

## Improvement of Mro Material Procurement Efficiency Through the Six Sigma Concept at PT Krakatau Steel (Persero) TBK

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### ABSTRACT

**Keywords:** MRO material, lead time, Six Sigma, DMAIC, BPA and consignment contract.

PT Krakatau Steel (Persero) Tbk (PTKS) is a State-Owned Enterprise engaged in the production of steel and related services. The MRO Procurement Department is a procurement function to process MRO Material purchasing at PTKS. The main problem currently faced is the lead time for the MRO material procurement process which takes a long time, the reason is that procurement is often conducted by spot method and repeatedly for the same material. Too long lead times pose a risk to the smooth production process due to the unavailability of MRO materials when needed. Referring to the MRO Procurement Department's KPI, >85% of the number of POs (Purchase Orders) issued must have a lead time of <41 days, however, based on the actual historical data for 2022, the PO lead time achievement for the MRO material procurement process does not meet the target. Department's KPI, >85% of the number of POs (Purchase Orders) issued must have a lead time of <41 days, however, based on the actual historical data for 2022, the PO lead time achievement for the MRO material procurement process does not reach the target. An alternative solution used to speed up procurement lead times is implementing a Blanket Purchase Agreement (BPA) and/or Consignment Contract for MRO routine/consumable material types. The results obtained are that the long and complicated MRO material procurement process for the same type of material can be eliminated, which means that with the improvements made, the MRO Procurement Department can implement a more efficient procurement process.



### Introduction

In a discussion forum entitled Prosperous and Connected Thanks to Infrastructure, President Joko Widodo said infrastructure is the foundation for Indonesia to be able to compete with other countries (Mollov, 2020). Infrastructure readiness is the foundation for Indonesia to grow into a developed country, which prevents Indonesia from being trapped in a developing country or middle-income trap (AKINOLA et al., 2022).

Infrastructure development will certainly have short-term and long-term effects for a country, in the short term it can create jobs, where human labor is the main factor supporting development (Bag et al., 2020). Meanwhile, in the long run, evenly distributed infrastructure will open up new access and facilitate existing access, of course, better connectivity will support the growth of new economic centers and not be concentrated in the capital city of Jakarta (Doan, 2020).

Infrastructure development is expected to have a positive impact on the national steel industry in line with an increase in per capita consumption. However, the growth in per capita steel consumption in Indonesia is much lower than in other countries in ASEAN, based on data from the World Steel Association, Indonesia's per capita steel consumption is around 55.2 kg/capita (Durdyev & Hosseini, 2020). Meanwhile, when compared to neighboring countries, domestic consumption is still above the consumption level of Myanmar at 51.9 kg/capita but still below Malaysia, which is around 210.5 kg/capita, Singapore at 273.5 kg/capita, and Vietnam at 239.8 kg. /capita (Fourie & Malan, 2020). The absorption of steel products in Indonesia is still dominated by the construction sector, which is 78%. This is a big question, why with the massive construction development, which is related to steel products and materials, however, the level of domestic consumption of steel per capita very low?

PTKS is a capital and technology-intensive upstream industry, the biggest factor that becomes a challenge is the supply chain, starting from the fulfillment of raw materials and also Maintenance, Repair, and Operation (MRO) materials to the distribution of their products to consumers (Gitta, 2023). As a state-owned company, it is obliged to carry out the function of procuring goods/services by referring to the internal Standard Operating Procedures in operations, by referring to the Regulation of the Minister of State-Owned Enterprises of the Republic of Indonesia No. PER-08/MBU/12/2019 concerning General Guidelines for the Implementation of Procurement of goods and services State-Owned Enterprise (NJOKI, 2023). PT Krakatau Steel issues internal procurement guidelines called Goods/Services Procurement Procedures which involve all related units, and regulate procedures for request processing, procurement processes, inspection of goods, storage of goods, and the process of using goods by requesters. Overall, the procedure contains guidance starting from the process of planning, implementing, and supervising the procurement of goods and services (Rane et al., 2020).

MRO Procurement Department organizational position under the Central Maintenance & Procurement Division, as a function of material procurement MRO plays an important role in the supply chain to support PT Krakatau Steel's production continuity (Sönnichsen & Clement, 2020). There is a need for innovation and improvement so that the availability of MRO materials can be met efficiently, effectively, and competitively, and must follow the principles of Good Corporate Governance (GCG), the principles that must be implemented are: Transparency, Accountability, Responsibility, Independence and Fairness (Wankmüller & Reiner, 2021).

PT Krakatau Steel has human resource assets arranged in an organizational form. Human resources have the expertise to support all business activities of PT Krakatau

Steel. Overall, the organization is led by a President Director who is fully responsible for all activities related to the company. Under the main director, there are five Directors and several Vice Presidents (VP) under the Director, and several VPs are directly supervised by the President Director. Under the Vice President, there are departments headed by managers who have specific responsibilities for their jobs.

The MRO Procurement Department position is under the Central maintenance & Procurement Division, which has the main duties and functions of controlling and planning field maintenance activities and workshops in processing factory equipment repairs, such as mechanical, automation, instrumentation and electrical as well as civil equipment, by making/modifying equipment factory and perform cost estimation, design and technical inspection, recalibration and management of plant utilities and energy management to ensure the smooth operation of the plant and maintain optimal Overall Plant Effectiveness (OPE), as well as strategic sourcing management and market analysis, managing the cataloging of non-development goods and services , evaluation of estimated prices, clearance of imported goods, handling shipments of import material (sea and air) freight, vendor management, warehousing management and procurement of Maintenance, Repair and Operation (MRO) materials, the entire activity should be ensure runs in the right quality, quantity, specification, price and on time according to company needs, and in accordance with the principles of Good Corporate Governance and the applicable Standard Operating Procedures.

Maintaining efficient production with few unplanned breakdowns is one way to reduce production costs. If a breakdown does occur unexpectedly, it must be quickly resolved so that production can restart as soon as possible to achieve specified production volume requirements. The ability to correct repairs can be measured by MTTR (Mean Time to Repair) while the minimum operational delay due to unscheduled breakdowns can be described by MTBF (Mean Time Between Failures). Referring to the explanation above, we know that proper and accurate Maintenance Management can optimize Plant Availability. In general, maintenance is divided into two, namely planned maintenance and unplanned maintenance. Planned maintenance activity care that is organized and carried out with forethought, control, and disability according to a predetermined plan. One of the planned maintenance activities is to plan and organize the availability of spare parts and consumables for maintenance needs.

## **Method**

The methodology chapter will explain the research flow comprehensively, starting with identifying the symptoms that led to the research and ending with the expected results. This chapter will study data collection and analysis methods developed to overcome MRO material procurement challenges through the Six Sigma concept.

## **Research Philosophy**

This research will use the philosophy of interpretivism. This philosophy was chosen because this research focuses on an in-depth understanding of the MRO (Maintenance, Repair, and Operations) material procurement process and how the Six Sigma concept

can be applied to increase efficiency at PT Krakatau Steel. Interpretivism allows researchers to understand complex social and organizational contexts and capture the nuances of the experiences of individuals involved in the procurement process.

### **Research Approach**

This research will use an inductive approach. This approach was chosen because the research aims to develop new understanding and theories based on data collected in the field. In an inductive approach, researchers begin by collecting empirical data through qualitative methods, such as semi-structured interviews, to explore the experiences, views, and practices that exist at PT Krakatau Steel regarding the procurement of MRO materials and the implementation of Six Sigma. From this data, researchers then identify emerging patterns, themes, and relationships, which are then used to form conclusions and new theories regarding increasing procurement efficiency.

### **Research Design and Strategy**

This study employs a qualitative approach to methodology. Through interviews with relevant stakeholders, qualitative data is used to determine the underlying cause of the material procurement process. According to Creswell (2010), qualitative research requires significant efforts, including the formulation of questions and procedures, the collection of specific data from related subjects, the inductive analysis of data from specific to general themes, and the interpretation of the data's meaning. This study will collect data through interviews with managers or superintendents of the Central Maintenance & Procurement Division and Rolling Mill Division.

### **Sampling Strategy**

This research implements a purposive sampling strategy, where the sample is selected deliberately based on certain criteria that are relevant to the research objectives. In the context of research on increasing the efficiency of MRO material procurement through the Six Sigma concept at PT Krakatau Steel, the selected participants will include individuals who have in-depth knowledge and direct experience in the procurement process and implementation of Six Sigma. This includes procurement managers, operational staff involved in procuring MRO materials, and Six Sigma experts or practitioners in the company. A purposive sampling approach ensures that the information collected is relevant and in-depth, providing meaningful insight into how Six Sigma concepts can improve procurement efficiency.

### **Data Collection Method**

This study employs a qualitative methodology, with data collected from several sources of data including MRO Procurement history from ERP/SAP, Questionnaires, discussions, and interviews.

#### **a. MRO Procurement data history**

The MRO Procurement data history is already archived in the ERP/SAP System of PTKS. The data stored in the ERP/SAP system is very complete, it can be traced starting from the initial request process from the user, the procurement process, and receiving and storage activities until the item is used by the user. The data source used is the history of

the procurement process from 2020 to the end of 2022. The data obtained from SAP are Purchase Requests that have been made by the authorized unit which is the Maintenance Service Department for plant spare or insurance spare items and also MRO Planning for common spare and consumable material types.

b. Interview

According to (Aprile et al., 2019) in qualitative approaches, the major data collection technique is the interview. Several employees with positions and responsibilities related to the material procurement process carried out by the Central Maintenance & Procurement Division were interviewed. Discussions with experienced employees who serve as mentors for the researchers in this study were also held. Data collection by referring to the literature review and then conducting interviews with sources working in the Central Maintenance & Procurement Division related to the material procurement process such as buyers, planners, mid-management which means the Superintendent, the decision maker which means the manager of procurement and another supporting department, as well as end users who use materials in the work area and external parties which is some PTKS's vendors. The following is a list of resource persons along with their profiles and a description of the work performed.

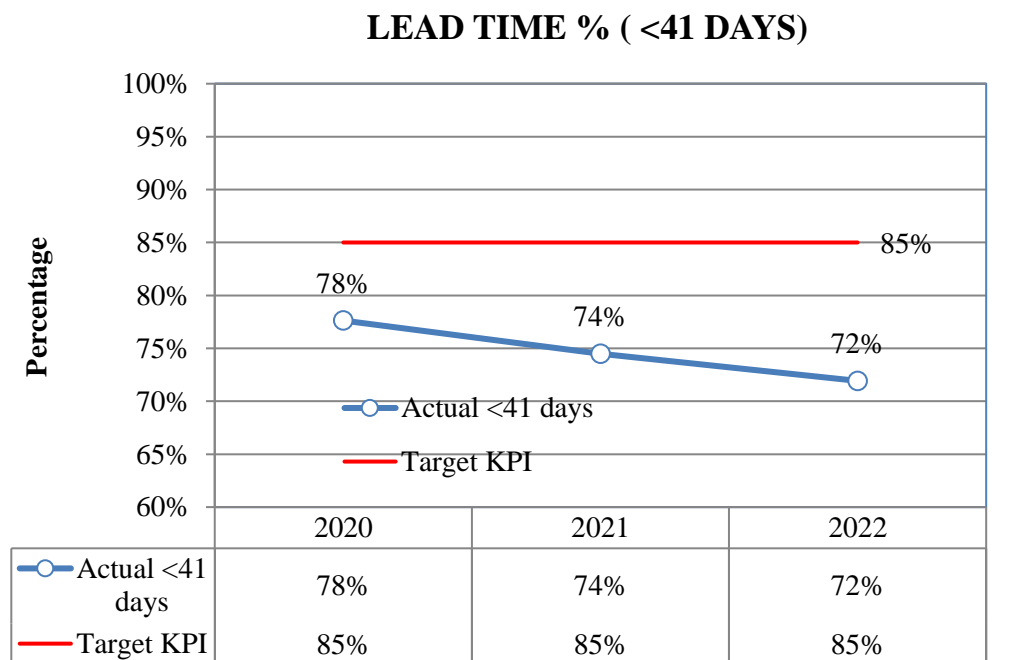
#### **Data Analysis Method**

The following final project research, based on qualitative data analysis, it conducted to identify problems in the MRO material procurement process by interviewing related parties, considering historical procurement data, and reviewing literature studies. According to Sugiyono (2019), data analysis in qualitative research is carried out during data collection, and after completing data collection within a certain period. By interviewing, the researcher then compiled an analysis of the answers that had been described.

## **Results and Discussion**

### **Identification Lead Time Procurement Process of MRO material**

Every material procurement process, especially spare parts procurement, requires quite a long lead time, starting from the PR preparation process (including the cataloging process, HPS/OE preparation, and PR release) to PO preparation (including the tender process, negotiation, and PO approval), coupled with a very large number of items and variants of spare parts and consumable materials. Following up on user complaints regarding the long lead time for spare parts procurement, it is necessary to find the best solution. From the evaluation results of spare parts PO report data on the SAP system from 2020, 2021, and 2022, procurement performance, especially in procurement lead time, has decreased, as in the following picture as follows:



**Figure 1**  
Average lead time for PR-PO spare parts in 2020-2022

From the graph above can be seen that there is a trend in the average lead time in the process of completing MRO material POs during the 2020, 2021, and 2022 time periods which tends to decrease in achieving lead times below 41 days, when referring to the standards used, namely Departmental MRO KPIs and Procurement Procedures The actual PTKS realization of PO lead time with a period of less than 41 days must exceed 85% of the total PO items.

The following are detailed stages of the procurement process so that a time reference of 41 days is set as stated in the PT Krakatau Steel (Persero) Tbk Goods Procurement Procedure.

**Table 1**  
PTKS goods procurement procedures

No	Activities	Times	Remark
1.	PR & Document Checking	2	
2.	Technical Explanation	0-8	If necessary
3.	Auction setup & send bid requests	2	
4.	The process of submitting price offers	3-10	
5.	Bid opening and COQ creation	2	
6.	Clarification and Negotiation	1-3	

7.	HPS/OE Evaluation	0-7	In case Final nego price > OE
8.	PO preparation	2	
9.	Release and signing of PO	1-5	

It must be admitted that the standard lead time of 41 days does seem very long, this can happen because PTKS still uses hard copies. From the first stage, the buyer will print all procurement files and then store them in a special folder where the documents will flow according to the ongoing process. Apart from that, some processes still require a wet signature, for example, HPS/OE evaluation approval and PO printed wet signature. This is a waste of time and requires migration to a digital system so that it can be truly paperless in the procurement process operations and of course, it will speed up the procurement process too.

**SIPOC Analysis**

To find out the factors that influence the procurement process, a tool is needed to understand the entire process. By using the SIPOC diagram, you can fully describe the procurement process implemented at PTKS. The following is a SIPOC table for the procurement process diagram.

**Table 2**

S	I	P	O	C
Supplier	Input	Process	Output	Customer
User Function (MS. Dept, etc.)	MWO and Reservation	Creating & Approval Purchase Request	Purchase Request Approved	Planner of MRO Proc. Dept
Vendor Management & Cataloguing	Prepare documents and eligible vendors	Selecting and Inviting	Request for Quotation (RFQ)	Vendors
Eligible Vendors	Quotations	Open all Quotations on the closing date	Comparison of Quotation	Buyer of MRO Procurement Dept
Buyer of MRO Procurement Dept	Proposed Quotation as a requirement	Bidding Process	Determined the lowest bidder	Vendors

Vendors with Lowest bidder	review technical specification	Clarification & Final Negotiation	Acceptance Final Price & specification	Users and Vendor
MRO Proc. Department	Draft and review PO	PO awarding and signing by both	Release PO	Manager MRO Dept. and Vendors
Warehouse Management Department	GR process	Closed MWO and Reservation	The request has been fulfilled	User Function (MS. Department & etc.)

The SIPOC Analysis is a tool utilized in the Six Sigma methodology to identify the essential elements of a process before initiating improvements. In this study, the SIPOC Analysis aids in detailing each step in the supply chain involving MRO (Maintenance, Repair, and Operations) material procurement. The SIPOC elements consist of Supplier, Input, Process, Output, and Customer. Suppliers are identified as vendors or distributors providing MRO materials, while inputs include material specifications, ordering requirements, and delivery information. The process involves request receipt, vendor evaluation, ordering, goods receipt, and quality control. Outputs are MRO materials received according to specifications, and customers are various departments within PT Krakatau Steel utilizing the materials for operational and maintenance needs.

As a result of this definition stage, specific objectives are formulated to reduce procurement cycle times, improve coordination between departments, and improve supplier management. This clear and detailed definition of the main problem allows Six Sigma to focus on critical areas that require improvement, as well as set realistic and measurable targets to improve the efficiency of MRO material procurement at PT Krakatau Steel.

**Measure Phase**

The historical of creation Purchase Requests will be displayed based on the commodity/Material group from 2020 to 2022, sorted from the highest number of PRs, as follows:

**Table 3**  
**Number of PR Material creation based on commodity materials/material groups from 2020 to 2022**

No	Commodity	Category	2022	2021	2020	TOTAL
1	9150	Oils And Greases: Cutting, Lubricating, And Hydraulic	371	475	358	1204
2	8010	Paints, Dopes, Varnishes And Related Products	528	367	127	1022
3	3110	Bearings, Antifriction, Unmounted	474	316	201	991

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4	6850	Miscellaneous Chemical Specialties	344	291	197	832
5	5310	Nuts And Washers.	343	197	216	756
6	5306	Bolts	359	178	134	671
7	5305	Screws.	364	165	121	650
8	4730	Fittings And Specialities, Hose, Pipe And Tube	356	175	88	619
9	6810	Chemicals	383	120	62	565
10	1365	Chemical, Agent, Stimulant	171	147	112	430
11	3439	Misc. Weldings, Soldering, & Brazing Supplies And Accessories	192	156	82	430
12	5330	Packing And Gasket Materials	166	131	68	365
13	4330	Centrifugals, Separators, And Pressure And Vacuum Filters	126	117	64	307
14	5345	Disks And Stones, Abrasive	126	120	61	307
15	4720	Hose And Tubing, Flexible	143	104	42	289
16	6110	Electrical Control Equipment	73	76	76	225
17	4820	Valves, Nonpowered	71	85	55	211
18	8030	Preservative And Sealing Compounds	80	87	36	203
19	6145	Wire And Cable, Electrical	111	55	35	201
20	7920	Brooms, Brushes, Mops, And Sponges	81	67	53	201
21	8020	Paint And Artist's Brushes	95	84	20	199
22	7530	Stationery And Record Forms	71	75	41	187
23	8430	Footwear, Man's	58	59	61	178
24	5930	Switches	96	34	33	163
25	4710	Pipe And Tube	96	34	29	159
26	3010	Torque Converters And Speed Changers	65	51	31	147
27	3455	Cutting Tools For Machine Tools	59	42	30	131
28	4810	Valves, Powered	70	32	17	119
29	5350	Abrasive Materials	64	32	23	119
30	4010	Chain And Wire Rope	35	41	41	117
31	9510	Bars And Rods, Iron And Steel	38	46	30	114
32	4320	Power And Hand Pumps	48	33	27	108
33	9520	Structural Shapes, Iron And Steel.	59	41	8	108
34	8040	Adhesives	56	29	21	106
35	5970	Electrical Insulators And Insulating Materials	35	34	36	105
36	5920	Fuses, Arresters, Absorbers, And Protectors	35	35	33	103
37	3422	Rolling Mills And Drawing Machines	52	24	25	101
38	6685	Pressure, Temperature, And Humidity Measuring And Controlling	48	26	24	98

39	3040	Miscellaneous Power Transmission Equipment	47	34	13	94
40	4940	Miscellaneous Maintenance And Repair Shop Specialized Equipment	62	25	3	90
41	7510	Office Supplies	24	32	33	89
42	6640	Laboratory Equipment And Supplies	57	21	10	88
43	8415	Clothing, Special Purpose	36	23	23	82
44	3910	Conveyors	34	26	20	80
45	9140	Fuel Oils	27	29	22	78
46	3030	Belting, Drive Belts, Fan Belts, And Accessories	40	21	16	77
47	3433	Gas Welding, Heat Cutting, And Metalizing Equipment	35	23	19	77
48	5963	Electronic Modules	23	28	25	76
49	3990	Miscellaneous Materials Handling Equipment	10	2	60	72
50	4240	Safety And Rescue Equipment	39	12	17	68
TOTAL			6376	445 7	2979	13812

The measurement results show that there is a significant imbalance between the number of requests for a commodity and the number of material codes processed in procurement. This means that many material requests are not processed properly, causing a backlog of requests and lengthening procurement cycle times. This situation indicates that the procurement methods currently implemented are less effective in handling high volumes of demand, thereby hampering operational efficiency.

The conclusion from this data analysis is the need to review the procurement methods applied at PTKS. Current methods are not able to accommodate procurement needs properly, which can be seen from the high number of unfulfilled requests. Therefore, a strategy is needed to reduce procurement cycle time by optimizing existing processes. One way is to simplify unnecessary procurement stages and improve existing work procedures.

**Improve Phase (Business Solutions)**

After analyzing the core problems, the next stage is to develop improvements as a solution to the problems faced. The following is a proposed solution to the root of the problem faced.

**Table 4  
Proposed solution**

No	Root Causes	Proposed Solution
1.	Lead Time procurement too long	Blanket Purchase Agreement and E-Procurement
2.	Repeated Purchase Request	

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3. Lack of planning

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4. Common Material

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The following is an explanation of the solution to the main problem of lead times that are too long and frequent requests for procurement of the same goods repeatedly using a Blanket Purchase Agreement.

A Blanket Purchase Agreement (BPA) is a simplified method of addressing anticipated repetitive needs for supplies or services by establishing “charge accounts” with qualified sources or suppliers. BPA’s promote competition and allow districts to utilize multiple vendors. It also simplifies the procurement of services. BPA’s are solicited for one year, with two one-year options. The district has the option whether or not to renew for an option year. BPA’s promote competition and allow districts to utilize multiple vendors. It also simplifies the procurement of services. A blanket purchase order can bring many benefits to the business if you use it correctly.

**Reduce costs and increase purchasing power.**

The blanket agreement can help organizations group all the good or service purchases that would otherwise be spread out over a long period and gain volume discounts. Besides, it also helps reduce administration costs significantly since you don’t have to involve all departments several times to manage the same purchase and find new suppliers or renegotiate terms and prices again for each order.

**Improve efficiency and shorten purchasing lead time**

A blanket PO streamlines the procedure of ordering repeated items. Rather than creating many individual purchase orders, you can just create one and receive it many times. On the other hand, when the supplier has all order information for a long period in advance, they can actively prepare all orders and reduce lead time.

**Reduce stock holding**

A blanket agreement specifies all of the terms and conditions of purchase, including the numbers needed and the expected delivery date. Therefore, it eliminates the need to have extra stock on hand which can help reduce inventory carrying costs and increase efficiency.

**BPA Implementation**

The control stage in implementing a Blanket Purchase Agreement (BPA) involves several key activities to ensure that the blanket purchase agreement is implemented effectively and efficiently. First, at the Implementation Plan stage, the company must prepare the implementation team and determine a clear timeline and milestones. After that, the BPA system is tested to ensure that all processes run smoothly before being fully implemented. Training of relevant staff is also essential to ensure that all parties involved understand the new policy. After training, the BPA system is implemented in stages with initial monitoring to identify and adjust any problems that may arise. Initial evaluation is

carried out to assess the success of implementation and make improvements based on feedback.

Furthermore, in Standardization activities, companies must set standards for the procurement process, including identification of common materials and suppliers used. This standard is then documented in the form of a clear and comprehensive SOP (Standard Operating Procedure). Standard socialization is carried out through training and dissemination of information to all teams involved in the procurement process. Implementation of standards is carried out in daily operations by monitoring compliance with established standards. Regular internal audits are conducted to ensure that all procedures and standards are properly followed, and adjustments are made, if necessary, based on audit results. Finally, the Control Plan involves the definition of relevant performance indicators (KPIs) to monitor the effectiveness of the BPA.

The data collection system must be implemented continuously to obtain accurate and up-to-date information. Regular monitoring of KPIs is carried out, with monitoring results reported to management. If areas requiring repair are discovered, corrective action is taken immediately. Periodic reviews of the control plan are also carried out to ensure continuous improvement and necessary adjustments.

## **Conclusion**

The procurement problem from 2020 to 2022 is the long lead time process. It can be seen from the KPI achievement data, especially regarding lead time, that the achievements do not reach the target. This long lead time is one of the findings of this research. In general, this research has several findings which can be concluded as follows:

1. Based on the results of interviews with all parties, the long and inefficient lead time for MRO procurement at PTKS is caused by several factors, namely: poor coordination between departments, inadequate procurement management, and less integration and automation of information systems.
2. The slow and inefficient MRO procurement process at PTKS creates various significant operational and financial challenges.
3. To increase efficiency and reduce the lead time for MRO material procurement at PTKS, several alternative solutions can be implemented, such as the use of Blanket Purchase Agreement (BPA) contracts and the implementation of E-Procurement.
4. The Six Sigma concept can create a strategy to increase the efficiency of MRO material procurement at PTKS. Researchers have developed this strategy through the Define, Measure, Analyze, Improve, and Control phases, thereby creating a business solution in the form of a strategy to increase efficiency using BPA and E-Procurement.
5. From a Supply Chain Management (SCM) perspective, these findings underline the importance of integrated and efficient supply chain management in improving a company's operational and financial performance.
6. By using Good Corporate Governance (GCG) principles in this research, PT Krakatau Steel ensures that the procurement process is not only financially efficient but also meets high ethical and compliance standards.

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