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Analysis and improvement proposal for the supply and storage process in Tier 1

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Abstract

In the present work, the supply and storage management analysis for a supplier company in the automotive sector is carried out. The main objective is to identify possible proposals for improvement in the supply chain by enhancing processes and decision-making in internal logistics processes. The proposed automated analysis is based on consolidating the requirements through an inventory policy with safety stock, a fixed review period, and the development and application of models implemented in a dynamic template in MS Excel to support operational decision-making. This tool will automatically allow the vehicle selection depending on the supply week and according to the actual operating restrictions of weight and volume. Also, it will automatically generate the number of standard packages to be filled and the maximum amount needed in the safety stock. Another relevant point discussed within the evaluation of the procurement policy is the suitability of the standard packages for procurement from demand, which can be considered a critical point in the negotiation process with the client.

Keywords: Operations Management, Internal Logistics, Supply and Storage Management, Inventory Policy and Standard Package, Consolidated Cargo Transport

1. Introduction

Supply and storage management both play an important role in supply chains and business logistics in general since, if developed efficiently, it increases and improves productivity, profitability, and company management, as well as the quality level of the services and/or products offered for the market (Feijoo et al. 2020).

Within the industrial sector, there is a need to be more competitive and efficient in their processes, so companies are forced to analyze and evaluate their operations to meet the client's expectations and level of service (Sánchez et al., 2020).

The company object of this study belongs to the industrial sector and performs activities related to full-service concepts for fastening technologies. A full-service provider supplies complete coverage of products and services in a particular domain, consolidated through a single point of contact. A full-service provider company can avoid loss of income by extending its service and adding it to the product. In this case, it covers all the products required by the client company for fastening and fixing parts. With this idea, the company is responsible for providing complete fastening technology for various products each year by minimizing complexity and costs throughout the value chain.

Currently, the company under study is negotiating to incorporate a new client to perform its functions of

supplying materials for fastening and fixing to a Tier level 1. Therefore, it is required to analyze the client's work scheme and identify critical points and value proposals that would be important to consider when conducting the negotiation and operational implementation of the logistics processes.

The supply and storage process under which it is currently operated in the Tier corresponds to a work scheme, where a series of activities are carried out that involve daily shipments of the requirements to an on-site warehouse called a supermarket. The collaborator manages shipments in the internal warehouse (supplier company's employee), who requests the requirements through the review of the forecasts report and according to the current stock. The supermarket's delivery to the production area is done manually by delivering daily tickets according to the number of materials needed. Then, the supplier in the internal warehouse proceeds to weight, label, and pack the material in the facilities for dispatch. Subsequently, a daily closure is made with the number of materials delivered to the client and then sent to the finance team for validation and scheduling for billing and payment.

As part of the Tier provisioning and storage process analysis, the following situations are detected. The input supply management is carried out through daily shipments of the requirements to the supermarket. The requirements are supplied in bulk, and no standard package is considered, and within the storage area, there is no defined and standardized control method or system to prevent daily supplies from being made, which directly influences transportation costs.

The situations above described imply a high consumption of resources to the supplier company, which is why arises a need to analyze and propose significant improvements to the supply and storage process of the Tier since, within the supplier company, there is no history of operations similar to the supply and storage scheme proposed by the client. However, it seeks to meet customer expectations and establish a good business relationship.

This paper is organized as follows. In section 2, the state-of-the-art is presented. Section 3 describes the methodology followed by the authors in this project. Also, this section presents the study case. Then, in section 4, the results of the experimentation are discussed. Finally, in section 5, there are listed the main conclusions reached derived from this work.

2. State of the art

Inventory management is one of the areas of logistics of a major study in operations management since its high impact on evaluating supply chains' effectiveness (Arango-Serna, et al. 2013).

It is essential to identify elements that intervene directly or indirectly in a model selection process to implement an inventory control system (Castro, 2003).

There is a wide range of approaches and methods for the implementation of inventory control systems, including the described ones in the next paragraphs.

In Castro (2003), the authors provide the structure for determining the inventory management model that best suits the nature of demand and other factors. In Cepeda & Jiménez (2016), they use a dynamic inventory model that incorporates various economic variables such as production, market demand, and the influence of inventories on price variation and deterioration. In Feijoo et al. (2020), the optimization of joint supplier-buyer inventories is studied, comparing them with traditional non-collaborative policies and analyzing the advantages of the focus on the total inventory costs of the chain.

2.1. Replenishment policies

Replenishment policies are business strategies designed to efficiently manage the flow of material resources. These strategies involve decisions related to the moment, the order amount, and other variables such as safety stock and the cycle level of service.

Replenishment policies can vary depending on the organization's internal requirements and guidelines, restricting them to two types (Chopra & Meindl, 2019): continuous review and periodic review. The first consists of performing the inspection of the inventory continuously and placing a size order (Q) when the stock decreases to the level established to place an order (ROP, reorder point); the second review consists of performing the inspection of the stock in fixed time intervals, and the order size may vary according to fluctuations in the items demand.

2.2. Load consolidation

Within logistics services, cargo consolidation and deconsolidation strategies respond to the efficiency needs of supply chains and seek as a primary objective the reduction of the total transportation cost from an origin to a destination.

Cargo consolidation is defined as grouping smaller shipments into larger loads, resulting in a reduction in the total cost of moving the cargo. The vehicles and personnel are programmed with an optimal design of the cargo dispatch to achieve cost reduction (Castrellón -Torres et al., 2015).

Hall (1987) highlights three types of consolidation: the consolidation of inventories refers to items stored, produced, and used at different times but transported simultaneously; the consolidation at vehicles refers to the space consolidation of the collection of articles from several suppliers delivered to a set of customers; finally, the consolidation at terminals consists of bringing several items from different destinations to a central node to be later dispatched.

3. Methodology

The objective of the proposed models is to automate the analysis to determine the number of the standard packages to be supplied for each article on a weekly basis, considering the client's requirements, and in turn, select the type of transport to use considering the weight and volume restrictions.

The results obtained constitute a tool for decision-making for the supplier company. The tool was developed considering the supplier's company's most relevant metrics and service level. Suitable for operational and financial outcomes, given the sector where the customer operates and the items' individual costs, the economic penalties of shortages surpass the cost of holding inventory and those attainable to transportation. However, this work defined the goal of fulfilling the required service level and the best use of the transportation available assets (i.e., consolidation) and avoidance of express or last-minute deliveries.

3.1. Information collection and classification of articles

The available information about the customer's supply and storage process is collected in this stage. This includes the demanded items list, the standard presentation of each article (units per box), the number of boxes per pallet, packaging measures and capacity, the weight unit and weight per box, and the forecasts report that the client sends weekly to the supplier to provide the visualization and update of the forecasted demand for each item.

For the analysis of the articles that make up the demand forecast report, the traditional ABC classification approach is used, consisting of ordering the items descending according to the criterion of the volume of demand.

The Pareto principle or ABC analysis is used in various managerial areas, particularly concerning the management inventory area, where it mentions that not all items should be controlled in the same way. The most critical articles (Zone A) should be handled and monitored with greater attention and with more sophisticated inventory control systems than those used for articles from zone B and C (Castro Zuluaga et al., 2011).

3.2. Database

The information obtained forms the database of the variables of interest in the process, as shown in Figure 1. The dynamic MS Excel template will search for the relevant process information for packaging allocation, weight and volume, standard packages, and item description in the database.

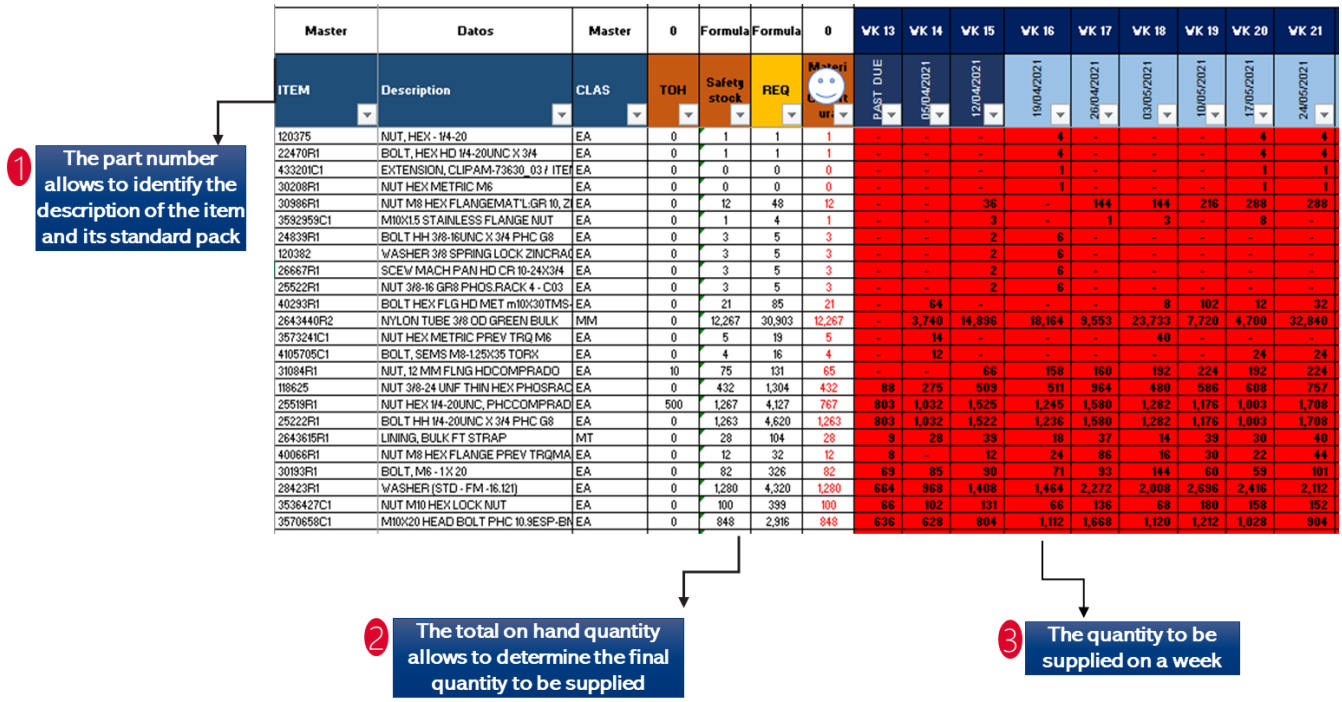
3.3. Input variables

Every week the supplier company receives updates of the client's forecast report according to the schedule coming from the master plan.

Within this report, the client provides the demand requirements visualization. Also, it shares information with the supplier about the available quantity, the safety stock, and the demand.

Standar pack	Type	Description	Box measure	Length	Width	Height	UoM VOLUME (M3)	Unit weight (g)	Weight * Standar (kg)
500	12	CAP, DUST	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	11	5.5
530	20	HEAVY HEX FLENGE HEAD BOLTCOMPRADO A ANIXTER	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	9	4.77
700	1	SCREW CAP HEX SOCKETM10 -1.5X25MM ZND	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	14	9.8
900	48	BOLT M8X1.25-35MM HEX W/THRD C	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	2	1.8
1600	10	BOLT M6 X 30 MM	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	4	6.4
500	1	BUTTON, FASTENER CABLE LOCKHELLERMAN TYTON	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	15	7.5
350	6	BOLT,HEX FLG HD METRIC M10 X|	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	11	3.85
360	10	BOLT M10 X 50 mm	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	17	6.12
300	36	HEAVY HEX FLANGE HEAD BOLTESP-BM-3.221-NPP	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	13	3.9
3000	2	BOLT, M6 - 1 X 20	40.6x40.6x40.6	0.406	0.406	0.406	0.06692	15	45
2334	1	SCREW M6 X 20 PAN HD ZINCRACK 2 - A04	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	3	7.002
1425	36	NUT M10 HEX FLANGE PREV TRQMAT'L:GR 10, PHOSPHATE COATING	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	9	12.825
1100	46	NUT SPEED M8X1.25 U NUTWITH 27.5 TO 28.5MM THROAT	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	16	17.6
2100	30	NUT, U SPECIAL M6C1P12843W	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	2	4.2
1500	26	NUT M8 SPECIAL U-NUT ZINCRACK 1 - A02	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	16	24
2200	20	NUT M8 HEX FLANGE PREV TRQMAT'L:GR 10, PHOSPHATE COATING	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	12	26.4
3000	3	COTTER PIN 3/16 X 1.0STD J 1.222	40.6x30.48x20.32	0.406	0.482	0.2032	0.03976	12	36
750	4	NUT 1/2-13 UNC HEX LOCKNON METALLIC INSERT	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	9	6.75
83	1	HEADED PINSSDT J-77.123	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	14	1.162
500	5	BRACKET, STEP MTG, DUAL	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	17	8.5
200	2	BOLT M8 X 25 SEMS TYPE-F ZINCRACK 4 - E02	25.4x20.32x15.24	0.254	0.2032	0.1524	0.00787	13	2.6
5000	2	CONDUIT,CABLE ELECTRICALTUBE 3/8 ID X .503 OD	40.6x40.6x40.6	0.406	0.406	0.406	0.06692	9	45
7500	3	NUT, HEX M6-ZND	40.6x40.6x40.6	0.406	0.406	0.406	0.06692	6	45

Figure 1. Extract of the items database supplied to the customer: presentation, description, volume, unit weight and standard weight.



Master	Datos	Master	0	Formula	Formula	0	WK 13	WK 14	WK 15	WK 16	WK 17	WK 18	WK 19	WK 20	WK 21
ITEM	Description	CLAS	TOH	Safety stock	REQ	Materi ur	PAST DUE	05/04/2021	12/04/2021	19/04/2021	26/04/2021	03/05/2021	10/05/2021	17/05/2021	24/05/2021
120375	NUT, HEX - 1/4-20	EA	0	1	1	1	-	-	-	4	-	-	-	4	4
22470R1	BOLT, HEX HD 1/4-20UNC X 3/4	EA	0	1	1	1	-	-	-	4	-	-	-	4	4
433201C1	EXTENSION, CLIP AM-73630_03 / ITE	EA	0	0	0	0	-	-	-	1	-	-	-	1	1
30208R1	NUT HEX METRIC M6	EA	0	0	0	0	-	-	-	1	-	-	-	1	1
30986R1	NUT M8 HEX FLANGE MAT'L:GR 10, Z	EA	0	12	48	12	-	-	36	-	144	144	216	288	288
3592959C1	M10X1.5 STAINLESS FLANGE NUT	EA	0	1	4	1	-	-	3	-	1	3	-	8	-
24839R1	BOLT HH 3/8-16UNC X 3/4 PHC G8	EA	0	3	5	3	-	-	2	6	-	-	-	-	-
120382	WASHER 3/8 SPRING LOCK ZINCRA	EA	0	3	5	3	-	-	2	6	-	-	-	-	-
26667R1	SCEW MACH PAN HD CR 10-24X3/4	EA	0	3	5	3	-	-	2	6	-	-	-	-	-
25522R1	NUT 3/8-16 GR8 PHOS.RACK 4 - C03	EA	0	3	5	3	-	-	2	6	-	-	-	-	-
40293R1	BOLT HEX FLG HD MET m10X30TMS-	EA	0	21	85	21	-	64	-	-	-	8	102	12	32
2643440R2	NYLON TUBE 3/8 OD GREEN BULK	MM	0	12,267	30,903	12,267	-	3,740	14,896	18,164	9,553	23,733	7,720	4,700	32,840
3573241C1	NUT HEX METRIC PREV TRQ M6	EA	0	5	19	5	-	14	-	-	-	40	-	-	-
4105705C1	BOLT, SEMS M8-1.25X35 TORX	EA	0	4	16	4	-	12	-	-	-	-	-	24	24
31084R1	NUT, 12 MM FLNG HDCOMPRADO	EA	10	75	131	65	-	-	66	158	160	192	224	192	224
118625	NUT 3/8-24 UNF THIN HEX PHOSRAC	EA	0	432	1,304	432	88	275	509	511	964	480	586	608	757
25519R1	NUT HEX 1/4-20UNC, PHCCOMPRAD	EA	500	1,267	4,127	767	803	1,032	1,525	1,245	1,580	1,282	1,176	1,003	1,708
25222R1	BOLT HH 1/4-20UNC X 3/4 PHC G8	EA	0	1,263	4,620	1,263	803	1,032	1,522	1,236	1,580	1,282	1,176	1,003	1,708
2643615R1	LINING, BULK FT STRAP	MT	0	28	104	28	9	28	39	18	37	14	39	30	40
40068R1	NUT M8 HEX FLANGE PREV TRQMA	EA	0	12	32	12	8	-	12	24	86	16	30	22	44
30193R1	BOLT, M6 - 1 X 20	EA	0	82	326	82	69	85	90	71	93	144	60	59	101
28423R1	WASHER (STD - FM -16.121)	EA	0	1,280	4,320	1,280	664	968	1,408	1,464	2,272	2,008	2,696	2,416	2,112
3536427C1	NUT M10 HEX LOCK NUT	EA	0	100	399	100	66	102	131	66	136	68	180	158	152
3570658C1	M10X20 HEAD BOLT PHC 10.9ESP-BN	EA	0	848	2,916	848	636	628	804	1,112	1,668	1,120	1,212	1,028	904

Figure 2. Report of the programmed requirements (demand).

Figure 2 shows the report of the programmed demand requirements, that is, the information for the MS Excel template. It is necessary to extract the Item column that denotes the part number or item required from the report. The TOH (Total on hand) column describes the quantity available in each item's inventory, and finally, the weekly demand to supply must be obtained, e.g., column 11 WK 16 (04/19/21).

3.4. MS Excel Template Structure

Figure 3 shows the structure of the MS Excel template in which the input variables described in the previous section are entered.

The template is organized as follows: in the *Item* column, the part numbers extracted from the report are recorded. In the *Description* column, the template looks for the description of the part number presented in the database. The forecast report information is given in the *TOH (total on hand)* column. In the *Requirement* column, it is provided the weekly demand to be supplied. In the *Standard package* column, the template looks for the standard of each part number in the database. The *Safety stock* column determines the amount of safety inventory that must be maintained according to the company's policy (10% of the weekly demand).

Later, in the *Quantity demanded* column, the number of parts to be supplied is obtained, considering: demand + safety stock – total available. In the *Standard package to be supplied*, the number of standard packages is determined by considering the quantity demanded between the units per standard package. In *Standard weight* demand* column, the weight of the standard package is quantified by the number of standard packages to be supplied. In the *Total weight* column, the total weight of the demand is shown. Finally, the *M3*Box* column quantifies the volume of the boxes to supply.

Once the input variables have been incorporated in the template (item, total on hand, and requirement), the other columns will be completed automatically through the referenced formulas, as well as a summary table (see table 1), in which the number of standard packages to be supplied (number of boxes). It is indicated the number of parts in the safety inventory, the total weight, the volume of the requirement, and the most appropriate transportation mode considering the restrictions.

Table 1. MS Excel summary template table.

Standard pack to be supplied	Parts in safety stock	Quantity demanded	Total weight of the require-ment (kg)	Total m^3	Transpor-tation mode
0	0	0	0	0	Citystar 5

As a part of the study of the replenishment and storage process of the Tier, the analysis of the supplier's standard packages suitability versus the client's demand is carried out since, previously, the client received the requirements supplies through daily shipments in bulk (without standard packages).

Figure 3. MS Excel database template.

Currently, what is sought within the objectives pursued in this analysis and at the supplier company's request, is the shipments consolidation of the weekly requirements by applying the standard package of the supplier to make the process more efficient.

4. Results discussion

Following the steps of the proposed methodology and as a result of the dynamic MS Excel template, it is obtained a tool to quantify the number of boxes (standard packages) that must fill each week, the amount that must keep in the safety stock, and the most appropriate transportation mode for the weight and volume of the weekly consolidated load.

Also, the ABC classification is carried out to determine the articles that represent the most significant demand volume. Table 2 shows the classification for 216 items registered in the report with the demand requirements.

Table 2 also indicates that within category A, 45 articles comprise 20.8% of the total and represent 79.99% of the volume demand. Within category B, 39 articles add 38.9% of the total, constituting 14.90% of the volume demand. Finally, 132 items are identified in category C, representing 61.1% of the total and representing 5.11% of the volume demand. The above data is represented in figure 4.

After classifying the items and analyzing the requirements report including the visualization of the demand forecasts, the following variations were observed between the supplier's standard packages and the customer's demand.

Table 2. Summary table of the ABC classification.

Cat	Items	%	% Acum	% of demand	% Acum demand
A	45	20.8%	20.8%	79.99%	79.99
B	39	18.1%	38.9%	14.90	94.89
C	132	61.1%	100.0%	5.11	100.00
	216	100%		100%	

Within the classification of the articles corresponding to category A (the articles with the highest volume demand), there are three-part numbers (items) with a magnitude of the variation between the standard packages higher than the behavior of the forecasted demand. That is, to supply the standard packages of the part number 120380 corresponding to a box with 15,000 units and considering its forecasted demand. From May 31 to July 26, 2021, the item would remain in inventory for around 6 to 8 weeks to be consumed. Also, in category B, eleven items are registered with considerable variations between the standard packages and the weekly demand. The above numbers are represented in

table 3.

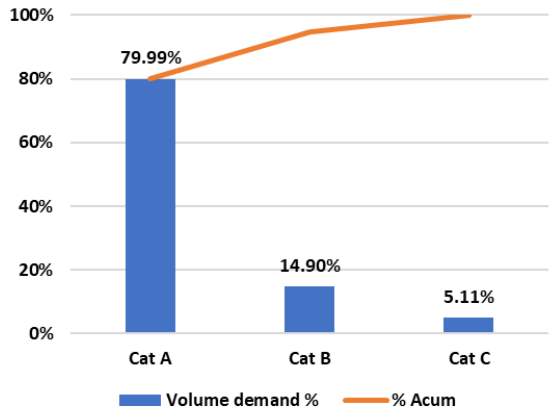


Figure 4. Pareto chart for the demand volume of each ABC category.

Table 3. Variation of the standard package versus the forecast demand for the items corresponding to category A and B.

Cat	Items	Standard package	Variation of the package/ demand standard
A	103375	13500	(3-5)
A	120380	15000	(6-8)
A	120361	15000	(4-8)
B	25519R1	6000	(3-5)
B	120217	17600	(8-14)
B	2643544R1	4578	(3-5)
B	3534518C1	4000	(3-6)
B	3544378C1	3500	(3-6)
B	40081R1	4000	(4-6)
B	3544376C1	4000	(4-6)
B	18481R1	3000	(3-4)
B	180020	2700	(3-5)
B	25402R1	6000	(7-10)
B	40233R1	5000	(3-31)

In category C (articles representing 5.11% of the volume of demand), the most critical variations between the standard package versus the forecasted demand are presented. In this category, there are 78 part numbers with variations ranging from 3 to 6600.

The factors observed in the articles of category C that propitiate these variations are the following: the demand is mainly minimal compared to the standard package. Another detected factor is that articles are not regularly demanded; that is, they are demanded only for 1 or 2 weeks in the analyzed period, and the amount required is minimal. These variations are presented in table 4.

From the preliminary analysis, it is observed that incorporating the standard component package to the requirements demand facilitates the processes of provisioning and storage to the supplier company. It also simplifies the processes of verification of material delivery. However, when performing the analysis concerning the inventory generated by the standard package, considerable variations are observed between the customer forecasted demand and the supplier's standard package. This situation could represent a critical point in the negotiation process with the new client and would impact the cash flow for the invoicing of the parts delivered and paid for by the client.

Table 4. Example of the variation of the standard package versus the forecast demand of the articles of category C.

Cat	Items	Standard package	Variation of the package/ demand standard
C	30208R1	6600	(3300-6600)
C	30281R1	7500	(22-3750)
C	120375	7000	(1400-1750)
C	3601546C1	14178	(80-1418)
C	3601546C1	14178	(273-709)
C	3548585C1	500	(250-500)
C	30264R1	22950	(190-478)
C	30381R1	10000	(189-400)
C	30281R1	7500	(150-750)
C	934871R1	13000	(100-271)
C	40235R1	2400	(35-600)
C	40280R1	700	(32-350)
C	934871R1	13000	(39-271)
C	30264R1	22950	(68-478)
C	3566930C1	900	(13-120)
C	3588152C1	1000	(12-250)

5. Conclusions

According to the general objective of this work, which consisted of carrying out the analysis of the supply and storage process to identify potential improvements in the process in terms of supply management, it was proposed to consolidate weekly shipments using an inventory policy with safety stock and a weekly fixed review period. Likewise, the load capacity analysis was carried out using a dynamic MS Excel template. In this template, based on the requirements and weekly forecasts of customer demand, as well as the quantity available in the warehouse, the amounts of standard packages to supply provided the following results: the weight and volume per box, the maximum amount needed in the safety stock and the total weight and volume of the consolidated requirement.

Based on the constraints and the requests made by the company under study, the MS Excel spreadsheet selects the most appropriate vehicle within its fleet to supply the consolidated demand. This solution allows a single delivery of supplies per week, avoiding daily ones and reviews of the internal warehouse. Therefore, it significantly reduces the additional resources allocated to the dispatch and the transportation of the orders supplied. In compliance with the specific objectives, the analysis showed critical factors that

might be relevant in the negotiation process of the service proposal.

By integrating the weekly demand and adding the component of the standard package, it was observed that only 16% of the number of parts is superior to the standard packages. It was also detected that, for the other numbers of parts, the magnitude of the variation between the demand and the standard package might represent a problem when negotiating the proposal to integrate it.

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