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Design of Power Pole Delivery Distribution in a Business Project at PT XYZ Bandung Branch Using DMAIC Method

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ABSTRACT

Introduction; This study aims to identify the causes of delays in the distribution of electricity pole shipments in the PT XYZ Bandung Branch project and formulate improvement solutions. **Method**; This research was conducted through the Six Sigma DMAIC (Define, Measure, Analyze, Improve, and Control) approach to identify the distribution process, measure current performance, classify and analyze the root causes of problems causing delays, and design improvements with the aim of minimizing delivery delays in similar projects. **Result**; The results showed that there were three main causes of delay with a contribution of 68% to the twelve causes of delay. In this study, a DPMO value of 20,833 was obtained with a sigma level of 3.5. **Conclusion**; Researchers suggest taking corrective action with 5W + 1H analysis based on the root cause of the problem. The implementation of these improvements is expected to increase the efficiency of the electric pole distribution process and company guidelines supported by continuous supervision.

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1. Introduction

Indonesia is an archipelago consisting of 17,508 islands listed in Law (UU) Number 6 of 1996 concerning Indonesian Waters. With so many islands, one of the main challenges facing Indonesia is the provision of reliable and equitable access to electrical energy across the country. Based on data from the Ministry of Energy and Mineral Resources (ESDM), the level of electricity distribution in Indonesia has reached a fairly high level, but the distribution of electricity still looks one-sided with Java and Bali as the main focus of electricity distribution in Indonesia, followed by Sumatra, Sulawesi and Kalimantan. The regions with the lowest electricity distribution are Maluku and Papua. The following is the distribution of electrical energy on various islands in Indonesia according to the Central Statistics Agency updated in January 2024 (BPS, 2024).

Table 1. Electricity Distribution Data in Indonesia by Island in 2021-2022

No.	Island	Electricity Distributed (Gwh)	
		2021	2022
1.	Jawa, Bali, dan Nusa Tenggara	187.243.33	197.984,93
2.	Sumatra	43.366,62	46.492,61
3.	Sulawesi	12.120,02	13.601,23
4.	Kalimantan	11.863,52	12.501,31
5.	Maluku dan Papua	3040,77	3181,4
	Indonesia	**257.634,26**	**273.761,48**

Source: Badan Pusat Statistik (Data Diolah), 2024

According to Yusgiantoro, (2025)and IESR, (2023), equitable electricity distribution can help minimize regional disparities and accelerate development in 3T areas (Outermost, Frontier, and Backward). As a strategic effort to support national development, the provision of adequate and equitable electrical energy can not only accelerate the rate of economic growth of a nation, but will also increase Indonesia's competitiveness in the international market. With a stable supply of electrical energy, Indonesia can build infrastructure to support productive and potential sectors that can improve people's quality of life in the future. Therefore, a material delivery distribution system (electric poles) is needed as a foundation for Delays in material delivery, such as electric poles, can lead to increased operational costs and reduced productivity. Therefore, a well-planned and integrated delivery distribution strategy is essential to ensure that material requirements, in this case electric poles, reach their destination and end users on time, with the right quality and at an appropriate cost (Machfudiyanto & Syahreza, 2022; Abdellatif & Alshibani, 2019).

PT XYZ is a company that focuses on logistics and freight forwarding business services. The company is one of the subsidiaries of X (Persero) which provides distribution and storage services. In the face of ever-changing global market developments, PT XYZ strives to continuously adapt by positioning itself as “Your Smart Logistics Partner” and acting as an integrated, reliable and trusted logistics service provider. Currently PT XYZ has more than 500 warehouses and 1,500 fleets distributed in several regions of Indonesia and has 45 networks spread across Asia, Europe, America and China. The company also operates 20 branch offices in almost all parts of Indonesia, with one of them located in Bandung Branch.

In carrying out the electric pole delivery project, PT XYZ handed over all project responsibilities to PT XYZ Bandung Branch through a Work Order (SPK) to carry out shipments starting from planning, loading goods, to transportation from loading points to

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predetermined areas. In carrying out the shipping process, PT XYZ Bandung Branch cooperates with PT Salam Pacific Indonesia Lines (SPIL) which is a container shipping company to transport goods by sea. While from the final port to consumers, PT XYZ Bandung Branch cooperates with PT XYZ Papua Branch using a 40 ft trailer type truck.

The electric pole distribution process begins after PT XYZ Bandung Branch receives information from PT ABC regarding the specifications of the electric poles to be distributed. This information includes the size, weight, and number of power poles to be delivered to the final destinations in Jayapura, Sorong, Manokwari, Merauke, Nabire, Biak, and Timika. After receiving the information, PT XYZ Bandung Branch is responsible for planning the optimal shipment and selecting the appropriate type of transportation, such as trucks and ships, to ensure the shipment can be carried out efficiently and on time. The following is the distribution information for the shipment of electric poles from Cilegon to Papua.

Table 2. Cilegon-Papua Power Pole Shipment Distribution Information

No.	Destination	Weight/Unit	Number of Poles (Pcs)	Total Weight	Number of Containers
1.	Jayapura	233	253	58.949	3
2.	Sorong	233	127	29.591	2
3.	Manokwari	233	259	60.347	3
4.	Merauke	233	464	108.112	5
5.	Nabire	233	189	44.037	2
6.	Biak	233	104	24.232	1
7.	Timika	233	104	24.232	1
	TOTAL	**1.500**	**349.500**	**7**	

Source: PT XYZ Bandung Branch, 2025

In the project, the number of distribution shipments of electricity poles per region varies, then PT XYZ Bandung Branch plans a shipping distribution project by dividing the electricity poles according to the needs as described in the table. This project is planned to be completed for three consecutive days in carrying out the shipping process from Cilegon to Tanjung Priok Port with a total of 1,500 poles using 17 containers. The container used is a 40 feet container type with an outer size of 12,192 x 2,438 x 2,591 meters and an inner size of 12,045 x 2,309 x 2,379 meters. As for the transport capacity, it reaches 67.3 cbm and a payload of 27,396 kg.

The background of this research is based on a case study on a power pole delivery distribution project at PT ABC. Where in the loading process, the container size used has the same length as the length of the electric pole. However, after the loading process is carried out, there is an obstacle where the container is very difficult to close and must be pushed strongly using a forklift to get more space. From this case, workers measured the length of the pole to get a precise pole length. The results showed that the length of the electric poles varied between 12 meters to 12.3 meters. This resulted in uncontrollable waiting time and delayed the target load plan because workers had to measure the length of the poles one by one. As a result, only two containers were successfully shipped to the port and far below the planned target of six containers. This loading process took quite a long time from 09.00 WIB - 21.00 WIB or around 12 hours. The causes of delays in the distribution of electricity pole shipments are as follows.

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	TOTAL	**1.500**	**349.500**	**7**	

Source: PT XYZ Bandung Branch, 2025

Table 3. Causes of Delayed Delivery

No.	Causes of Delay	Frequency
1.	Pole length difference	17
2.	Pole weight difference	17
3.	Slow manual measurement	5
4.	Container overload	2
5.	Documents pending	2
6.	Work accident	1
7.	Undisciplined driver	3
8.	Unsuitable planning schedule	1
9.	Lack of transportation equipment	2
10.	Container addition	1
11.	Containers are late entering the port pass gate	7
12.	Facultative holiday	1

Sumber: PT XYZ Bandung Branch, 2025

This power pole delivery project became a case study in the author's research because it revealed a number of challenges faced by PT XYZ Bandung Branch during the project. In addition, ensuring the right quality of electric poles is also a challenge in multimodal delivery distribution. By looking at and analyzing the phenomena that occur in the shipping process, the researcher will make recommendations for redesigning shipments such as arranging electric poles in containers to utilize space and identifying improvement steps in the shipping process by examining the core of the problem using the DMAIC method to minimize obstacles in the distribution process of shipping electric poles, so that the project can run smoothly and efficiently.

2. Theoretical Framework

2.1 Distribution

Distribution is the process of moving products or services from producers to end consumers using various channels and methods. According to (Kotler & Keller, 2021), distribution includes all activities that ensure products or services are available to customers at the right time and place. Meanwhile, according to Yusuf et al., (2019) distribution is a variety of activities that provide convenience in storage, distribution, and delivery in the form of goods or services from producers that have been tailored to their needs.

Distribution also includes various types of strategies based on market needs, such as direct, indirect, selective, exclusive distribution, and so on. According to (Czinkota et al., 2021), successful distribution relies heavily on effective coordination with various elements in the supply chain, including supply chain, warehousing, and inventory management. Based on several definitions that have been described, it can be concluded that distribution is an important process in the supply chain that aims to ensure that goods or services reach the end consumer efficiently, on time, and as needed. Distribution objectives include several important aspects, namely:

1. Provide goods or services efficiently to consumers.
2. Optimizing the flow of goods to minimize logistics costs.
3. Ensure the availability of goods according to market or project needs.
4. Increase added value in a fast and timely service.

According to Hartono & Susanti, (2023), distribution functions as a link between producers and consumers by ensuring that goods reach the hands of end consumers on time and in the right condition.

2.2 Shipping

Shipping is one of the keys in distribution logistics that aims to move goods from the point of production or warehouse to the end consumer or project site. According to Hartono & Susanti, (2023), shipping is not only the physical movement of goods, but includes time, cost, and service quality management to ensure customer satisfaction. Effective delivery must have a strategy in determining routes, utilizing transportation capacity, and fulfilling customer requests in accordance with agreed agreements and time standards. Meanwhile, according to Gunawan et al., (2025) and (Herlinah, 2025) shipping is an activity of product distribution from producers to consumers, this activity can also be interpreted as one of the activities to support the marketing process to facilitate the distribution of goods.

According to (Purwantomo & Ediarsa, 2020), shipping is the process of shipping from one part to another to make it easier for consumers. Delivery involves various elements such as transportation scheduling, selection of appropriate modes, and optimization of fleet usage. In the delivery of electric poles, shipping is key in ensuring that materials arrive according to the planned time and schedule. From several definitions that have been described, it can be concluded that shipping is an activity carried out to distribute and move goods from one place to another to ensure a smooth distribution process.

In shipping, it is necessary to consider the components that are important to deliver goods effectively, including:

1. Route and Delivery Schedule: According to Hussain, (2025), route optimization is a strategy to minimize mileage and transportation costs. Well-designed route optimization can minimize travel time and fuel consumption, thereby reducing logistics costs.
2. Transportation Fleet Management: According to Lambert, Stock, and choosing the right and appropriate mode of transportation (land, sea, air) depends on the type of goods being shipped, the distance, and the urgency of the delivery time. In delivering power poles to Eastern Indonesia, consolidation of land and sea transportation is often used to reach locations in the archipelago (Gnap et al., 2019).
3. Shipping Technology: According to research conducted by (Gunasekaran et al., 2017) the utilization of technologies such as GPS tracking, Transport Management System (TMS), and Internet of Things (IoT) can increase the transparency and efficiency of the shipping process and can provide data in real time that helps in logistics decision making.

In the power pole delivery project, an efficient and effective delivery strategy is needed to overcome challenges and obstacles such as geographical conditions and limited infrastructure in Eastern Indonesia, such as in Manokwari, Nabire, Sorong, and so on. According to a journal by Rejeb et al., (2023), distribution in Eastern Indonesia requires good coordination between sea and land transportation modes. This is because the region has limited infrastructure problems that affect delivery lead times. The following are strategies that can be used to improve shipping efficiency, including:

1. Consolidation of Cargo; The merging of multiple shipments into one to maximize ship or truck load capacity, minimize shipping frequency, and reduce logistics cost.
2. Just in Time Delivery (JIT); The application of just in time delivery principles allows deliveries to be made on time, reducing the need for stock storage in warehouses (Heizer and Render, 2020).
3. Collaboration with Third Party Logistics (3PL); The application of Third Party Logistics utilizes the services of party logistics providers with the aim of overcoming part or all of the delivery process, especially in areas with limited access and difficult to reach.

2.3 Six Sigma Methodology (DMAIC)

According to Kurniawan, (2024); and Mohamed Alshabibi et al., (2025) Six Sigma is a method or technique of controlling or improving quality towards a target of 3.4 failures per million opportunities for each product transaction towards zero detect opportunities. Meanwhile, according to (Siddiqui & Iqbal, 2021) Six Sigma is defined as a data-based approach to improving processes. Six Sigma can also be interpreted as a business strategy to eliminate waste, reduce costs due to poor quality, and improve the effectiveness of all operations, so as to meet consumer needs and expectations(Murmura et al., 2021).

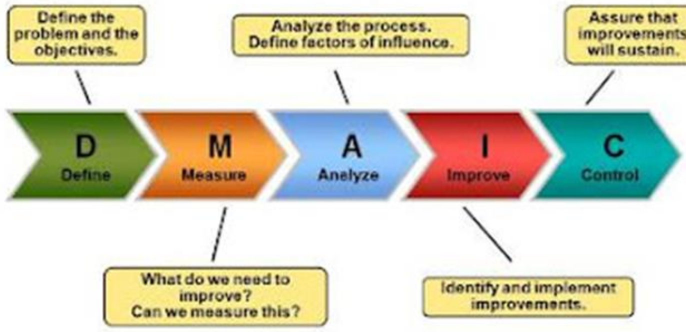
The concept of Six Sigma is a structured problem-solving approach called DMAIC. According to (Saxena, 2021) DMAIC contains a five-phase improvement cycle, including Define, Analyze, Improve, and Control. Using DMAIC systematically can overcome a problem, such as helping to identify or solve the root of the problem through a set of tools and techniques at each stage (Deniz & Çimen, 2018). In this study, researchers will apply Six Sigma DMAIC to the improvement of the electric pole delivery process which needs to be improved, controlled, and improved. Afifa & Damayanti, (2023) says that the Six Sigma method can be measured from the level of performance which has 6 sigma levels with different DPMO values. In principle, the higher the sigma level, the better the process performance. DPMO indicates how many errors will appear if an activity is repeated one million times. The following is a simple explanation of DPMO to describe the quality or capability of a process.

Table 4. Sigma Level

Sigma Level	DPMO	Yield
6	3.4	99.9997%
5	233	99.98%
4	6,210	99,4%
3	66,807	93.3%
2	308,538	69,2%
1	691,462	30.9%

Sumber: PT XYZ Bandung Branch, 2025

The Six Sigma concept is widely used in a company to encourage improvement and strive for excellence in quality standards and customer satisfaction (Karwande et al., 2023). Initially, the Six Sigma concept was developed and adopted in the manufacturing sector, but actually the application of this concept is a process approach that can be used in all business fields. Examples of the application of this concept include improving on-time delivery, reducing cycle time in hiring and training new employees, minimizing complaint resolution time in information technology organizations and improving standard order fulfillment time. The following is an image of the concept and flow of the DMAIC method.



Source: PT XYZ Bandung Branch, 2025

Figure 1. DMAIC Framework

3. Method

Research methods in general are scientific ways to obtain data with specific purposes and uses. This research uses a qualitative method with a case study approach. Qualitative research aims to gain a general understanding of social reality from the perspective of participants (Ratnasari, 2020). Qualitative methodology consists of philosophical perspectives, assumptions, and approaches taken to make analysis, criticism, replication, repetition, and / or adaptation. Qualitative methodology refers to the research approach as a tool used to structure the study, collect data, and analyze data (Rakhmawati et al., 2019).

According to Bokdan Jiang & Murmann, (2023) a case study is a research that examines thoroughly and intensively both in terms of issues and events related to geographic conditions repeatedly. The cases tested are not only limited to individuals or organizations, but also apply to the limits of the system, program, responsibility, collection or population. The purpose of case studies is to gain in-depth knowledge about the object of discussion in question, and research using case studies is exploratory and descriptive (Rakhmawati et al., 2019). Based on this explanation, descriptive research with a case study approach is a study that aims to test and develop data obtained at the research location with the aim of anticipating problems that arise.

his research utilized a written interview methodology by developing questions in advance as a general foundation and allowing them to be developed into more specific ones. Interviews were conducted with relevant individuals, either because of their authority in a particular position or their direct involvement in the electricity pole delivery distribution project. A total of 12 informants participated in this study, consisting of representatives from PT XYZ Bandung Branch, PT XYZ Papua Branch, PT SPIL, and PT ABC. Informants were selected using a purposive sampling technique to ensure that data were obtained from parties directly involved in the planning, implementation, and evaluation of the electricity pole delivery distribution process.

Table 5. Research Informant

No	Institution / Company	Position / Role	Number of Informants
1	PT XYZ Bandung Branch	Project Manager, Logistics Supervisor, Loading Operator, Planning Staff	4
2	PT XYZ Papua Branch	Distribution Supervisor, Receiving Officer, Fleet Coordinator	3
3	PT SPIL	Shipping Coordinator, Port Operations Staff	2
4	PT ABC	Project Owner Representative, Quality Control Staff, Procurement Officer	3
		Total	**12**

Source: Data Processed 2025

Observation and documentation methods were also carried out to collect data that could provide an overview of local conditions and become the background for research discussions (Rakhmawati et al., 2019). In conducting this research, the methods used were observation and documentation. The observation method is used through direct observation of the object under study. Researchers went directly to the field, precisely at the location of loading electricity poles, namely at PT ABC if needed. Meanwhile, the documentation method is used by researchers to complement the data with the aim of analyzing the problems being investigated. In this approach, researchers investigate references such as books and journals that are relevant to the research topic. Researchers will also attach documentation taken during the research process to strengthen data sources.

4. Results and Discussion

4.1 Define

According to Afifa & Damayanti, (2023) Define explains that the stage where problems or opportunities for improvement are clearly defined, the scope of the project is determined, and the needs and expectations of customers (stakeholders) are identified. Meanwhile, according to Siddiqui & Iqbal, (2021) emphasizes that at this stage, the business processes to be improved are mapped as a whole, including the identification of customers and suppliers involved. From these two definitions it can be concluded that, at the Define stage in the DMAIC methodology, the first step taken is to analyze the scope of delivery of electric poles. This analysis aims to thoroughly understand the distribution process from start to finish, including the parties involved, the documents used, and the expected end result. To support this mapping, tools in the form of SIPOC (Supplier, Input, Process, Output, Customer) diagrams are used as visual aids that illustrate the relationship between suppliers, inputs, main processes, outputs, and consumers in the delivery distribution system.

The researcher then proceeds with the calculation stage to determine the percentage of delays that occur in the distribution process. This step is the basis for identifying Critical to Quality (CTQ) elements, which are key aspects that directly affect customer perception and satisfaction with the quality of distribution services. CTQ is defined as the main element that is an indicator of the success of distribution services, especially in terms of timeliness of delivery, conformity of the number of goods sent with orders, and the physical condition of the goods received by customers in good condition and in accordance with the specified technical specifications. CTQ identification is carried out with the aim of directing the focus of improvement on important elements in the distribution process, so that performance improvement efforts are not only based on assumptions, but also supported by objective data and analysis.

Based on an interview with the Project Manager of PT XYZ Bandung Branch (Informant 1), the following statement was obtained:

"*The main issue we face in the field is the mismatch between the pole length and container size. This causes the loading process to take much longer than planned*."

In addition, the Logistics Supervisor (Informant 2) added:

"We often do not receive accurate pole dimension data from the supplier, so the staff must remeasure each one manually. This slows down the daily loading schedule."

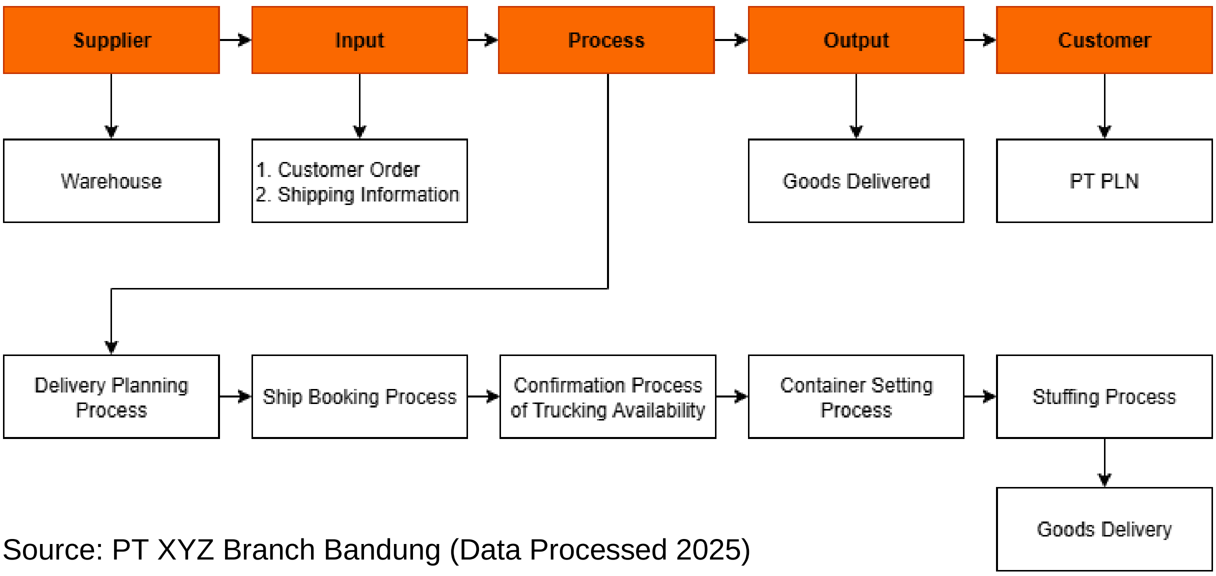
From the perspective of PT SPIL as the sea freight company, the Shipping Coordinator (Informant 7) stated:

"Delays in container entry at Tanjung Priok Port often occur because the shipping documents are not yet complete, so the vessel cannot depart as scheduled."

Meanwhile, a representative from PT ABC (Informant 10) confirmed that the differences in pole length and weight were caused by variations in the manufacturing process, not by shipping errors. The findings from these interviews reinforce that the main problems that must be clearly defined at the Define stage are product specification inconsistencies and delivery delays caused by inefficient coordination among parties involved.

4.1.1 SIPOC (Supplier, Input, Process, Output, Customer)

According to Pande et al. (2000), the SIPOC diagram is a visual representation of the business process flow that illustrates the relationship between the five main components, with the aim of obtaining a comprehensive understanding of the structure and scope of the process. The preparation of the SIPOC diagram in this study is adjusted to the distribution flow in the electricity pole delivery project carried out by PT XYZ Bandung Branch, with a logistics route from the loading location in Cilegon to the unloading location in Papua. This diagram plays an important role in providing an initial overview of the distribution process, so that it can be used as a basis for further analysis, such as identifying Critical to Quality (CTQ) and tracing the root causes of delivery delays. The following is a SIPOC Diagram on the distribution process of power pole shipments carried out during the project.



Source: PT XYZ Branch Bandung (Data Processed 2025)

Figure 2. SIPOC Diagram

4.1.2 CTQ (Critical to Quality)

According to Gaspersz, CTQ (Critical to Quality) are key elements of a process, product, or service that must be controlled and met in order to meet the quality specifications desired by customers. CTQ is usually measured by quantified parameters and used to monitor process performance continuously. Meanwhile, George (2022) states that CTQ is part of the Six Sigma strategy that aims to translate customer needs into measurable technical specifications. By identifying CTQ, organizations can determine what factors have the most influence on the quality of products or services received by customers. From the definition that has been presented, it can be concluded that CTQ (Critical to Quality) is a characteristic in determining the key to quality delivery and is directly related to the customer.

Based on the data obtained by researchers, there are twelve causes of delays that result in the logistics process being hampered. In this study, CTQs are critical factors that determine the success of the distribution process of sending electric poles. CTQ is determined by identifying the main customer requirements and translating them into measurable parameters that affect the quality of the process. The following calculations determine the percentage of defect rates in the delivery process.

$$\boldsymbol{Percentage\ of\ Delay} = \frac{Number\ of\ Delay}{Total\ Number\ of\ Delay} x\ 100\%$$

Based on the data analysis calculations above, it was found that out of a total of twelve causes of shipping delays, there are five dominant factors that rank the largest as causes of shipping delays that make a significant contribution. The five factors are, pole length difference (28.33%), pole weight difference (28.33%), and late container entering the port pass gate (11.67%), slow manual measurement (8.33%), undisciplined driver (5%). The five causes of delay that have been described in the table above have a contribution of 82% to the twelve causes of shipping delays in the delivery of electricity poles.
Branch, 2025

Table 6. Percentage of Late Delivery

No.	Cause of Delay	Percentage
1.	Pole length difference	$\frac{17}{60}\ \chi$ 100% = 28,33%
2.	Pole weight difference	$\frac{17}{60}\ \chi$ 100% = 28,33%
3.	Slow manual measurement	$\frac{5}{60}\ \chi$ 100% = 8,33%
4.	Container overload	$\frac{2}{60}\ \chi$ 100% = 3,33%
5.	Documents pending	$\frac{2}{60}\ \chi$ 100% = 3,33%
6.	Work accident	$\frac{1}{60}\ \chi$ 100% = 1,57%
7.	Undisciplined driver	$\frac{3}{60}\ \chi$ 100% = 5%
8.	Unsuitable planning schedule	$\frac{1}{60}\ \chi$ 100% = 1,57%
9.	Lack of transportation equipment	$\frac{2}{60}\ \chi$ 100% = 3,33%
10.	Container addition	$\frac{1}{60}\ \chi$ 100% = 1,57%
11.	Containers are late entering the port pass gate	$\frac{7}{60}\ \chi$ 100% = 11,67%
12.	Facultative holiday	$\frac{2}{60}\ \chi$ 100% = 3,33%

Source: PT XYZ Branch Bandung (Data Processed 2025)

In this study, CTQ was developed not only from secondary company data but also from direct interview results with field informants. For instance, according to the Distribution Supervisor of PT XYZ Papua Branch (Informant 6):

"*Delays often occur not only because of the pole length issue, but also because the vessel schedules do not align with the time the containers arrive at the port*."

By combining quantitative data with actual interview findings, CTQ can be identified more accurately, allowing the focus of improvement efforts to be directed at the most influential elements affecting customer satisfaction and distribution performance.

4.2 Measure

According to Deniz & Çimen, (2018), the measure stage is the basis for assessing the extent to which a process is able to produce products or services with a minimum level of defects in accordance with Six Sigma standards to set a maximum tolerance of 3.4 defects per million opportunities. Therefore, in this research, the measure stage is focused on identifying and measuring the level of problems that are the main cause of delays in the distribution process of sending electric poles. The analysis in this stage is done quantitatively using two tools, namely DPMO to determine process capability and Pareto Diagram to identify dominant causal factors based on the 80/20 principle. From these tools, it is expected that this measure stage will become a strong foundation for the next stages in an effort to improve the distribution process systematically and data-based. The following is an analysis of the causes of delays in electricity poles at the measure stage.

4.2.1 Defect Per Million Opportunities (DPMO)

$$\boldsymbol{DPMO} = \frac{Number\ of\ Defect}{Number\ of\ Shipment\ \ x\ Opportunity\ per\ Shipment\ x\ 1.000.000}$$

From this formula, the calculation process will be carried out to determine the DPMO value in the distribution of electricity pole shipments. From the collection of information that has been obtained by researchers, there are defects that occur in the delivery of electric poles totaling 6 shipments with a total of 24 shipments of electric pole shipments. Opportunity per shipment becomes an error-prone point per shipment with a total of 12 errors that have been described in the define stage of the CTQ section. The following is an application for calculating the DPMO value.

$$\boldsymbol{DPMO} = \frac{6}{24\ x\ 12\ x\ 1.000.000} = 20.833$$

From this calculation, the DPMO value is 20,833, which indicates that there are 20,833 defects in one million opportunities or opportunities. It can be concluded that the shipping distribution process is still far from the process quality standards. From this value, researchers try to convert the DPMO value into a sigma level using a sigma calculator, which when converted is at the 3.5 sigma level, while the minimum standard according to Pande et al. (2000) is level 4 sigma with a DPMO value of 6,210 σ.

4.2.2 Pareto Diagram

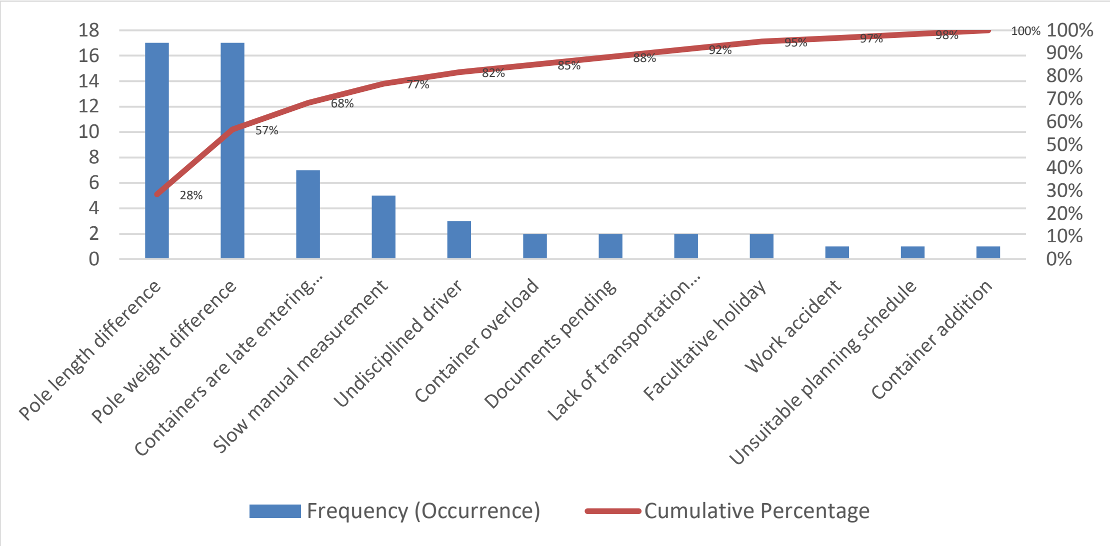
After calculating the DPMO value at the previous stage, the next step in the measure stage is to identify the main causes of defects in the distribution process of sending electricity poles. Therefore, researchers need tools in the form of pareto diagrams as part of the Six Sigma approach in analyzing the focus of process improvement. Yemima (2014) explains that the Pareto Diagram was first introduced by Pareto and first used practically by Juran. Meanwhile, according to Heizer, Jay, and Barry Render (2006) define Pareto Diagrams as a method for managing errors, problems, or defects in order to focus attention on efforts to solve major problems. This diagram sorts the data classification from left to right according to the highest to lowest ranking order, making it easier to identify the most crucial problems to be addressed immediately. From both definitions, this diagram is useful for identifying and prioritizing dominant problems, as well as assessing the impact of improvements made.

Table 7. Cumulative Percentage of Late Delivery

No.	Cause of Delay	Percentage	Cumulative Percentage
1.	Pole length difference	28,33%	28%
2.	Pole weight difference	28,33%	57%
3.	Containers are late entering the port pass gate	11,67%	68%
4.	Slow manual measurement	8,33%	77%
5.	Undisciplined driver	5,00%	82%
6.	Container overload	3,33%	85%
7.	Documents pending	3,33%	88%
8.	Lack of transportation equipment	3,33%	92%
9.	Facultative holiday	3,33%	95%
10.	Work accident	1,67%	97%
11.	Unsuitable planning schedule	1,67%	98%
12.	Container addition	1,67%	100%

Source: PT XYZ Branch Bandung (Data Processed 2025)

The results of data analysis show that there are three main cause categories that cumulatively contribute most significantly to the total defects in the distribution process of electric pole shipments. The three categories include, pole length difference of (28.33%), pole weight difference of (28.33%), and container delay in entering the port pass gate of (11.67%). Combined, these three factors account for a cumulative contribution of 68.33% of all delay problems. This finding reinforces the validity of the Pareto principle, which states that most problems can be traced back to a small number of root causes. The focus of operational improvements in this study is directed at these three dominant factors given their large influence on the decline in distribution performance, even though they have not yet met the cumulative percentage of 80%. The following is the cumulative percentage of the Pareto Diagram depicted in the form of a pareto curve.



Source: PT XYZ Branch Bandung (Data Processed 2025)

Figure 3. Pareto Diagram of Delayed Delivery

Based on the results of the cumulative value calculation, the three main causes, namely, differences in pole length, differences in pole weight, and late containers entering the port pass gate as a whole have not reached the 80% threshold as is commonly used as a reference in the Pareto principle. However, the application of the Pareto Diagram in this study is still considered relevant and methodologically justified. This is expressed by Juran and Godfrey (1999), where the pareto principle is not an absolute rule, but rather an analytical guideline that aims to identify a small number of causes that have the greatest impact on a problem.

4.3 Analyze

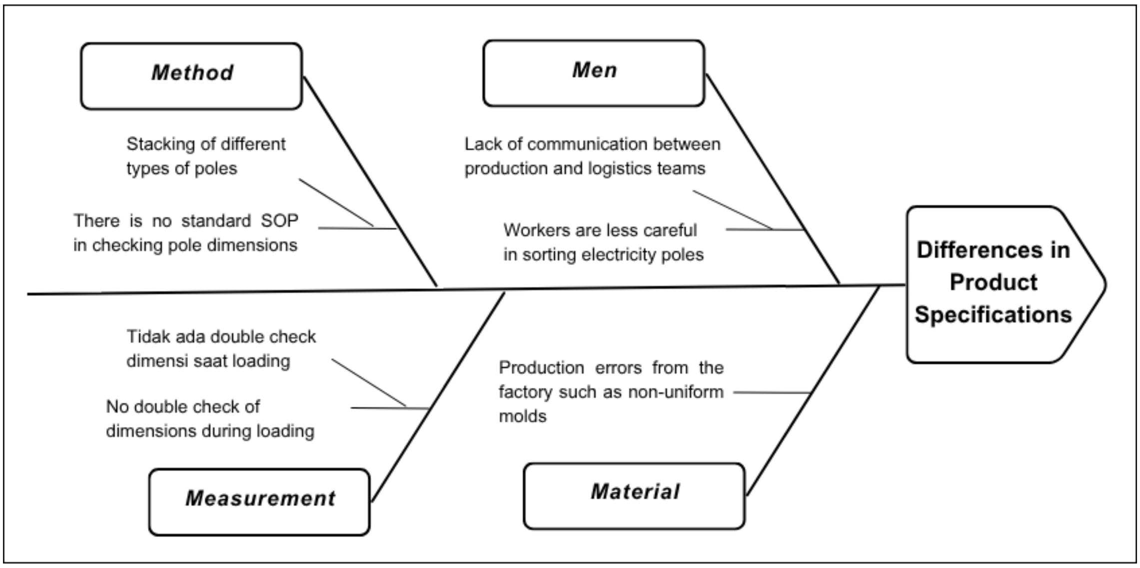
In the Analyze stage of the DMAIC method, the main focus is on identifying and deeply understanding the root causes of the problems that contribute to late delivery of power poles. After identifying the problem in the Define stage and measuring it in the Measure stage, this step becomes one of the most important stages to find out the causal factors that are fundamental and systemic, not just symptoms that appear on the surface. To support this analysis, two Fishbone Diagram tools were used to group the three dominant causal factors described in the Measure stage. According to Dr. Kaoru Ishikawa, the Fishbone Diagram aims to assist the team in identifying the root causes of problems in a systematic and structured manner. In the Fishbone Diagram, there are six categories used to group the causes of problems into several main categories such as man, machine, method, material, environment, and measurement.

Based on the identification results at the measure stage, three dominant causal factors were found that contributed to the delay in the delivery of electric poles, namely, differences in pole length, differences in pole weight and late containers entering the port pass gate. The first two factors, namely differences in pole length and weight, are analyzed in one Fishbone Diagram because both represent the physical characteristics of the product and have a direct relationship to the suitability of the technical specifications of the material (electric poles). These two factors are categorized as part of the product specification issues that affect the loading process and delivery accuracy. Therefore, this analysis approach is combined in one diagram to identify the main cause of the non-conformity of product specifications (electric poles).

4.3.1 Fishbone Diagram of the First Factor

The Fishbone Diagram for the first factor focusing on the product specification aspect will be explained in detail to identify the root cause of the length and weight discrepancies of the power poles in the shipping process. The product specification factor is an important component in the distribution chain, as non-conformance to technical standards can cause disruptions in the stuffing process, imbalances in container loads, and delays in the inspection and acceptance stages of goods at the destination site.

In this Fishbone Diagram analysis, the cause categories are grouped into several main elements, namely Man, Method, Material, and Measurement based on a list of possible root causes of each factor. Through this approach, various possible causes of differences in product specifications will be explored with the aim of obtaining a more detailed understanding of the contribution of each element to the occurrence of differences in material dimensions (electric poles). The following is a Fishbone analysis of the product specification factor.



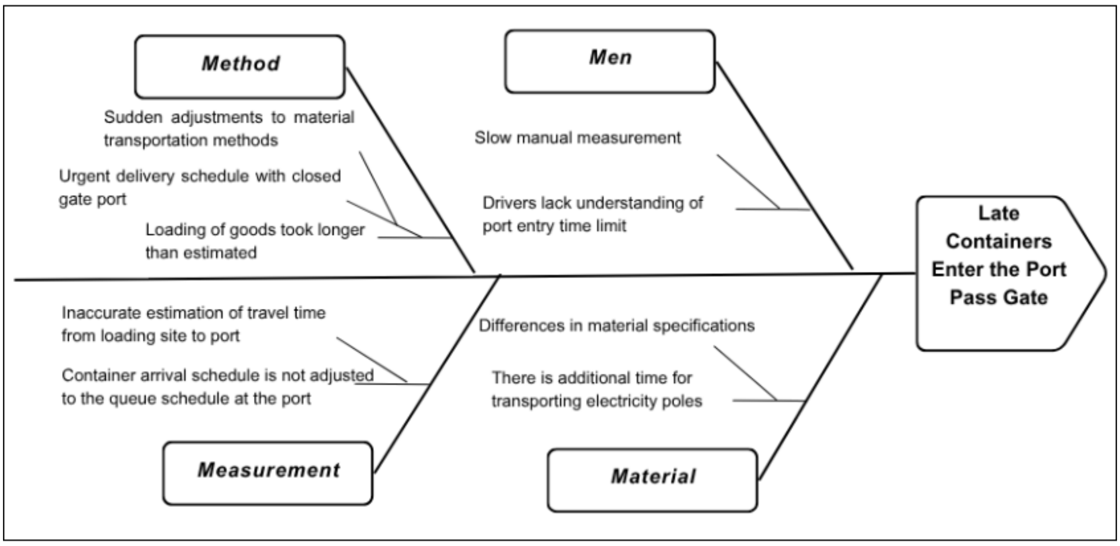
Source: Data Processed 2025

Figure 4 Fishbone Diagram of the First Factor

4.3.2 Fishbone Diagram of the Second Factor

The second factor in the Fishbone Diagram analysis is late containers entering the port pass gate. In this case, researchers tried to identify and investigate the root causes of the delay. Based on the list of possible causes, the delay in the container factor in entering the port pass gate is caused by a number of interrelated factors, both from the internal operational side and external conditions that are beyond the direct control of the shipper. Identifying these root causes is important to formulate strategic solutions that can improve the efficiency of the distribution process, especially in shipping power poles by sea.

In this Fishbone Diagram analysis, the cause categories are grouped into several main elements, namely Man, Method, Material, and Measurement based on a list of possible root causes of each factor. Through this approach, various possible causes of late containers entering the port will be explored with the aim of obtaining a more detailed understanding of the contribution of each element to the delay. The following is a Fishbone analysis of the product specification factor.



Source: Data Processed by Author 2025

Figure 5. Fishbone Diagram of the Second Factor

4.4 Improve

The Improve stage in the process improvement approach emphasizes the importance of structured corrective action planning. This planning includes resource allocation, prioritization, and identification of relevant and applicable alternative solutions (Siddiqui & Iqbal, 2021). According to Afifa & Damayanti, (2023), an improvement plan will be effective if it is prepared using the 5W+1H approach (What, Why, Where, When, Who, and How), so that every solution implemented can be targeted, measurable, and accountable both operationally and strategically.

Based on the results of the root cause analysis obtained through the Fishbone Diagram, the main focus of the Improve stage was directed at two main factors causing delays in the distribution of electricity poles. First, there was a mismatch in product specifications, especially related to the length and weight of electricity poles, which did not meet technical standards and had an impact on increasing the loading process time. Second, constraints in the container entry process to the port pass gate, which directly affected the delay in the shipping schedule. To overcome these problems, corrective solutions will be systematically designed and implemented based on the 5W+1H approach. This approach aims to ensure that every corrective action taken is not only able to solve the problem temporarily, but also prevent the recurrence of similar problems in the future, especially in the handling of large-dimensional and heavy-dimensional goods.

Table 8. Analysis of Improvement Factors Related to Differences in Product Specifications

Factor	Question Analysis	Description
Differences in Product Specifications	What? (What need improvement?)	Unclear planning and coordination of the delivery process.
	Who? (Who should be responsible for the implementation of improvement?)	Quality control, procurement, and checker
	When (When will the improvement be made?)	Before the distribution of power pole delivery, especially the loading process
	Why? (Why improvement must be made?)	To avoid differences in product specifications in the delivery distribution process that can result in re-adjustment of transportation selection, additional costs, product defects and hamper the overall distribution process.
	Where? (Where improvement will be made?)	Production process and product quality checking through quality control and procurement teams
	How? (How is the implementation of the improvement plan?)	Conduct double check process in quality control, check product specifications before distribution process, improve coordination between parties and plan a structured delivery system based on field conditions.

Source: Data Processed by Author 2025

Table 9. Analysis of Improvement Factors Related to Late Container Entry at Port Pass Gate

Factor	Question Analysis	Description
Late containers enter the port	What?	Sub-optimal planning and estimation of time calculations in the loading and

pass gate	(What need improvement?)	shipping process.
	Who? (Who should be responsible for the implementation of improvement?)	Distribution team and driver
	When (When will the improvement be made?)	During the planning process (before the delivery process is carried out, especially the loading process because it requires a long lead time)
	Why? (Why improvement must be made?)	To avoid additional cost, lead time, and maintain customer satisfaction.
	Where? (Where improvement will be made?)	Loading Site
	How? (How is the implementation of the improvement plan?)	Re-designing the design of electric pole delivery, especially in the placement of electric poles that are more effective by taking into account the dimensions of the poles and the types of containers used (this process requires a long lead time) and calculating the maximum closed gate limit after the loading process.

Source: Data Processed by Author 2025

4.5 Control

This research is limited to the improve stage, so researchers cannot carry out the control and supervision stages of improvement continuously. This is due to time constraints and research conditions, where during the research implementation period, the delivery of the material under study (electric poles) was only carried out once with the same shipping transportation method, namely using a 40 ft container. Therefore, researchers have not been able to proceed to the control stage to conduct continuous evaluation of the implementation of improvements that have been recommended by researchers. At the improve stage, the company is expected to supervise and control similar delivery projects to minimize delays in the future.

5. Conclusion

Based on the research that has been conducted, several conclusions can be drawn. There are twelve identified causes of late delivery, with the most dominant contributing factors being material specification issues, namely differences in pole length (28.33%), differences in pole weight (28.33%), and late containers entering the port pass gate (11.67%), resulting in a cumulative contribution of 68%. Although this cumulative value has not reached 80%, the use of Pareto diagrams remains relevant for this study. The calculation results show that the DPMO value is 20,833, indicating that there are 20,833 defects per one million opportunities. When converted to the sigma value, the process capability is at 3.5 sigma, which has not yet met the Six Sigma standard (4 sigma with a DPMO value of 6,210). In the analysis stage, the root causes were categorized into two main factors: product specifications (pole length and pole weight) and late containers entering the port pass gate, which are interrelated.

This study has several limitations. The analysis is limited to the factors identified within the observed company and does not include external variables such as supplier reliability, weather conditions, or port congestion that may also affect delivery timeliness. Additionally, data collection was based on a specific period and a particular product type (electric poles), which may limit the generalizability of the findings to other products or industries. The study also relies on available internal reports and interviews, which may contain subjective elements or incomplete information.

Based on the findings and identified limitations, several recommendations can be proposed to improve shipping and distribution performance. Companies should enhance coordination and information transparency among related parties, as well as establish a more structured and integrated delivery planning system. It is also recommended to redesign the electric pole delivery layout to achieve a more effective arrangement that considers pole dimensions and container types. Furthermore, it is crucial to ensure that material specifications match the provided information by implementing a double-checking process before distribution to prevent specification discrepancies and late deliveries. Future research is suggested to involve a broader range of data, additional variables, and comparisons with other industries to obtain more comprehensive and generalizable insights.

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