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Research Article

FSN Analysis of Spare Parts Based On Turnover Ratio In PT XYZ Maintenance Warehouse

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ABTRACT

The primary function of the warehouse is to store raw materials, semi-finished goods, finished products, and spare parts. The Maintenance Division of PT XYZ does not have a policy on the placement of spare parts. There are two warehouses for storing spare parts. The distance of the second warehouse is 470 meters from the first warehouse. Although the second warehouse is farther away, operators frequently use it to store spare parts. It causes the flow of spare parts to be less than optimal, especially if the spare parts are needed suddenly. This study aims to design a policy for grouping spare parts in two warehouses using the FSN (Fast-Slow Non-Moving) method based on the turnover ratio. FSN analysis is a classification method based on the frequency of use. The calculation results show that the maintenance division can group spare parts into three groups to minimize the distance for taking spare parts. The FSN analysis states that 83.9% of the 1045 electric spare parts and 79.5% of the 39 FC production spare parts are in the non-moving category. Meanwhile, as many as 51.8% of the 2670 mechanical spare parts are in the slow-moving category. Managerial decisions dictate that electrical and FC production parts are placed in the second warehouse, while mechanical parts are in the first warehouse. By implementing FSN, companies can achieve operational efficiency and can increase the reliability of the overall maintenance system.

1. INTRODUCTION

PT XYZ, a steel industry company supplying construction materials, is located in Banten, Indonesia. The maintenance division operates two warehouses at separate locations. Warehouse One has a dual function, serving as a storage facility for spare parts and as a workshop. In contrast, Warehouse Two is dedicated solely to spare parts storage, but it is smaller than Warehouse One. The spare parts in these warehouses are critical for factory repairs. However, many spare parts needed for repairs are often stored in Warehouse Two, farther from the factory's machinery area. This distance creates challenges, as these parts are often required during repair work.

A well-organized placement strategy can enhance the efficiency of the spare parts picking process (A. Kumar & Shukla, 2022a). By adopting innovative layout designs and storage techniques, the picking process becomes more streamlined and manageable (Y. Kumar, 2017). Choosing the right storage location in the picking area plays a main role in improving the performance of the order-picking system (Sitorus et al., 2020). Optimizing product placement helps minimize travel time during order picking, leading to greater overall efficiency. Properly arranging items in the warehouse boosts productivity, reduces material handling time and costs, and improves distance efficiency (Candrianto et al., 2020).

The current company spare part placement policy is to store spare parts in empty regions. Spare parts with the same type and location of use are obtained but are located in both warehouses. The number of spare parts recorded in the current system is 5366 spare part items. The distance between equipment for the material handling process affects operational efficiency, especially the time and energy required for transportation and retrieval (Chan & Chan, 2011). The distance between warehouse one and warehouse two is 470 meters, shown in Figure 1, the location of warehouse one and warehouse two. If the spare parts used are in warehouse two, it will require a longer movement distance. So, it is necessary to determine the policy for the spare parts stored in each warehouse.

Good inventory grouping will create the efficient and effective warehouse arrangement (Chen et al., 2008; Wijaya, 2022). A better warehouse layout helps inventory control by preventing the accumulation and mixing of goods. It also reduces search time and ensures that warehouse capacity is utilized, which can help the logistics and warehousing process run smoothly (Bortolini et al., 2019). Placing fast-moving goods near the entrance and exit and slow-moving goods on easily accessible shelves will reduce unnecessary movement and increase productivity (Jemelka et al., 2016).

One method used to classify inventory is FSN (Fast-Slow-NonMoving) analysis. FSN analysis groups items into three categories: fast-moving, slow-moving, and non-moving goods. It is a classification method based on frequency of use (Amalia et al., 2023; Budruk, 2016; Devarajan & Jayamohan, 2016; Y. Kumar, 2017). This grouping allows for the implementation of more appropriate inventory policies for each category (A. Kumar & Shukla, 2022b; Madan & Ranganath, 2014; Mor et al., 2021). The advantage of FSN analysis is that it can store fast-moving spare parts closer to the warehouse and easily accessible, and can help in effective warehouse management. The disadvantage or gap in FSN analysis is that it only relies on the formula and information that has been collected about spare parts. Because if the modified spare part list requirements are not informed, this can reduce the quality of the material so that it falls into the slow turnover or non-moving category (S Sareminia, et a,.2023).

This study uses FSN analysis based on the turnover rate, which helps allocate storage space more effectively. The turnover ratio is critical for assessing a company's management inventory. A slow turnover ratio indicates unused stock and dead stock (Devarajan & Jayamohan, 2016). This analysis is also beneficial for ensuring that more frequently used items are placed in locations closer to the entrance and exit, making it easier to access when taking them (Oswald & Anand Deva Durai, 2014; Tambunan et al., 2018). The turnover ratio value of each item can be used as a basis for inventory control policies and helps prevent large amounts of stock storage, especially for items that are not moving or rarely used. Thus, this analysis can minimize costs (A. Kumar & Shukla, 2022b).

Many previous studies have discussed FSN Analysis in the manufacturing or automotive sectors, but studies using FSN Analysis in the steel industry and maintenance warehouse are still limited. This study fills the gap by applying FSN Analysis in the context of a steel industry maintenance warehouse, which is separated into three sections, namely mechanical spare parts, electrical spare parts, and production spare parts. These spare parts are spare parts that are used for a lengthy period and are critical spare parts for the continuity of operations in steel factories.

Based on field observations, the storage policy at PT XYZ currently uses a random storage system, spare parts are stored in space. Lifting and transport facilities are needed to support activities in the warehouse. Currently, Warehouse One is provided by overhead cranes with a capacity of 5 tons and 25 tons and a forklift with a capacity of 5 tons. In addition, there are several portable lifters with a capacity of 1 ton and a trolley with a capacity of 1 ton. The facilities in Warehouse One are rather adequate, especially for spare parts with spacious weight and dimensions. Meanwhile, Warehouse Two only has a manual lift with a capacity of 1 ton and a trolley, so it is unsuitable for large equipment and will complicate the handling process. Warehouse Two can use forklifts even though their movement area is limited. This study aims to obtain a grouping of spare parts placed in Warehouse One and Two by applying the FSN based on the turnover ratio.

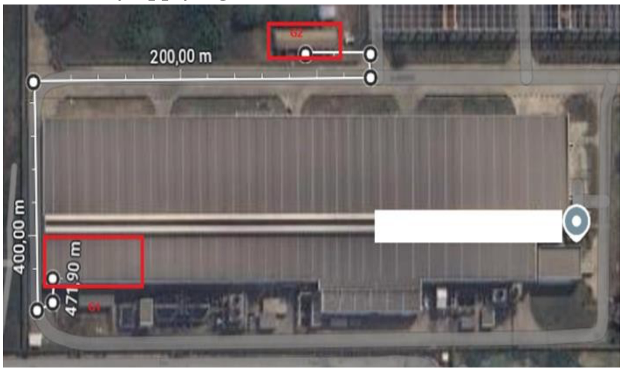

Fig 1. Location of Warehouse one and two (Source: Google Map 2024)

2. METHOD

FSN analysis is a classification method based on the frequency of use (Budruk, 2016; Devarajan & Jayamohan, 2016; Y. Kumar, 2017). The method used in this study is FSN analysis based on TOR (turnover ratio) values (Budruk, 2016; Devarajan & Jayamohan, 2016; A. Kumar & Shukla, 2022a; Y. Kumar, 2017; P & Ranganathan, 2017), as follows:

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1. Class F (Fast) Items: These are fast-moving spare parts with TOR values greater than 3.
2. Class S (Slow) Item: These are slow-moving spare parts with TOR values ranging from 1 to 3.
3. Class N (Non-Moving) Items: These are non-moving spare parts with TOR values less than 1.

The steps to analyze FSN are as follows (Hudori et al., 2019):

1. Determine the existing material data used.

$$Pak = Paw + Pms - Ppk \quad (1)$$

$$Prt = \frac{Paw + Pak}{2} \quad (2)$$

$$TOR = \frac{Ppk}{Prt} \quad (3)$$

2. Grouping goods with FSN Analysis (Fast, Slow and Non-moving) based on TOR, with the following criteria (Devarajan & Jayamohan, 2016):
   a. Sort data based on the highest to lowest TOR value.
   b. Determine the classification F (TOR > 3), S (3 ≤ TOR ≤ 1), N (TOR < 1).

1. *Research Framework*

Warehouses One and Two are the objects of this research. The grouping analysis uses FSN, taking into account the turnover ratio. The research framework includes:

1. Identification of problems and research objectives.
2. Exploring literature sources.
3. Conducting observations at the research location.
4. Conducting data analysis.
5. Providing recommendations for placing spare parts in Warehouses One and Two.

2. *Data Collection Techniques*

Data collection in this study was in the form of a case study at Warehouses One and Two at PT XYZ. The data collected were spare part usage from 2018 to July 2024, equipment trees from machines, and location plans for Warehouses One and Two.

3. *Data Processing Methods*

This study aims to produce clustering spare parts for Warehouses One and Two. The data process with FSN is based on the turnover ratio. The general stages in data processing are as follows:

1. The first step is to combine data and spare part areas. We divide the spare part area into three sections: the ME area for mechanical spare parts, the EL area for electrical spare parts, and the FC area for production spare parts.
2. The second step is to process spare part movement data.
3. The third step is to count the FSN with the turnover ratio (TOR). The formula for the turnover ratio is Annual Demand / Average Inventory.
4. The fourth step is to analyze with a graph based on the spare part FSN
5. The fifth step is to remove spare parts that are no longer in use.
6. The sixth step is to determine the spare parts that will be allocated in Warehouses One and Two.

3. RESULT AND DISCUSSION

The data collected is spare part data used on the machine. The equipment tree or detailed machine drawings generate the research data. Spare part usage movement data is depicted from 2018 to July 2024. The total current spare part data is 5366 spare parts. The data is grouped into three areas: 1) ME for mechanical spare parts totaling 4092 items or 76.3%, 2) EL for electrical spare parts amount 1235 items or 23%, and 3) FC is a production spare parts around 39 items or 0.7%. FSN calculates all spare part data. The decision-makers determine spare part placement policies using spare part weight.

Data processing is based on incoming spare part transaction data (purchased spare parts) and outgoing spare parts (used spare parts). Data is processed to obtain the cumulative remaining value of the stored spare parts. Data obtained from spare part usage is the monthly spare part amount value. This data will be entered and combined with transaction data to get changes and movements in spare part data. The movement of spare parts can be seen in Figure 2.

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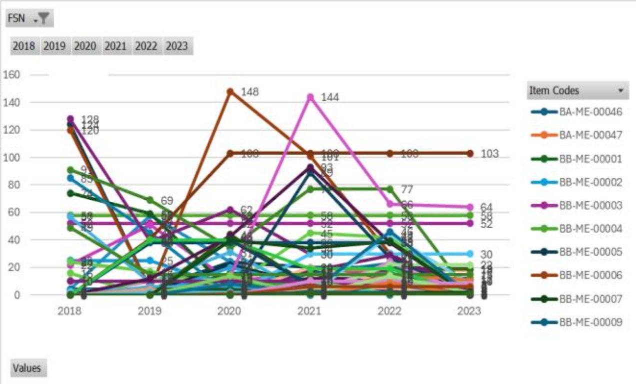

Fig 2. Historical Data on Spare Part Usage

Figure 2 shows historical data on spare part usage based on remaining stock available in quantity units. The data shown in the graph is sample data of several spare parts available at PT XYZ. The results of the transfer value are the basis for calculating the TOR (Turn Over Ratio), as in Table 1.

Table 1. Calculation of TOR (Turn Over Ratio)

No	Item Code	Dev	Mass (kg)	Demand	Avr Stock	TOR
1	AA-ME-00040	ME	23	2	1	2
2	AA-ME-00048	ME	27	12	6	2
3	AA-ME-00063	ME	10	28	14	2
4	AA-ME-00064	ME	12	5	2.5	2
5	AA-ME-00065	ME	18	23	11.5	2
6	AA-ME-00066	ME	24	5	2.5	2
7	AA-ME-00067	ME	20	2	1	2
8	AA-ME-00001	ME	1	34	17	2
9	AA-ME-00002	ME	1	12	7	1,71
10	AA-ME-00003	ME	1	2	1	2
:	:	:	:	:	:	:
:	:	:	:	:	:	:
5366	AJ-FC-00001	FC	0	0	10	0

Calculation example:

Ex: for AA-ME-00040,

TOR = demand / average stock = 2/1 = 2

Table 1 shows the TOR value. Overall, the results of the TOR calculation show a turnover rate of less than 3. The highest value of the TOR calculation is 22, while the smallest value is 0. The TOR (Turn Over Ratio) calculation categorises spare parts. Spare part categories with a TOR value > 3 as Fast Moving, TOR value < 1 or 0 as Non-Moving. Figure 3 shows the historical data for all spare part usage.

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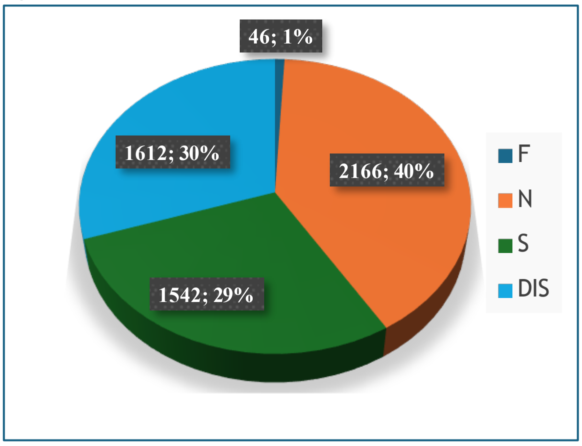
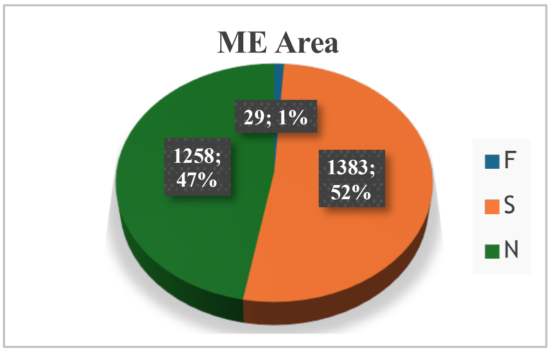


Fig 3. Historical Data Spare Part Usage

Based on Figure 3, the fast category is 46 items or a percentage value of 1%. The Slow category has 1542 items with a percentage value of 29%. The Non-Moving category has 2166 items, which is equal to 40%. There are also 1612 unused spare parts (DIS) that are similar by a percentage of 30%. The next step is to consider removing DIS spare parts from the calculation. The final results of other spare parts will be re-calculated to see the category from each area. Figure 4 (a, b, c) explains the results of the assessment based on the field.



a

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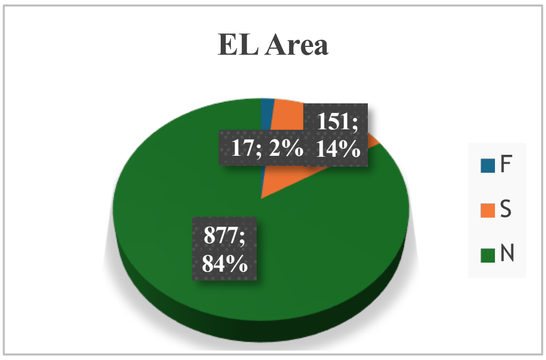

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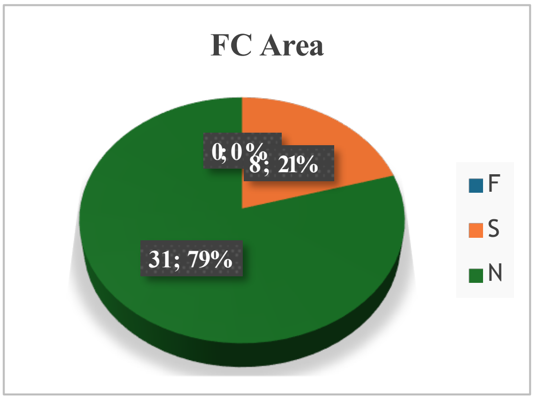

c

Fig 4a, b, c. FSN Diagram of Each Area.

Figure 4 shows the percentage of each area. The ME area, the Fast category, has 29 items with a percentage value of 1.1%. The Slow category has 1383 items with a percentage value of 51.8%. The Non-Moving category has 1258 items with a percentage of 47.1%. It also obtained 1.422 spare parts that are no longer used.

Figure 4 also indicates the categories in the EL area. The fast category for the EL area is 17 items with a percentage value of 1.6%. The Slow category is as many as 151 or equal to 14.4%. The non-moving category is 877 items with a percentage of 83.9 % and also obtained spare parts that are no longer used as many as 190. Based on the FSN calculation, in the FC area, there are no spare parts that fall into the fast category. The slow category 8 item is on par with 0.5%. The non-moving category had 31 items with a percentage of 79.5%.

Based on the FSN calculation for the three areas, the spare parts from the EL and FC areas are mostly non-moving. So EL and FC spare parts will be placed in Warehouse Two. Warehouse One store ME spare parts. The ME area has more spare parts in the slow and fast categories. It is contrasted with the EL and FC areas. However, EL and FC spare parts weighing 500 kg will be stored in Warehouse One. The consideration is that in Warehouse One, there is an overhead crane that will facilitate the handling process, especially for heavy spare parts.

Fast moving spare parts have high demand and often rotate in inventory. The characteristics are high demand, large order frequency, high risk of stock shortages while placement: Close to the picking area to reduce handling time and costs. Managerial Implications are for Stock Management optimization, where the appropriate placement of F, S, and N helps improve operational efficiency and reduce handling costs.

This classification makes it easier to identify products that need to be managed as a priority to avoid stockout (F) or overstock (S, N). Logistics Process Efficiency with F placement in an area close to the distribution point, picking and packing process time can be minimized so that it can reduce disruption to logistics activities, increase storage space utilization, especially in warehouses with limited capacity.

Most studies only rely on the turnover ratio to determine the categories of Fast-Moving (F), Slow-Moving (S), and Non-Moving (N). This study uses turnover ratio as the basis for classification but also relates it to other factors, such as the pattern of spare parts usage in the PT XYZ maintenance system. The results show that some spare parts with low turnover still have a strategic role in operations. There is also not much application of FSN in the steel industry. Data processing shows that slow-moving parts in the steel industry still have strategic value, distinct from other sectors that tend to eliminate this category. It can provide specific insights that can be applied to the division of spare parts in the steel industry. The limitation of this research is that the case study is still limited to one company in the steel industry.

4. CONCLUSION

The conclusion from this research, are:

1. Unused spare parts are removed and denoted with the label DIS.
2. Warehouse One keeps ME spare parts because of more content fast and slow-moving spare parts. In addition, warehouse one put away EL and FC spare parts weighing more than 500 kg. There is a crane that facilitates the movement of EL and FC spare parts.
3. Warehouse Two for spare parts FC and EL codes with slow and non-moving categories.

Due to the high number of spare parts, future research will focus on grouping spare parts by type to facilitate. This grouping aims to facilitate the picking process or when controlling stock.

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NOMENCLATUR

Pak	:	end inventory
Paw	:	initial inventory
Pms	:	incoming goods
Ppk	:	goods used
Prt	:	average inventory
TOR	:	inventory turnover