Optimization of Spare Parts Inventory Management: A Case Study of a Cosmetics Manufacturing Plant

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Abstract: Inventory constitutes both a necessity and a significant financial constraint for companies, making its management crucial. Poor inventory management, particularly stockouts and overstocking of spare parts, can lead to considerable costs. In this context, our work aims to improve the management of spare parts inventory in a cosmetics factory by implementing a new management policy. We undertook a classification of spare parts based on their criticality.

Keywords: Inventory Management, Supply, Criticality.

1. INTRODUCTION

Inventory management plays a critical balancing act within organizations. It ensures the availability of necessary resources, like spare parts, to maintain operations and fulfill customer demands. However, excessive inventory levels tie up significant capital, reducing cash flow and hindering investment opportunities (S. Chopra et al, 2016) . Conversely, inadequate stock levels can lead to production delays, dissatisfied customers, and potential revenue losses due to stockouts (Gronroos, C. ,2011).

This challenge is particularly pertinent for spare parts inventory in manufacturing plants. Unlike finished goods, spare parts have a sporadic demand pattern, often driven by unforeseen equipment breakdowns. Maintaining a sufficient stock of spare parts is crucial to minimize downtime and ensure smooth production processes. However, overstocking spare parts can lead to high carrying costs, including storage space, obsolescence, and deterioration (Staudinger et al ,2018).

Therefore, optimizing spare parts inventory management is essential for achieving a balance between minimizing costs and ensuring operational efficiency. This paper presents a case study of a cosmetics manufacturing plant, aiming to improve its spare parts inventory management practices.

2. METHODOLOGY

2.1 Case Study Description

We focused on the issue of inventory management within a cosmetics company. Due to the importance of activities centered around inventory and its movement, we recognize that the maintenance department in any company strives to ensure that equipment is in optimal working condition when needed. This performance measure, known as availability, is impacted by interruptions caused by unexpected breakdowns. However, the spare parts required to replace faulty components are not always available, leading to prolonged equipment downtime due to stockouts.

On the other hand, in the context of corporate inventory management, even if production is often regular, the flow of spare parts is frequently irregular. This inevitably causes fluctuations in stock levels, representing the difference between incoming and outgoing flows at each production station, resulting in either stockouts or overstocking. Consequently, there is no consistent availability of spare parts, which leads to stockouts or excessive inventory.

Our case study aims to address these challenges by implementing a rigorous spare parts inventory management system to ensure a constant availability of spare parts while minimizing excessive storage costs. This approach is intended to guarantee the continuity of production operations in the cosmetics manufacturing plant.

2.2 Parameters for Determining Criticality

Unit Price of Each Spare Part (Pu):

The unit price of each spare part is a crucial factor in determining its criticality. Expensive spare parts represent a significant investment for the company, and inefficient management of these parts can lead to high costs and financial losses. Therefore, it is essential to closely monitor high-cost parts to optimize their management, minimize costs, and maximize profitability.

Delivery Time (DA):

Delivery time is another key factor in determining the criticality of spare parts. Parts with long delivery times can cause disruptions in the production process if they are not available when needed. A long delivery time increases the risk of stockouts, which can result in costly production stoppages.

Hence, it is important to categorize these parts based on their criticality to ensure proactive inventory management and avoid operational interruptions.

Consumption (C):

The consumption rate of spare parts over the study period is also an important parameter. A spare part with high consumption requires rigorous management to ensure it is always available when needed. Frequent stockouts of these parts can disrupt production and lead to additional costs. By considering consumption, we can identify the most critical parts for production and implement effective replenishment strategies to maintain an optimal stock level.

By combining these three parameters, we can establish an accurate classification of spare parts based on their criticality. This will improve inventory management and reduce the risks associated with stockouts and excessive costs.

2.3 Data Collection

For our case study, we collected data on spare parts from a cosmetics company over a 7-year period, from 2016 to 2022. The data includes the unit price, consumption rate, and lead time for each spare part. These details were extracted from the company's Computerized Maintenance Management System (CMMS) database. This dataset enables us to assess the criticality of each spare part and identify the most crucial components for optimal inventory management. We have organized this data in Table 1 to facilitate analysis and interpretation. (Jmarealisation , 2024),

Table 1. Spare Parts Data from the Cosmetics Company (2015-2023)

Designation	Reference	P. U (€)	D. A (days)	Consumption C
SOUPAPE	4985	140,00	36	6
MODULE ETHERCAT	2944	110,80	195	2
ELECTRODISTRIBUTE	2665	124,24	15	8
MANOMETRE	0563	16,78	16	8
TETE TULIPE FORMAT	2092	218,70	77	2
FILTRE CASSE VIDE	4466	142,67	60	42
VANNE	3259	111,34	24	4
	3177	582,70	6	25
JOINT OR	4223	78,19	52	8
CAPTEUR INDUCTIF	3269	52,28	37	3
VENTOUSE JUPE	3136	10,92	21	102
FILTRE CHARBON	1296	165,40	48	51
TIGE D'ORIENTEUR	2594	163,85	51	27
CELLULE REFLEX	3461	152,00	17	14
TUYAU ALIKLER	0649	34,54	20	44
PISTOLET DE LAVAGE	0008	226,19	57	8
JEU DE CHIFFRES	2968	39,00	20	25
JOINT PISTON	3129	80,15	42	30
5 JOINTS FKM	4313	170,00	55	41
VENTOUSE 1 SOUFFLET	3440	12,51	18	11
PORTE DOUILLE	2755	16,95	51	29
JOINT	4635	4,73	79	43
HUILE REDUCTEUR	4651	24,41	47	35
VENTOUSE 2 SOUFFLETS	3442	13,28	3	9
JOINTS OR	4484	3,20	30	22
JOINT VANNE	0560	41,78	22	60
VENTOUSE	4742	5,66	6	55
VENTOUSE	3061	14,00	32	30
SILENCIEUX	2162	5,45	4	16
VENTOUSE	4781	12,60	44	40
RELAIS	2629	80,80	30	14
LAME SUPERIEURE	3176	1007,86	6	23
DISQUE SILICONE	3280	1,12	14	181
RONDELLE BELLEVILLE	2391	0,31	10	73
JOINT CLAMP	0664	1,37	7	96
VENTOUSE ARTE0812	4771	12,60	3	101
JOINT SMS CARRE EPDM	0136	0,95	3	172
JOINT DE PISTON	2764	56,50	82	41
CIRCLIPS	4886	0,11	5	20
JOINT TORIQUE	2327	6,53	30	20

ACCOUPLEMENT	1647	2,18	4	20
POCHE FILTRANTE	1235	4,16	31	17
KIT DU CLAPET	5008	329,60	84	15
JOINT CLAMP DN51 EPDM	0940	1,34	7	19
KIT DE MEMBRANES	5007	116,25	30	14
TETE D'IMPRESSIO	3501	643,00	8	22
JOINT CLAMP	3933	12,90	64	9
PIECE CLAMP	3939	124,60	10	1
RESSORT RETENTION	4056	338,98	1	7
MANCHON	0841	1,06	3	13
REDUCTEUR	2956	357,50	45	16
LAME COUPELAIZE	4389	3,73	10	11
GARNITURE	4457	631,00	24	5
CONNECTEU	0636	14,20	2	3
JOINT	1748	11,00	20	1
KIT JOINTS	0305	48,80	8	6

2.4 *Rating of Criticality Calculation Parameters for Spare Parts:*

Risk ratings are coefficients assigned to each spare part, allowing us to calculate the criticality of each item. Each rating corresponds to one of the criteria mentioned above.

Table 2. Consumption Rating

Consumption	Level
1≤ C ≤11	1
11<C<25	5
25 ≤C <50	7
50≤C ≤181	9

Table 3. Delivery Time rating

D.A	Level
1≤ D. A≤ 20	1
20<D.A≤45	5
45<D.A<80	7
80≤D.A≤195	9

Table 4. Unit Price Rating

P.U	Level
P.U <10	1
10<P.U <50	5
50 <P.U <110	7
110 <P.U≤643	9

3. RESULTS AND DUSCUSSION

3.1 Calculating the Criticality (Cr) of Spare Parts:

We evaluated the criticality (Cr) of spare parts (PDR) using three essential parameters: unit price (P.U), delivery time (D.A), and consumption (C). Criticality represents a measure of the strategic importance of each spare part, considering the potential impact of a failure on operations. This approach allows us to prioritize spare parts based on their contribution to risk management and operational continuity, which is crucial in the dynamic context of inventory management for a cosmetics company. The equation used to calculate criticality is as follows: $Cr=P.U\times D.A\times C$

Table .5 shows the results of the criticality calculation for the spare parts stored in the warehouse:

By using this method, we were able to evaluate and classify spare parts based on their respective criticality, facilitating the prioritization of inventory management actions to optimize availability and reduce operational risks.

Table 5. Calculation of Spare Parts Criticality

References	P. U Rating	D.A Rating	C Rating	Cr
4985	7	3	1	21
2944	7	7	1	49
2665	7	1	1	7
0563	3	1	1	3
2092	7	5	1	35
4466	7	5	7	245
3259	7	3	1	21

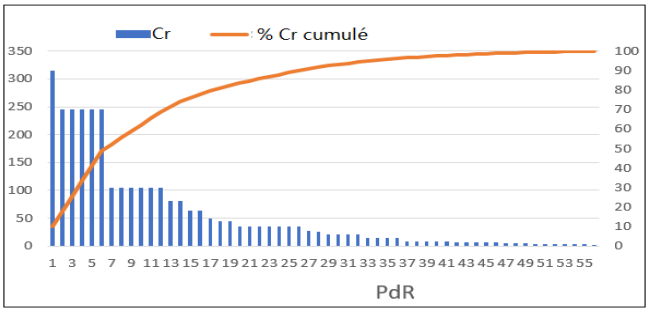
3.2 Pareto Analysis of Critical Spare Parts:

To identify and prioritize the most critical spare parts (PDR), we conducted a Pareto analysis, an effective method for focusing efforts on the most impactful elements. In this analysis, we used the criticality (Cr) of each PDR.

We created a summary Fig 1 that includes each PDR's reference number, individual criticality, cumulative criticality

(progressive sum of criticalities ranked in descending order), and cumulative criticality as a percentage. This Fig 1 allowed us to clearly identify the PDRs that contribute most significantly to the total stock criticality, providing a solid basis for management and optimization decisions.

Fig 1: Pareto Diagram



After conducting an in-depth analysis using the ABC classification method, we identified 17 Class A items, which account for 79.53% of the total value of spare parts (PDR) with high criticality. These strategically crucial items represent only 30% of the total number of PDRs, yet they require special attention to prevent any critical stockouts.

Additionally, we identified 16 Class B items, which collectively make up 94.95% of the total value of PDRs, with criticality levels ranging between 15 and 49. Although these items constitute 58.9% of the total number of PDRs, they still demand careful management to minimize potential operational risks. The remaining 23 items were classified as Class C, representing the spare parts with the lowest criticality in our analysis. The three criticality classes are summarized in Table 6.

Table 6. Prioritization of Spare Parts Based on Criticality Level

Criticality Range |	Status	Class	Comments
49 ≤Cr ≤315	High	A	Requires appropriate measures to prevent stockouts.
15 < Cr < 49	Moderate	B	Needs to be addressed to avoid potential issues.
Cr ≤15	Low	C	Meeting supply objectives has no significant consequences.

4. CONCLUSIONS

Our primary contribution is a thorough analysis of spare parts data from a cosmetics manufacturing company, aimed at exploring an improved stock management approach. We classified the parts according to their criticality, dividing them into three categories: A, B, and C. This approach has successfully reduced both ordering and holding costs while ensuring adequate availability of critical parts.

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