

### **1.3 Research Objectives**

The Objectives will be to Improve lead time supply in accordance with the mandatory OTIF branch target of 90% and under the agreement with the customer.

### **1.4 Significance of Study**

The benefits or significance of this research are:

#### **1.4.1 For the Company**

By improving forecast, lead time supply and inventory management, it can make:

1. Spare parts stock efficient, so that it can reduce company costs and increase profits for the company.
2. Increase customers satisfaction index, so that it can be customers are increasingly confident about repeat orders and increased purchasing volume.
3. Increase the manpower competency of those who carry it out, be making work effective and efficient so that it can improve other things.

#### **1.4.2 For the Authors**

1. As the application of academic knowledge to solving problems encountered in companies.
2. As one of the educational graduation requirements.

### **1.5 Research Questions**

Some of questions used in thesis research include the following:

- How to increase service level (inventory availability) at UT Ketapang?
- How to speed up lead time supply at UT Ketapang?

### **1.6 Hypothesis**

By maximizing support points UT ketapang, can increase product support level by improving using the OTIF method.

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## CHAPTER 2 - LITERATURE REVIEW

This chapter will explain general information and theoretical foundations from various sources or literature that support this research project. This project will analyze and make improvements to the supply acceleration, forecasting system, and spare parts inventory management at PT United Tractors Pontianak Branch, especially the Ketapang Support Point. This chapter is also useful for increasing understanding of the on-time-in-full theory and methods that will be applied to solve the problem formulation in this research.

### 2.1 Theoretical Perspectives

#### 2.1.1 Forecasting

Forecasting as the cornerstone for all organizational planning and oversight endeavors. It's reasonable to anticipate that enhancing the precision of these predictions will subsequently enhance overall operational effectiveness. Forecasting is a combination of art and science (process) in predicting events that will occur in the future. The forecasting process often involves the analysis of historical data which is used to project future situations using mathematical models. (Jay Heizer, Barry Render, Chuck Munson, 2020)

##### 2.1.1.1 Forecasting Principles and Objectives

To achieve effective results, it is important to have a thorough understanding of the principles underlying the forecasting process. (Arnold dan Chapman, 2004:204)

1. Habits of errors in forecasting, because forecasting is a process of trying to estimate future events that are not yet known, the results of forecasting will not be free from errors.
2. Error estimates should be included in every forecast. Every forecast is predicted to have errors so that in every forecasting you must know the estimated errors that will affect or determine the level of confidence that will be produced.

The estimated error can be in the form of a percentage deviation between forecasting and actual demand and the maximum and minimum range values can be determined.

3. Forecasting in groups or groups will be more accurate. In a group the behavior of individual items is random, including when there is instability in the group.
4. Forecasting is done in a shorter period will be more accurate. Forecasting made over a long period of time has a higher degree of uncertainty than forecasting for a short period of time.

So, the purpose of forecasting is:

- a. Can reduce uncertain conditions in production.
- b. Anticipate the actual demand earlier.
- c. Materials for making order schedules.

#### 2.1.1.2 Forecasting Process

As explained by Jay Heizer, Barry Render, Chuck Munson in 2010, there are seven stages in the forecasting process, namely:

1. Identify the purposes for which forecasts are used.
2. Selection of items to be estimated.
3. Determination of the relevant time period.
4. Selection of the appropriate forecasting model.
5. Collection of required data.
6. Making forecasts based on data.
7. Verification and application of forecast results.

#### 2.1.1.3 Forecasting Period

Generally, forecasting can be classified based on the future time span it predicts. According to Jay Heizer, Barry Render, Chuck Munson in 2010. there are three categories of forecasting periods is:

### 1. Short-range forecast

- Up to 1 year, generally less than 3 months.
- Purchasing, job scheduling, labor rates, work assignments, production rates.

### 2. Medium-range forecast

- 3 months to 3 years
- Sales and production planning, budgeting

### 3. Long-range forecast

- years and over
- New product planning, facility location, research, and development

#### 2.1.1.4 Forecasting Methods

There are several methods that can be used in forecasting. Approaches to forecasting can be divided into two main categories, namely forecasting based on quantitative and qualitative data. (Jay Heizer, Barry Render, Chuck Munson, 2020).

1. Qualitative forecasting: Forecasting involves generating estimates by incorporating elements like the judgment of the decision-maker, emotional insights, personal background, and value systems.
2. Quantitative forecasting: Forecasting that utilizes various mathematical models based on historical data and/or related variables to anticipate future needs.

In quantitative forecasting, there are several methods commonly used, as follows:

- Time Series Models
  1. Naive approach
  2. Moving Averages
  3. Exponential Smoothing
  4. Trend Projection
- Association Model
  1. Linear regression

#### 2.1.1.5 Moving Average

This approach transforms historical data reflecting actual demand from previous periods into projected forecast values for upcoming periods. The method of moving average is employed according to (M.M Ali, Babai M.Z et al, 2015) when the demand lacks any discernible trend or seasonality.

Utilizing the moving average proves beneficial under the assumption that market demand will exhibit a tendency to remain relatively steady over time. (Jay Heizer, Barry Render, Chuck Munson, 2020).

Here's the formula for this method:

Or it can be expressed through a formula:

$$F_t = (D_{t-1} + D_{t-2} + D_{t-3} + \dots + D_{t-n}) / n \quad (2.1)$$

$F_t$  = Forecasting results on the period  $t$

$D_t$  = Actual demand in period  $t$

#### 2.1.1.6 Forecasting Accuracy

Accurate estimation of future demand is crucial for production planning and spare parts inventory management. Various methods have been developed to address the uncertainty in spare parts demand. Statistical methods like exponential smoothing and regression analysis have been used for decades by decision makers to forecast spare parts demand. Additionally, alongside uncertainty reduction methods like forecasting, approaches such as adding redundant spare parts as a means of uncertainty management have been formulated for manufacturing planning and control systems. While these methods are effective when the coefficient of variation is low, they tend to perform poorly for items with irregular or intermittent demand patterns. (Mubarokeh, N Ahmadi et al, 2017).

The value deviation in the forecasting process reflects the extent to which the accuracy or quality of the forecast has been made. The smaller the error value, the more optimal the forecast is.

To obtain accurate forecasting results, it is important to test accuracy by finding the minimum error value through calculations (Yager, Ronald R. Alajlan, Naif, 2014).

It consists of three stages in measuring errors in forecasting, namely mean absolute percent error (MAPE), mean absolute deviation (MAD) and mean squared error (MSE), (Barry Render, Jay Heizer, Chuck Munson, 2020).

- Mean Squared Error (MSE)

$$\text{MSE} = \frac{\sum E_t^2}{n} \quad (2.2)$$

MSE is the average of the squared errors that occur during the forecasting period.

- Mean Absolute Deviation (MAD)

$$\text{MAD} = \frac{\sum |E_t|}{n} \quad (2.3)$$

MAD is the average of the absolute errors that occur during the forecasting period.

- Mean Absolute Percentage Error (MAPE)

$$\text{MAPE} = \frac{\sum |E_t|/D_t}{n} \quad (2.4)$$

MAPE is the average percentage of the absolute value of the error that appears during the forecasting period against actual demand.

### 2.1.2 Demand Management

Demand management is one of the core elements in supply chain management. The focus of this aspect is to combine the need for fast and sufficient supply to achieve balance and strategic alignment with demand, in line with operational capabilities in the supply chain. Accurate information is a critical element in ensuring product availability following every request. Information inaccuracy is a

serious challenge in the supply chain, resulting in synchronization in fulfilling growing demand, which in turn results in inefficient customer service,

poor stock management, and high build-up of old or expired stock, especially exacerbated by the wide variety of product variations (Daniela De Castro, 2014).

#### 2.1.2.1 Temporal patterns of demand features

The time series approach to forecasting operates by assuming that the future is closely related to the past. In simple terms, they analyse historical events at specific time intervals and use past data sets to formulate predictions. Time series analysis relies on evenly spaced data points (such as weekly, monthly, quarterly intervals).

When viewed through the Figure 2.1, there are four components in the demand time series pattern:

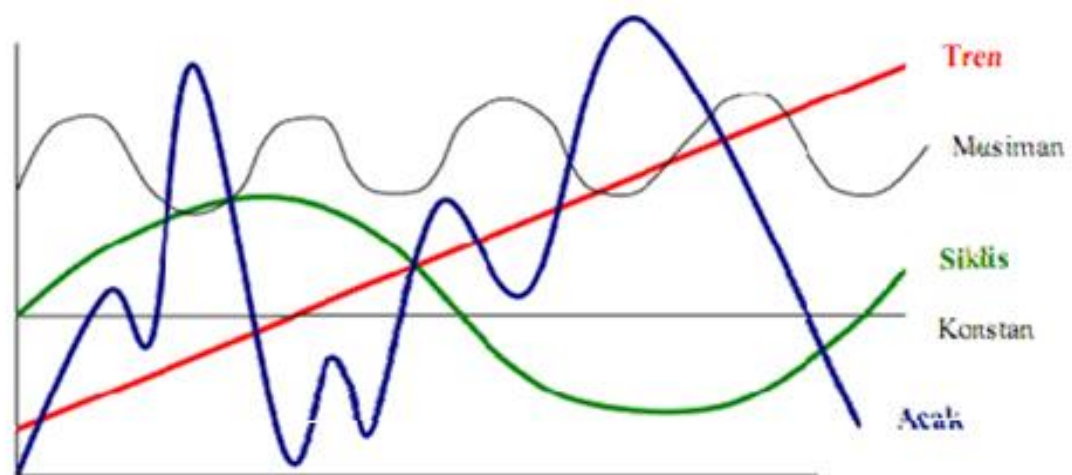


Figure 2.1 Demand rate patterns from historical data

(Source: Arnold & Chapman, 2004)

##### 1. Trend.

Trend patterns in demand describe changes in data over time by slowly increasing or decreasing. This pattern can be applied to data on income, population, age distribution, or cultural aspects. Trend patterns in demand often appear in products that are trending and experiencing increased demand.

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## 2. Seasonality

The pattern generally appears in products whose demand is affected by seasonal factors such as holidays, weather conditions, and certain celebrations. The time interval for seasonal requests usually lasts a year, although some may recur on a monthly or weekly basis. Seasonal patterns characterize data that repeats after daily, weekly, monthly, or quarterly intervals.

## 3. Random

Random patterns occur in products where the demand is affected by various factors in each period. The patterns that are formed tend to be random and unpredictable, although the variations that occur are generally small.

## 4. Cycle

The cyclic pattern shows similarities to the seasonal demand pattern. However, the difference lies in the longer length of the cycle periods, often on a scale of several years or even decades, as opposed to seasonal patterns which tend to occur over shorter time intervals.

### 2.1.3 Inventory

Spare parts inventory management holds paramount importance for manufacturing companies, given the diverse range of items they handle. This study introduces a simulation model designed for managing a company's spare parts inventory. The model involves categorizing various items and simulating the existing inventory policy. A novel approach is also suggested to optimize inventory management. The outcomes highlight cost reduction and efficient storage utilization through the new approach. Furthermore, the simulation model serves as a valuable tool for practitioners in devising effective inventory strategies tailored to the unique attributes of different items. (Rinaldi, Marta et al, 2022)

Raw materials, component parts, finished goods, and semi-finished products that are placed in certain locations in the supply chain process are the concept of inventory. Inventory is an asset owned by a company with the aim of reselling it within a certain period in certain business operations. It also includes materials in the production stage and materials that have not yet been used in the production process. According to the definition from the APICS dictionary, inventory refers to materials used to support production, whether in the form of finished or semi-finished products,

which also includes support for maintenance activities, repairs, operational supplies, and customer service.

With the aim of reducing costs and increasing sales, companies need to maintain inventory while anticipating variations and uncertainties. Carrying out strategies such as accelerating supply times to customers and maintaining inventory is important, apart from increasing production capacity. So, some common reasons why companies must have inventory include the following.

1. So that the purchase or preparation costs and storage costs can be balanced.
2. To meet service levels for customers, as well as meet customer needs both in terms of quantity and supply lead time.
3. To anticipate conditions during the production process that problems occur that are not planned.
4. To avoid closing production facilities or stopping production due to:
  - a. Broken machine.
  - b. Component broken.
  - c. Unavailability and delays in components or spare parts.
5. To optimize discounts when purchasing.
6. To anticipate price increases.

There are several benefits resulting from having inventory for the company, including:

1. Eliminate potential delays in the arrival of goods.
2. Avoid potential damage to goods.
3. Maintain the stability of the company's operations.
4. Maximizing the use of production machines.
5. Provide good service to customers.

From a physical perspective, inventory can be divided into the following types:

1. Inventory of raw materials (raw material), which includes basic materials for the manufacture of goods, such as metal, wood, and other materials used in the production process.

2. Inventory of materials or assembled components (purchased parts/components), namely inventories of goods in the form of components or spare parts purchased from other parties and can be assembled into the final product.
3. Inventory of auxiliary materials (supplies) includes goods needed in the production process but are not part of the finished product.
4. Inventory of goods in process or semi-finished (work in process), is the result of each stage of the production process that still needs further processing to become the final product.
5. Inventories of finished goods, in the form of goods that have been produced or processed in factories and are ready to be sold and sent to customers.

Inventory can also be grouped based on its function, as explained by Rangkuti (1996):

1. Batch Stock / Lot Inventory This is inventory made or purchased in larger quantities than currently needed. This approach has advantages, such as obtaining price discounts, increasing production efficiency, and reducing transportation costs.
2. Fluctuation Stock This inventory is prepared to deal with unpredictable fluctuations in customer demand. If fluctuations in demand are very high, then this supply is needed in significant quantities to respond to erratic changes in demand.
3. Anticipation Stock This is an inventory that is prepared to anticipate fluctuations in demand that can be predicted easily, for example based on seasonal patterns that occur in one period. These supplies are used up against sharp increases in demand or usage.

#### 2.1.3.1 Inventory Classification

Spare parts categorization is operationally vital, streamlining decision-making for forecasting and stock control. This aids managers in focusing on critical stock-keeping units (SKUs). Similar components are grouped into classes. In the past, demand patterns were categorized before selecting estimation methods for future requirements and inventory management. The goal was to find the best forecast

methods. Spare parts classification and demand forecasting relate to stock control, especially for slow-moving items with substantial inventory. Even small management improvements yield cost savings (Muhbarokah, N Ahmadi et al, 2017).

By using the FSN Analysis method, inventory can be grouped based on the level of movement speed of each product. The categorization relies on the material consumption pattern, specifically utilizing movement analysis as its foundation.

The classification involves grouping items into fast-moving, slow-moving, and non-moving categories based on transaction frequency. FSN analysis proves particularly valuable in addressing obsolete items, whether they be spare parts, raw materials, or components. It aids in organizing stock in storage, determining distribution strategies, and refining handling methods. The primary objective of this analysis is to manage and mitigate inventory obsolescence. In cases of swift technological advancements, frequent updates to this classification are necessary (Devarajan Divya, Jayamohan MS, 2015).

To classify stock or inventory, we can also use ABC analysis, where we calculate the multiplication of the annual demand level for each inventory item and its unit cost. (Barry Render, Jay Heizer, Chuck Munson, 2020).

- a. Class A refers to items with a high annual demand value. While these items may only account for about 15% of the total inventory, they account for around 70% to 80% of the total requested value.
- b. Class B refers to inventory items with a moderate annual demand value. This group accounts for about 30% of the total number of supply items and accounts for about 15% to 25% of the total demand value.
- c. Class C consists of items with a low annual demand value. Although they only account for about 5% of the total value of annual demand, this group makes up about 55% of the total number of supply items.

#### 2.1.3.2 Safety Stock

To prevent stock or goods shortages, additional inventory is needed which is called safety stock. This becomes relevant in situations where demand or use of goods

exceeds projections, or when delays occur in the delivery and receipt of goods. Thus, inventory in the form of safety stock is maintained to ensure adequate availability.

The following are ways to calculate the amount or value of Safety Stock as shown in Table 2.1 (Rahmat, 2015):

$$SS = \text{Safety Factor} \times \text{Standard Deviation} \quad (2.5)$$

Note: Safety Factor = standard factor standard based on service level

Table 2.1 Safety Factor Standard

| Service Level | Safety Factor |
|---------------|---------------|
| 50            | 0             |
| 75            | 0,67          |
| 80            | 0,84          |
| 85            | 1,04          |
| 90            | 1,28          |
| 94            | 1,56          |
| 95            | 1,65          |
| 96            | 1,75          |
| 97            | 1,88          |
| 98            | 2,05          |
| 99            | 2,33          |
| 99,86         | 3,00          |
| 99,99         | 4,00          |

The following is a Figure 2.2 that compares safety stock with total shortages:

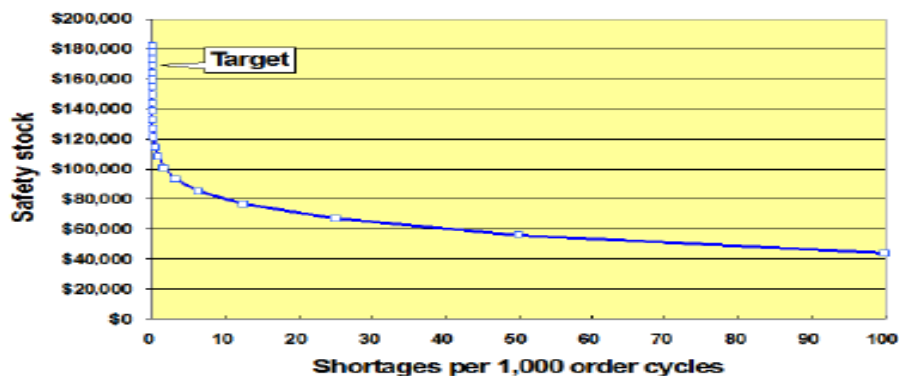


Figure 2. 2 Comparison of safety stock with shortages

(Data Source: BAUER College of Business Teaching Materials, University of Houston)

### 2.1.3.3 Maximum Stock Level

To minimize the risk of excess stock or inventory, it is necessary to set a maximum limit called the Maximum Stock Level. Through an analysis that considers

demand, order intervals, order times, and safety stock, the value of the Maximum Inventory Level can be determined.

The formula used to calculate the maximum stock level is as follows. (Grace, 2015):

$$MSL = (Da \times (R + L)) + SS \quad (2.6)$$

Information:

Da Average demand during a certain period (pcs/days)

R = Review Cycle (Days)

SS = Safety Stock (pcs)

L = Leadtime (Days)

#### 2.1.3.4 Vendor Held Stock

In managing inventory, the company implements several systems including the Vendor Held Stock Agreement (VHS). Vendor Held Stock is an inventory management system and spare parts and other materials that are regulated and managed by suppliers. This system aims to manage stock or demand for goods between companies and suppliers in a timely, orderly, and structured manner with the right quantity and quality. In this system, suppliers are required to provide several items in their warehouses (Wahyuni Sri, 2020).

#### 2.1.3.5 Economic Order Quantity

Economic Order Quantity (EOQ) is one method that can be applied to manage inventory. The use of EOQ greatly facilitates its implementation. (Rinaldi, Marta 2022).

There are several assumptions used (Jay Heizer, Barry Render, Chuck Munson, 2020):

1. Demand for goods is predictable and does not change.
2. The time between ordering and receiving goods is always consistent.
3. Receipt of goods is always timely and complete.
4. There is no reduction in the number of goods.

5. Changing fees only consist of ordering fees and storage fees.

6. The risk of stock shortages can be avoided by placing orders at the right time.

The inventory model aims to optimize expenses by minimizing the costs incurred. The costs that generally affect the total cost are the ordering fee and the storage fee, while the cost for the goods themselves is fixed. So, if the company succeeds in reducing ordering costs and holding costs, the overall cost can be optimized.

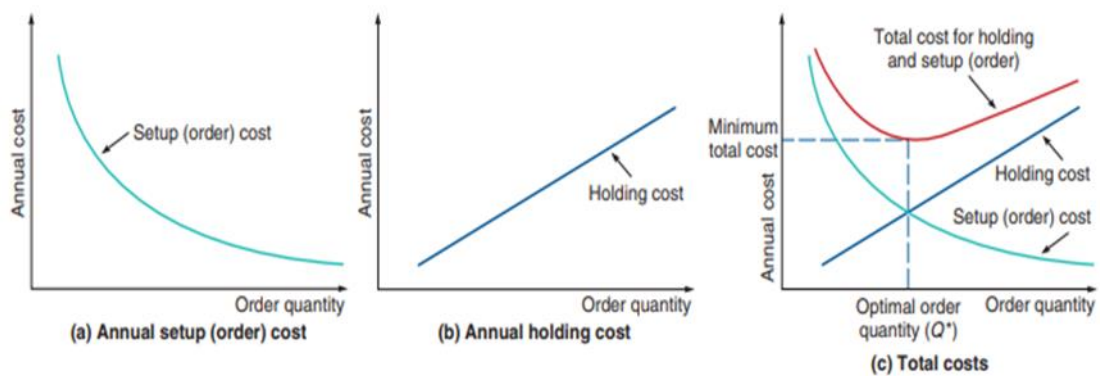


Figure 2.3 Economic Order Quantity Model

(Source: Jay Heizer Books, 2020)

In Figure 2.3, the optimal ordering occurs when the meeting point between the ordering cost curve and the holding cost curve is reached.

a. Order cost

These are the steps for calculating the cost of an order:

$$\begin{aligned}
 1. \text{ Annual setup cost} &= (\text{Number of orders placed per year}) \times (\text{Order cost per order}) \\
 &= \frac{\text{Annual demand}}{\text{Number of units in each order}} \times (\text{Order cost per order}) \\
 &= \frac{D}{Q} \times S \quad (2.7)
 \end{aligned}$$

$$\begin{aligned}
 2. \text{ Annual holding cost} &= (\text{Average inventory level}) \times (\text{Holding cost per unit per year}) \\
 &= \frac{\text{Order quantity}}{2} \times (\text{Holding cost per unit per year}) \\
 &= \frac{Q}{2} \times H \quad (2.8)
 \end{aligned}$$

### 3. Optimal order quantity

$$\frac{D}{S} \times S = \frac{Q}{2} \times H \quad (2.9)$$

### 4. Optimum number of units per order

$$2DS = Q^2H$$

$$Q^2 = \frac{2DS}{H}$$

$$Q^* = \frac{\sqrt{2DS}}{H} \quad (2.10)$$

Information:

Q = Number of units per order

Q\*= Optimum number of units per order (EOQ)

D = Annual demand in units for the inventory item

S = Setup or ordering cost for each order

H = Holding or carrying cost per unit per year

#### b. Number of orders

Next determine the estimated number of orders in 1 year

$$N = \frac{\text{Demand}}{\text{Order Quantity}} = \frac{D}{Q^*} \quad (2.11)$$

While the time between each request

$$T = \frac{\text{Number of months in a year}}{N} \quad (2.12)$$

#### c. Total Cost

Calculate the total costs incurred in a year.

$$TC = \frac{D}{Q} S + \frac{Q}{2} H \quad (2.13)$$

#### d. Re-order Points

Calculating the right moment for re-orders to prevent stock outs that can result in an instant reduction in full availability.

ROP = (Request in a month) x (Time of purchase in months)

$$ROP = (d \times L) \quad (2.14)$$

The assumption in this equation is that the demand during the buying period and the supply time are assumed to be unchanged. However, to deal with the possibility of a surge in demand, the existence of reserve stocks is necessary. Therefore, with reserve stock included, the equation becomes:

$$ROP = \text{Number of requests} + \text{Safety stock} \quad (2.15)$$

The step to get the demand per month (d) is to divide the total demand in a year (D) by the number of months in a year.

$$d = \frac{D}{\text{Number of months in a year}} \quad (2.16)$$

#### 2.1.3.6 Availability / Service level

Availability is the percentage of the total number of orders received compared to the number of orders that can be fulfilled according to customer demand. (Schreibfeder, 2010). Achieving optimal levels of availability is of great significance, as customers may look elsewhere to shop if our products are not available. The primary objective of inventory management is reflected in achieving availability, which has a direct impact on customer service.

The availability calculation method is as shown in the following formula, as mentioned by Schreibfeder (2010):

*V = of line item for stocked products shipped complete in 1 shipment by promise date*

*Total number of line items for stocked products ordered*

### 2.1.3.7 Days of Inventory

Days of Inventory is a calculation of the number of days in which stock can meet demand. A sign of positive performance in the supply chain is the ability to move assets or inventory efficiently. Therefore, it can be considered that the shorter the Inventory Day, the better the supply chain performance in inventory management. The steps to calculate Days of Inventory involve comparing the amount of goods in stock with the average sales during a specific period. Accurate calculation of Inventory Days facilitates better decision-making for management concerning the overall inventory value.

$$\text{DOI} = \frac{\text{Stock Value}}{\text{Average COGS over a certain period}} \times 30 \text{ Days} \quad (2.17)$$

### 2.1.4 The Fishbone Diagram

The Fishbone Diagram, also known as the Ishikawa Diagram or Fishbone Chart, was introduced by Kaoru Ishikawa, a Japanese engineer and professor of quality management. Ishikawa developed this tool in the 1960s as a means to analyze and visualize potential causes of a problem or issue. Although created decades ago, the Fishbone Diagram remains relevant today and is an integral part of methodologies such as Six Sigma and various quality management approaches. The Fishbone Diagram, or Cause-and-Effect Diagram, is a visual tool used for identifying and organizing potential causes of a specific problem or effect. Developed by Kaoru Ishikawa, a Japanese quality control expert, this diagram helps teams analyze and understand the root causes of issues in a structured way. Here is a comprehensive explanation of the Fishbone Diagram:

Components of the Fishbone Diagram:

1. Effect or Problem (Head of the Fish): This represents the issue or problem that the team is trying to address. It is placed at the head of the diagram.
2. Main Categories (Bones): The main branches extending from the spine of the fish represent different categories of factors that could contribute to the problem. Commonly used categories are People, Process, Equipment, Materials, Measurement, and Environment (6M).

3. Subcategories (Secondary Bones): Each main branch further extends into subbranches that detail specific factors or causes related to the main category.

#### Steps to Create a Fishbone Diagram:

1. Define the Problem: Clearly articulate the problem or effect that needs analysis and place it at the head of the diagram.
2. Identify Main Categories: Determine the broad categories of potential causes relevant to the problem. Attach these categories as main branches to the spine.
3. Identify Subcategories: Break down each main category into specific subcategories that may contribute to the problem. These become the secondary branches.
4. Brainstorm and Identify Causes: Collaboratively brainstorm and identify potential causes within each subcategory. Attach these causes to the corresponding subbranches.
5. Analyse and Prioritize Causes: Evaluate and prioritize the identified causes based on their significance and relevance to the problem.

#### Purpose and Benefits:

1. Root Cause Analysis: Helps teams systematically identify and understand the root causes of problems.
2. Visual Representation: Provides a clear and organized visual representation of potential causes, facilitating better communication within a team.
3. Problem-Solving Tool: Supports structured problem-solving by breaking down complex issues into manageable components.
4. Team Collaboration: Encourages collaboration and involvement from cross-functional teams in analysing and solving problems.

The Fishbone Diagram is widely used in quality management, process improvement, and problem-solving methodologies to address various challenges in a systematic and structured manner.

#### **2.1.5 Lead Time**

Lead time is the amount of time that passes from the start of a process until its conclusion. Companies review lead time in manufacturing, supply chain management,

and project management during pre-processing, processing, and post-processing stages. (Will Kenton, 2023).

The Key of Lead Time:

- Lead time measures how long it takes to complete a process from beginning to end
- In manufacturing, lead time often represents the time it takes to create a product and deliver it to a consumer.
- Lead time is calculated by adding any combination of the number of days to procure materials, manufacture goods, and deliver finished products.
- Factors that can impact lead time include lack of raw materials, breakdown of transportation, labour shortages, natural disasters, and human errors.

In some cases, companies can improve lead times by implementing automated stock replenishment and just-in-time (JIT) strategies.

#### **2.1.6 Task Analysis Hierarchy**

To analyse the task in more depth, the Hierarchical Task Analysis (HTA) approach is used. This concept, as explained by Jhon Annett (2000), not only outlines the actions taken, but also details the objectives of each action and the operations implemented to achieve these goals. HTA is used in the context of describing the operation of a bus system, with a focus on identifying factors that annoy drivers. In the HTA, an operational description is given regarding each main goal in bus operations, covering every step involved in achieving these goals, both physically and cognitively. The HTA development process involves five stages, namely setting analysis objectives, determining the objectives of each task, identifying task information sources, collecting data, and designing decomposition diagrams and validating the decomposition through collaboration with relevant stakeholders (Annett, John 2000).

#### **2.1.7 DMAIC**

DMAIC is a core methodology within the Six Sigma concept. This methodology guarantees a quantitative approach to continuous improvement and cost

reduction by reducing output variation to a level suitable for each organization, as described by Mustapha Roslina et al. (2016).

1. Define - The first step in the DMAIC cycle involves clarifying team roles, project scope and boundaries, customer expectations and needs, project specific objectives, and service delivery timeframe.
2. Measure - The performance measurement stage of the running process. This includes identification of measurement criteria, data collection, comparison with best standards, and monitoring for further improvements and capabilities.
3. Analyse – The process of in-depth analysis of the existing situation. The data collected about the process is analysed, compared with the ideal data, and then an investigation is carried out to identify the root of the deviation between the observed and expected data.
4. Improve - Process improvement stage. Improvement proposals are generated, processes are refined, tested, and implementation of the improvements is carried out.
5. Control - Creating mechanisms to maintain improvement and monitor ongoing performance. This improvement process also continuously monitors the results and compares them with the desired data.

#### **2.1.8 Determination of Resource Persons**

In accordance with the guidelines in the qualitative research approach, the selection of research sources is carried out randomly, but still adheres to the principles that apply in the process. (Bachtiar et al, 2006):

1. Appropriateness  
Measuring the suitability of sources is based on competence and knowledge related to the topic and research objectives.
2. Adequacy  
The informants will be selected in an appropriate way, following the categories relevant to the research, including position, experience, level of education, and other relevant factors.

### 2.1.9 On Time In Full (OTIF)

**OTIF is a characteristic of PT United Tractors that is not owned by other distributor companies. What is the meaning of OTIF?**

On-time: The order is received by the customer according to the specified time limit.

In-full: The order is received by the customer in the quantity according to the order.

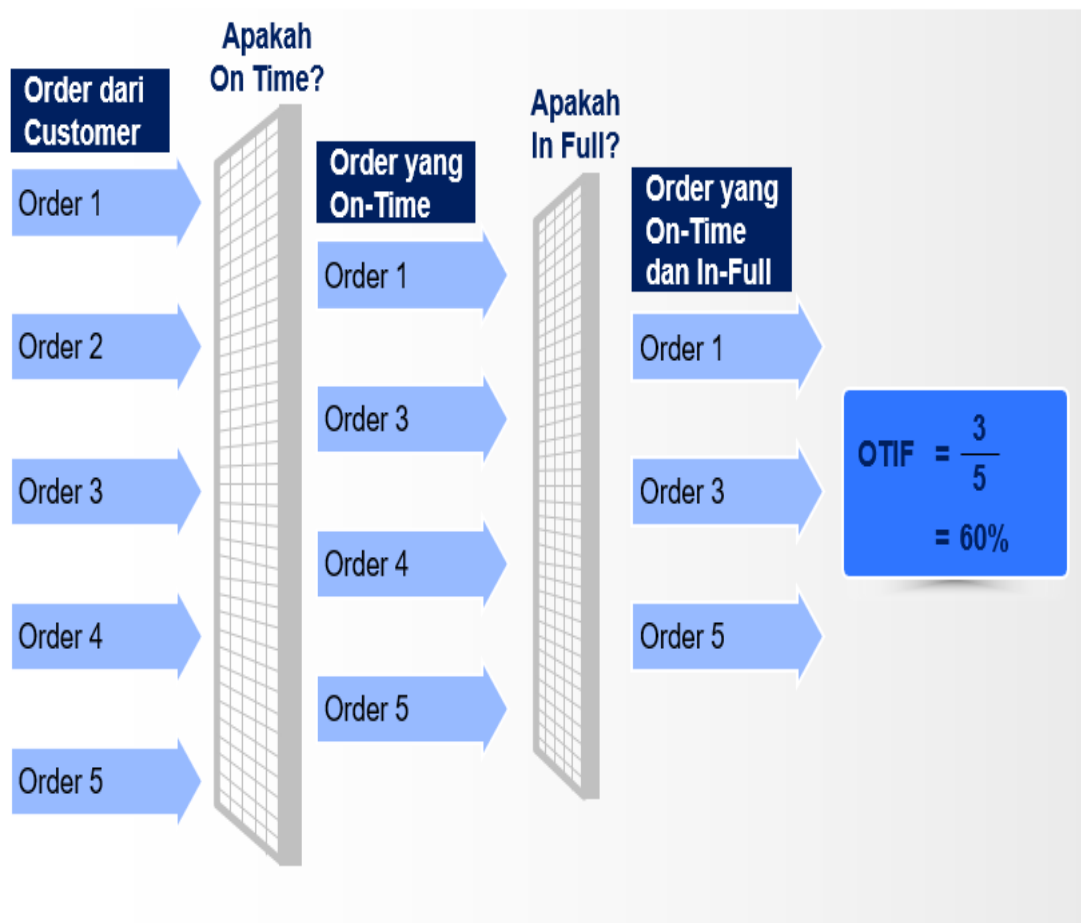


Figure 2.4 Concept of the OTIF

OTIF is the application of “Serve”, as part of UT's SOLUTION culture.

It is necessary to follow these four stages to implement OTIF:

- 1) Align the definition of OTIF with your customers (Head of Logistics and Head of Plant for sites and Purchasing Manager and/or owner for branches)
  - Agree on calculation methods and targets for “On Time”
  - Agree on the calculation method and target for "In Full"
- 2) Sign off the agreement with the customer.
- 3) Design and implement a tracking mechanism for OTIF.
- 4) Regular review of OTIF
  - Daily internal review with UT internal team
  - Weekly OTIF review meeting with customers

## **2.2 Previous Studies**

### **2.2.1 Ali, Babai M.Z. “On the use of Simple Moving Averages for supply chains where information is not shared”.**

Despite the recognized advantages of sharing information, numerous supply chains encounter challenges that prevent them from doing so. These hurdles include issues like the compatibility of information systems, concerns about information quality, and considerations related to trust and confidentiality. Additionally, a continuous stream of academic papers has delved into a phenomenon termed Downstream Demand Inference (DDI), wherein the upstream participant in a supply chain can deduce downstream demand without resorting to a formal information-sharing mechanism.

Recent studies indicate that, in a more practical context with fewer restrictive assumptions, achieving DDI is not feasible with optimal forecasting methods or Single Exponential Smoothing. However, it becomes possible when supply chains employ a Simple Moving Average (SMA) method. This paper puts forth a straightforward DDI strategy based on SMA tailored for supply chains facing limitations on information sharing. This strategy empowers the upstream participant in the supply chain to mathematically infer consumer demand without the necessity

for direct information exchange. A comparative analysis is conducted between the proposed DDI strategy and the existing No Information Sharing (NIS) strategy. The analytical comparison demonstrates that adopting the DDI strategy leads to a reduction in Mean Squared Error (MSE) within the supply chains.

### **2.2.2 N. Ahmadi Mobarakeh, et al, “Improved Forecasts for uncertain and unpredictable Spare Parts Demand in Business Aircraft's with Bootstrap Method”.**

Accurate demand forecasting is a crucial factor in determining the performance of a supply chain, particularly in non-contract spare service supply chains. The significance of this becomes more pronounced due to customers not being obligated to order necessary spare parts directly from the Original Equipment Manufacturer (OEM), given the presence of multiple suppliers. Among the sectors most impacted by this phenomenon are the supply chains for business aircraft spare parts. This is attributable to the highly unpredictable travel patterns and usage associated with business aircraft, in contrast to more predictable passenger airline carriers. The substantial uncertainty and unpredictability in demands, coupled with resulting inaccurate forecasts, have severe financial implications. Additionally, predicting the demand forecast for each part is computationally expensive due to the vast number of spare parts in business aircraft supply chains.

Therefore, the objective of this paper is to explore forecasting methods, their variants, and artificial intelligence (AI) techniques specifically developed for irregular demands. The aim is to propose the most effective method variant capable of accurately forecasting not only uncertain but also unpredictable demand, as observed in the context of business aircraft spare parts supply chains. The Bootstrapping (BS) method is chosen as the most suitable base method for uncertain and unpredictable demand forecasting, given its inherent ability to reduce error through resampling with replacement. Both point and interval (existing) and sliding window (proposed) BS methods are implemented using MATLAB, and the results of demand forecasts are compared with those generated from benchmarked existing forecasting methods such as Croston, Croston variants (SBJ, SNB, TSB), moving average (MA), single exponential smoothing (SES), and commercial (proprietary black box) methods. The

data for this study is sourced from Dassault Aviation. The findings reveal that the proposed sliding windows BS variant with the 'Mean' function outperformed 75% of the spare parts, leading to significant financial gains in terms of inventory holding and storage costs.

### **2.2.3 Divya Devarajan, MS Jayamohan, “Stock control in a chemical firm: combined FSN and XYZ analysis”.**

In the structure of working capital for most businesses, inventories hold a strategically significant position and form the largest component of current assets. Effective inventory control has become a critical challenge in the realm of working capital management. The proficiency of inventory control directly impacts a firm's flexibility. Strategic management of inventories ensures efficient utilization of working capital by maintaining optimal levels of materials and components, preventing overstocking and avoiding the blockage of working capital in excess inventory.

The success of a company hinges on timely project completion within specified budgets and with the required performance. A streamlined and effective inventory management system contributes to a firm's ability to maintain a competitive advantage, especially in an uncertain economic environment. In the case of the chemical firm under consideration, the absence of specific inventory materials management techniques has led to stock accumulation. This issue has resulted in profit losses, which are detrimental to a company's competitiveness. This paper examines the chemical firm's inventory management system, employing a combined FSN and XYZ analysis to address the challenges faced.

### **2.2.4 Ronald R. Yager and Naif Alajlan “A note on mean absolute deviation”.**

We present the concept of Mean Absolute Deviation (MAD) and propose a straightforward approach for computing MAD without resorting to the absolute value. This method is applicable to both continuous and finite-valued random variables. Additionally, we introduce the concept of sub-mean and illustrate the connection between MAD and the disparity between the mean and sub-mean. Our analysis extends to MAD in the context of random variables with symmetric probability

density functions. Furthermore, we address the challenge of determining the optimal estimation of a random variable under diverse error metrics.

#### **2.2.5 Samuel Jebaraj Benjamin and M. Srikamaladevi Marathamuthu, “The use of 5-WHYs technique to eliminate OEE’s speed loss in a manufacturing firm”.**

This paper aims to mitigate or eradicate speed losses in overall equipment effectiveness (OEE) within a lean manufacturing setting. Conducted as an action research study, this research employs the 5-whys analysis technique from lean manufacturing to address and reduce speed losses.

The application of the 5-whys analysis technique at XYZ Corporation, a manufacturing industry, successfully eliminated its primary speed loss, resulting in substantial annual savings of USD 32,811.5.

The 5-whys analysis technique, traditionally associated with enhancing OEE by addressing quality and changeover losses, has demonstrated effectiveness in addressing speed loss. Speed loss, considered a predominant and challenging aspect among OEE losses, has been effectively tackled using this approach. The findings suggest the broader applicability of the 5-whys analysis technique beyond its initial purpose, providing valuable insights for other organizations. The study's outcomes also open avenues for extending the use of the 5-whys analysis technique to address various OEE losses and non-value-added activities within the broader context of lean philosophy. Limited efforts have been made thus far to extend the application of the 5-whys analysis technique beyond its original scope. The insights gained from this study offer potential applications in other organizational contexts. Furthermore, the study's outcomes suggest the possibility of broadening the scope of the 5-whys analysis technique to address different OEE losses and non-value-added activities within the realm of lean philosophy.

#### **2.2.6 Marta Rinaldi and Marcello Feraa, et al, “A new procedure for spare parts inventory management in ETO production: a case study”**

Managing the inventory of spare parts is a crucial yet strategic process for many manufacturing companies dealing with a diverse range of items.

This study focuses on creating a simulation model for effective spare parts inventory management in an Engineering to Order (ETO) company. Initially, diverse items were analyzed and categorized into four groups. Subsequently, a simulation model was developed to replicate the existing inventory policy used for monitoring and control. The study concludes with the implementation of a new procedure designed to enhance current inventory management practices. The results indicate that the new procedure leads to a reduction in both total costs and the maximum storage space required for the items. Furthermore, the simulation model can serve as a practical tool for practitioners to identify an appropriate inventory strategy based on the specific characteristics of different items.

#### **2.2.7 Roslina Mustapha<sup>1</sup> and Nurul Fadly Habidin, “Using DMAIC in Improvement of Customer Satisfaction and Facilities provided at Commuter Stations”.**

Applying the Six Sigma methodology to enhance both customer service and amenities at commuter stations is under discussion. It underscores the importance of commuter station management being attentive to passengers' needs and preferences. The study employs the DMAIC approach, incorporating customer viewpoints to address dissatisfaction with the services and facilities provided at these stations.

#### **2.2.8 Sri Wahyuni, Suparno, and Iwan Vanany, “The Proposed Model of Suppliers Performance Measurement for Vendor Held Stock (VHS) in Mining Industry”**

Vendor Held Stock (VHS) involves the storage and management system for spare parts and other materials, necessitating coordination with suppliers in the case study context. This research focuses on a nickel mining company in Indonesia, where all suppliers are mandated to store spare parts and materials in their warehouses. The study's objective is to formulate a performance measurement system for VHS suppliers in the given case study. Key performance indicators (KPIs) are identified to ensure timely, systematic, and well-organized fulfilment of buyer demand with the correct quantity and maintained quality. The methodology for measuring supplier performance combines the Analytical Hierarchy Process (AHP), The Objective

Matrix (OMAX), and Fishbone Diagram Methods. The anticipated outcomes of this research include measurement models and the identification of root causes, leading to solutions for improving overall supplier performance.

### **2.2.9 Beena Puthillath, Bhasi Marath, “Analyzing the cause of human electrical accidents using Swiss Cheese mode”.**

This study seeks to investigate the factors that contribute to electrical accidents, aiming to comprehensively understand and model their causes across various levels. The authors have employed the Swiss Cheese model framework to categorize the causes of accidents within the electricity distribution sector. Through a Delphi-type expert survey, the researchers identified the "Cheese Slice" (level) and the corresponding causes (holes) associated with electrical accidents. Input from one hundred experts, each possessing over five years of experience in electrical utility companies, was gathered to delineate the Cheese Slice and holes, offering insights into the occurrence of electrical accidents. The findings highlight the significance of effective training in safe work practices, fostering safe knowledge, and implementing closer supervision to address the human factor-related holes in the Cheese Slice. Additionally, the research presents and discusses variations in the perception of managers, supervisors, and workers regarding the importance of different causes of electrical accidents. It's essential to note that this research relies on expert opinions and survey data, without incorporating actual accident data. Nevertheless, the identified causes of accidents at various levels (Cheese Slice) provide a basis for targeted interventions to enhance safety. Given the widespread use of electrical energy, improving electrical safety emerges as both a social concern and necessity.

### **2.2.10 Beatriz Navas de Maya, et all, “A practical application of the Hierarchical Task Analysis (HTA) and Human Error Assessment and Reduction Technique (HEART) to identify the major errors with mitigating actions taken after fire detection onboard passenger vessels”.**

Fire incidents on passenger ships pose significant risks to personnel, passengers, the environment, and the vessel itself. Consequently, the actions taken by crew members upon detecting a fire onboard a passenger vessel are of paramount

importance. The SAFEMODE project endeavour's to advance contemporary safety practices by offering a curated collection of Human Factors (HFs) Fact Sheets, encompassing well-established HFs techniques for accident investigations. These resources aim to assist accident investigators and safety managers in maritime organizations.

This paper proposes the application of two Fact Sheets from SAFEMODE: Hierarchical Task Analysis (HTA) and Human Error Assessment and Reduction Technique (HEART). The approach involves demonstrating how HTA can be employed to model human response actions to a fire onboard a passenger vessel. Subsequently, it utilizes HEART, a systematic human error reduction and prediction method, to forecast and quantify probable errors. The findings indicate that six human response errors are most likely to occur, with a Human Error Probability of 0.16 according to the HEART analysis. The paper concludes by recommending remedial measures to mitigate each identified error.

A summary of previous research and the methods used are shown in Table 2.2

| No | Research Title                                                                                                    | Author                           | Focus Area             | Research Findings                                                                                                                                                                                                              |
|----|-------------------------------------------------------------------------------------------------------------------|----------------------------------|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | On the use of Simple Moving Averages for supply chains where information is not shared.                           | M.M. Ali. M.Z. Babai et al, 2015 | Forecasting Inventory  | Simple Moving Averages for inventory planning                                                                                                                                                                                  |
| 2  | Improved Forecasts for uncertain and unpredictable Spare Parts Demand in Business Aircrafts with Bootstrap Method | Mobarakeh,N. Ahmadi et al, 2017  | Inventory Management   | Forecasting methods for spare parts and demand classes                                                                                                                                                                         |
| 3  | A new procedure for spare parts inventory management in ETO production: a case study                              | Rinaldi, Marta et al, 2022       | Inventory Management   | Spare parts classification, Economic Order Quantity Method                                                                                                                                                                     |
| 5  | Using DMAIC in Improvement of Customer Satisfaction and Facilities provided at Commuter Stations                  | Mustapha Roslina et al, (2016)   | DMAIC Concept          | DMAIC theory to Customer Satisfaction Improvement                                                                                                                                                                              |
| 6  | The Proposed Model of Suppliers Performance Measurement for Vendor Held Stock (VHS) in Mining Industry            | Wahyuni Sri (2020)               | Maintenance Management | Vendor Held Stock, which is an inventory system and management of spare parts and other materials that must be prepared and managed by suppliers, with is using of IT system companies to linkage or not (with agreement only) |