
3.4.3.2 Solution Determination

At this stage, a search and determination of solutions will be implemented in the research after the root of the problem is identified. The process of finding a solution involves compiling a Problem Identification and Corrective Action (PICA) table.

3.4.4 Improve

After the solution to the problem and system requirements is clearly stated, the next step is to carry out the improvement phase by formulating a solution based on the analysis results from previous research.

3.4.4.1 Improvement Proposals

Once the data has been analysed, the anticipated outcomes are derived from the proposed solution. This entails the development of a novel order process model tailored for the company, serving as a recommended management project to achieve the defined objectives of this study.

3.4.4.2. Implementation

For all agreement contract commodity between customers and PT UT will be process. Once the recommendations are approved, the proposal will be put into action, and data will be gathered post-implementation for evaluation purposes.

3.4.5 Verification

The verification outcomes after the application of the new recommendations hold great significance. The assessment of implementation aligning with expectations is crucial. Certain data will be gathered and subject to evaluation. The aim is to assess the system, identifying any potential bugs or system crashes when issues arise within the essential system. These evaluations can lead to modifications, enhancements, or refinements in the system's design or programming process. If issues are detected, the stage will loop back to the rectification process in order to address the requirements identified through evaluation.

3.4.6 Control

The concluding phase involves controlling and upkeeping the implemented measures, along with the confirmed recommendations from this thesis that have yielded positive outcomes. Control can be achieved by executing a scheduled internal audit program and periodically monitoring reports.

CHAPTER 4 – RESULTS AND DISCUSSIONS

4.1 Problem Discussion

For the fourth chapter, the availability spare parts inventory service level and on time in full will be described at UT Ketapang only. The level of service is shown through instant full availability and on time in full which has not yet reached the predetermined target. Requests for spare parts from customers in the Ketapang area rarely get what is ordered, besides that the supply of part orders takes a long time, causing the "ready-for-use" condition of customers' heavy equipment to take longer.

In this chapter, we will also explain the analysis carried out to determine the right spare parts so that the full instant can be increased, while the service level can be increased, which is reflected through the full instant availability as of requests. In addition to determining spare parts, stock level determination will also be carried out, producing a list of stock item data along with minimum and maximum stock levels.

To determine spare parts and stock levels, calculations will be carried out quantitatively using a monthly spare parts movement approach for one year or what is known as month movement, as well as forecasting using historical demand data including the Simple Moving Average method. A qualitative approach will also be applied by considering information from customers, such as spare parts usage planning, unit damage trends, and predictions of future spare parts usage, including deterministic calculations based on the useful life of spare parts. With this method, criteria will be obtained that must be approved by PT. United Tractors and Customers to determine what items will be used as stock by customers and that will be purchased.

4.2 Data Collection

As context for key issues and analysis in finding solutions, we collect a variety of data, including service levels, sales contributor, otif parts, and historical demand data. We got this data from the system at PT. United Tractors Pontianak Branch. It is hoped that this data can become the basis for process improvements and be used as a reference for calculating appropriate inventory stock levels and lead time supply.

a. Service level data

Service level data is the basis for identifying main problems, because from this information it can be seen how accurate the selection of items and determining stock levels are in meeting existing demand.

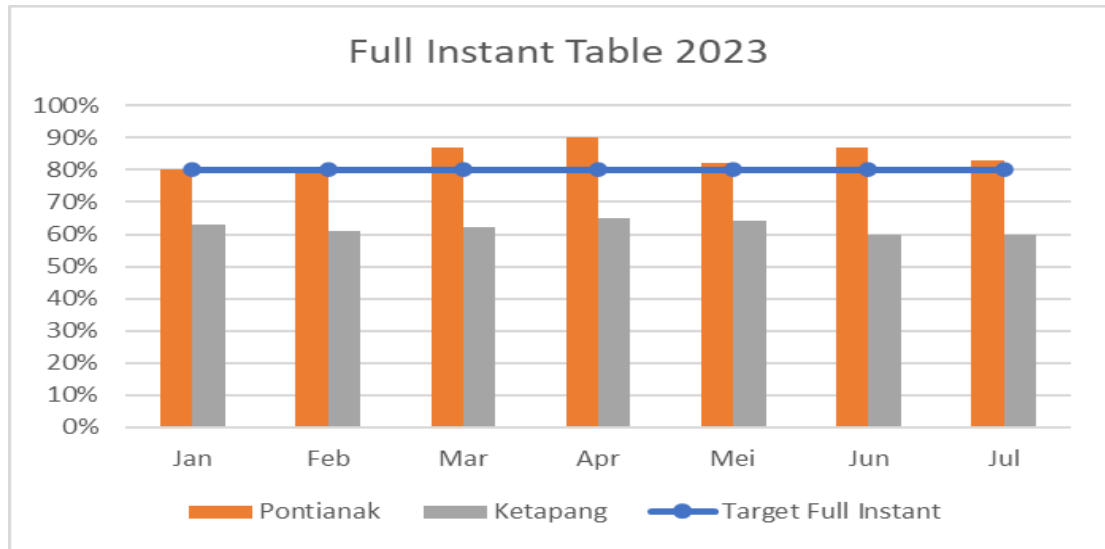


Figure 4.1 Service Level Graph in 2023

From Figure 4.1 it shows that, the target of achieving a service level of 80% has never been achieved throughout 2023 for ketapang point support. The service level calculation is carried out by comparing the number of call frequencies that can be fulfilled with the stock in the warehouse UT Pontianak and ketapang with the total frequency of all customer requests during 2023. The service level calculation can be simplified using the formula below:

$$\text{Service Level} = \frac{\text{Available demand frequencies}}{\text{all demand frequencies}} \times 100\% \quad (4.1)$$

b. Interviews data

Information gathering through interviews with Pontianak Parts Supply Chain Officer, branch internal team service and with customer users ketapang area revealed that the forecasting method applied in 2022 is as follows:

Based on the results of interviews with Parts Supply Chain Officer PT. UT, findings include:

- The forecasting method applied in 2022 is using the 12-month moving average method for all items that have undergone transactions, including those in the Fast moving and slow-moving categories.
- The stock ordering process is carried out every month.
- lack of communication with service team to anticipate the need for parts which are always urgent or backlog stock.
- The service level is not achieved, and the reason is because there are many new items that have not been included in the forecasting calculations.

The following are the summary results of an interview with customers ketapang area:

- The service level from PT. UT ketapang unsatisfied, has not achieved the target set at 80%, focuses on the Fast-moving category (Parts Periodical Service, Consumable Parts).
- Delivery lead time is too long, both in stock in UT Pontianak and stock in UT Nusantara.

And the last interview is with internal branch team service, are:

- Too often the system states that the part has never been transacted at UT Pontianak.
- The parts team often asks about trends in spare part needs from the service team, only managing it using existing data.
- Lack of proactive communication with the mechanic and sales team to directly ask for parts that are often not available when needed.

4.3 Data Processing

To facilitate the problem analysis process, the historical spare parts transaction data obtained from UT Pontianak and Ketapang was grouped using the FSN Analysis method to obtain three classifications of goods, namely fast moving, slow moving and nonmoving (Devarajan Divya, Jayamohan MS, 2015). Each group of goods can be analyzed and managed differently.

Researchers classify by grouping the level of frequency of annual movements in each month which we call "Month Movement" which means how many months movements or transactions occur in each year. Table 4.1 will explain the distribution of spare parts based on Month Movement combined with FSN analysis.

Table 4.1 Classification of FSN Analysis

Month Movement	Classification
5 – 12 Month Movement	Fast Moving
1 – 4 Month Movement	Slow Moving
0 Month Movement	Non-Moving

From table 4.1, it is explained that the fastmoving spare parts category is transactions that occur within 5 months to 12 months of the year. Slow moving spare parts are spare parts that have transactions in 1 month to 4 months during a year, while non-moving spare parts are those that have never been transacted in a year.

SLOC	RANK	Jan-23		Feb-23		Mar-23		Apr-23		May-23		Jun-23		Jul-23	
		ITEM QTY	TOTAL MAP	ITEM QTY	TOTAL MAP	ITEM QTY	TOTAL MAP	ITEM QTY	TOTAL MAP	ITEM QTY	TOTAL MAP	ITEM QTY	TOTAL MAP	ITEM QTY	TOTAL MAP
KETAPANG	A	79	272,120,931	84	379,186,840	82	284,184,859	75	263,900,459	79	300,790,023	92	360,099,338	93	452,322,764
	B	56	147,179,602	58	124,057,779	55	119,684,917	51	166,075,825	61	209,153,168	57	162,255,740	59	152,700,952
	C	63	147,087,185	67	128,510,406	66	113,239,475	58	97,097,391	74	149,195,243	72	155,192,734	72	173,238,286
	D	36	44,189,346	39	50,936,960	24	55,370,514	31	49,812,968	33	49,211,849	51	128,545,961	57	122,585,160
	E	31	39,934,671	37	47,391,881	49	114,350,376	47	84,427,362	50	88,107,652	51	62,843,093	50	55,740,576
	F	37	39,243,263	43	102,069,649	39	53,769,624	45	90,085,167	43	79,158,579	45	223,325,504	56	234,388,997
	G	34	104,486,146	50	128,855,220	53	130,666,826	50	91,679,185	48	144,037,158	50	123,512,134	61	109,540,694
	H	31	112,284,633	42	199,877,347	42	123,005,129	49	93,584,055	50	94,167,360	50	100,250,467	61	105,027,115
	I	19	41,809,756	31	86,066,027	34	70,365,500	26	53,337,765	26	57,455,671	27	58,697,185	25	58,447,288
PKTP Total		386	948,335,533	451	1,246,952,109	444	1,064,637,220	432	990,000,177	464	1,171,276,703	495	1,374,722,156	534	1,463,991,832

Table 4.2 Pareto Rank Stock

From this table, it can be seen that the current rank of ready stock in UT Ketapang is less proportional, both in terms of quantity and amount, so there should be more moving items in ranks A, B and C.

4.4 Problem Analysis

After analyzing the data, several problems can be identified at PT. UT Ketapang support point is related to service levels and on time in full. The main problem that was revealed was those service levels full instant and on time in full never reached the target during January until July 2023, as shown in Table 4.6.

	Target	Jan	Feb	Mar	Apr	Mei	Jun	Jul
OTIF	90%	57,52%	68,16%	71,24%	69,83%	66,66%	67,63%	64,85%
Full Instant	80%	63%	61%	62%	65%	64%	60%	60%
RSPD CKG	3 days	6	6	5	5	5	6	6
Stok CKG	15 Days	27	28	27	22	23	22	22

Table 4.3 Main problems

4.5.1 Finding the Root of the Problem using fishbone diagram

Use of Using a Fishbone Diagram, also known as an Ishikawa or Cause-and-Effect Diagram, can be an effective method to identify the root causes of a problem. Here's a step-by-step guide on how to find the root of a problem using a Fishbone Diagram:

- Define the Problem:

Clearly articulate the problem or effect that needs analysis. This becomes the "head" of the fish.

- Identify Main Categories (Fishbones):

Draw the main categories of factors that may contribute to the problem. Common categories include People, Process, Equipment, Materials, Measurement, and Environment (6M).

- Identify Subcategories (Bones):

For each main category, identify subcategories that break down specific factors related to the problem. These become the "bones" of the fish.

- Brainstorm Potential Causes:

Conduct a brainstorming session with a cross-functional team to identify potential causes within each subcategory. Write these causes as branches off the subcategories.

- Analyze and Prioritize Causes:

Evaluate and prioritize the identified causes. Consider factors such as relevance, impact, and frequency.

- Ask "Why?" Multiple Times:

Use the "5 Whys" technique to drill down into each identified cause. Ask "Why?" repeatedly to uncover deeper layers of causation.

- **Identify Root Causes:**

Through analysis and discussions, identify the root causes—the fundamental issues contributing to the problem.

- **Verify and Validate:**

Confirm the root causes with data and team consensus. Ensure that the identified causes align with the actual problem.

- **Develop Solutions:**

Once the root causes are identified, brainstorm and develop potential solutions or corrective actions to address each root cause.

- **Implement and Monitor:**

Implement the chosen solutions and monitor their effectiveness. Continuously assess and adjust the solutions as needed.

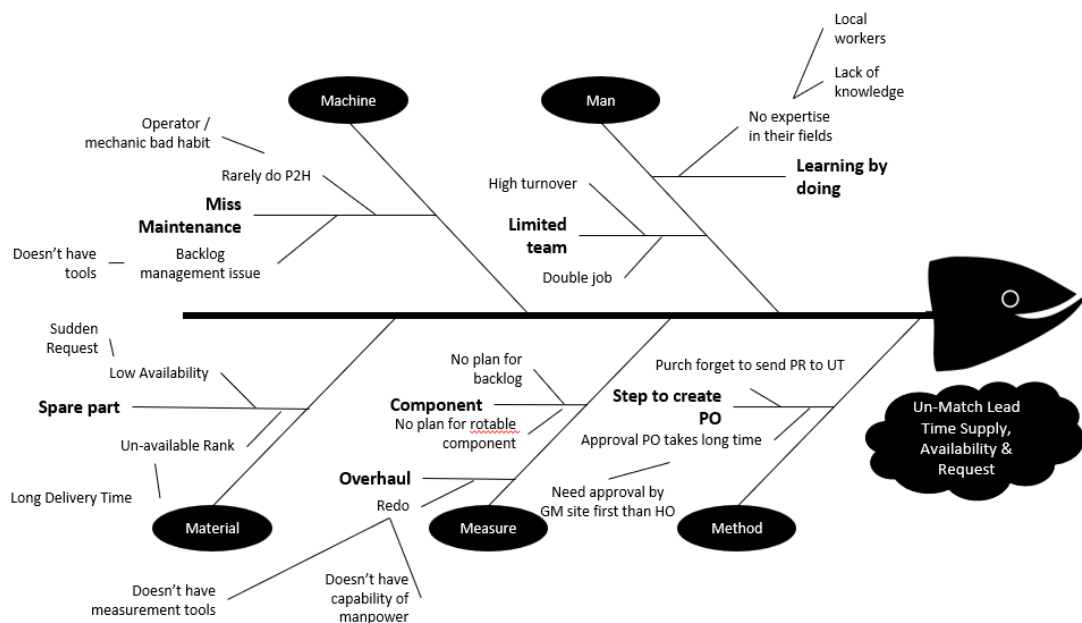


Figure 4.3 Fishbone Diagram

Through the Fishbone Diagram, in MATERIAL section, several aspects of the causes for non-OTIF (On Time In Full) can be explained, namely:

1. Order Processing Method for stock items.
2. Processing Method for accelerated delivery.

The causes of these two root problems can be identified as follows:

1. Order Process Method for stock.

- Incorrect (inefficient) number of orders (Qty Order).
- Incorrect (ineffective) selection of order items.

2. Processing Method for accelerated delivery.

- Less frequency of delivery from Pontianak to Ketapang
- For urgent needs, air freight deliveries from Jakarta cannot go directly to Ketapang.

4.5.2 Determining Solutions and Improvement Ideas

To formulate ideas for improvements or solutions to be taken, the step is to create a root cause and problem-solving table.

Table 4.4 Root Cause & Problem Solving.

Main Problem	Problem Indication	Corrective Action	Method Solving
Low Availability	High Demand un-match availability	Enhancing accuracy & quantities forecasting	Forecast Accuracy
Low Delivery Time	Less frequency delivery	Create delivery alternatives	Task Analysis

From table 4.7 can clearly see a summary of the causes of the problem, pica and the solution methods written here.

4.5 Improvement

4.5.1 Forecasting

Based on the analysis obtained from data collection and processing, it was found that demand data has an unstable pattern and does not have a regular trend or seasonality and there is no weighting, so a good forecasting method is to use quantitative methods and simple moving averages (M.M Ali, Babai M.Z et all, 2015).

In this research, the forecasting process will involve seeking a Moving Average forecasting model by comparing data for three periods, specifically the third month, sixth month, and twelfth month in 2022. Forecasting will involve product sampling that represents both Fast-Moving and Non-Moving categories.

4.5.1.1 Fast Moving Product Forecasting Testing in the past year

In the fast-moving section there are problems with availability and stock qty, so that the service level is not achieved according to the target of 80%.

according to Barry Render, Jay Heizer, Chuck Munson, 2020 the most appropriate forecasting method is the moving average method. To get the most accurate calculations, 3 types of time series data will be used, that are the third month, sixth month, and twelfth month, so that you can see the difference in accuracy that occurs in forecasting calculations with three types of time series data.

The equation employed are for the Moving Average Model is:

$$F_t = (D_{t-1} + D_{t-2} + D_{t-3} + \dots + D_{t-n}) / n \quad (4.3)$$

F_t = Forecasting in period t

D_t = Demand in the period t

Forecasting part number 600-185-6110 (Fast Moving Parts)

The Moving Average model forecasting calculation for January 2023 with a 12-month period is carried out as follows:

$$\begin{aligned} \text{Forecast Jan 2023} &= (\text{Actual Jan 2022} + \text{Actual Feb 2022} + \text{s/d Des 2022}) / 12 \quad (4.4) \\ &= (6+7+9+11+12+5+1+11+14+12+7+6) / 12 \\ &= 8,5 \end{aligned}$$

So, the forecasting result for January 2023 is = 8,5.

Then the forecasting process is carried out for the next month until April 2023. The forecasting results are shown in table 4.9.

Tabel 4.5 Parts number forecasting results 600-185-6110

Parts Number	Month	Actual sales	Forecast Result			
			Naïve	12 Month Moving Average	6 Month Moving Average	3 Month Moving Average
600-185-6110	Jan-23	12	6	8,5	8,5	8,3
	Feb-23	10	12	9,0	10,3	8,3
	Mar-23	9	10	9,3	10,2	9,3
	Apr-23	5	9	9,3	9,3	10,3

There are differences in the forecasting results from the three calculated time periods. To find out which forecast is the most accurate, it is necessary to test the error of the results.

The following is a detailed explanation regarding the moving average calculation.

For example, we calculate the moving average of Air Cleaner Assy parts with part number 600-185-4200, this calculation is based on 2021 purchase data for 12 months for 2022 forecasting as follows:

$$\text{Forecast Jan 2022} = (\text{Actual sales Jan 2021} + \text{Actual Sales s/d Des 2021}) / 12$$

$$= (6 + 3 + 9 + 6 + 6 + 3 + 9 + 6 + 6 + 3 + 9 + 6) / 12$$

$$= 72 / 12$$

$$= 6$$

So, the 12-month forecast for January 2022 is = 6

Forecast with a 6-month moving average model for January 2022

$$(\text{Actual Sales Jul 2021} + \text{Actual Sales Aug 2021} + \text{s/d Dec 2021}) / 6 = 6,5$$

So, the 6-month forecast for January 2022 is = 6,5

Forecast with a 3-month moving average model for January 2022

$$(\text{Actual Sales Oct 2021} + \text{Actual Sales Nov 2021} + \text{Dec 2021}) / 3 = 6$$

So, the 3-month forecast for January 2022 is = 6

And so on, until we find a forecast with graphic numbers whose results fluctuate, to make the calculations easier, we need to process the input using Microsoft Excel from February to December 2022 with the example in the table as follows:

Parts Number	Month	Actual Sales	Forecast Period for 2022		
			12 Month Moving Average	6 Month Moving Average	3 Month Moving Average
600-185-4200	Jan-21	6			
	Feb-21	3			
	Mar-21	9			
	Apr-21	6			
	May-21	6			
	Jun-21	3			
	Jul-21	9			
	Aug-21	6			
	Sep-21	6			
	Oct-21	3			
	Nov-21	9			
	Dec-21	6			
	Jan-22	4	6,0	6,5	6,0
	Feb-22	6	5,8	5,7	6,3
	Mar-22	8	6,1	5,7	5,3
	Apr-22	4	6,0	6,0	6,0
	May-22	8	5,8	6,2	6,0
	Jun-22	10	6,0	6,0	6,7
	Jul-22	6	6,6	6,7	7,3
	Aug-22	4	6,3	7,0	8,0
	Sep-22	8	6,2	6,7	6,7
	Oct-22	6	6,3	6,7	6,0
	Nov-22	8	6,6	7,0	6,0
	Dec-22	4	6,5	7,0	7,3
	Minimum		5		
	Maximum		8		

Tabel 4.6 Min-Max Forecasting Example

4.5.2 Contract Agreement System for Improving and Measuring Service Level

In accordance with the results of data collection and processing, the service level was not achieved due to slow moving stock with a service level does not achieve too.

a. Service Level Calculation Coverage

According to the fishbone diagram analysis in figure 4.3 and data on the contribution of not available slow-moving parts in table 4.28, the biggest cause of parts not being available is the demand for new parts. A request is classified as "new" if it has

occurred only one up to twice in the previous 12 months. Such items cannot be predicted using historical data.

b. Parts Supply Lead Time Complaints.

Apart from the problem of measuring service level parts, delays in supply of fast-moving parts due to the customer administrative process of waiting for PO Release with a lead time of 6 working days, is also a problem for UT so it really affects the customer productivity of heavy equipment work. A new system is needed to provide a solution to this problem.



Figure 4.3 Flow Process Approval PO (Average) Customer to PT. UT Ketapang

To overcome the problem of service levels that are too broad in scope and slow supply processes, researchers propose that it is necessary to limit the scope of measuring service level performance to only items that already have historical transactions in previous months. By using the commodity contract agreement system, which is an inventory and management system for spare parts and other materials that must be prepared and managed by the supplier. This system functions to regulate demand or stock of goods between the company and suppliers, with the hope that this can be done on time, systematically, in an organized manner with the correct quantity and quality maintained by requiring suppliers to provide several goods in the supplier's warehouse (Wahyuni Sri, 2020). With that contract, the parts supply process can also be agreed with a new flow which can cut the supply lead time.

c. Improved parts supply speed

To improve lead-time supply parts, improvements need to be made in the PO manufacturing section. The researcher proposes a contract system where there is already a supply agreement so that waiting spare part from PO creation does not need to be done before the delivery process but is done using a collective PO. Spare parts

supply references can use the Purchase Request (PR) according to the agreement between both parties will be:

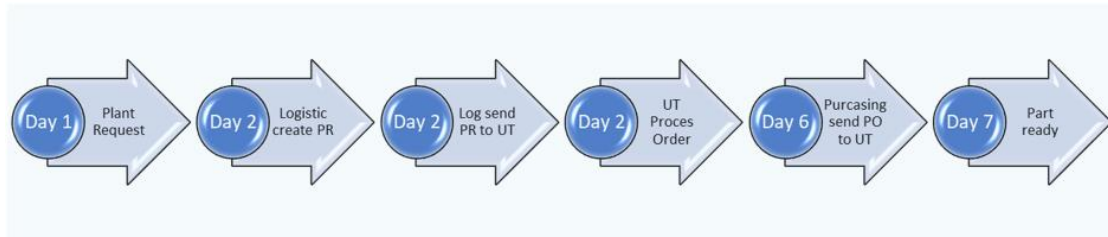


Figure 4.4 Flow new parts order process from general customer to UT Ketapang

From Figure 4.4, the improvement in spare parts supply lead time, which was previously 6 days PO already send to UT, can be accelerated to 7 Days part ready receive customers.

The next improvement in lead time is regarding the delivery of parts which are usually from the UT Jakarta depot or the Komatsu (KMSI) Jakarta principle to UT Pontianak, now you can send it directly from the UT Jakarta depot or the Komatsu (KMSI) Jakarta principle to UT Ketapang, an easy comparison is attached in the following table:

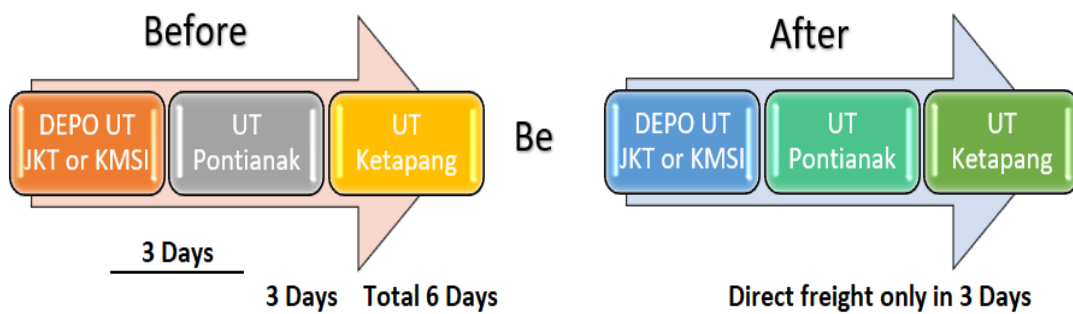


Figure 4.5 lead time part supplying from Depo/KMSI to UT Ketapang

The final improvement to speed up delivery time is to change the regular supply pattern which has previously used trucks only once per week and only on fridays from Pontianak to Ketapang, now it has flexible days, and as long as the truck is full it can be sent on the same day, this is used to refill UT Ketapang stock and fulfill UT Ketapang customer Pos. Apart from that, urgent parts in stock at UT Pontianak can be sent via air freight to UT Ketapang right away. This has been proven to speed up delivery lead times.

4.6 Implementation & Verification

4.6.1 Implementation & Verification of Forecasting in 2023

The OTIF process, full instant availability and accelerate lead time supply from July to December 2023 has been carried out in accordance with the researcher's proposal, namely:

1. Implement a 12-month moving average for fast-moving products.
2. Propose to accelerate lead time supply.

4.6.2 Evaluation OTIF and Availability performance in 2023

After implementing forecasting and inventory control methods according to researchers' recommendations, figures 4.11 and 4.12 are the achievements of otif and Availability in 2023.

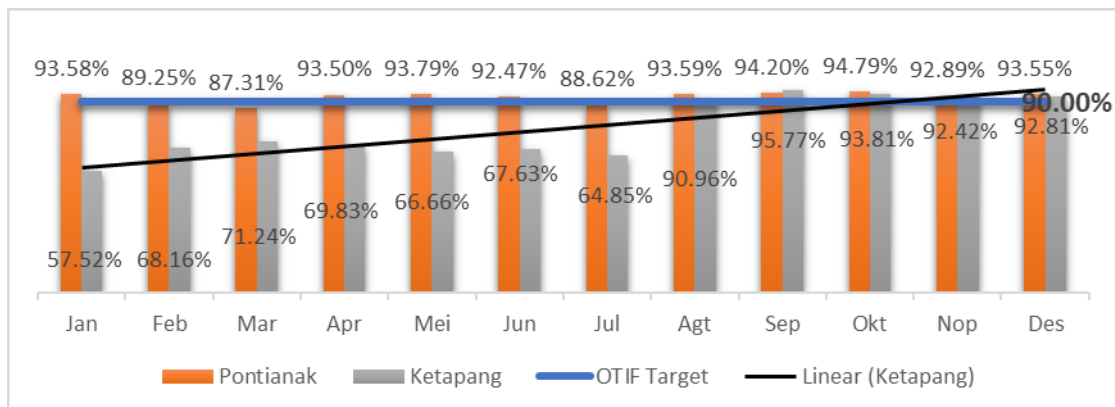


Figure 4.6 OTIF Performance Trend

The upward movement of motive improvement is very clear from the graph, that the process of bringing in goods is on time and in full supply.

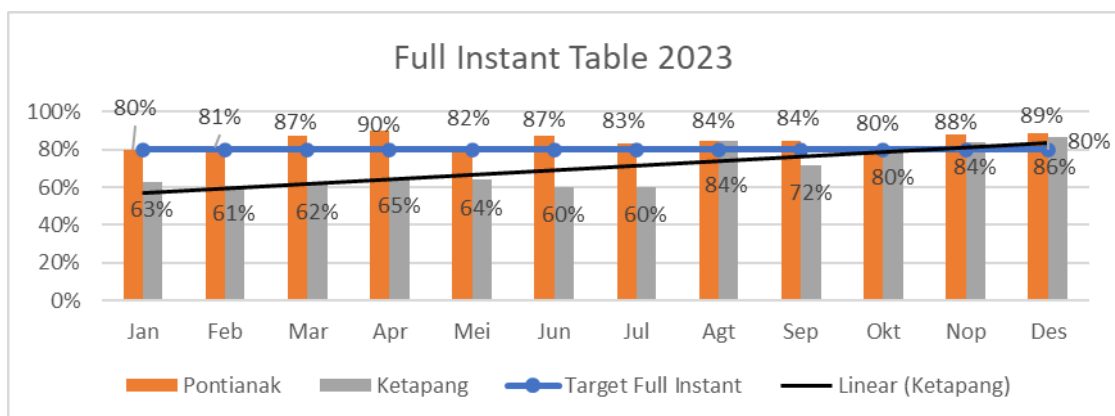


Figure 4.7 Trend Availability