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Strategy for Determining Priority of Production Material Inventory with AHP Topsis and Monte Carlo Integration in Metal Stamping Industry

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Abstract

Optimal inventory management is key to the smooth production process in the manufacturing industry. Overstock and material shortages are challenges caused by fluctuations in demand and the types of materials with different characteristics. This research aims to develop a strategy for prioritizing material inventory that requires special attention compared to other inventories using AHP TOPSIS method, as well as to ensure the optimal inventory amount so that the material reorder process can be carried out accurately and efficiently using the monte carlo simulation method. The strategy used in determining the priority of reordering production materials is to establish a priority order of materials based on the level of importance. Material coil ranks first with the highest value of 0.530, followed by sheet metal, supported inv, chemical, shaft, and packaging material. Next, to determine the reorder quantity of coils using monte carlo simulation for three scenarios during the period from January to March 2025. The prediction results indicate that scenario 2 has an accuracy rate of 92%, so it is selected as the reference. The amount of coil material orders based on scenario 2 is 605,433 KGM for January, 676,097 KGM for February, and 549,784 KGM for March.

Keywords: *Prioritization Strategy; AHP Topsis Integrity; Monte Carlo*

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INTRODUCTION

Inventory is one of the most important things that is of special concern to the company. The availability of inventory can affect all activities which takes place in the company both in planning, control, materials standard, process material and goods So. The role of proper inventory management has an impact big on performance system manufacturing (Mohktari, 2018).

Based on Statista Industrial Market 2024 data, the metals stamping industry sector has shown an increase over a decade. Starting from 2014 at 82.12 trillion rupiah, increasing in 2023 to 196.32 trillion rupiah. This shows strong growth in the metals manufacturing sector during that period. (Statista, 2024).

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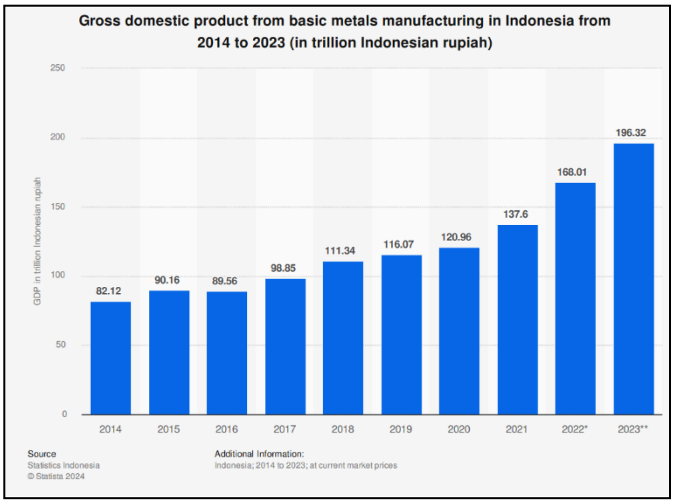

Figure 1.1 Growth of the metals manufacturing sector 2014-2023
(Source: Statista, 2024)

Industry Metals manufacturing is one of the manufacturing sectors that is experiencing rapid growth, with various products produced in this industry, such as ready-to-assemble metal goods industrial units for electronics, automotive and construction manufacturing. In metals production stamping for product needs electronic has a short life cycle with ever-changing market demand (Kemenprin.go.id).

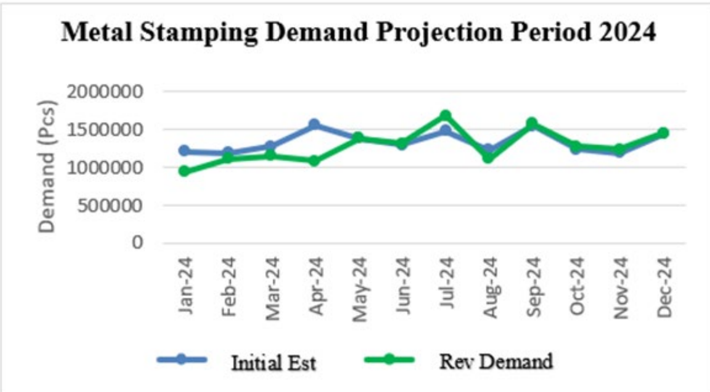

Figure 1.2 Projection of *Metals Stamping Demand* for the Period 2024
(Source: KI Company Data, 2024)

In Figure 1.2, the projection of *metals stamping demand* for the 2024 period, it is shown that *demand* continues to fluctuate. In January 2024, *demand* changed when *demand* information was released, namely when the initial estimate was issued, then getting a revision of demand, it was seen that there was a significant change.

In this case management inventory become very crucial and has an important role For guarantee smoothness production, where inventory management must be able to control inventory availability . However In reality, management has not been able to control the availability of inventories , which has even resulted in overstock and shortages of materials , and has not yet can determine supply with capacity warehouse owned to the maximum. Phenomenon the occurs because of inventory own various type product and it 's hard to predict amount material

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needs due to uncertainty the number of items that requested by the customer. The following is the business process for procuring material supplies in the manufacturing industry:

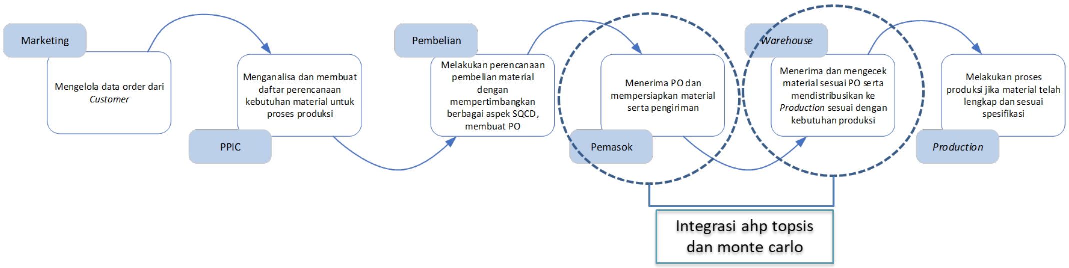

Figure 1.3 Business process for procuring raw material inventory in the manufacturing industry
(Source: Saputro., D, 2021)

In the business process of procuring raw material supplies, it starts with the marketing team managing customer order data which is the basis for planning material requirements for production by the PPIC team. If you have received a list of material requirements, the purchasing team will analyze it by considering various aspects, one of which is SQCD, if it is appropriate, it will continue by creating a PO. The supplier will prepare the material and make the delivery. Furthermore, the warehouse will receive the material with the appropriate specifications, and distribute it to the production section for input into the production process. The integration of AHP TOPSIS and Monte Carlo is reflected in the supplier and warehouse business processes.

Inventory is said to be efficient and effective if the inventory meets demand in sufficient quantities and good quality, because accuracy in fulfilling inventory will have an impact on the company's efficiency in meeting customer needs (Wulansari, 2017). In fulfilling inventory, companies or organizations must replenish goods or items when they reach the reorder point. In determining the number of items to be ordered, it must be done carefully, because at any time it can cause a shortage if the inventory is insufficient before the replenishment period. However, the company also cannot place orders in large quantities because it will cause overstock (Octaviany & Dendi, 2022). At the time inventory exceeding company needs (overstock) will also cause the stored inventory to become damaged or No worthy use, it will increase the company's storage costs (Lahu & Sumarauw, 2017).

Types of inventory that are abundant in the storage warehouse sometimes it's hard to be controlled, so that a reference is needed in determining which inventory priorities only need to be given more attention , therefore an approach is needed to determine Which inventory items need to be given special priority over materials others. However, to determine inventory priorities, consideration of these inventory criteria is required . Criteria the covering lead time , annual usage , life time , cost, storage capacity as well as reliability supplier . One of the common methods used to determine the weight of each criterion is the AHP method. (Ayan et al., 2023; Saaty & Katz, 1990). The weighting of the criteria in AHP is carried out and assessed by experts in their fields by giving a score to each alternative that has been provided. One of the shortcomings of AHP is that the assessment tends to be subjective. Therefore, to fill this gap, an advanced

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method is used to search for ideal solutions and anti-ideal solutions and compare the distance of each alternative to the ideal solution using TOPSIS (Papathanasiou & Ploskas, 2018).

The combination of the AHP-TOPSIS methods is an ideal combination because the combination of these two methods utilizes the advantages of each method, by overcoming the limitations of the AHP method, is efficient and saves time, produces the same decisions and is very close to the preferences of the expert who makes the decision (Sharma et al., 2020).

Once the inventory items that need to be prioritized are known, further analysis is carried out related to the amount of material inventory replenishment that needs to be prioritized . However, amount Usage or demand sometimes cannot be known with certainty so that stock sometimes runs out when needed. To predict the number of orders material and reorder point time using Monte Carlo simulation (Octaviany & Dendi, 2022). Method mountain carlos is method analysis numeric Which involving sample experiment number random. With use method simulation mountain carlos useful to predict demand and supply so as to save handling costs and capacity supply (Erwin, 2016). The most important decision making in the inventory system namely determining the amount of how much much and when is the right time to order materials . If the stock material no controlled properly and precisely, the company will incur lower operational costs, expensive (Mohktari, 2018).

METHODOLOGY

This research uses quantitative descriptive method. The following is a research flow chart consisting of:

1. Introduction
   At this stage, it is the initial stage of research, starting with identifying phenomena and problems to be studied. The problems are formulated problem For determine objective study. Limitation problem made For give results in accordance with objective study, so that can give benefits for industry manufacturing.
2. Stage studies literature
   After getting a research topic, the next step is to conduct a literature study. Literature study obtained to support the research topic. In the research This done studies literature associated with system inventory and the methods used are AHP TOPSIS related to determining inventory priorities and the *Monte Carlo method. Carlo* is related to the amount of material ordered and when is the right time to order the material.
3. Stage collection data
   At the data collection stage, the data collected is in the form of primary data and data secondary. Primary data collection data from questionnaire as well as interview by party *expert* in their field to determine inventory criteria, inventory classification hierarchical structure, determine the comparative value of inventory criteria and to assess the performance of alternative choices related to the given criteria. In the inventory criteria, literature

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studies and discussions with *experts* in their fields were carried out. The questionnaire was filled out by a total of 7 respondents with details of 6 *expert sources* in their fields and 1 external source who is an expert in their field. While For data secondary is data *demand* period 2023-2024 obtained data from the company for processed use method simulation *Mont Carlo* .

4. Stage processing data And Analysis
   At the data processing stage, the collected data will be processed according to model mathematical Which has determined. After do processing data results are obtained for further analysis.

   Multi inventory priority selection criteria using AHP by conducting a criteria assessment. Then arrange the problems into hierarchical levels. Create a pairwise comparison matrix of criteria, calculate *geoman* and *matrix after geoman* , *matrix after normalized* , calculate *eigenvalues* , calculate *consistency index* and *ratio* if the data is consistent then continue by calculating the priority weight of the criteria if not then return to distributing the questionnaire to *human experts.* Data is said to be consistent with *a Consistency Ratio* (CR) value ≤ 0.1, then the questionnaire can be decided correct. Where these weights become data that will be entered in the ranking of alternative choices to be processed using TOPSIS, by creating *a decision matrix* or performance *table*, then the next step is to normalize the decision matrix and the normalized matrix multiplied by the sub-criteria weights to obtain a normalized weighted matrix (*weighted normalized matrix*). Next, determine the positive and negative ideal solutions by calculating the distance to the positive and negative ideal solutions. The next step is to calculate the preference value for each alternative and calculate the alternative ranking to obtain the alternative order of material inventory.
   After getting the order of the material that needs to be prioritized, the next step is integration by calculating the number *of* material orders to be ordered using *Monte Carlo simulation* . Data processing with *Monte Carlo simulation* , namely to determine the optimum number of reorders . By determining the cumulative probability, determining the initial interval and the final interval of the cumulative probability, simulating 3 scenarios and then analyzing, so as to obtain a prediction of the inventory to be ordered. The data used for *Monte Carlo simulation is historical demand* data , namely the period 2023 - 2024. From this integration, the order of inventory that needs to be prioritized and *the quantity of* inventory to be ordered are obtained.
5. Conclusion
   From the results of data processing and analysis, conclusions and suggestions will be produced. in the form of criticism use for support study furthermore.

RESULTS AND DISCUSSION

The following is a comparative test between criteria, the criteria used in this study in a hierarchical structure are annual usage, life time, cost, capacity inventory and supplier reliability. The comparative test between criteria was conducted by filling out a questionnaire by 7 expert sources. Where 6 sources are

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experts in their fields and 1 external source is an expert in their field. Respondents come from the assistant manager level of the production department, PPIC, warehouse, purchasing, quality, cost control, sales & marketing and even BOD, with more than 15 years of work experience in the metal stamping manufacturing industry, where the amount of experience has a great impact on decision making related to the selection of production material inventory priorities. The following is data from both internal and external sources, experts in their fields in this study:

Table 1. Data of Respondents Who Participated in the Research

Expert No.	**EXP-1**	**EXP-2**	**EXP-3**	**EXP-4**	**EXP-5**	**EXP-6**	**EXP-7**
Position	*Manager Prod*	*Manager PPIC & Whs*	*Manager Purchasing*	*Manager Quality*	*Assistant Manager Sales & Marketing*	Direktur	GM *Purch & Cost Control*
Department	Production	PPIC & *Warehouse*	*Purchasing*	*Quality*	*Sales &* *Marketing*	BOD	*Purchasing & Cost Control*
Length of Term In Office	15 Tahun	15 Tahun	15 Tahun	22 Tahun	28 Tahun	15 Tahun	21 Tahun

In collecting historical data in the form of coil usage data or demand in 2023 and 2024, it is used to predict demand in 2025, as follows:

Table 2 Historical Data on *Coil Usage* (KGM)

Month	**Demand In 2023**	**Demand In 2024**
Januari	510,342	676,097
Februari	452,158	571,676
Maret	451,377	545,382
April	540,838	549,784
Mei	595,302	605,433
Juni	575,400	600,933
Juli	478,884	609,918
Agustus	507,706	640,106
September	549,765	565,008
Oktober	601,154	645,416
November	522,933	528,627
Desember	444,085	599,668

After collecting data, the next stage is to process the data. The following are the stages of data processing in this study:

- Determination of Criteria Consistency Ratio

Table 2 Comparison Criteria

Comparison criteria	***Expert***							***Geoman***
	1	**2**	**3**	**4**	**5**	**6**	**7**	
Lead Time - Annual Usage	7	1	1	3	7	2	2	2,487

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Lead Time - Life Time	0.167	0.143	3	2	1	1	0.14	0.574
Lead Time – Cost	0.143	111	0.2	1	1	0.2	0.14	0.265
Lead Time - Capacity Inv	7	1	1	5	0.143	2	2	1,534
Lead Time - Supplier Reliability	8	1	0.2	0.2	0.143	3	2	0.831
Annual Usage - Life Time	0.2	0.111	0.33	0.333	0.2	0.14	3	0.299
Annual Usage – Cost	0.143	0.111	0.14	1	0.143	0.14	0.2	0.191
Annual Usage - Capacity Inv.	0.125	0.125	1	3	0.143	3	3	0.669
Annual Usage - Supplier Reliability	0.2	0.2	1	0.333	0.143	0.14	0.2	0.246
Life Time – Cost	0.143	0.143	0.2	1	1	3	0.14	0.404
Life Time - Capacity Inv.	0.125	0.143	3	3	1	1	3	0.901
Life Time - Supplier Reliability	6	0.143	3	0.333	1	3	0.2	0.909
Cost - Capacity Inv.	0.125	9	5	3	1	1	3	1,752
Cost - Supplier Reliability	0.143	9	5	1	1	7	3	2,015
Capacity Inv. - Supplier Reliability	0.125	1	1	1	1	1	0.14	0.563

After calculating the geometric mean , the next step is to create the after geometric matrix :

Table 3 Matrix After Geoman

Criteria	***Lead Time***	***Annual Usage***	***Life Time***	***Cost***	***Capacity Inv.***	***Supplier Reliability***
Lead Time	1	2.487	0.574	0.265	1.534	0.831
Annual Usage	0.402	1	0.299	0.191	0.669	0.246
Life Time	1.744	3.349	1	0.404	0.901	0.909
Cost	3.780	5.237	2.48	1	1.752	2.015
Capacity Inv.	0.652	1.494	1.11	0.571	1	0.563
Supplier Reliability	1.203	4.066	1.10	0.496	1.777	1
Total	8.781	17.633	6.56	2.926	7.634	5.565

The following is the matrix after normalization , in this study:

Table 4. Matrix After Normalization

Criteria	***Lead Time***	***Annual Usage***	***Life Time***	***Cost***	***Capacity Inv.***	***Supplier Reliability***	***Priority Vector***	***Matrix x Priority***	***Consistency***
Lead Time	0.114	0.141	0.087	0.090	0.201	0.149	0.131	0.803	6.154
Annual Usage	0.046	0.057	0.046	0.065	0.088	0.044	0.058	0.803	13.961
Life Time	0.199	0.190	0.152	0.138	0.118	0.163	0.160	0.803	5.018
Cost	0.430	0.297	0.378	0.342	0.229	0.362	0.340	0.803	2.364
Capacity Inv.	0.074	0.085	0.169	0.195	0.131	0.101	0.126	0.803	6.380
Supplier Reliability	0.137	0.231	0.168	0.170	0.233	0.180	0.186	0.803	4.313

The next step is to calculate the average value of the priority λ_{max}vector so that the result is called :

$$\lambda_{max} = \frac{6.154+13.961+5.018+2.364+6.380+4..313}{6} = 6.365$$

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Next, calculate the Consistency Index (CI) value using the following formula:

$$CI \quad = \frac{\lambda_{max} - N}{N-1}$$

$$= \frac{6.365-6}{5}$$

$$= 0.073$$

Then calculate the Consistency Ratio value with n = 6 and RI = 1.24, with the following formula:

$$CR \quad = \frac{CI}{RI}$$

$$= \frac{0{,}073}{1{,}24}$$

= 0.059, CR value ≤ 10%, then the paired matrix for the criteria can be said to be consistent.

So that the criteria weighting results are obtained:

Table 5 Criteria Weight

Code	***Criteria***	**Weight**
C1	*Lead Time*	0.131
C2	*Annual Usage*	0.058
C3	*Life Time*	0.160
C4	*Cost*	0.340
C5	*Capacity Inv.*	0.126
C6	*Supplier Reliability*	0.186

The following is the weight of each criterion, obtained from the results of the criteria weighting using AHP. The weight will be used to determine the weighted decision matrix of each alternative.

Table 6 Code Weight Criteria

Weight	**C1**	**C3**	**C3**	**C4**	**C5**	**C6**
	0.131	0.058	0.160	0.340	0.126	0.186

Next, create a decision matrix. The decision matrix is obtained from historical company data and discussions with experts in the field. Identify the criteria through discussions with respondents, namely the criteria that include the benefit criteria (+) which means profitable and the cost criteria (-) which means detrimental. Identification of these criteria is carried out if the value is smaller, it is better because it causes costs , while if the value is greater, it is better because it will provide benefits to the company (Prabowo, 2020). The following are the characteristics of the cost and benefit criteria seen in table 7.

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Table 7 Characteristics of *Cost* and *Benefit Criteria*

Criteria	Characteristics
Lead Time	*Cost*
Annual Usage	*Benefits*
Life Time	*Benefits*
Cost	*Cost*
Capacity Inv.	*Cost*
Supplier Reliability	*Benefits*

The following is a decision matrix for each alternative:

Table 8 *Decision Matrix*

Criteria	C1	C2	C3	C4	C5	C6
	Min	**Max**	**Max**	**Min**	**Min**	**Max**
	(*Day*)	**(Unit/ *Month*)**	**(*Years*)**	**(Unit/ IDR)**	**(m^3)**	**(Scale 1 -25)**
Coil ((KGM)	2	548500	5	15400	2250	24
Chemical (*liter*)	5	14500	2	12500	700	23
Packaging Material (Pcs)	6	9300	2	10000	1050	22
Shaft (Pcs)	3	78050	2	15380	700	24
Sheet Metal (KGM)	4	117500	4	14500	1450	25
Supported Inv. (Pcs)	7	5980	1	8000	550	20
Sum square root	9	566610	7	30663	3041	53

In the next stage, normalize the decision matrix. The following is the normalization of the decision matrix:

Table 9 *Normalized Decision Matrix*

Criteria	C1	C2	C3	C4	C5	C6
	Min	**Max**	**Max**	**Min**	**Min**	**Max**
Coil	0.226	0.968	0.668	0.502	0.74	0.455
Chemical	0.484	0.026	0.281	0.408	0.23	0.441
Packaging Materials	0.674	0.016	0.281	0.326	0.345	0.409
Shaft	0.316	0.138	0.295	0.502	0.23	0.455
Sheet Metal	0.4	0.207	0.555	0.473	0.477	0.474
Supported Inv.	0.737	0.011	0.141	0.261	0.181	0.377

In the next stage, determine the weighted normalization matrix. The following is a weighted normalized decision matrix:

Table 10 *Weighted Decision Matrix*

Criteria	C1	C2	C3	C4	C5	C6
	Min	**Max**	**Max**	**Min**	**Min**	**Max**
Coil	0.03	0.056	0.107	0.171	0.093	0.085
Chemical	0.063	0.001	0.045	0.139	0.029	0.082
Packaging Materials	0.088	0.001	0.045	0.111	0.043	0.076
Shaft	0.041	0.008	0.047	0.17	0.029	0.085
Sheet Metal	0.052	0.012	0.089	0.161	0.06	0.088

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Supported Inv.	0.096	0.001	0.023	0.089	0.023	0.07

The following is an example of a Weighted Decision Matrix calculation. :

$$Y_{ij} = w_i x r_{ij}$$

$$= 0.226 \times 0.131$$

$$= 0.030$$

Then determine the positive ideal solution and negative ideal solution. The following are the results obtained from the positive ideal solution and negative ideal solution:

Table 11 Positive Ideal Solution and Negative Ideal Solution

Ideal *positive (v*)*	0.03	0.056	0.107	0.089	0.023	0.088
Ideal negative *(v-)*	0.096	0.001	0.023	0.171	0.093	0.07

After getting the positive ideal solution and negative ideal solution, the next step is to determine the distance of the positive ideal solution and the negative ideal solution. The following are the results of the distance of the positive ideal solution and the negative ideal solution from each alternative.

Table 12 Distance of Positive Ideal Solution and Negative Ideal Solution

Alternatives	**D***	**D-**
Coil	0.108	0.122
Chemical	0.102	0.083
Packaging Materials	0.106	0.082
Shaft	0.113	0.09
Sheet Metal	0.097	0.089
Supported Inv.	0.122	0.108

In the next stage, determine the preference value. A larger preference value indicates that the alternative to be chosen as a priority is Coil with a score of 0.503. The following are the preference scores of each alternative:

Table 13 Preference Scores

Alternatives	***Preferences***	***Ranking***
Coil	0.530	1
Chemical	0.448	4
Packaging Materials	0.434	6
Shaft	0.443	5
Sheet Metal	0.481	2
Supported Inv.	0.469	3

Monte Carlo Simulation Calculation :

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Monte Carlo simulation , namely determining the cumulative probability and then determining the initial interval and the final interval. The following is a table of probability, cumulative and interval from Monte Carlo simulation for scenario 1:

Table 14. Probability, Cumulative, Initial Interval and Final Interval of Scenario 1

Month	***Demand* (KGM)**	**Probability**	**Cumulative**	**Initial Interval**	**End Interval**
Jan-23	510,342	0.082	0.08	1	8
Feb-23	452,158	0.073	0.15	9	15
Mar-23	451,377	0.072	0.23	16	23
Apr-23	540,838	0.087	0.31	24	31
May-23	595,302	0.096	0.41	32	41
Jun-23	575,4	0.092	0.5	42	50
Jul-23	478,884	0.077	0.58	51	58
Aug-23	507,706	0.081	0.66	59	66
Sep-23	549,765	0.088	0.75	67	75
Oct-23	601,154	0.096	0.84	76	84
Nov-23	522,933	0.084	0.93	85	93
Dec-23	444,085	0.071	1	94	100
Total	6,229,944				

Next, perform the cumulative probability calculation, namely by calculating the results of the probability distribution with the next probability distribution.

$K_1 = A_1 = 0.082$

$K_2 = A_2 + K_1 = 0.073 + 0.082 = 0.15$

$K_3 = A_3 + K_2 = 0.072 + 0.15 = 0.23$

$K_4 = A_4 + K_3 = 0.087 + 0.23 = 0.31$

$K_5 = A_5 + K_4 = 0.096 + 0.31 = 0.41$

$K_6 = A_6 + K_5 = 0.092 + 0.41 = 0.50$

$K_7 = A_7 + K_6 = 0.077 + 0.50 = 0.58$

$K_8 = A_8 + K_7 = 0.081 + 0.58 = 0.66$

$K_9 = A_9 + K_8 = 0.088 + 0.66 = 0.75$

$K_{10} = A_{10} + K_9 = 0.096 + 0.75 = 0.84$

$K_{11} = A_{11} + K_{10} = 0.084 + 0.84 = 0.93$

$K_{12} = A_{12} + K_{11} = 0.071 + 0.93 = 1.00$

Next, determine the initial interval value and the final interval value, then determine the random number using the formula:

$R_i = (\text{d } R_{i-1} + \text{O}) \bmod \text{m}$

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By generating random values using the following values d = 21, O = 17, m = 95, the following random numbers will be obtained:

R_1= (21 x 12 + 17) mod 95 = 79

R_2= (21 x 79 + 17) mod 95 = 61

R_3= (21 x 61 +17) mod 95 = 63

R_4= (21 x 63 + 17) mod 95 = 10

R_5= (21 x 10 + 17) mod 95 = 37

R_6= (21 x 37 + 17) mod 95 = 34

R_7= (21 x 34 + 17) mod 95 = 66

R_8= (21 x 66 + 17) mod 95 = 73

R_9= (21 x 73 + 17) mod 95 = 30

R_{10}= (21 x 30 + 17) mod 95 = 77

R_{11}= (21 x 77 + 17) mod 95 = 19

R_{12}= (21 x 19 + 17) mod 95 = 36

The following are the random numbers generated:

Table 15 Random Numbers Scenario 1

No	Random Number
1	79
2	61
3	63
4	10
5	37
6	34
7	66
8	73
9	30
10	77
11	19
12	36

Next is to do a simulation by comparing random numbers with random number interval values. The following are the simulation results for 2024 scenario 1:

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Table 16 Simulation Results for 2024 Scenario 1

Month	Simulation Results 2024 (KGM)
January	601,154
February	507,706
March	507,706
April	452,158
May	595,302
June	595,302
July	507,706
August	549,765
September	540,838
October	601,154
November	451,377
December	595,302

Then the simulation results in 2024 are compared with the actual data in 2024 to calculate the accuracy that has been done. The accuracy of the Monte Carlo simulation in 2024 scenario 1 is 91%. The following is the calculation of the accuracy of the Monte Carlo simulation.

Table 17 Comparison Results of *Monte Carlo Simulation* 2024 Scenario 1

Month	*Real* Results 2024 (KGM)	Simulation Results 2024 (KGM)	Presentation
January	676,097	601,154	89%
February	571,676	507,706	89%
March	545,382	507,706	93%
April	549,784	452,158	82%
May	645,933	595,302	92%
June	600,933	595,302	99%
July	609,918	507,706	83%
August	640,106	549,765	86%
September	565,008	540,838	96%
October	605,416	601,154	99%
November	528,627	451,377	85%
December	599,668	595,302	99%
Average			91%

Next is to do a simulation for demand in 2025, the steps used are the same to find the probability, cumulative and initial interval and final interval. The following is a table of probability, cumulative, initial interval and final interval.

Table 18. Probability, Cumulative, Initial Interval and Final Interval of Scenario 1

Month	*Demand* (KGM)	Probability	Cumulative	Initial Interval	End Interval

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Jan-24	676,097	0.095	0.09	1	9
Feb-24	571,676	0.08	0.17	10	17
Mar-24	545,382	0.076	0.25	19	25
Apr-24	549,784	0.077	0.33	26	33
May-24	605,433	0.085	0.41	34	41
Jun-24	600,933	0.084	0.5	42	50
Jul-24	609,918	0.085	0.58	51	58
Aug-24	640,106	0.09	0.67	59	67
Sep-24	565,008	0.079	0.75	68	75
Oct-24	645,416	0.09	0.84	76	84
Nov-24	528,627	0.074	0.92	85	92
Dec-24	599,668	0.084	1	93	100
Total	7,138,047				

Next is to do a simulation by comparing random numbers with random number interval values. The following are the results of the 2025 simulation scenario 1:

Table 19. Simulation Results for 2025 Scenario 1

Month	**Simulation Results 2025 (KGM)**
January	645,416
February	640,106
March	640,106
April	571,676
May	605,433
June	605,433
July	640,106
August	565,008
September	549,784
October	645,416
November	545,382
December	605,433

The following is a table of probability, cumulative and interval from the Monte Carlo simulation.

Using the LCG method, with the formula R_i= (d R_{i-1}+ O) mod m generates random values using the following parameter values d = 21, O = 17, m = 95 for the scenario 1, d = 26, O = 13, m = 95 for the scenario 2, d = 23, O = 11, m = 95 for the scenario 3.

The following is a random number generated:

Table 20 Random Numbers

No	**Random Numbers**	**Random Numbers**	**Random Numbers**

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	Scenario 1	Scenario 2	Scenario 3
1	79	40	2
2	61	8	57
3	63	31	87
4	10	59	17
5	37	27	22
6	34	50	42
7	66	78	27
8	73	46	62
9	30	69	12
10	77	2	2
11	19	65	57
12	36	88	87

The following is the calculation of the accuracy of the monte carlo simulation:

Table 21 Monte Carlo Simulation Comparison Results 2024

Month	*Real* Results 2024 (KGM)	Scenario 1		Scenario 2		Scenario 3	
		Simulation Results 2024 (KGM)	Presentation	Simulation Results 2024 (KGM)	Presentation	Simulation Results 2024 (KGM)	Presentation
January	676,097	601,154	89%	595,302	88%	510,342	75%
February	571,676	507,706	89%	510,342	89%	478,884	84%
March	545,382	507,706	93%	540,838	99%	522,933	96%
April	549,784	452,158	82%	507,706	92%	451,377	82%
May	645,933	595,302	92%	540,838	89%	451,377	75%
June	600,933	595,302	99%	575,400	96%	575,400	96%
July	609,918	507,706	83%	601,154	99%	540,838	89%
August	640,106	549,765	86%	575,400	90%	507,706	79%
September	565,008	540,838	96%	549,765	97%	452,158	80%
October	605,416	601,154	99%	510,342	79%	510,342	79%
November	528,627	451,377	85%	507,706	96%	478,884	91%
December	599,668	595,302	99%	522,933	87%	522,933	87%
Rata-rata			91%		92%		84%

The following is the result of the demand simulation for 2025 scenarios 1, 2, and 3:

Table 22 Simulation Results for 2025 Scenarios 1, 2 and 3

Month	Simulation Results 1 (KGM)	Simulation Results 2 (KGM)	Simulation Results 3 (KGM)
January	645,416	605,433	676,097
February	640,106	676,097	609,918
March	640,106	549,784	528,627
April	571,676	640,106	571,676
May	605,433	549,784	545,382

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June	605,433	600,933	600,933
July	640,106	645,416	549,784
August	565,008	600,933	640,106
September	549,784	565,008	571,676
October	645,416	676,097	676,097
November	545,382	640,106	609,918
December	605,433	528,627	528,627

In the prediction of inventory to be ordered in 2025 for 3 months in scenario 1 is 645,416 KGM for January, 640,106 KGM for February, 640,106 KGM for March, with an accuracy percentage of 91%. While for scenario 2 is 605,433 KGM for January, 676,097 KGM for February, 549,784 KGM for March, with an accuracy percentage of 92%. While for scenario 3 is 676,097 KGM for January, 609,918 KGM for February, 528,627 KGM for March, with an accuracy percentage of 84%. The selected scenario is Scenario 2 because the accuracy percentage level is higher. In addition, when compared to the Simple Moving Average (SMA) calculation method, the simulation results of scenario 2 have the smallest difference compared to other scenarios The simulation results are seen from the suitability and accuracy level (Putra, et al., 2022).

Calculation with *Simple Moving Average*

Simple Moving Average calculation are used to compare with *the Monte Carlo results* whether the results are close and to see the suitability of the simulation results with the *Simple Moving Average method* . The following are the results of calculations with *a simple moving average* :

Table 23 *Simple Moving Average*

Month	***Demand***	***Forecast***	***| Error |***	***Error²***	**%** ***Error***
Jan-24	676097				
Feb-24	571,676				
Mar-24	545,382				
Apr-24	549,784	597,718	47,934	2,297,692,004	0.09
May-24	605,433	555,614	49,819	2,481,961,324	0.08
Jun-24	600,933	566,866	34,067	1,160,538,913	0.06
Jul-24	609,918	585,383	24,535	601,968,842	0.04
Aug-24	640,106	605,428	34,678	1,202,539,641	0.05
Sep-24	565,008	616,986	51,978	2,701,672,288	0.09
Oct-24	645,416	605,011	40,405	1,632,566,449	0.06
Nov-24	528,627	616,843	88,216	7,782,086,180	0.17
Dec-24	599,668	579,684	19,984	399,366,384	0.03
Jan-25		591,237			
Total		5,920,769	391,616	20,260,392,025	0.68
Average			43,513	2,251,154,669	0.08
			MAD	**MSE**	**MAPE**

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The following is the calculation for 23 :

$$F_4 = \frac{F1+F2+F3}{3} = \frac{676.097+571.676+545.382}{3} = 597{,}718$$

$$MAD = \frac{\sum(Actual-Forecast)}{n} = \frac{391.616}{9} = 43{,}513$$

$$MAD = \frac{\sum(Actual-Forecast)^2}{n} = \frac{20.260.392.025}{9} = 2{,}251{,}154{,}669$$

$$MAPE = \frac{\sum(Actual-Forecast)/\ Actual}{n} = \frac{68\%}{9} = 0.08$$

CONCLUSION

Strategy used in determining the priority of reordering production materials is to establish a priority order of materials based on the level of importance. Material coil ranks first with the highest weight of 0.530, followed by sheet metal, supported inv, chemical, shaft, and packaging material. Next, to determine the reorder quantity of coils using Monte Carlo simulation for three scenarios during the period from January to March 2025. The prediction results indicate that scenario 2 has an accuracy rate of 92%, thus it is chosen as a reference. The amount of coil material orders based on scenario 2 is 605,433 KGM for January, 676,097 KGM for February, and 549,784 KGM for March.

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