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Analysis of the Factors Causing Delays of Delivery Using the Six Sigma Method (Case Study: Kompindo Wiratama Inc.)

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A B S T R A C T

The distribution of goods is a very important part of the service or manufacturing industry. One way to maximize the product distribution process is to maintain the quality of service. Service quality is how a company meets or exceeds customer expectations. The problem experienced by Kompindo Wiratama Inc. occurs because of production target discrepancies resulting in delays due several factors. One method that can be used for reducing delivery delays to improve service quality, namely the method of Six Sigma using DMAIC. The concept of DMAIC starts from a stage that define, measure, analyze, improve, and control and at each stage, D-M-A-I-C has objectives and tools different. Obtained an average DPMO value of 33349.08 and an average sigma value of 3.3691. The sigma level that has been achieved is still far from the Decried target, namely 3.4 DPMO and 6 Sigma. The repair phase uses the 5W + 1H analysis technique based on the source of the problem at the fishbone diagram of each CTQ to explain the proposed results of the analysis. After the results of the proposal are given based on the method Six Sigma improvements in handling the four factors of delivery delays will reduce the occurrence of delivery delays in the following months and years. This can improve the quality of service in delivery and maintain customer trust by the company motto, which is "delivery, quality and zero defect".

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1. INTRODUCTION

The distribution of goods is a very important part of the service or manufacturing industry, distribution is a marketing activity to facilitate the delivery of products from the hands of producers to consumers (Jamaludin, 2022). One way to maximize the product distribution process is to maintain the quality of service. Service quality is how a company meets or exceeds customer expectations (Rizkiana C, Bekti S, Suryawardana E & Indriyanti I, 2023). Researchers agree on the definition of service quality, stating that service delivery can coordinate, match, or override shopper Decries

(Mahsyar S & Surapati U, 2020). Service quality increases customer satisfaction, and cost control, and increases profits. If in the implementation of the distribution process, there are problems such as delays in delivery, consumer confidence will decrease and the company will experience losses such as complaints or termination of cooperation between companies and consumers (Indriyani, 2020).

Kompindo Wiratama Inc. is an industrial company that was founded in 2005 to produce automotive parts. Kompindo Wiratama Inc. already has a warehouse in Jakarta and many customers spread across Gresik, West Java, and abroad. Customer satisfaction is a top priority that is always held by this company. The problem experienced by Kompindo Wiratama Inc. is that it occurs in the logistics sector, namely in the product distribution process. This occurs because product demand is quite diverse and the production process is constrained by several factors such as production planning, lack of delivery, inspections, and product quality which causes production target discrepancies resulting in delays.

The studies carried out, (Sulistyo & Nugroho, 2022) observed that the Six Sigma method using DMAIC could solve most delivery delay problems due to miss routes with a percentage of total failures of 91.6%. The sigma value is 142.39 which represents that after sending the package, there are 33166.7 chances that the resulting delivery will fail. The root of the problem from the main cause is to lack of focus due to excessive fatigue in working more than 8 hours. To overcome this, the addition of 6 more warehouse employees to sort packages and anticipate when conditions are crowded. Also, several studies have been conducted to solve the problem of delivery delay using the Six Sigma method (Primandaru & Soeparno, 2019).

In this article, the Six Sigma method is used to find and reduce the causes of off graDec and errors. Meanwhile, DMAIC is a process that focuses on measurement to improve quality towards the target Six Sigma. The concept of DMAIC starts from a stage that define, measure, analyze, improve, and control and at each stage, D-M-A-I-C has objectives and tools different (Gaspersz, 2011). The combination of Six Sigma and DMAIC will solve the problem of delivery delay and give improvement that can reduce it in the long term.

2. LITERATURE REVIEW

2.1. Service Quality

Service quality is how far the difference is between expectations and actual service. Service quality is an important thing that must be considered and maximized to survive and remain the choice of customers (Riyadin, 2019). According to (Cesarina C, Juliansyah F & Fitriyani R, 2022) several quality dimensions are used as a reference, including (1) Responsiveness. Namely the expertise of employees responsible for helping buyers and availability to serve what the buyer needs properly, (2) Reliability. namely the expertise of employees to provide services as expected quickly, accurately, and satisfactorily, (3) Empathy, which is a caring reaction to be able to provide more personal attention to customers by understanding customer expectations, and convenience for communicating, (4) Assurance, namely the knowledge of officers who are owned, in the form of skills, courtesy and trust given so that customers are free from risk, (5) Tangible, which includes physical facilities, employee tools for means of communication.

2.2. Six Sigma

The concept of Six Sigma was introduced by Motorola Corporation to the manufacturing arena in 1987. Six Sigma concepts in Motorola were used not only to make a product without defects but also to eliminate the flaws in all corporations. It is based on the SPC, through which defects can be down to 3.4 parts per million opportunities. Chance is the probability of not complying with the necessary specifications (Singh M & Rathi R, 2019).

After the identification of problems is carried out. Then, group the data on the check sheet. Then, create a histogram to find out the distribution/spread of data so that it will be easier to obtain information, analyze, conclude, and act from the data. Next, a SIPOC (Supplier, Input, Process, Output, Customer) diagram is made to Describe the flow of the production process contained in the delivery process from

the administration to the customer.

The second is measure. The initial step in the measurement process is to classify data on the amount of late delivery based on the factors. The initial step in the measurement process is to classify data on the amount of late delivery based on the factors (Shaker Abualsaud, A., Ahmed Alhosani, A., Youssef Mohamad, A., Nasser Al Eid, F., & Alsyouf, I., 2019). From here, a Pareto diagram can be formed which functions to determine the types of problems that have the most potential value to determine priorities for work system improvement. Next, a P control chart is made which is used to Describe the process of shipping goods. The P control chart is used to assess whether the process is stable or not, as well as to find out variations from the existing data. Data for the P control chart can be done with the formula:

$$P1 = \frac{np1}{n1} \quad (1)$$

$$CL = \bar{P} = \frac{\Sigma np}{\Sigma n} \quad (2)$$

$$UCL = \bar{P} + 3\sqrt{\frac{\bar{P}\,(1-\bar{P})}{n}} \quad (3)$$

$$LCL = \bar{P} - 3\sqrt{\frac{\bar{P}\,(1-\bar{P})}{n}} \quad (4)$$

Where:

P : Proportion
CL : Control line
UCL : Upper control line
LCL : Lower control line
n : Defect value
np : Delivery value

Finally, Defects Per Million Opportunities (DPMO) calculation and Six Sigma levels are performed (Widjajanto S & Purba H, 2021). Data for the DPMO can be done with the formula:

$$DPMO = \frac{sum\ of\ the\ defect}{sum\ of\ the\ delivery\ x\ CTQ} \text{x } 1.000.000 \quad (5)$$

Then the sigma value is determined through the DPMO conversion table to sigma value.

The third is analysis. At this stage, evaluation carried out to find out the causes of the most frequent types of defects that occur is explained by a cause-and-effect diagram is a structured approach that allows for more detailed analysis in finding the causes of something problems, discrepancies, and gaps (Ahmad, 2019). This analysis uses 5M+1E, namely machine, man, method, material, measurement, and environment.

Fourth is an improvement. This stage is carried out after conducting a fishbone analysis. This stage uses the 5W + 1H analysis technique (what, when, where, why, who, and how) to explain the proposed analysis results based on the root of the problem in the fishbone diagram. The use of elements of 5W + 1H makes questions according a problem that happened (Indrawansyah I & Cahyana B, 2019).

The last one is control. Giving recommendations to the company is also carried out by monitoring and maintaining the results of the improvements that have been made. In this case, it is not carried out by researchers, but by companies.

3. RESEARCH METHOD

The secondary data collection technique used was obtained from data on the 2022 delivery process at Kompindo Wiratama Inc. with literature techniques from books and journals from previous researchers regarding the analysis of delivery delays using the Six Sigma method using DMAIC. The analytical method can be seen in Fig. 1.

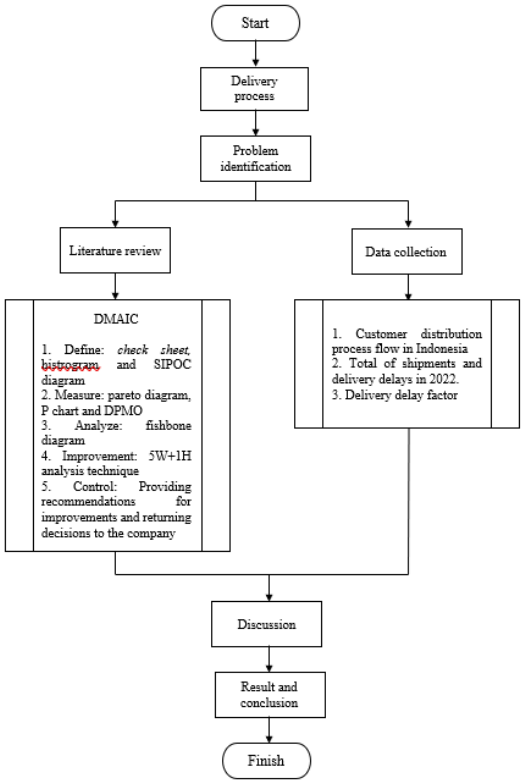

Fig. 1. Flow chart analysis stage

4. RESULT AND DISCUSSION

4.1. Define

Identification of the problem under study is the delay in product delivery which can affect the quality of service in the distribution process at kompindo Wiratama Inc. Following are the results of the analysis at the stage defined:

1. Check Sheet

Check Sheet is a tool Designed to simplify the data collection process. In many cases, recording is done to make it easier to see data patterns when collecting data. Based on the results of data collection, the check sheet can be seen in Table 1.

Table 1. Check sheet of delivery data

No	Month	Delivery total (times)	Delivery delay (times)	Delivery delay factor (times)			
				Production planning	Lack of delivery	Inspection	Product Quality
1	Jan.	2036	284	219	49	9	7
2	Feb.	1756	418	340	47	29	2
3	Mar.	2312	402	365	26	9	2
4	Apr.	1941	189	139	33	17	0
5	May.	1539	142	87	38	5	12
6	Jun.	2027	207	159	31	10	7
7	Jul.	2010	93	76	1	8	8
8	Aug.	2479	204	159	8	19	18
9	Sep.	2487	524	439	16	19	50
10	Oct.	2496	465	395	3	57	10
11	Nov.	2491	364	264	16	38	46
12	Dec.	2200	189	99	9	37	44
Total		**25774**	**3481**	**2741**	**277**	**257**	**206**

2. Histogram

The histogram is a graph that contains a summary of the distribution (dispersion or variation) that displays the frequency of the data. Based on the data obtained, a histogram of the delivery delay factor from January to

December 2022 can be seen in Fig. 2.

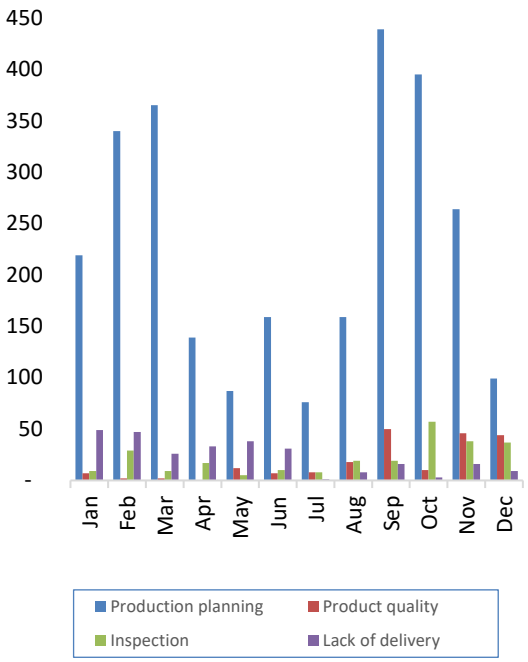

Fig. 2. Histogram of delivery delay factors

From the histogram image above, the number of delivery delays in 2022 is influenced by four factors, namely production planning, product quality, inspection, and delivery shortages. It can be seen that each factor in each month has a different number of delivery delays and fluctuates for one year. Later, from this histogram you can find the distribution of the data so that you know the variation of the data from the highest to the lowest.

3. SIPOC Diagram

The SIPOC diagram stands for 5 elements of the quality system via the supplier, input, process, output, and customer which is used to Describe the flow of the production process contained in the delivery process from the administration to the party customer. The SIPOC diagram of the shipping process at Kompindo Wiratama Inc. can be seen in Table 2.

Table 2. SIPOC Diagram of the shipping process

Supplier	Input	Process	Output	Customer
Production and division warehouse	Finish good product	• Stock checked • Provision of information to PPIC • Scheduling and delivery plans • Product preparation according to the delivery plan • Fleet truck preparation • Prepare product in the delivery area • Making travel documents • Submission to inspection record • Load check truck must be by the travel document	The delivery process to Gresik and Jakarta warehouses. The total shipments that occurred from January to December 2022 at PT Kompindo Wiratama were 25,774 times with a total delay of 3,481 times so a delay percentage of 13.5% was obtained	• PT Kayaba Indonesia • PT Hitachi Astemo • Autoliv Indonesia • Sungwoo Indonesia • Sinar Berlian Chemindo • Interglobal Electric Parts • Isuzu Astra Motor Ind • Garuda Motor Ind • Megatama Spring Parts • APM Shock Absobers Ind • Mitrabuana Sukses

4.2. Measure

The measure stage is the second operational step in the Six Sigma quality improvement program. The following are the results of the

analysis at the measure stage:

1. Pareto Diagram

Making a Pareto diagram serves to determine the types of problems that have the most potential value to determine priorities for work system improvement. The following is a Pareto diagram of delivery delay factors that cause delays from January to December 2022.

$$= \left(\frac{\text{Total of delivery delay factors for production planning}}{\text{The total number of delivery delay factors}}\right) x\ 100\% \quad (6)$$

$$= \left(\frac{2741}{3481}\right) x\ 100\% = 78{,}74\%$$

Table 3. Factor percentage of delivery delays in January - December 2022

The order of delivery delay factors	Number of delivery delays (times)	Percentage of delivery delays (%)	Cumulative Percentage (%)
Production planning	2741	78,74	78,74
Lack of delivery	277	7,96	86,70
Inspection	257	7,38	94,08
Product Quality	206	5,92	100
Total	**3481**		

Based on Table 2, the highest delivery delay factor in January-December 2022 is for production planning, which is 2.741 times with a delivery delay percentage of 78.74%. Fig.3 is a Pareto chart that illustrates the delivery delay factors in January-December 2022.

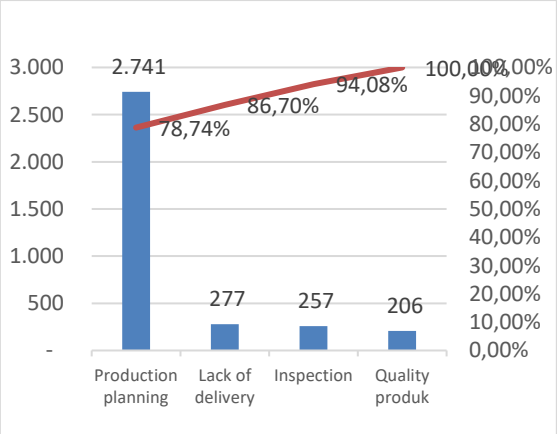

Fig. 3. Pareto chart of delivery delay factors January - December 2022

2. P Chart

The P control chart is used to assess whether the process is stable or not, as well as to find out the variation from the existing data. The following is the calculation on the P control chart:

a. Calculating the proportion of late delivery factors for production planning

$$P1 = \frac{np1}{n1} \quad (7)$$
$$= \frac{219}{2036}$$
$$= 0{,}108$$

$$CL = \bar{P} = \frac{\Sigma np}{\Sigma n} \quad (8)$$
$$= \frac{2741}{25774}$$
$$= 0{,}106$$

$$UCL = \bar{P} + 3\sqrt{\frac{\bar{P}\ (1-\bar{P})}{n}} \quad (9)$$
$$= 0{,}106 + 3\sqrt{\frac{0{,}106\ (1-\ 0{,}106\ )}{2036}}$$
$$= 0{,}127$$

$$LCL = \bar{P} - 3\sqrt{\frac{\bar{P}\ (1-\bar{P})}{n}} \quad (10)$$
$$= 0{,}106 - 3\sqrt{\frac{0{,}106\ (1-\ 0{,}106\ )}{2036}}$$
$$= 0{,}086$$

The calculation results of the proportion of defects CL or, LCL, and other UCL can be seen in the attachment, the Table 3 is a summary table of the proportion of delays in delivery factors for production planning.

Table 3. Results for calculating the proportion of late delivery factors for production planning

Mon	Total shipments (times)	Production planning factor (times)	P	CL	UCL	LCL
Jan	2036	219	0,108	0,106	0,127	0,086
Feb	1756	340	0,194	0,106	0,128	0,084
Mar	2312	365	0,158	0,106	0,126	0,087
Apr	1941	139	0,072	0,106	0,127	0,085
May	1539	87	0,057	0,106	0,130	0,083
Jun	2027	159	0,078	0,106	0,127	0,086
Jul	2010	76	0,038	0,106	0,127	0,086
Aug	2479	159	0,064	0,106	0,125	0,088
Sep	2487	439	0,177	0,106	0,125	0,088
Oct	2496	395	0,158	0,106	0,125	0,088
Nov	2491	264	0,106	0,106	0,125	0,088
Dec	2200	99	0,045	0,106	0,126	0,087
Total	**25774**	**2741**				

Based on the results above, we get P, CL, LCL, and UCL data based on delivery delay factor data for production planning, it will produce a graphical form according to Fig. 4.

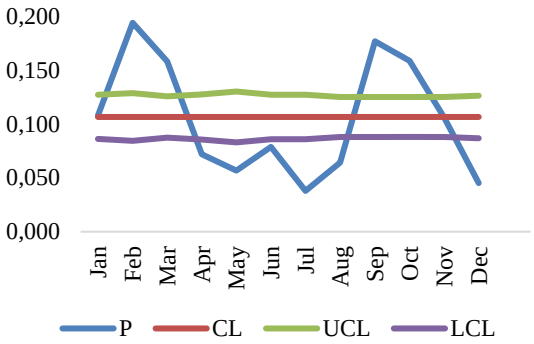

Fig. 4. Graph of the proportion of late delivery factors for production planning

From the results of the graph above, ten points are out of the upper and lower control limits, namely February, March, April, May, June, July, August, September, and December. This shows that the control of late delivery of goods is still experiencing many problems.

b. Calculates the proportion of delivery delay factors for lack of delivery

The calculation results of the proportion of defects CL or, LCL, and other UCL can be seen in the attachment, Table 4 is a summary table of the proportion of delays in delivery factors for lack of delivery.

Table 4. Results for calculating the proportion of late delivery factors for lack of delivery

Mon	Total shipments (times)	Lack of delivery factor (times)	P	CL	UCL	LCL
Jan	2036	49	0,024	0,011	0,018	0,004
Feb	1756	47	0,027	0,011	0,018	0,003
Mar	2312	26	0,011	0,011	0,017	0,004
Apr	1941	33	0,017	0,011	0,018	0,004
May	1539	38	0,025	0,011	0,019	0,003
Jun	2027	31	0,015	0,011	0,018	0,004
Jul	2010	1	0,000	0,011	0,018	0,004
Aug	2479	8	0,003	0,011	0,017	0,005
Sep	2487	16	0,006	0,011	0,017	0,005
Oct	2496	3	0,001	0,011	0,017	0,005
Nov	2491	16	0,006	0,011	0,017	0,005
Dec	2200	9	0,004	0,011	0,017	0,004
Total	**25774**	**277**				

Based on the results above, we get P, CL, LCL, and UCL data based on delivery delay factor data for lack of delivery, it will produce a graphical form according to Fig. 5.

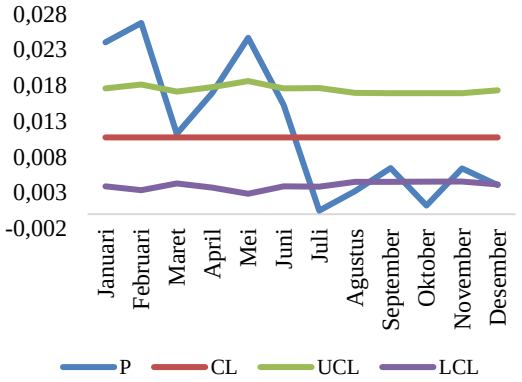

Fig. 5. Graph of the proportion of late delivery factors for lack of delivery

From the results of the graph above, six points are out of the upper and lower control limits, namely January, February, May, July, August, and October. This shows that the control of late delivery of goods is still experiencing many problems.

c. Calculating the proportion of late delivery factors for inspection

The calculation results of the proportion of defects CL or, LCL, and other UCL can be seen in the attachment, table 5 is a summary table of the proportion of delivery delay factors for inspection.

Table 5. Results for calculating the proportion of late delivery factors for inspection

Mon	Total shipments (times)	Inspection factor (times)	P	CL	UCL	LCL
Jan	2036	9	0,004	0,010	0,017	0,003
Feb	1756	29	0,017	0,010	0,017	0,003
Mar	2312	9	0,004	0,010	0,016	0,004
Apr	1941	17	0,009	0,010	0,017	0,003
May	1539	5	0,003	0,010	0,018	0,002
Jun	2027	10	0,005	0,010	0,017	0,003
Jul	2010	8	0,004	0,010	0,017	0,003
Aug	2479	19	0,008	0,010	0,016	0,004
Sep	2487	19	0,008	0,010	0,016	0,004
Oct	2496	57	0,023	0,010	0,016	0,004
Nov	2491	38	0,015	0,010	0,016	0,004
Dec	2200	37	0,017	0,010	0,016	0,004
Total	**25774**	**257**				

Based on the results above, we get P, CL, LCL, and UCL data based on delivery delay factor data for inspection, it will produce a graphical form according to Fig. 6.

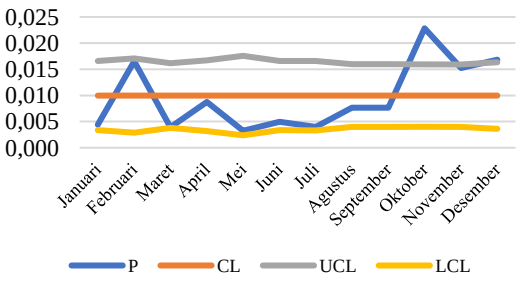

Fig. 6. Graph of the proportion of late delivery factors for inspection

From the results of the graph above, two points are out of the upper control limit and lower control limit, namely October and December. This shows that the control of late delivery of goods is still experiencing many problems.

d. Calculating the proportion of late delivery factors for product quality

The calculation results of the proportion of defects CL or, LCL, and other UCL can be seen in the attachment, table 6 is a summary table of the proportion of delivery delay factors for product quality.

Table 6. Results for calculating the proportion of late delivery factors for product quality

Mon	Total shipments (times)	Product quality factor (times)	P	CL	UCL	LCL
Jan	2036	7	0,003	0,008	0,014	0,002
Feb	1756	2	0,001	0,008	0,014	0,002
Mar	2312	2	0,001	0,008	0,014	0,002
Apr	1941	0	0,000	0,008	0,014	0,002
May	1539	12	0,008	0,008	0,015	0,001
Jun	2027	7	0,003	0,008	0,014	0,002
Jul	2010	8	0,004	0,008	0,014	0,002
Aug	2479	18	0,007	0,008	0,013	0,003
Sep	2487	50	0,020	0,008	0,013	0,003
Oct	2496	10	0,004	0,008	0,013	0,003
Nov	2491	46	0,018	0,008	0,013	0,003
Dec	2200	44	0,020	0,008	0,014	0,002
Total	**25774**	**206**				

Based on the results above, we get P, CL, LCL, and UCL data based on delivery delay factor data for product quality, it will produce a graphical form according to Fig. 7.

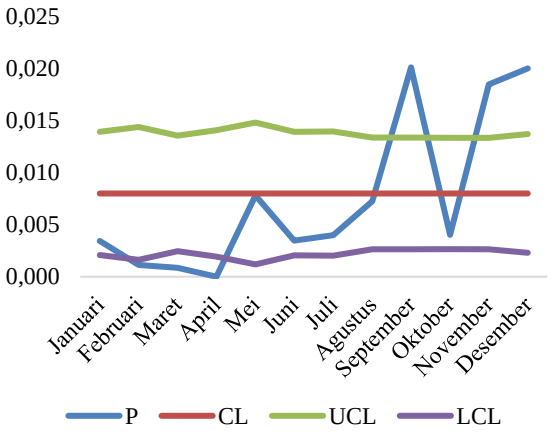

Fig. 7. Graph of the proportion of late delivery factors for product quality

From the results of the graph above, six points are out of the upper and lower control limits, namely February, March, April, September, November, and December. This shows that the control of late delivery of goods is still experiencing many problems.

4. DPMO Values and Levels Six Sigma

Last, DPMO and level calculations are performed by Six Sigma. DPMO stands for defect per million opportunities which is a measure of internal failure six sigma. The following is an example of calculating the DPMO in January 2022:

$$\text{DPO} = \frac{\text{total of defect product}}{\text{total of inspection x CTQ}} = \frac{284}{2036\ x\ 4} = 0{,}034872 \quad (11)$$

$$\text{DPMO} = \text{DPO x } 1.000.000 = 0{,}034872 \text{ x } 1.000.000 = 34.872$$

From the calculation above, in January 2022 there were 2036 product deliveries with a total of 284 late deliveries. Whereas Opportunities or quality characteristics (CTQ) is 4, so the probability of failure occurring in one million products is 34.872 times. To measure levels sigma can use a tool in the form of a DPMO conversion table to value sigma (sigma value conversion table can be seen in the attachment). Because the DPMO value is not in the sigma conversion table, an interpolation calculation is performed to determine the sigma value, there is:

$x_1 \rightarrow 35.148$ $\quad y_1 \rightarrow 3{,}31$

$x \rightarrow 34.872$ $\quad y \rightarrow$ (unknown)

$x_2 \rightarrow 34.379$ $\quad y_2 \rightarrow 3{,}32$

$$\frac{x-x_1}{x_2-x_1} = \frac{y-y_1}{y_2-y_1} \quad (12)$$

$$\frac{34872-35148}{34379-35148} = \frac{y-3{,}31}{3{,}32-3{,}31}$$

$$\frac{-276}{-769} = \frac{y-3{,}86}{0{,}01}$$

$$y = 3{,}3136$$

From the DPMO value of 34.872 it is at the level of 3.3136 sigma which means that currently, the company is still at level 3 sigma. Table 7 is a summary of the results of DPMO calculations and levels of sigma on late delivery from January to December 2022.

Table 7. Summary of DPMO and level calculation results from Six Sigma in January – December 2022

No	Month	Delivery total (times)	Delivery delay (times)	*CTQ*	DPMO	Sigma Value
1	Jan	2036	284	4	34872	3,3136
2	Feb	1756	418	4	59510	3,0589
3	Mar	2312	402	4	43469	3,2118
4	Apr	1941	189	4	24343	3,4713
5	May	1539	142	4	23067	3,4942
6	Jun	2027	207	4	25530	3,4510
7	Jul	2010	93	4	11567	3,7712
8	Aug	2479	204	4	20573	3,5421
9	Sep	2487	524	4	52674	3,1195
10	Oct	2496	465	4	46575	3,1790
11	Nov	2491	364	4	36532	3,2924
12	Dec	2200	189	4	21477	3,5242
Total		**25774**	**3481**		**400189**	**40,4290**

From the table above, the average DPMO value and the average value sigma in January to December 2022 are as follows:

$$\text{Average of DPMO} = \frac{\text{total of DPMO from January} - \text{December}}{12} \quad (13)$$
$$= \frac{400189}{12}$$
$$= 33349{,}08$$

$$\text{Average of sigma value} = \frac{\text{total of sigma from January} - \text{December}}{12} \quad (14)$$
$$= \frac{40{,}4290}{12}$$
$$= 3{,}3691$$

So, from data on delivery delays that occurred from January to December 2022, an average DPMO value of 33349.08 was obtained and an average value sigma of 3.3691. Where is the level of Sigma that has been achieved is still far from the Decried target of 3.4 DPMO and 6 Sigma. The amount of variation in the increase in DPMO is influenced by the large number of defects that occur in each production period. If a process is continuously controlled and improved, it will show a production failure DPMO value that continues to decrease over time, and process stability increases continuously.

4.3. Analyze

At this stage, it is done using fishbone diagrams with 5M+1E analysis to find out the root of the problem. Here is the fishbone diagram of each CTQ:

1. Fishbone diagram of late delivery factors for production planning

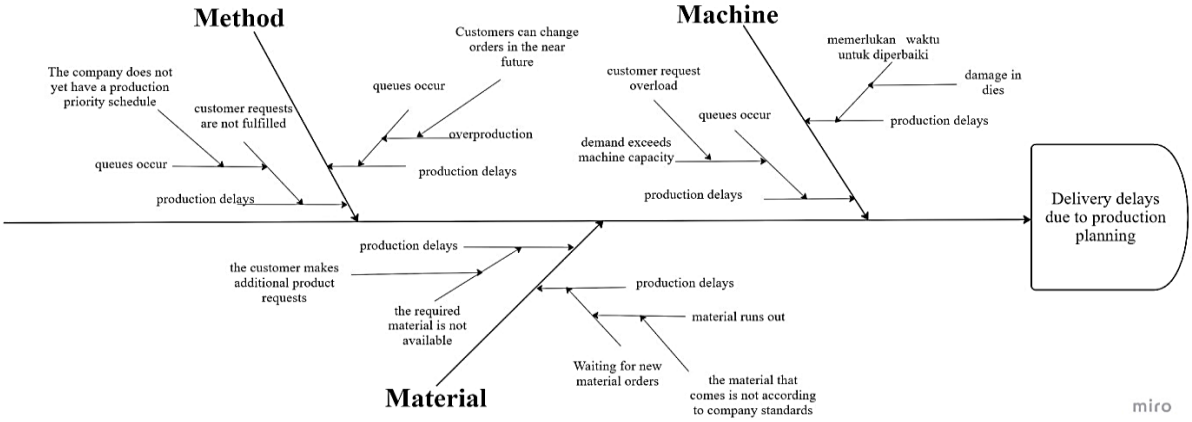

Fig. 8. Fishbone diagram of root causes of production planning CTQ

The analysis in Fig. 8 uses methods, materials, and machines to find out the root Causes of CTQ production planning that cause delivery delays. The Table 8 is an explanation of the Fishbone diagram analysis.

Table 8. Fishbone diagram analysis of production planning CTQ

Factors causing the problem	The root of the problem	The impact of the root cause
Method	The company does not yet have a production priority schedule	The company only has a daily schedule and production targets without a priority schedule for products to be shipped earlier. Thus, the production that should have been carried out that day was shifted which caused production queues and production delays for products customers other
	Customers may change their orders shortly	every month customers have sent daily preorder, but sometimes customers make changes to the addition of products within a short time. This resulted in daily production must be added which causes over and production delays.
Material	Customers make additional product requests	With the sudden increase in product demand, the company does not have material storage, resulting in production delays which result in late delivery
	The material that comes does not meet company standards	Purchased materials that do not meet company standards, such as defects, too thick, or too thin. This will lower product standards if the production process continues. So the occurrence of material vacancies must add lead time and reorder materials. As a result, the production process is late and the delivery is late too.
Machine	Overload request customer	Too much production demand will cause excess daily machine capacity. So that there is a queue on the machine and production delays. As a result, it causes delivery delays
	Damage dies	Damage dies (mold) used for the process press need time to be repaired so the production process and subsequent processes are late which causes delivery delays.

2. Fishbone diagram of late delivery factors for lack of delivery

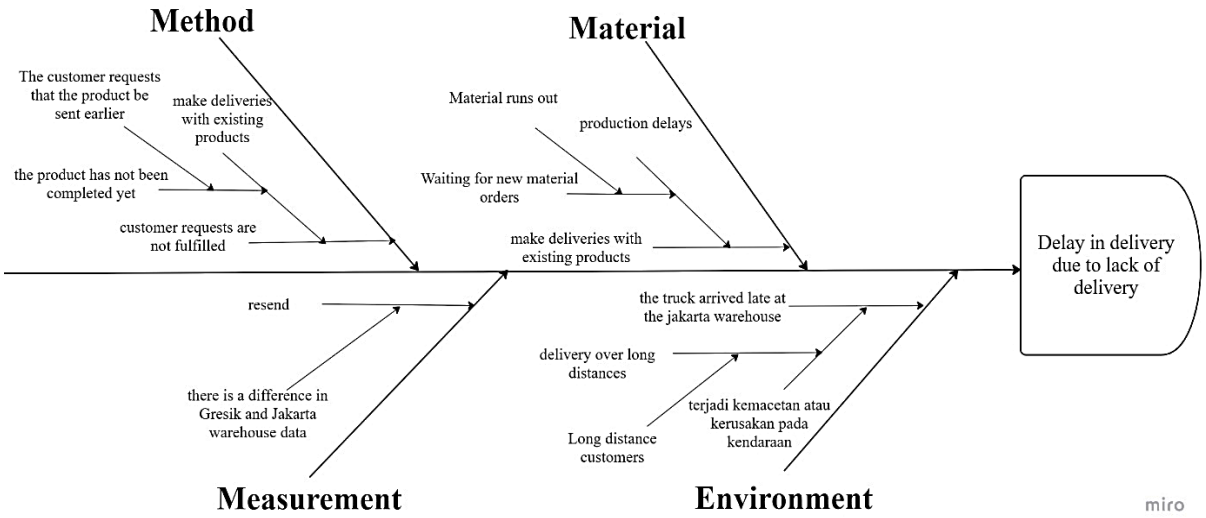

Fig. 9. Fishbone diagram of late delivery factors for lack of delivery

The analysis in Fig. 9 uses method, material, measurement, and environment to find out the root cause of CTQ delivery shortages that cause delivery delays. The Table 9 is an explanation of the diagram analysis fishbone:

Table 9. Fishbone diagram analysis of CTQ lack of delivery

Factors causing the problem	The root of the problem	The impact of the root cause
Method	The customer requested that the product be shipped earlier	The company does not always have safety stock so when customers withdraw goods earlier production has not been completed. The company will ship the product finished goods that existed beforehand that caused the need customer not met and there is a delay in delivery.
Material	Materials run out	The arrival of materials has been calculated, but sometimes there are delays in the arrival of materials or damaged materials which cause vacancies in stock materials. So, it takes longer waiting time and production delays. Shipments are made with the number of existing products or change the delivery schedule.
Measurement	There is a difference in Gresik and Jakarta warehouse data	In the process of product delivery customers in Jakarta then pass through the Jakarta warehouse transit. Sometimes there is a difference in product calculations of the finished goods between the Jakarta and Gresik warehouses or product damage on the way which requires re-shipment from the factory. This requires travel time and delivery delays occur.
Environment	The distance of customers is far away	Distance customers who are outside the city require time and long distances. So that conditions cannot be predicted such as long traffic jams or vehicle damage. This resulted in trucks arriving late at the Jakarta warehouse and delays in delivery.

3. Fishbone diagram of late delivery factors for inspection

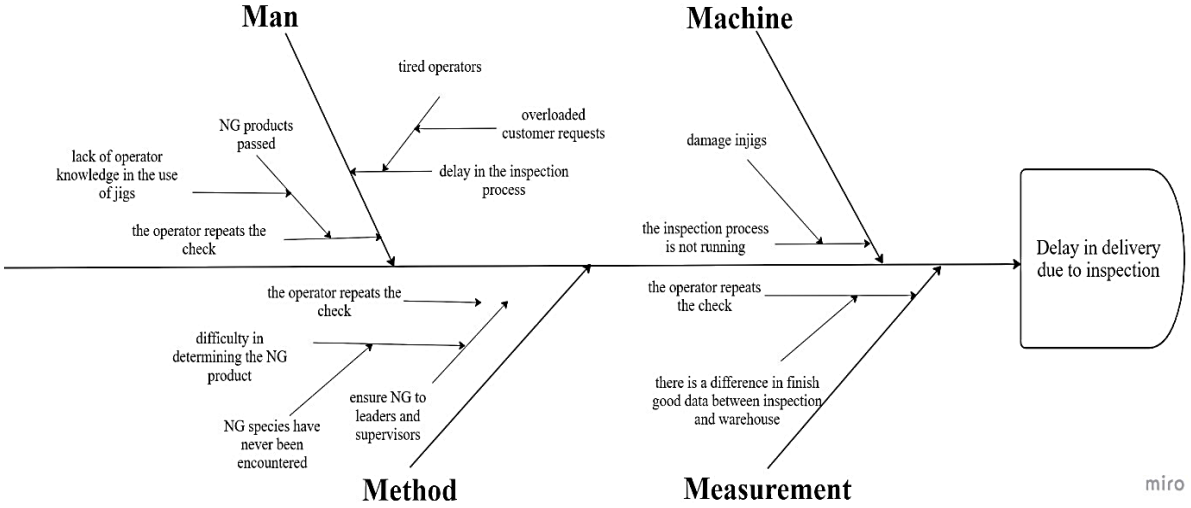

Fig. 10. Fishbone diagram of late delivery factors for inspection

The analysis in Fig. 10 uses man, method, machine, and measurement to find out the root Cause of the CTQ inspection which causes delivery delays. Table 10 is an explanation of the diagram analysis fishbone.

Table 10. Fishbone diagram of late delivery factors for lack of delivery

Factors causing the problem	The root of the problem	The impact of the root cause
Man	Lack of operator knowledge in the use of jigs	Jig is used as a tool to determine an OK or NG product. The operator's lack of knowledge about the use of jigs makes NG products pass which causes them to re-check so that delivery delays occur.
	Request customer overload	The more demand for products, the operators increase their working time which causes work fatigue and delays in the process inspection. This causes delivery delays.
Method	NG type has never been found	The NG type has been determined for each product, but sometimes there are new NGs that have never been found which makes it difficult to determine the type of product. It takes time to discuss between the leader and supervisor. The inspection process is carried out again. This causes delivery delays due to wasted product checking.
Machine	Damage to jigs	Damage jig causes process inspection to stop so that product checking cannot be continued and causes delays in delivery.
Measurement	Data discrepancies occur finish good between inspections with the warehouse	Product availability data finish good between the inspection and the warehouse there is a difference, and it must be re-checked. it adds up lead time and delivery delays

4. Fishbone diagram of late delivery factors for quality product

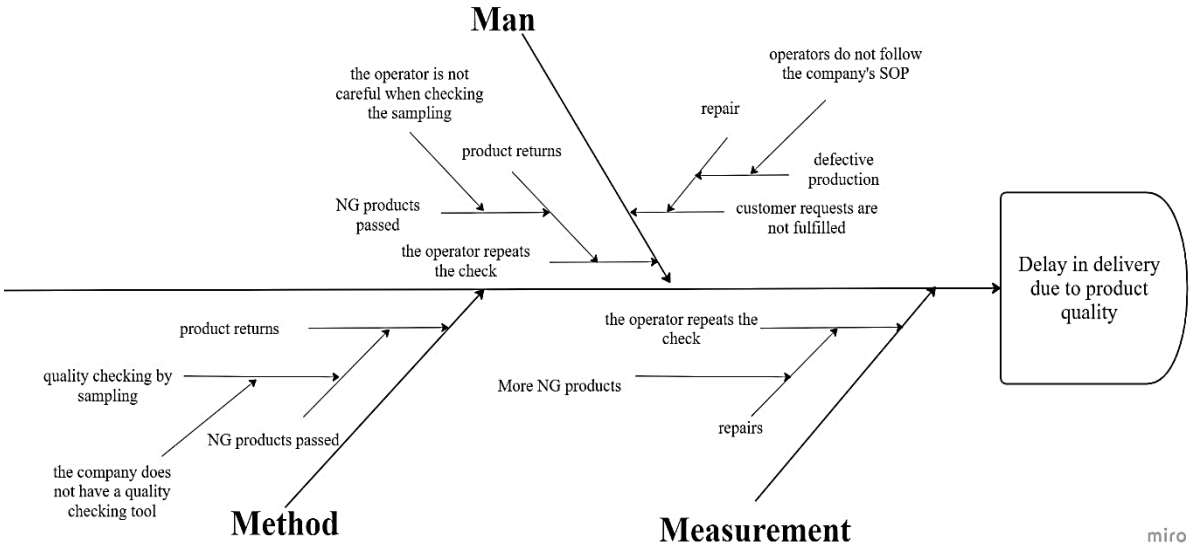

Fig. 11. Fishbone diagram of late delivery factors for quality product

The analysis in Fig. 11 uses man, method, and measurement to find out the root cause of the Quality products that cause delivery delays. The Table 11 is an explanation of the diagram analysis fishbone on:

Table 11. Fishbone diagram of late delivery factors for quality product

Factors causing the problem	The root of the problem	The impact of the root cause
Man	The operator is not careful when checking the sampling	Checking quality by sampling can make NG products pass which causes the return of goods so that a re-check is carried out. This causes delays in delivery because the process is done twice.
	Operators do not follow company SOPs	Operators do not follow the SOPs and work instructions given so the production is defective, so repairs and requests must be made customer cannot be fulfilled. As a result, delivery delays occur.
Method	The company does not have a quality-checking tool	Quality checking is done by sampling because the company does not have a quality test kit. This often causes NG products to pass and product returns for repair. So delivery delays occur.
Measurement	More NG products	If there are more NG products, it can be said that the product is not by company standards, which causes the product to be repaired and re-checked. This causes delivery delays to occur.

4.4. Improve

At this stage it is carried out after carrying out the analysis fishbone. This stage uses the 5W + 1H analysis technique (what, when, where, why, who, and how) to explain the proposed analysis results based on the root of the problem in the fishbone diagram. Tables 12, 13, 14, and 15 are explanations of the proposed results of each CTQ:

1. Proposed analysis results from production planning CTQ

Table 12. Proposed analysis results from production planning CTQ

No	The root of the problem	5W+1H	Explanation
1.	The company does not yet have a production priority schedule	What	Not yet have a production priority schedule
		When	At the time of going through the production process
		Where	Line production
		Why	To avoid production queues that have piled up due to increased product demand which causes delays in production and delivery to customers other
		Who	Supervisor and PPIC admin warehouse communicate with supervisor production
		How	Create weekly schedules and work priorities on demand for customers. Also giving deadline changes in addition to product demand so that there is no sudden production and according to the existing schedule
2.	The customer may change the order soon	What	The sudden addition of product orders
		When	At a time, adjacent to the delivery schedule
		Where	On the PPIC section
		Why	To avoid buildup of production that is not according to schedule because it can cause overwork and delivery delays
		Who	PPIC Admin and purchasing
		How	Give Deadline changes in addition to product demand so that there is no sudden production and according to the existing schedule
3.	Customers make additional product requests	What	Additional product requests
		When	At a time, adjacent to the delivery schedule
		Where	On the PPIC section
		Why	To avoid lead time because it does not exist stock material
		Who	PPIC Admin Warehouse
		How	Give Deadline changes to additional product requests so that there is no sudden production and according to the existing schedule and prepare additional materials for safety stock
4.	The material that comes does not meet company standards	What	The material differs from the company standard
		When	when the material arrives
		Where	At the warehouse raw material
		Why	To avoid differences in product quality that have been determined by the company and customer. At the same time avoiding ordering material repeatedly which adds to the cost lead time because the process of waiting for material to come and the cessation of the production process due to material emptiness.
		Who	Supervisor and PPIC admin warehouse
		How	Do crosscheck at the time of purchasing materials and placing orders for materials by taking them into account lead time to prevent material shortages and production delays
5.	Overload request customer	What	Overload product requests
		When	At the time of monthly orders and additional orders
		Where	Online production
		Why	To avoid excess daily machine capacity, prevent accumulation of production queues, and overwork employee
		Who	PPIC Admin Warehouse
		How	Make daily production schedules and targets considering machine capacity. Also giving deadline changes in addition to product demand so that there is no sudden production and according to the existing schedule
6.	Damage dies	What	Damage dies
		When	At the time of production
		Where	Online production
		Why	To avoid delays in the production process
		Who	Area worker Molding
		How	Make dies recommend indies most frequently used and dies that are prone to damage. Make Backup plan production schedules to avoid current production vacancies dies in repair

2. Proposed analysis results from lack of delivery CTQ

Table 13. Proposed analysis results from lack of delivery CTQ

No	The root of the problem	5W+1H	Explanation
1.	The customer requested that the product be shipped earlier	What	Product requests sent ahead of schedule
		When	At the time the production was not finished
		Where	Online production
		Why	To avoid the accumulation of ineffective production and twice delivery and to maintain satisfaction customer
		Who	PPIC Admin and purchasing
		How	Give Deadline the maximum limit for changes in forwarded shipments so that the company can rearrange production schedules according to priorities
2.	Materials run out	What	Stock materials run out
		When	At the time of going through the production process
		Where	At the warehouse raw material
		Why	For the production process to continue running and there is no accumulation of processes that cause lead time increase
		Who	Supervisor and PPIC admin warehouse
		How	Make material orders with calculations lead time arrival and add material orders for safety stock
3.	There is a difference in Gresik and Jakarta warehouse data	What	There is a difference in data between the Gresik and Jakarta warehouse admins
		When	At the time of delivery
		Where	Jakarta Warehouse
		Why	To keep the transit process at the Jakarta warehouse running according to procedures and there are no data discrepancies so satisfaction customer maintained, as well as the absence of repeated shipments
		Who	Warehouse admin Gresik and Jakarta
		How	Do crosscheck before making shipments and adding the number of products to safety stock so that if there is damage on the way there is no need to wait for delivery from the Gresik warehouse
4.	Distance customers far away	What	The company owns customers with great distance
		When	During the delivery process
		Where	Jakarta Warehouse
		Why	To maintain the quality and accuracy of delivery
		Who	Head of Gresik Warehouse and driver
		How	Check the vehicle before delivery and health driver, as well as make early deliveries to anticipate unexpected events such as long traffic jams and vehicle breakdowns

3. Proposed analysis results from inspection CTQ

Table 14. Proposed analysis results from inspection CTQ

No	The root of the problem	5W+1H	Explanation
1.	Lack of operator knowledge in the use of jigs	What	Operators are not aware of the use of jigs
		When	When carrying out the process inspection
		Where	Room Inspection
		Why	To prevent NG products from escaping, the checking process is repeated and the company's standards decrease
		Who	Supervisor production, leader, and operator inspection
		How	Do training and regular understanding of the use of jigs for several products so that NG products do not pass and company

No	The root of the problem	5W+1H	Explanation
			standards are maintained
2.	Request customer overload	What	Overload product requests
		When	At the time of monthly orders and additional orders
		Where	Room Inspection
		Why	To avoid work fatigue which will lead to unfocused and NG products can pass or repeated checks occur
		Who	Supervisor production and PPIC
		How	Make schedules and daily production targets considering the capabilities of the operator inspection. Also giving deadline changes in addition to product demand so that there is no sudden production and according to the existing schedule
3.	NG type has never been found	What	There is a new type of NG
		When	When carrying out the process inspection
		Where	Room Inspection
		Why	To avoid NG products from passing and company standards are maintained
		Who	Supervisor production and leader
		How	Change schedule inspection for products with NG that have never been encountered during the discussion process so that operators can continue to work on the process inspection on other products. Then socialize about the new NG that has been found.
4.	Damage to jigs	What	There is damage to the jig
		When	When carrying out the process inspection
		Where	Room Inspection
		Why	To keep the process inspection does not stop and there is a queue that adds lead time
		Who	Supervisor production, leader, and operators repair
		How	Make a backup jig as a form of anticipation of accidental damage
5.	Data discrepancies occur finish good between inspections with the warehouse	What	There are differences in product data on inspection and warehouse
		When	During the data-checking process
		Where	Warehouse finish good
		Why	To avoid product differences that can add upload time and repeated checks
		Who	Operator inspection and warehouse finish good
		How	Do Crosscheck Data before committing to packing and moving the product to the warehouse finish goods so that the data is appropriate when the delivery process takes place

4. Proposed analysis results from quality product CTQ

Table 15. Proposed analysis results from quality product CTQ

No	The root of the problem	5W+1H	Explanation
1.	The operator is not careful when checking the sampling	What	Inaccurate in the quality checking process by sampling
		When	During the quality-checking process
		Where	Room Quality control
		Why	To avoid product returns by customer
		Who	Leader and operator quality control
		How	Adding operators in quality control so that quality checking by sampling does not only rely on one operator which can make the chance of not being thorough is greater
2.	Operators do not follow	What	Operators do not follow SOP

No	The root of the problem	5W+1H	Explanation
	company SOPs	When	During the quality checking process
		Where	Room Quality control
		Why	To avoid defective products being sent to the customer that makes returns happen and satisfaction customer decrease
		Who	Supervisor and operator quality control
		How	to Conduct regular monitoring of the operator's working methods until they are by the SOP
3.	The company does not have a quality-checking tool	What	There is no quality test equipment
		When	During the quality-checking process
		Where	Room Quality control
		Why	To make checking can be done automatically according to standard test equipment and checking can be done quickly
		Who	Manager and supervisor quality control
		How	Conduct discussions and submit to the owner about the need for quality test equipment to maximize the company's product standards so that defective products that pass can be avoided and no product returns occur
4.	More NG products	What	Products with NG quality are more numerous
		When	When carrying out the process inspection
		Where	Room Inspection
		Why	So that the company's standards do not decrease, preventing the process inspection repeatedly and maintaining the trust customer
		Who	Supervisor production and production operators
		How	to Make observations during the production process by checking SOPs and work instructions that are carried out to ensure that production is carried out correctly and there are not many defects that occur

4.5. Control

This control phase is the last operational stage in the DMAIC cycle. But this study did not. The implementation of control is carried out by the company and the improvment stage is only a suggestion.

5. CONCLUSION

Based on the results and discussion of the research that has been conducted at Kompindo Wiratama Inc., it can be concluded that delivery delays from January to December 2022 consisted of the four most frequent factors, there are production planning 2.741 times, delivery shortages 277 times, inspection 257 times, and quality product 206 times. Obtained an average DPMO value of 33349.08 and an average sigma value of 3.3691. The sigma level that has been achieved is still far from the Decired target, namely 3.4 DPMO and 6 Sigma. The repair phase uses the 5W + 1H analysis technique (what, when, where, why, who, and how) based on the source of the problem at the fishbone diagram of each Critical To Quality to explain the proposed results of the analysis. The results of research that has been done on analysis of the factors causing delivery delay using the Six Sigma method with DMAIC according to the research objectives. Future research is expected to combine other methods with Six Sigma and can be analyzed for other problems to reduce the defects.

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