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Development of the warehouse management system in the tailoring company Cheila C&C

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***ABSTRACT**: In recent years, all organizations that contribute to the national economy through the transformation of raw materials have recognized the need to make efficient use of raw materials management, in addition to paying more attention to the costs derived from inventories, reprocessing and loss of productivity due to lack of communication, poor management of plant design and the internal flow of both material and staff. In the case of Cheila C&C, a company dedicated to provide tailoring services, it is proposed to carry out a warehouse management where through a diagnosis, in which tools such as SWOT, Vester Matrix, process diagrams, among others, will be used; The objective is to determine its current situation, identifying important factors such as weaknesses, strengths, cycle times, movement crossings and many more, then, applying plant and inventory design models, guarantee an efficient internal flow of both raw materials and personnel, also establishing fundamental policies such as reorder points, safety stock, thus improving its inventory management and capacity to respond to demand. Finally, the model is financially validated with a cash flow, to which indicators such as the IRR and NPV are applied, which must yield results greater than 0 to determine if it is viable. The latter obtained a result of $5'069,507. Mixed research is used to make calculations with the data supplied by the entity and others obtained through observation, to arrive at quantifiable results that, by their nature, are verifiable and can be described. In this way, three inventory models are used with respect to the characteristics and needs of the company, to improve the response to the variability of demand, increasing the level of service by up to 95%, modifying the internal flow by applying the SLP method, thus reducing the number of crossings in the operation route, validating the new plant design using a simulation and guaranteeing the viability of the project with indicators such as the ITR, which yields a result of 56%.*

KEY WORDS - *Costs, demand, plant design, inventories, service level.*

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I. INTRODUCTION

According to the Organization for Economic Cooperation and Development (OECD) [1], Colombia is the sixth country with the highest tax rate charged to organizations, which becomes a variable that cannot be controlled, which is why the need for internal management to efficiently control operating and production costs becomes much more noticeable.

In this context, organizations have been relentlessly seeking to reduce their costs through good practices and the implementation of optimal management systems. Inventory models and plant design are key players in this exercise.

"We always have too much of what is not sold or consumed, and too much depleted of what is sold or consumed." Carlos Vidal

The difficulty of not having complete knowledge about the process, not having a clear inventory policy and not measuring the effects of unnecessary displacements, as well as possible delays in the processes, is the daily life in many organizations, for this reason it is the purpose of this research to determine the diagnosis of the company, this will be validated by means of a simulation in Simio software, to provide a clearer vision of the application of the results.

Finally, the elaboration and implementation of this research is important because it contributes to the logistic and productive development of Cheila C&C, makes it possible to apply engineering tools to the manufacturing process and proposes an efficient internal management that reduces the crossovers between processes, It also establishes a safety stock that will be able to reduce the cost of shortages and guarantee a service level above 95%, which is reflected in better process management, increased profitability and cash flow, with an internal rate of return (IRR) of 56% and a net present value (NPV) of $5'069.507.

II. METHODOLOGY

In the study mixed research is carried out since it will combine qualitative and quantitative approaches, this information is necessary for the approach of the inventory management and plant distribution models that when simulated will be the primary base for comparison and verification of the feasibility of the project.

In order to carry out the diagnosis, the first step is the collection of information, the organization provides a history of data that allows analyzing a previous behavior of the demand in terms of finished products and customers, a second part of the information is collected through tools such as the survey, which is a technical instrument that takes the form of a colloquial dialogue [2] and the interview to the project manager, which is used to collect qualitative and/or quantitative information from a statistical population [3]. Its subsequent tabulation is done by means of a SWOT that helps to understand the decision-making process in any environment, as it provides a broad view of the scenario, situation and competitors [4]. The Vester matrix was also applied; this development tool, which is part of the Logical Framework, helps and facilitates the identification of the problems with the greatest impact in the field to be applied [5], and finally, the affinity diagram, which allows an analysis by groups based on methods such as brainstorming [6].

STRATEGIES SO	1. Financially evaluate the purchase of a sewing machine, in case of purchase train workers in its operation [O5, F4] 2. Establish process manuals together with workers based on their activities. [O1, F1] 3. Show physical plant to suppliers and customers, evidencing the processes and work environment, generating confidence in them. [O4, O2, F2] 4. Evaluate the possibility of generating your own brand [O3, F3]
STRATEGIES WO	1. Generate an inventory system to establish the minimum safety stock [O3, D2] 2. Establish maximum process capacities to avoid non-compliance. [O4, D1] 3. Identify the sectors for the utilization of the remnant [O2, D4]
STRATEGIES ST	1. Increase the manufacturing capacity of the production plant, so as not to depend 100% on external entities. [A2, F3] 2. Re-evaluate and control safety stock to avoid process delays due to shortages of raw materials [A1, A4, F5]
STRATEGIES WT	1. Generate an inventory system to establish the minimum safety stock [A1, A4, D2, D5] 2. Establish the location of raw materials, product in process and finished product in order to identify the resources available at the moment. [A4, D3] 3. Implementing satellite compliance policies [A2, D3]

Figure 1. SWOT Matrix Strategies

Source: Autors, 2021.

Fig. 1 shows how the SWOT matrix jointly identifies the perception of Cheila C&C workers, thus achieving an internal and external analysis with precise characteristics such as strengths and opportunities. In the crossing proposed by the matrix, the importance of strategies to mitigate problems such as safety stock and delays in the process is highlighted, one of them is obtained from the crossing between A1, A4 and F5. Another strategy urges to improve inventory management, the location of raw materials, products in process and finished products, which is obtained from the cross between A1, A4 and D2, D5.

On another aspect, focusing on processes and production, a process diagram is constructed, which is a graphic representation of the activities carried out in a company, their order and interrelationships [7]. The route diagram, which complements the information contained in the process diagram, consists of a plan (which may or may not be to scale) of the plant or section where the process under study is carried out [8] and the operations diagram, which is a graphic representation of all the operations and inspections that are part of a process [9].

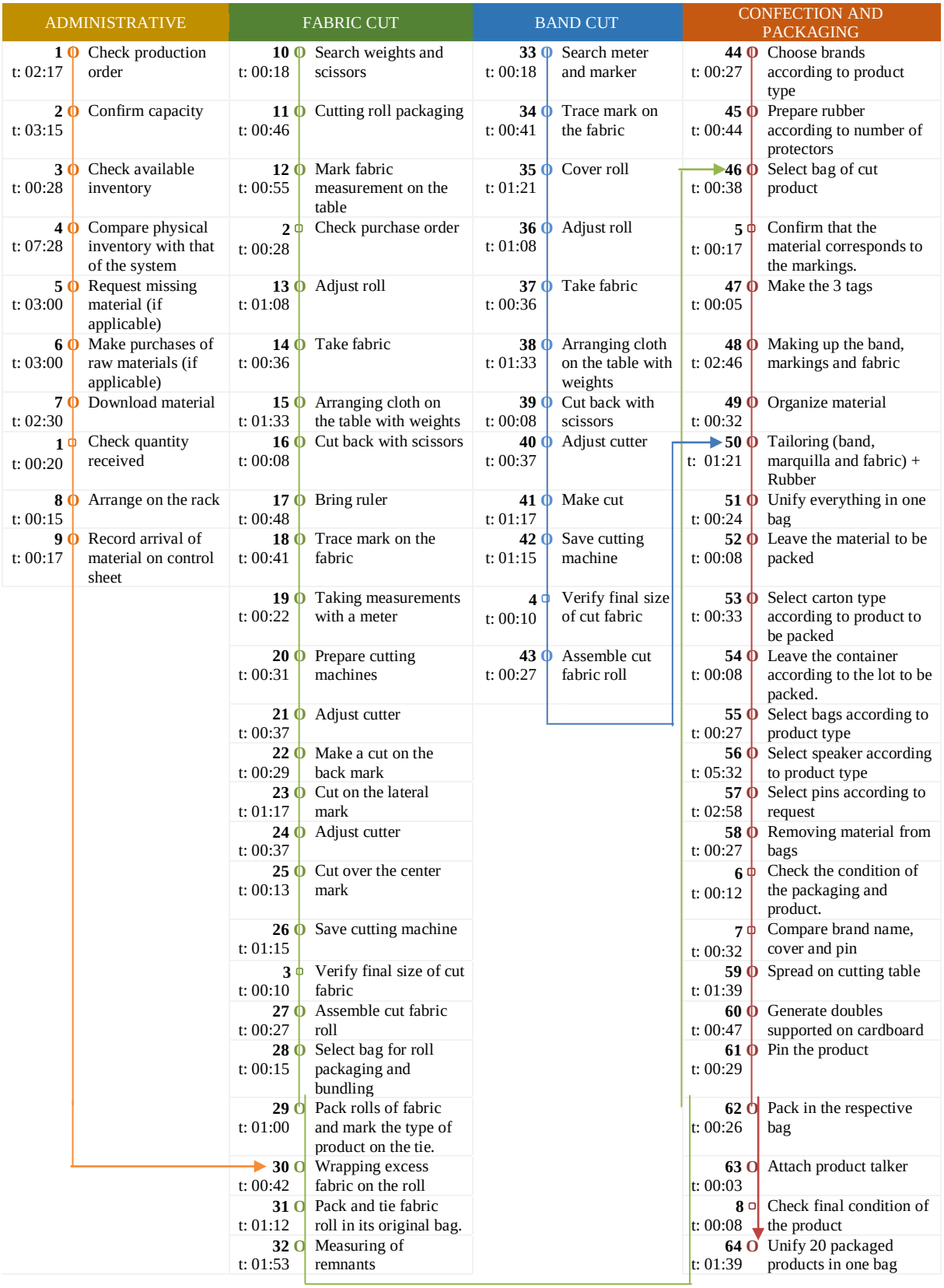

Figure 2. Process diagram

Source: Autors, 2021

Fig. 2 shows a compilation of the operations and inspections carried out during the process and, at the same time, the time spent by each one in their execution. The vertical lines show the continuous activities, and the columns show those that are carried out in parallel, however, it is indicated where they are joined.

Subsequently, the analysis of historical Cheila C&C data is performed to forecast the demand behavior in the next 12 months, which is fundamental to establish the inventory size, as well as to run the models that will be presented later [10] while working on the plant design that will then be validated by means of a simulation.

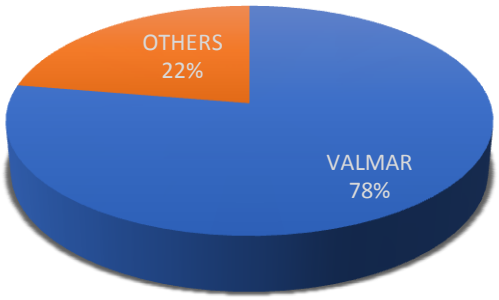

Figure 3. Customer participation
Source: Autors, 2021.

Fig. 3 shows the result of the analysis of the data, which shows that the Valmar customer represents 78% of historical sales, which is why the study considers only the behavior of this customer, understanding that, because it has such a high participation, it represents the fluctuations in the demand of Cheila C&C and therefore, it is sufficient information to make decisions.

When making the forecasts, which are the behaviors expected in the coming months based on historical data [11], it was decided to work with a classification by families in which three of them represent more than 90% of the share of sales, these were:

1. Mattress protectors
2. Pillow protectors
3. Blankets

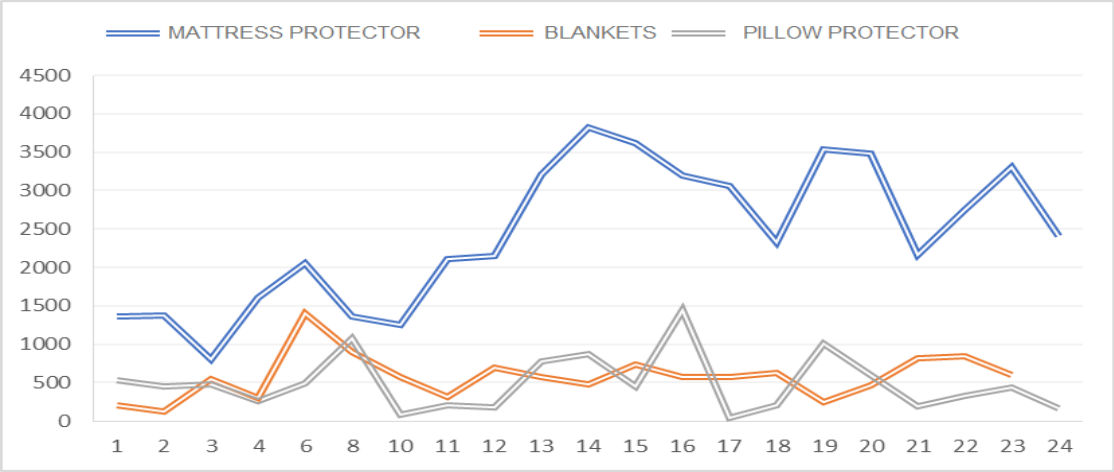

Figure 5. Historical data behavior

Source: Autors, 2021.

Fig. 5 shows the historical demand of each family and, due to its characteristics, a goodness-of-fit test should be performed on each family to determine if, despite the variability of the data, it corresponds to a normal distribution [12].

After corroborating that the data indeed come from a normal distribution, the respective forecasts are made in which the decision criterion for choosing the model is the lowest error.

In the case of mattress protectors, the best fitting model was exponential smoothing, as shown in Table 1.

Table 1. Forecast exponential smoothing of mattress protectors

Mattress protector			α	DMA	y = 720,36ln(x) + 1399,8	
			0,94914944	577,21		
Period	Historical Data	Forecast	A_t	e_t	Fitting curve	Deseasonalization
1	1.258	1.258,00	1.258,00	0,00	1.399,80	0,90
2	2.104	1.258,00	2.060,98	846,00	1.899,12	0,66
3	2.143	2.060,98	2.138,83	82,02	2.191,20	0,94
4	3.204	2.138,83	3.149,84	1.065,17	2.398,43	0,89
5	3.826	3.149,84	3.791,62	676,16	2.559,17	1,23
6	3.614	3.791,62	3.623,03	177,62	2.690,51	1,41
7	3.190	3.623,03	3.212,02	433,03	2.801,56	1,29
8	3.061	3.212,02	3.068,68	151,02	2.897,75	1,11
9	2.320	3.068,68	2.358,07	748,68	2.982,59	1,03
10	3.538	2.358,07	3.478,00	1.179,93	3.058,49	0,77
11	3.478	3.478,00	3.478,00	0,00	3.127,15	1,11
12	2.157	3.478,00	2.224,17	1.321,00	3.189,83	1,09
13	2.746	2.224,17	2.719,46	521,83	3.247,49	0,68
14	3.305	2.719,46	3.275,23	585,54	3.300,87	0,82
15	2.405	3.275,23	2.449,25	870,23	3.350,57	0,98
16		2.449,25	3.052,94			
17		3.052,94	2.279,19			
18		2.279,19	3.274,99			
19		3.274,99	3.139,77			
20		3.139,77	4.378,95			
21		4.378,95	5.063,38			
22		5.063,38	4.689,82			
23		4.689,82	4.055,26			
24		4.055,26	3.795,62			
25		3.795,62	2.866,97			
26		2.866,97	4.167,18			
27		4.167,18	4.114,94			

Source: Autors, 2021.

The behavior of the data can be seen in Fig. 6.

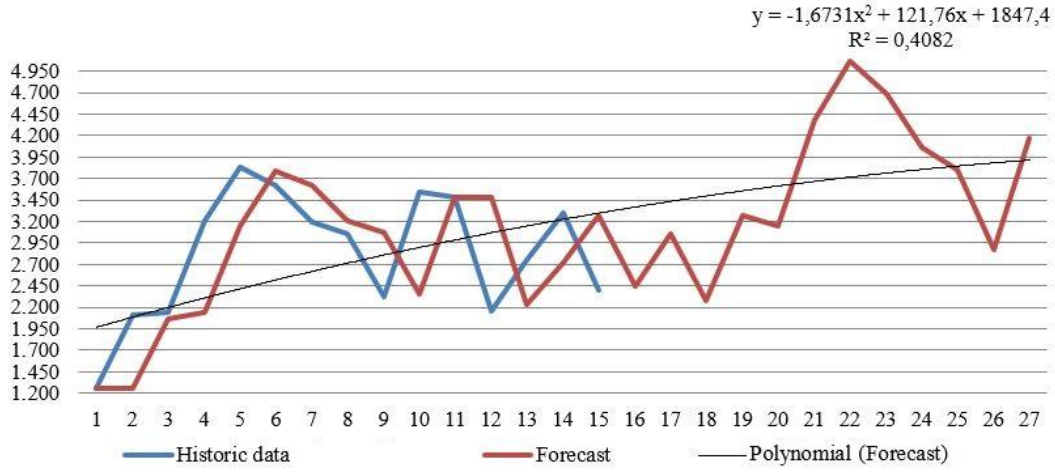

Figure 6. Data behavior
Source: Autors, 2021.

From the equation obtained from the trend line, the forecast for the following 12 months is constructed. This has an average of 2,739 units per month and a deviation of 890 units.

For the case of pillow protectors, the best fitting forecast was Holt's method, the $\alpha = 0.17$ and the $\beta = 0.82$ respond to the values with which the error is lower, this was obtained using Solver, from Excel.

Finally, the forecast that best adjusted to the family of blankets was the exponential smoothing method, as well as the mattress protectors, with $\alpha = 0.25$, which is the value with the lowest error, obtained using Excel Solver.

III. RESULTS

Inventory management has a significant impact on administrative management, as it directly affects the company's financial statements, such as the balance sheet and the profit and loss statement. Likewise, some important efficiency indicators can be significantly affected, such as the ratio of current assets to current liabilities, and the Return on Investment (ROI). [13].

In the case of Cheila, after having the forecasts, the EOQ model with probabilistic demand is developed to calculate the size of the inventory, taking into account the following parameters:

Q = Order size, in units

$$Q = \sqrt{\frac{2AD}{vr}} \quad (1)$$

H = Inventory holding cost, in %

SS = Safety inventory, in units

$$SS = k\hat{\sigma}L \quad (2)$$

v = Unit value, in $/unit

s = Reorder point, in units

$$s = \hat{x}_L + SS \quad (3)$$

C = Cost of ordering

x^L = Expected demand over the replenishment time L, in units

$$\hat{x}_L = dL \quad (4)$$

σ^L = Standard deviation of forecast errors on replenishment time L, in units of time replacement time L, in units

$$\hat{\sigma} = \hat{\sigma}_{1\sqrt{L}} \quad (5)$$

L = Resetting time

k = Safety factor

p = Probability

For the development of the model, it is applied for each family. The first case will be mattress protector, the data used for the calculations can be seen in table 2.

Table 2. Mattress protector data

$\bar{x}$	3.601
σ	890,658431
A	$ 30.000
C	$ 5.400
s	5,0%
L (days)	8
P1	0,95
P2	0,05
k	1,64

Source: Autors, 2021.

P1 corresponds to the level of service to be achieved with the model and is decided by the plant manager, in this case it is determined to be 95%, then P2 = 1- P1 (6) and with this value the normality tables are used to establish the safety factor (k) or in its absence, to Excel using the formula INV.NORM. STANDARD ().

Replacing equations 1, 2, 3, 3, 4 and 5 gives the following results. Refer to table 3.

Table 3. Mattress protector results

EOQ =	3.099	
σL =	460	
xL =	840	Units
SS =	757	Units
Reorder	1.597	Units

Source: Autors, 2021.

Establishing the inventory policy: Q = 3,099 units of mattress protectors should be ordered each time the inventory reaches a level of 1,597. The safety stock should be equal to 757 units, which will allow 95% of customer orders to be satisfied.

In the same way the exercise is done for each family, in the case of pillow protectors it is obtained that the inventory policy is established as follows: Q = 1,525 units of pillow protectors should be ordered each time the inventory reaches a level of 325 stock. The safety stock should be equal to 188 units, which will allow 95% of customer orders to be satisfied.

And for blankets: Q = 1,223 blanket units should be ordered each time the inventory reaches a level of 207 stock. The safety stock should be equal to 74 units, which will allow 95% of customer orders to be satisfied.

The second model applied is a stochastic model with space constraint, which determines the optimal number of units to order in order to maximize the space used in inventory and to efficiently manage inventory costs. This model adds the following parameters:

Q = Order size, in units

$Q = \sqrt{\frac{2Dv}{r - 2\lambda * \text{Ai}}}$ (7)

λ = Lagrange multiplier

A= Area or volume

Ai = Area or volume occupied by an item i

This model, unlike the EOQ, is executed for the three products simultaneously, because the result is expected to be an optimal quantity to order of each product in such a way as to maximize the use of the finished product space and, incidentally, to homogeneously respond to Cheila's inventory needs, i.e., that all references are in stock. The data to be used for this model can be seen in table 4.

Table 4. Data for all products

			Mattress	Blanket	Pillow
	Average demand		840	133	138
	Sales price		$ 5.400	$ 5.500	$ 3.200
5,0%	Cost to maintain		$ 270	$ 275	$ 160
Space	Ai	m^3	0,006	0,0096	0,001288
	A	4,57 m^3			

Source: Autors, 2021.

In this case, the Lagrange multiplier allows creating a restriction in the model so that the volume or total area of the references is not greater than the total space available to store finished products. For this reason and in order not to perform a trial-and-error test, Excel was used to determine the value of λ, from the hypothesis tests, establishing that the space required, that is, the additional space needed, is equal to 0 and that this result is obtained by changing values of λ, in other words, to find the optimal value.

Excel determined that the optimal value of λ = 13,806.2623, and with this parameter, now we proceed to replace equation 7. The result can be seen in table 5.

Table 5. Space constrained model results

	Mattress	Blanket	Pillow	Total
Q	211	337	60	607
Σ Ai	1,264	3,2360	0,0768	4,58 m^3

Source: Autors, 2021.

Establishing the inventory policy: Order 211 units of mattress protectors, 60 units of pillows and 337 units of blankets for a total available space of 4.57m^3.

Note that the optimal order quantity for each product is less than the average monthly quantity of demand, which indicates that there is insufficient space to meet the demand without exceeding the capacity of the finished goods area. This also means that products must be temporarily stored in other areas, and as an improvement action, a larger space should be allocated for finished products.

The third and last probabilistic or stochastic model is with missing parts, which adds the following parameter:

B1: Costs of shortages

B1 = $30.000 corresponds to the value incurred by the company if there are shortages in the process. In Cheila's case, when an order is not fulfilled, it is not lost, but rescheduled as a pending order and delivered in the next order.

For mattress protector:

Replacing the equations 1, 4, and 5 it is obtained that Q = 3099, x^L = 460 and σ^L = 840.
Subsequently in this model, the safety factor must be calculated and given the behavior of the shortages, in which a production order is not lost if it is not delivered in full, the following equation is used $\frac{DB_1}{\sqrt{2\pi}Qv\sigma_L r} < 1$ (8)

The result obtained was: 1,7920 < 1

When applying equation 8, if the result is less than 1, it will correspond to the value of k, otherwise, as it happened, equation 9 will have to be used.

$$k = \sqrt{2\,ln\left(\frac{DB_1}{\sqrt{2\pi}Qv\sigma_L r}\right)} \text{ (9)}$$

The result was: 1,0801.

By obtaining the value of k, the reorder point can be calculated with equation 3, in addition to the safety stock with equation 2.

Finally, in this model, the level of service that will be available under these conditions can be calculated with equation 10.

$$P_2 = 1 - \frac{\hat{\sigma} G_U(k)}{Q} \text{ (10)}$$

With the value of k, you can the of the function $G_u(k)$ in the normality tables.

The result for this case was: 0.9965

The policy for this product according to the shortage model is: Q = 3,099 units of mattress protectors should be ordered each time the inventory reaches a level of 1,337. The safety *stock* should be equal to 497 units, which will allow 99.65% of customer orders to be satisfied.

In the same way the exercise is replicated for each family, in the case of pillow protectors it is obtained that the inventory policy is established as follows: Q = 1,525 units of pillow protectors should be ordered each time the inventory reaches a level of 302 stock. The safety stock should be equal to 182 units, which will allow 99.76% of customer orders to be satisfied.

And for blankets, the policy with the shortage model is: Q = 1,251 blanket units should be ordered every time the inventory reaches a level of 230 stock. The safety *stock* should be equal to 91 units, which will allow 99.76% of customer orders to be satisfied.

Considering that, when carrying out the entire inventory system, a safety stock and a need for space are required, it is necessary to rethink the current design of the production plant. According to the characteristics of the overall process of Cheila C&C, it was decided to use the SLP methodology. [14].

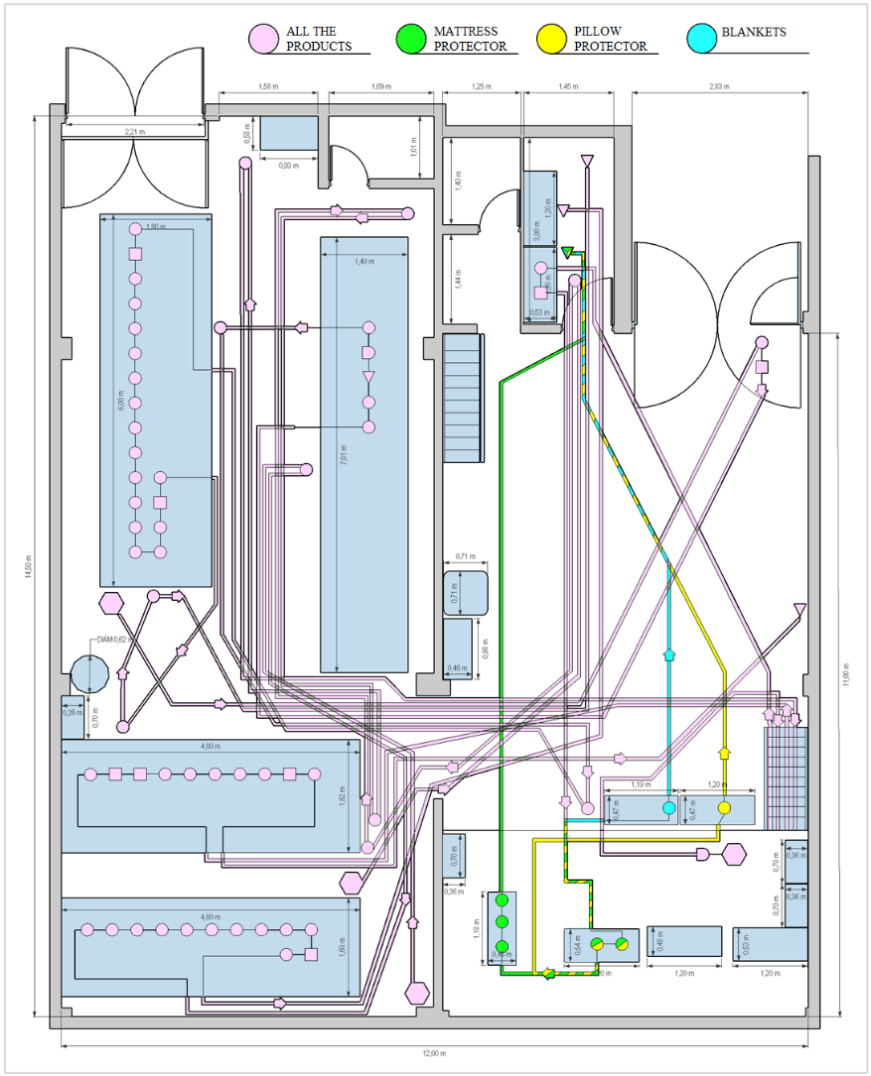

Figure 7. Compilation of route diagrams
Source: Autors, 2021.

Figure 7 shows more clearly the difference between the processes depending on the previously selected families, where the dark areas represent the crossings during the process, which are responsible for increasing production times, productivity and even cost overruns, which is why the plant layout seeks to minimize these crossings. The purple color shows the path shared by the three products, the green color represents the mattress protector, the yellow color represents the pillow protector, and the blue color represents the blanket.

IV. SIMULATION

To validate the entire study, it was decided to carry out a simulation that shows the system capacity, flow and possible improvement in case of applying the proposed changes. For this work, Simio modeling software was used, which allows 2D and 3D schemes, providing sufficient tools to develop the proposal. [15].

First, a scheme was drawn up to summarize the unification of processes in the same area, as shown in figure 8.

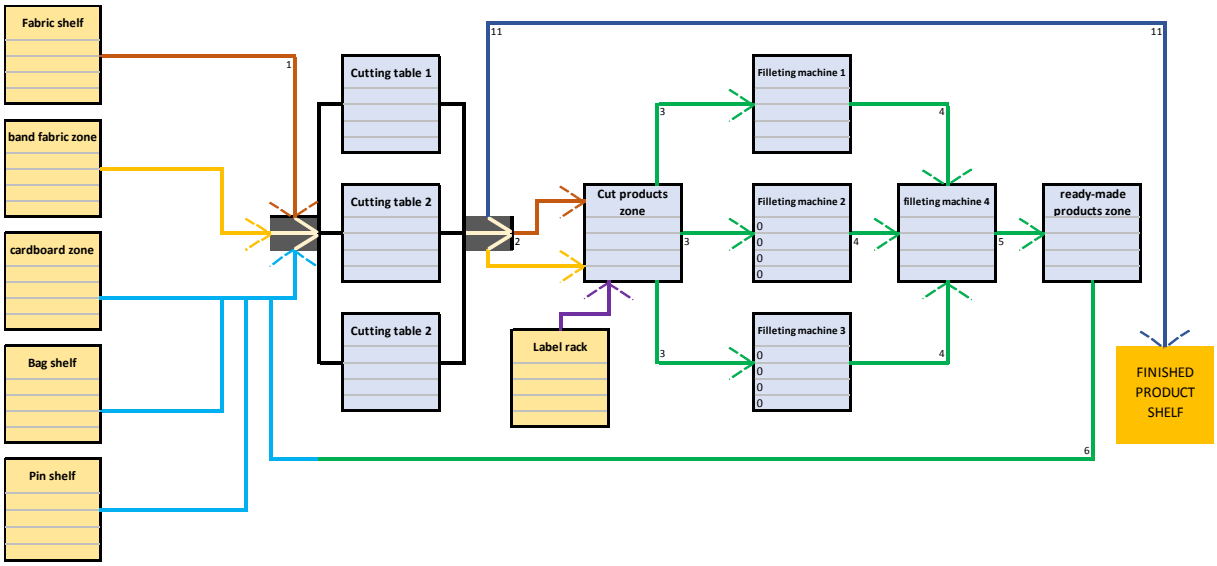

Figure 8. Initial simulation scheme
Source: Autors, 2021

Subsequently, the times of the process diagram are taken as a basis for identifying the trend of the data. The Stat-Fit program is used to determine which distribution best fits the data, its corresponding graph and its respective pp plot, the latter in case the data belong to a normal distribution. When running the software, it says that the behavior accepts 5 distributions. For the handling of the information, it was decided to work with a normal distribution, with a mean of 57 and a deviation of 7.55 minutes, these values were divided into 2, because, when taking the times, everything was contemplated in a batch of 50 layers of fabric, however, they go through a cutting process, ending with 100 units per cycle.

Table 6 shows the passage of all data through Stat-Fit and Colab for Cheila C&C operations, inspections and transports. Those presented as process averages are transport times for which no probability distribution is determined. This information is included in the Simio software.

Table 6. Probability distributions of the current process

MATERIAL	AREA	DISTANCE	MEDIA	DATA INCLUDING SIMIO
Fabric	Transport to cutting table	36,19	6,30	X = 6,30
Band	Transport to cutting table	1,39	0,13	X = 0,13
Fabric	Cutting tables	42,15	113,73	Normal X=57 DESV=7,55
Band	Cutting tables	0,00	8,66	Normal X=8,66 DESV=0,0367
Packaging	Cutting tables	0,00	132,11	Normal X=132 DESV=36.6
Fabric	Transportation to cut p. area	16,49	0,75	X = 0,75
Mark	Transportation to cut p. area	29,54	2,63	X = 2,63
P. Mattress- P. Pillow	Transport to filleting machine 1,2,3	12,16	1,27	X = 1,27
P. Mattress- P. Pillow	Transport to filleting machine 4 and flat	0,00	0,20	X = 0,20
Band – Blanket	Transport to filleting machine 4 and collarin	12,16	1,47	X = 1,47
P. Mattress- P. Pillow	Filleting machine 1,2,3	0,00	131,52	Normal X=132 DESV=25,4
P. Mattress	Filleting machine 4	0,00	94,57	Normal X=94,6 DESV=16
P. Pillow	Flat	0,00	26,88	Triangular (17,8 - 36,7 - 25,8)
Blanket	Machine collarin	0,00	67,28	Triangular (40,7 - 107 - 55)
P. Mattress- P. Pillow - Blanket	Transportation to the p. ready-to-wear area.	14,68	0,92	X = 0,92
Cardboard	Transportation to the p. ready-to-wear area.	33,22	1,98	X = 1,98
Bag	Transportation to the p. ready-to-wear area.	15,23	1,13	X = 1,13
Talkers	Transportation to the p. ready-to-wear area.	41,79	9,95	X = 9,95
Packaging	Transport to cutting table	14,42	0,70	X = 0,70
Finished product	Transportation of finished product	9,75	0,58	X = 0,58

Source: Autors, 2021

Material arrivals at Cheila C&C are handled based on weekly historical data provided by Valmar and are only performed for the 3 type A families selected above (mattress protector, pillow protector and blanket). As well as operations, inspections and transfers are included in Stat-Fit. When running the software, it confirms

that, despite the variability of the three families, they fit an exponential, triangular and lognormal distribution, and rejects the use of the uniform distribution.

With these results, the simulation of the actual process is started. When taking times for the process diagram, batches of 50 units are considered, therefore, the system was adjusted to these quantities. Each element that goes through the simulation will be as if it were 50 in real life.

The material arrivals are taken in 2 forms, one where the distribution given by the Stat-Fit is expressed and the other with a percentage of participation. Due to the general scheme of Cheila C&C, the material arrivals are taken on a weekly basis as shown in table 7.

Table 7. Probability distributions and participation in the current process

Producto	Distribución (Weeks)	Participación
P_Protector	Random.Exponential(1/11)	64
P_Cobija	Random.Exponential(1/3)	18
P_Almohada	Random.Exponential(1/3)	18

Source: Autors, 2021.

The system in its interior, apart from the information entered from table 6, makes necessary the execution of several Processes, being these used as decisions of routes to follow and value assignments.

The cutting tables have a particular case and it is the realization of several processes in it, even in different stages, therefore, the Math.If formula is used to join the distributions in the processing times as follows: Math.If (Entity.Is.P_Protector, Random.Normal (57, 7.55), Entity.Is.P_Cobija, Random.Normal (57, 7.55), Entity.Is.P_Almohada, Random.Normal (57, 7.55), Entity.Is.Banda, Random.Normal (8.66, 0.04), Random.Normal (132, 36.6)).

When the process requires determining which area to go to, decision weights are established indicating the corresponding route, usually with a probability of 33% when it is a 3-path decision and 50% when it is a 2-path decision.

The arrival of bags is done as an independent process, while cardboard, talkers and unit bags are put together because they are all presented at the end of the process. The determination of units is not based on any probability distribution, but according to the occurrence of events.

The Simio software generates an Excel report with a lot of information regarding each input, server and output. For the current process, the utilization of the system with respect to its capacity is quite low. The server with the highest is table 3 with 46%, followed by filleting machine 4 with 38%.

When analyzing this data, the absence of the other products handled by Cheila C&C must be taken into account, since in this case only the 3 type "A" products are considered, which are mattress protector, pillow protector and blanket, which represent approximately 75% of the company's total production. However, the missing 15% would not modify 100% of the data of the current process because, being so specific, they do not go through all the servers.

The proposed process considers 2 important factors, the first one is the inventory system, being this the main change in the arrivals of the system and the second one the modification of the distribution in the plant, which in the simulation will be presented only as an update of the system, the travel time.

As in the simulation of the current process, the data are entered into the Stat-Fit software, which confirms that the data of the three families, despite their variability, conform to a normal, lognormal, triangular and uniform distribution; due to the origin of the data, it was decided to use the normal distribution.

When executing the arrivals of materials, the forecasts previously made are taken as a basis, with them the type of distribution is determined using the Stat-Fit software. These are included in the Simio software including their percentage of participation.

Table 8. Utilization of the forecasted process

Object Type	Object Name	Data Item	Statistic Type	Value
Combiner	Filleting machine4	ScheduledUtilization	Percent	38,26758639
Combiner	Ready-made products zone	ScheduledUtilization	Percent	0,00
Combiner	Pcutting zone1	ScheduledUtilization	Percent	0.00
Server	Machine collarin	ScheduledUtilization	Percent	4,890959806
Server	Filleting machine1	ScheduledUtilization	Percent	27,74685713
Server	Filleting machine2	ScheduledUtilization	Percent	20,85626833
Server	Filleting machine3	ScheduledUtilization	Percent	12,28344826
Server	Table1	ScheduledUtilization	Percent	31,70732172
Server	Table2	ScheduledUtilization	Percent	27,71713034
Server	Table3	ScheduledUtilization	Percent	46,79772394
Server	Flat	ScheduledUtilization	Percent	2,542601523
Server	Pcutting zone2	ScheduledUtilization	Percent	0,03

Source: Autors, 2021.

Table 8 shows that, as in the current process, a full week is simulated with the work schedule as a restriction. In comparison, it is evident that with the same resources an increase in the units to be sold of type "A" products is foreseen, increasing the utilization of the system, however, this does not exceed its own limit. The cutting tables have an average utilization of 57% because they are used for the cutting process of all fabrics, bands and packaging of finished products; in turn, the filleting machine 4 has a utilization of 65%, being the final neck of the filleting machines 1, 2 and 3. The use of the latter is very difficult to increase due to the specialization of its work and that, according to forecasts, sales tend to be very similar to the current quantities.

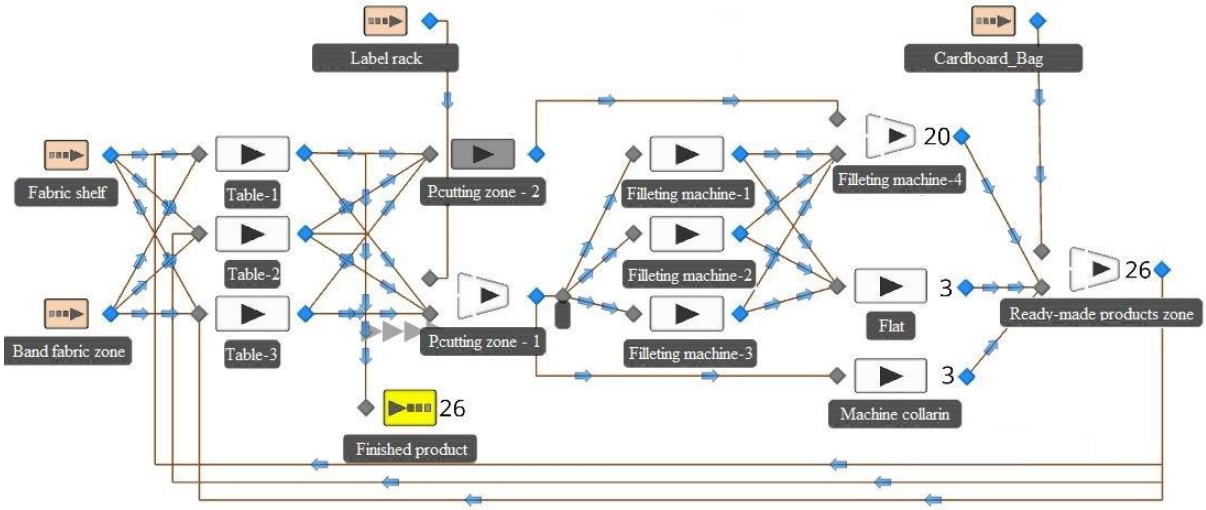

Figure 9. Simulation of the predicted process
Source: Autors, 2021.

Figure 9 corresponds to the simulation based on the forecasts; when compared with the average of the projected data, it is evident that in the case of pillow protectors and blankets it is the same. However, in mattress protectors there are 2 units above the average, this data is considered adequate because its arrival is determined by a normal distribution with a mean of 900 and a deviation of 213 units.

V. DISCUSSION

When talking about cost reduction, the general concept is to optimize the use of raw materials and labor. However, after the Second World War, the increase in demand motivated the production boom, which led entire organizations to mass production, resulting in losses in the millions for some of them. Poor planning and lack of focus on the use of materials and inventories led to studies that over time have relentlessly searched for the most efficient way to manage, plan and organize operations.

In this sense, according to the research of this article, we found a 2013 study of the Universidad Libre de Bogotá entitled "SISTEMA DE GESTIÓN DE ALMACÉN PARA S Y D COLOMBIA S.A" [16], which

shares several lines of research and is quite similar to the work done in Cheila C&C, in addition to sharing the need to establish a system that would allow them to efficiently manage their activities, reducing costs and above all, improving the profit margin, so it is relevant to discuss the results of the two investigations.

Both studies focus on a warehouse system that allows an efficient use of all the resources that are handled in the processes and considerably reduce operating costs, for which similar methodologies are proposed, such as conducting a preliminary diagnosis, in which the characteristics of the organizations are known as well as the detail of their processes, however, while the study of S&D Colombia S.A. focuses more on the processes, without leaving aside the distribution in plant, the study of Cheila C&C focuses on internal flows and inventory management..

First of all, when making the preliminary diagnosis of the situation of S&D Colombia S.A, the tool "Decision Matrix" was used to determine the priority of the areas involved in which senior management should focus to attack the problem, this tool takes place from the analysis of the SWOT matrix previously made and proposes the crossing between actions and factors that may influence, which may not yield the results expected for the organization, because the analysis that defines the priority, The analysis that defines the priority depends directly on subjective values that are assigned by the researcher [17], in this sense, for Cheila C&C, it was determined that the ideal tool for this analysis was the Vester matrix, which allows a correlation between all the problems presented by the organization and thus establish the nature of these, defining that the passive problems are a consequence of the central problem, which in turn, are derived from the active problems. With this, there is a clearer vision of the priority in which the problems should be addressed, since by solving the active ones, the central one will be directly attacked, which will result in the disappearance of the passive ones.

In both studies, numerous product references were found; however, S&D carried out an individual analysis of sales revenue and participation with respect to the total percentage; subsequently, and thanks to the application of the ABC classification, it grouped their behavior by families and graphed it; this made it possible to construct complete and detailed information by reference that provides sufficient support in the event of making any decision [18]. The Cheila C&C study did not perform the sales analysis; it considered it pertinent to base its criteria only on the participation by family.

For the analysis of the plant design of the company S&D Colombia S. A, a thread diagram was made, which measures the distances and routes that are traveled within a space, however, the graphical representation of this is confusing, it does not allow a clear view of the routes and possible crossings that occur during the operation [19], however, the route diagram presented in the study of Cheila C&C, shows the displacement of the operators and easily identifies the crossings that must be made by the operators, the route diagram presented in the Cheila C&C study, shows the displacement that the operators must perform and easily identifies the crossings that must be avoided in case of evaluating any improvement proposal.

Finally, in the financial evaluation of the project initially mentioned, the projection is made from 2009 to 2015, giving a broader perspective of the behavior of the company's activity and the evolution of the possible implementation of the proposal, in addition to including three possible scenarios that could be presented and that can be of vital support for decision-making, while the Cheila C&C study bases its analysis on the next 12 months of the presentation of the results and the application of the net present value and the internal rate of return, which does not mean that it is not sufficient, but it could consolidate a more robust basis for decision making.

Given this, it is pertinent to determine that, for future studies of warehouse management systems, it is essential to carry out the preliminary diagnosis as was done in both studies, as well as the individual analysis by reference of the entire organization, which, although it is a robust work, will allow reaching more detailed results. Also, the management of inventories as was done in Cheila and the management indicators as in the case of S&D, finally the importance of simulating the results and studying the financial viability with a minimum horizon of 5 years, with indicators such as IRR and NPV, which will allow a clearer understanding of the behavior of possible investments over time and that will be fundamental support for decision making. [20].

VI. CONCLUSIONS

The internal analysis of the organizations is of utmost importance, since it allows establishing the behavior of the organization and the way it responds to internal and external challenges in solving problems, taking advantage of opportunities and strengthening weaknesses, understanding that the result of the skills and strategies applied daily, it is expected to respond to market demands and thus, improve to become increasingly competitive.

Inventory management is a fundamental pillar in the operation of the activities, since in this research it was found that it not only influences costs and the amount of space they occupy, but also represents a direct influence on the level of service offered, which is why it cannot be an issue on which decisions are not taken daily. In this case, where the behavior of demand is probabilistic, continuous review systems become an almost essential tool, since it is necessary to constantly monitor its behavior and, therefore, the size of the inventory, as

well as its policies.

Unnecessary displacement of raw materials and personnel can simply translate into wasted time and production cost overruns. The application of methods to reduce this type of aspect is fundamental in the manufacturing process, since the correct distribution in the plant not only reduces the crossings that occur during the process, but also maximizes the use of the plant capacity by redistributing the displacements and establishing the correct arrangement of spaces.

The application of modeling software in the structural and operational changes that are expected to be implemented to improve any aspect within an organization, allows to have a clearer picture to make the right decisions. The process in which the proposed change of this research was simulated in terms of design and plant capacity with respect to demand forecasts, allows to conclude that it facilitates the interpretation of the results and dynamizes the explanation of them.

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