs and a percentage of 44% in the period July to December 2022. Based on the data obtained, the occurrence of *customer claims* on Stay L *products* due to rust on the product.

Figure 8. Rust on *Stay L products*

Figure 5.10 explains the shape of rust found in *Stay L* products, this rust is the cause of the *claim*. Therefore, it is necessary to find the cause of rust on Stay L products*, it is necessary to make* a fishbone diagram to *help make it easier to find the cause of rust on* Stay L products.

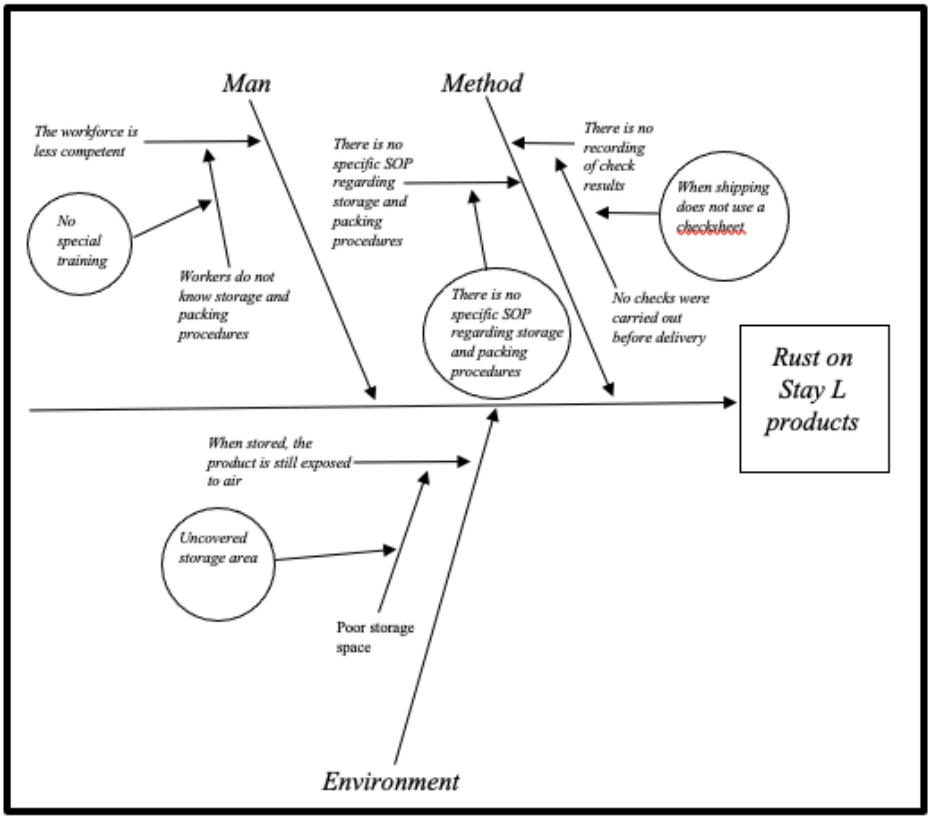


Figure 9. Fishbone diagram *of* the causes of rust on *Stay L products*

Based on the *fishbone diagram* that has been made, a more in-depth analysis can be continued to determine the priority of improvement to minimize the claim rate with the FMEA (*Failure Mode Effect Analysis) method*

Table 4. FMEA table of Stay *L products*

Modes of Failure	***Effect of Failure***	***S***	***Causes of Failure***	***O***	***Curent Controls***	***D***	***RPN***
Rusty	*Products that have rust will not be accepted by customers and customers will submit claims for replacement of a number of products.*	*8*	***Man*** *Workers do not receive special training on how to store and pack goods in a certain manner*	*3*	*Carrying out packing without following special SOPs regarding procedures for storing and packing goods*	*3*	*72*
			Method *There are no special regulations regarding packing and storing goods in the warehouse.*	*5*	*Placing products in the warehouse without special treatment.*	*6*	*240*
			There is no recording of check results.	*6*	*Sending goods without a checksheet.*	*6*	*288*
			Environment *When stored, the product is still exposed to air.*	*8*	*Storing items without wrapping them tightly*	*8*	*512*

3.4 Improve Step

After analysis using the *fishbone* diagram and the previous FMEA Table, the largest RPN value was obtained which must be prioritized for improvement. So a 5W + 1H table was created to determine the improvements made.

Table 5. Table of 5W+1H Stay *L products*

Factor	***What***	***Why***	***How***	***When***	***Where***	***Who***
Man	*The workforce is less competent*	*because the workforce does not know how to store and pack goods in the correct manner*	*Make special provisions for packing and conducting training*	*January 2023*	*Warehouse*	*Supervisor and Staff PPIC*
Method	*There are no special regulations regarding storing goods in the warehouse*	*The existing SOP has not been specifically created*	*Completing incomplete SOPs*	*January 2023*	*Warehouse*	*Supervisor and Staff PPIC*
	There is no recording of check results	*No checks were carried out before delivery*	*Double check before delivery and record the results of the check*	*Before delivery*	*Warehouse*	*Supervisor and operator Quality*
Environtment	*When stored, the product is still exposed to air*	*Poor storage space*	*Create a closed storage area so that the product is not directly exposed to air*	*January 2023*	*Warehouse*	*Staff Engineering*

3.4.1 Improvement Plan

Based on the improvement plan that has been made previously in the 5W + 1H table, improvements can be made to minimize the occurrence of *claims* on *Stay L products*,

1. Rack Design Manufacturing

The preparation of rack design is carried out based on the NIDA method which consists of the following stages (Meliones et al., 2018),

A. Identify Needs

Based on Table 4, the priority of repair that must be prioritized based on the largest RPN value is the environmental factor, which causes rust on *Stay L* products because when the product is stored it is still exposed to air. Then from Table 5 obtained improvements that can be made to the environmental factor is to make a closed storage area with the aim that the product is not exposed to air and water directly.

B. Revival of Ideas in Planning (Ideas)

This stage is carried out to generate ideas in designing based on the needs of the previous stage. In the previous stage, it was obtained that it was necessary to make improvements to store products closed, namely by making shelves closed or wrapping products properly and suitable for long storage, because previously the product was only put in plastic packing, not tightly closed and then placed on the shelf.

C. Product Design Decision (*Decision*)

At this stage, an assessment is carried out to decide on the dimensions, size and material to be used for the design of the rack. The specifications of the rack made are using aluminum plate material with a thickness of 3 mm, aluminum material was chosen because aluminum is a rust-resistant material. Also combined with hollow iron with a size of 3 x 3 cm as a frame to support the product (Chaeron et al., n.d.). Hollow iron was chosen because it is famous for being sturdy and also has a fairly affordable price. Then the aluminum material is combined with rubber on the edge of the shelf door so that when the shelf is closed, the conditions inside the shelf are really tight so that air and water do not enter it. In addition, shelves are made with a size of P x L x H = 50 cm x 50 cm x 50 cm, this aims to take advantage of empty shelves. According to the picture below.

Figure 10. Stay L *product shelf holder*

Based on the selection of materials and sizes that have been predetermined, details of costs can be made for the material for making this rack, namely:

Table 6. Table of material requirements for racking

Material	***Matrial Needs***	***Material Price***	***Total Price***
Aluminium Sheet (3mm Thickness)	*6 Sheet 50 cm x 50 cm*	*Rp 255.000 / Sheet (50 x 50 cm)*	Rp 1.530.000
Hollow Steel (Size 3 x 3 cm)	*24 Stick (50 cm/Stick)*	*Rp 325.000 / Panjang 6 m*	Rp 650.000
Rubber (3mm Thickness)	*4 Pcs (50 cm x 3 cm)*	*Rp 70.000 / Pcs (100 cm x 100 cm)*	Rp 7.000
Total Price			Rp 2.187.000

The price determined is based on the price circulating in the market today and also the price listed does not include the cost of making the shelf.

D. Making Work Facility Design (*Action*)

At this stage, a design is carried out based on the stages that have been passed before. The design is made using the *Autodesk Fusion 360* application, here are the designs that have been made.

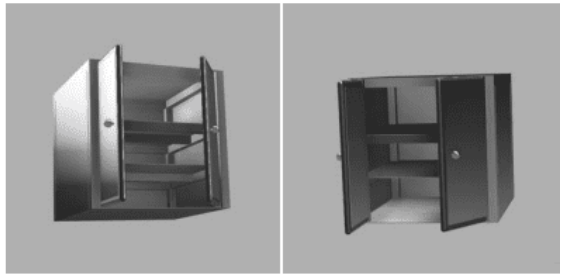


Figure 11. Stay L *product rack design shape*

The rack design is made according to the size and material that has been selected before, after which a strength test is carried out by simulation using the *Autodesk Fusion 360 application*. The part that is carried out by the strength test is the part that will later become the place where the product is stored, there are 3 parts in the shelf that will be tested with a weight of 10 kg which is equivalent to 400 pcs *of Stay L* products. then the test results can be obtained as follows,

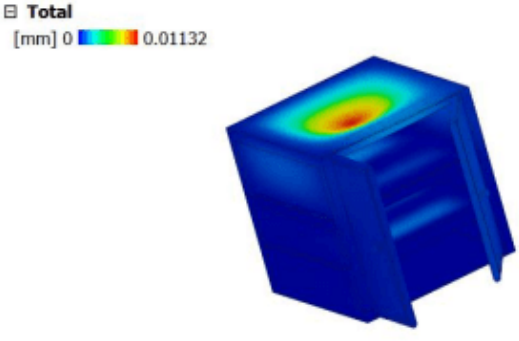


Figure 12. Stay L *product rack strength test*

It can be seen in Figure 12 where there is a color that if interpreted as blue is very safe and the more towards the red color it is dangerous (Sittig, 2017). Based on the results of this test, it can be concluded that the material selection and design of the rack is very strong to support as many as 400 pcs of parts and a total of 1200 pcs of *Stay L products*.

2. Creation of custom SOPs

Making special SOPs by adding product inspection procedures before delivery and recording them in the *checksheet* to ensure that the product has guaranteed quality. The things that must be discussed in the special SOP are as follows,

- Product inspection procedures
- Recording of examination results into checksheets
- Procedures for storing products on the shelf

Based on the provisions above, SOPs can be made as follows,

PT Rekadaya Multi Adiprima Automotive Part & Manufacture	**Standard Operating Procedures**	Plan/Division : 1/Metal Proces : Packing

Document Number		**Stay L Product Packing Work Instructions**
Document Name	Stay L Product Packing Work Instructions	
Date		

	Process Stages	Point check	Addition
1.	After production, the parts are collected in one container to make it easier for the next process	Make sure the items are not scattered	
2.	After that, carry out a thorough inspection of the product. The checks carried out are: • Size dimensions • Visual form of the product	• Make sure the dimensions of the goods comply with specifications • Make sure there is no NG from the production process • Make sure to record the checking results in the Checksheet	Separate products that do not comply with product specifications into one container
3.	Carry out an inspection to ensure there is no rust on the product	Make sure there is no rust on the product	Separate products that have rust
4.	Record the inspection results in the Checksheet	Make sure the checksheet has results that match the product condition	*Checksheets are created per 1 pack of product and checksheets must be kept for delivery*
5.	Next, package the product using plastic packing (double plastic to make it stronger)	Make sure the plastic is in good condition (no tears)	There are 100 pieces of product per plastic
6.	The plastic is closed tightly so that no air and water enters	Make sure the packaging is really tight	
7.	Store the packaged products on the designated shelves	Make sure the packaging is not damaged when placed on the storage shelf	
8.	When sending, include the checksheet that was created previously	Make sure the checksheet matches the product to be sent	

Information			Approved		
			Production	Quality	Engineering
Part name	Stay L				
Customer	PT Nusa Keihin Indonesia				
Qty	100 Pcs / Pack				

Figure 13. SOP Product packing work instructions *L*

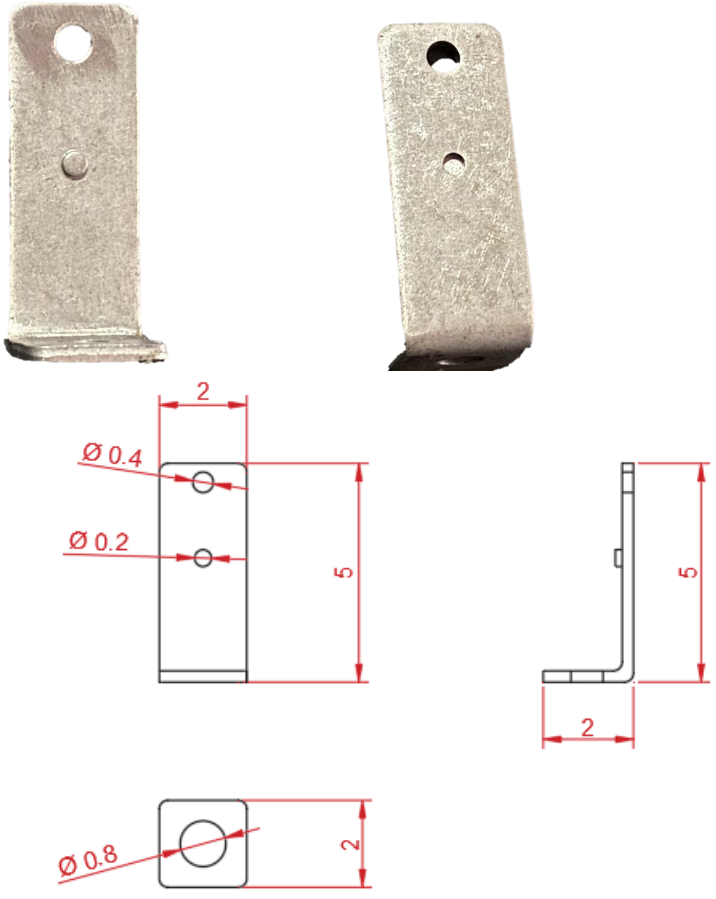
Figure 13 is an SOP made specifically in accordance with the necessary provisions, for more details the SOP can be seen in the appendix. Based on the SOP, it is necessary to make a checksheet to record the results of the examination. Here is an example of a checksheet that needs to be created

PT Rekadaya Multi Adiprima Automotive Part & Manufacture	**INSPECTION DATA RESULT**	Document Number	
		Document Name	*Checksheet* Stay L
		Date	

Part name	Stay L

Customer	PT Nusa Keihin Indonesia

3D Images and 2D Product Images



No	Check Item	Tools	Specification		measuring results					Average
			Standard (cm)	Tolerance (cm)	1	2	3	4	5	
1	Diameter 1	Caliper	0.4	± 0.1						
2	Diameter 2	Caliper	0.5	± 0.1						
3	Diameter 3	Caliper	0.8	± 0.1						
4	Lenght	Caliper	5	± 0.2						
5	Width	Caliper	2	± 0.2						
6	Height	Caliper	5	± 0.2						
7	Thickness	Caliper	0.26	± 0						
8	Visual	Eye	No Deffect							
			No Corrotion							

	Supplier : PT Rekadaya Multi Adiprima			Customer : PT Nusa Keihin Indonesia			RESULT	
							OK	NG
	Known by	Checked by	Made by	Known by	Checked by	Made by		

Figure 14. *Stay L* product *checksheet*

3.5 Tahap Control

After the improvement is made, the control or monitoring stage of the improvement process that has been carried out aims to assess and review whether the improvements made can fix the problems that occur.

3.5.1 Measurement after repair

The step that must be done in the control stage is to validate measurements by determining and documenting the resulting performance improvements based on improvements that have been made to prove the improvements made can provide changes or not. The data used after the repair is as follows

Table 7. Data for January – March 2023

Month	***Total Delivery (Pcs)***	***Claim Date***	**Total *claim* *(Pcs)***
January	1000	12/01/2023	17
February	1000	17/02/2023	23
March	1000	08/02/2023	12
Total	3000		52
Average	1000		17,4

After data processing, a comparison of calculation results is then carried out to compare the results after and before the improvement is made (Shahriar et al., 2022). Then the following results are obtained,

Table 8. Comparison table of DPMO values and *Sigma Level* before and after repair

mparison table of DPMO Value and Sigma Level for Stay L products before and after repair		
riode	*Before*	*After*
	July – December 2022	*January – March 2023*
erage Number of Units (Pcs)	1.000	1.000
erage Number of Claims (Pcs)	77	17,4
portunities (Unit)	1	1
fect Per Unit (Unit)	0,077	0.0174
tal Opportunity (Unit)	1.000	1.000
fect Per Oppurtunity (Unit)	0,077	0.0174
fect Per Million Oppurtunity (Unit)	77.000	17.400
vel Sigma	2,925	3,611

Based on Table 8, we can see the comparison between before and after repairs. The data used is data with a period of 6 months before the repair and 3 months after the repair. So that there was a decrease in DPMO by 61.93%.

4. Conclusion

After deeper observations, here are some conclusions obtained, including:

1. Customer claim problems at PT Rekadaya Multi Adiprima, especially in plant 1, are found in several products, including Stay L, Stay S, Metal Stopper Bumper, and Rubber Sus. The product with the highest customer claim rate is the Stay L product.'

2. The product with the highest customer claim value is the Stay L product with a claim caused by the discovery of rust on the product.

3. Based on the data processing carried out, it was found that the DPMO value of Stay L products was 77,000 Units, at the Sigma Level worth 2,925. After the implementation of improvements, the DPMO value and Sigma Level obtained for the DPMO value is 17,400 Units and the Sigma Level is 3,611.

4. Improvements that can be made are to make storage bins closed and make the latest SOPs.

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