ISBN: 978-981-18-5852-9
WCSE 2022 Spring Event: 2022 9th International Conference on Industrial Engineering and Applications
doi: 10.18178/wcse.2022.04.182

Model of Supply Chain Management based on the Application of Lean Tools and DDMRP to Decrease Returns in Retail SMEs

Rodrigo Salas-Musso[1], Esteban Galliani-Nadramia[1], Juan Quiroz-Flores[1 +], Alberto Florez-Perez[1] and Martin Collao-Diaz[1]

[1]Facultad de ingeniería y arquitectura, Universidad de Lima

Abstract. The retail industry is very supportive for the development of the country since they contribute 10.3% of the country's GDP and it's on constant growth. On the other hand, the emergence of the COVID-19 caused an increase in the digital consumption. This research consists of the implementation of Lean Manufacturing tools that have two tools of use that are standardized work and Poka Yoke. On the other hand, there is the DDMRP tool that helps the company with their supply chain management. Finally, with the results obtained, a certain improvement can be seen in the three indicators that were focused on greater detail. The first was the delayed orders due to stock breakage, which fell to 2.55%, reaching the target percentage. The other two indicators that did not reach their objectives were returns for errors and returns for damages that had a decrease of 1.24% and 3.89% respectively, but they still had a regular improvement that will have to be analyzed which will be the best implementation so that this time achieve the desired goals.

Keywords: Retail, Supply management, Lean manufacturing, Standardized work, Poka Yoke, DDMRP, Returns

1. Introduction

Currently the commercial sector is one of the few that keeps a continues growth in the complicated situation of today's day and age, this is due the constant development of the retail industry which promotes big investments because of the consumers' optimism [1]. This sector represents 10.3% of Peru's GDP meaning that it is a key factor of the development of the country's economy [2]. On another hand the surge of the COVID-19 pandemic has caused an increase in e-commerce because of different factors like social distancing, mobility restrictions, consumers change in behaviour, and so on. Generating an acceleration of the development of e-commerce [3]. In Peru's case this industry saw an increase in revenue of 87% in 2020 which was the largest increase in all Latin America over countries such as Brazil (61%), Colombia (53%) and Mexico (50%). This can lead to the assumption that e-commerce in the country will continue to develop, and it is estimated that by 2025 it will reach a 10% of the industries revenue doubling the actual revenue levels in 2020 which are 5% [4]. Nevertheless, a challenge for this industry is the supply chain mismanagement that affects between 30% and 80% of the companies of this sector [5]. This proofs that a main concern in the retail industry is the difficulty of stablishing a supply chain and dealing with stock outs.

According to researched information, the identified problems can show a different perspective of which it is desired to find in the case study. First, with the implementation of inventory practices in that the main identified problem was the threat of the COVID-19 pandemic that affected the retail sector lowering their liquidity and generating massive employee's firings because of the lack of economic sustainability. Also, there is a problem with the performance of the company which didn't reach its target value because of the low inventory capacity which leads to the delay of the lead time of the orders causing a mistrust between the clients and the company. On the other hand, another problem found was the strategic model of a SME in the retail industry, in which their financial situation showed a deficiency to develop in the industry and to generate revenue in the best way possible. The area that showed the best performance was the utilization of resources, innovation in sales techniques, and customer interaction. That's why the commercial sector suffered deficiencies that can be compared to the study case.

+ Corresponding author. Tel.: + 511 4376767; fax: +511 4378066.
E-mail address: jcquiroz@ulima.edu.pe

Under this context, the desired objective is that the studied commercial sector decreases its deficit levels with the elements mentions before that were the utilization of resources, the innovation, and the improvement of the customer interaction and to improve the current methods of inventory management. The searched investigations showed that a retail company could increase its revenue by increasing the service level by 5%. Also, in another case study the increase of the average monthly sales had a significative impact in the final revenue. In this case study an augmentation of the service level to improve the relationship between the client and the company through an efficient service model was proposed in conjunction with a better system to take advantage of all the resources in the company to avoid losses in a possible future. Nevertheless, the objectives that could be put into practice were the impact of a strategic model for the retail management in a SME, and an implementation of a better inventory management for the retail industry. Finally, it is concluded that all of o these factors show that the industry that was determined has suffered changes that need to be fixed to strengthen the weaknesses present in the company.

This scientific article is organized as the following layout Abstract, Introduction, State of the Art, Contribution, Validation, and Conclusions.

2. State of the Art

2.1. Order fulfillment in the retail industry

Retail companies commonly have problems with stock outs and improper picking. These are key elements in the situation of non-fulfilment of orders, that's why they must be considered when implementing improvements to the core activities [6-7]. Likewise, the stages of order confirmation, shipping method, return method, logistic services, and after sale services must be clearly defined for a correct tracking of the orders [8]. In the same way, the order of fulfilment time is crucial for the customer satisfaction and to avoid the loss of future customers [9].

2.2. Lean Manufacturing in the retail industry

Over time, the retail companies have evolved and grown adapting different tools for their proper evolution like digitization and different lean tools [10]. These last ones are usually applied to production companies, but in recent times they have been applied to service companies [11-12]. To develop the correct way to use these tools they must take in consideration different conditions like the analysis of the best solution for the current problem, the industry standard that they aspire to achieve, the correct training of the personnel, and the correct tracking of the desired key performance indicators [13].

The correct implementation of the Lean Manufacturing tools such as Standardized work and Poka Yoke can help the companies with the optimization of the performance of their activities, the establishment of the optimal lead time, and the determination of the resources needed for an optimal operation [10-13].

2.3. DDMRP in retail

Demand Driven Materials Requirement Planning (DDMRP) is an innovative concept that allows a company to have a better supply planning, but due to the novelty of this concept it hasn't been applied to many study cases yet [14-15]. By using this methodology, the company bases their supply chain in the client's requirements instead of the supply that they can provide having in consideration the forecast of the demand, the planification and the materials consumption [16]. Also, the traditional planning of methods such as MRP are quite efficient for a company's supply planning, but the problem here is they don't take in consideration inventory management [17].

Finally, a correct implementation of a DDMRP system offers a great opportunity of improvement and gives the company the edge over the competition. Despite the difficulties that this implementation signifies the benefits provided are increasing the service levels, decreasing stock outs, and reducing the cost of lost sales [16-17].

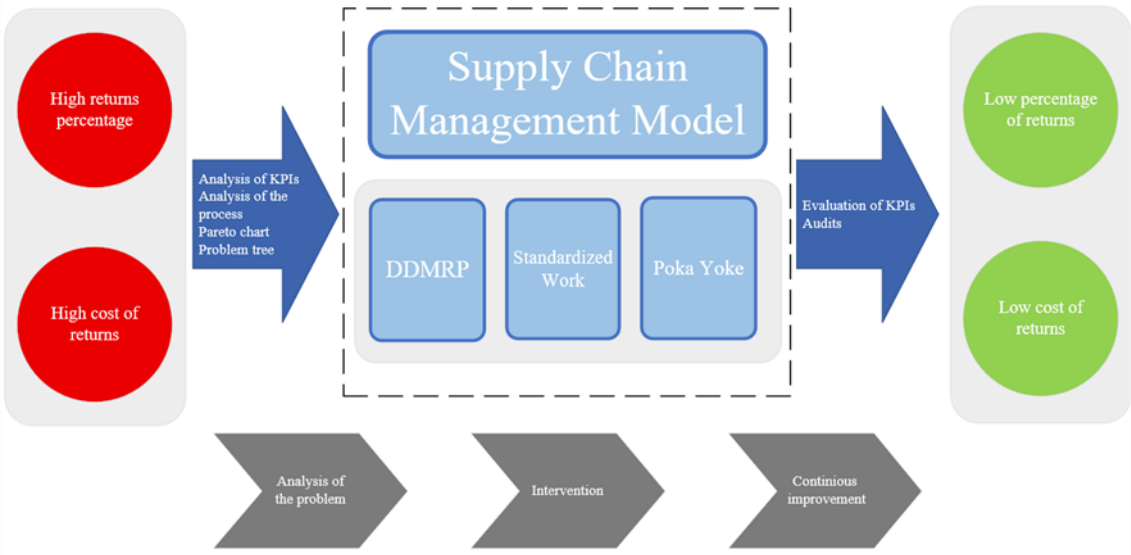

Fig. 1: General view of the Supply Chain Management Model.

3. Contribution

3.1. Model Basis

Currently, the retail industry is growing due to the modern times increasing the consumption of local and online stores in these years. Many factors are the cause of these changes such as the growth of e-commerce and the surge of the COVID-19 pandemic. This has also brough the attention of a serious problem which is a correct supply of material which affects a large part of the retail industry. That's why research of the best methods and actions has been done to propose adequate tools to solve this emerging situation. For this, information has been gathered from 20 investigations and the ones better suited for this study case were tools form Lean Manufacturing (Standardized Work and Poka Yoke) and DDMRP which are tools that have a small amount of research in this field and the synergy created between them are helpful for the solution of these problems.

Table 1: Comparison matrix of the proposal components vs the state of the art

Causes / ***Articles***	***Non-Standardized procedures***	***Inefficient supply systems***	***Incorrect defectives control***
Xie.Y; Zhang.L (2020)	Standardized work		Poka Yoke
Caldas.M et al (2020)	Standardized work		Poka Yoke
Kortabarria.A et al (2018)		DDMRP	
Shofa,M et al (2020)		DDMRP	
Rothenburger.W (1999)	Standardized work		Poka Yoke
Rodrigues.V et al (2015)	Standardized work		
Proposal	***Standardized work***	***DDMRP***	***Poka Yoke***

3.2. Proposed Model

The value of this proposal is the implementation and combination of DDMRP, a tool that has been recently applied for the retail industries, and Lean Manufacturing tools such as Standardized Work and Poka Yoke. These tools have been chosen to solve the difficulties developed on the problem tree that cover stock outs, non-standardized practices and evitable errors present in the processes of the company. These will help to decrease or mitigate the main problem present which is the high return of orders and the high cost of returns.

3.3. Model Components

PHASE 1: Analysis of the problem

This phase consists in the execution of all the previous actions before the intervention. The first step is to analyze the key performance indicators (KPIs) of the SME to determine where the most important problem lies and what problems are of bigger relevance. For this it's important to identify the processes involved in the KPIs to determine what is going wrong. Then these processes are submitted to a TIS analysis in which the problems are defined, quantified, and categorized in a Pareto chart. Finally, the problem tree is constructed with the problems found in the previous step and possible solutions are proposed to solve the root of these problems.

PHASE 2: Intervention

The second phase consists in applying the tools proposed in the analysis of the problem in this case the proposed methodology is to apply DDMRP, standardized work and Poka Yoke which will be used for different areas of the supply chain.

For the correct application of DDMRP the materials in stock need to be prioritized according to their importance so a buffer could be applied to them, then this buffer will be checked to see if the values assigned are the correct ones, if not, they will be modified until they have a correct value. Finally, the material planning will be done to proceed with the purchasing orders.

About the standardization of work the processes of the company will be revised and they will be evaluated to see if the current way of working is correct. If not, new practices will be proposed, and a new process of work will be developed. Finally, this new process will be implemented and tested to see if the operations have improved.

Finally, the Poka Yoke tool will be put in practice, for this all the actions in the process will be revised and the actions that the tool can be applied for will be selected, then the best option for application will be selected, and finally it will be evaluated if the proposed solution is the correct one.

For these three tools a supply plan, a standardized work document and a Poka Yoke checklist will be used as an instrument of control respectively.

PHASE 3: Continuous improvement

In this phase, it will be evaluated and verified if the objectives set in the implementation are being met through indicators, to ensure the development of the improvement.

3.4. Indicators

- OTIF: Measures the percentage of orders that are delivered on time and with no problems with the products.

  Objective: Increase OTIF to 95%

$$OTIF = \left(\frac{Ordersontime}{Totalorders} \right) \times 100 \quad (1)$$

- Returns index: Measures the percentage of orders that were returned by the clients in comparison with the total of delivered orders.

  Objective: Decrease the return index to 5%

$$\mathrm{Re}turns = \left(\frac{\mathrm{Re}turnedorders}{Totalorders} \right) \times 100 \quad (2)$$

- Stock out: Measures the number of materials supplied in relation to the number of materials that are required.

  Objective: Decrease the stock break to 3%.

$$Stockout = \left(\frac{Nonsuppliedmaterials}{Totalmaterialssuplied} \right) \times 100 \quad (3)$$

- Returned orders cost: Measures the percentage of the gross profit that it costs to return the orders.

  Objective: Decrease the cost of returns to 3%

$$\mathrm{Re}\,turnedorder\,\mathrm{cos}\,t = \left(\frac{\mathrm{Cos}\,tofreturnedorders}{Grossprofit} \right) \times 100 \tag{4}$$

4. Validation

4.1. Initial Diagnosis

The initial results in this case study show a technical gap in the return percentage with a value of 10.5% of the total orders delivered which is out of the industry standards of a maximum of 9% limit for the returns permissible [18]. The economic impact of this situation is S/. 4,318.38 which represents 8.71% of the gross income of the company this also exceeds the permissible limit of loss of income of SMEDs which is rated at a maximum of 5% meaning that the percentage of returns is a serious problem in this case study.

4.2. Validation Design and Comparison with the Initial Diagnosis

The model that was proposed for this case study was put to the test by a simulation with the Arena 16.10 software the desired simulation was the whole process of the company, from the reception of the orders to the delivery of the products. Then the obtain results are compared to the initial values and the expected values of the key performance indicators to show the improvement that the model generated.

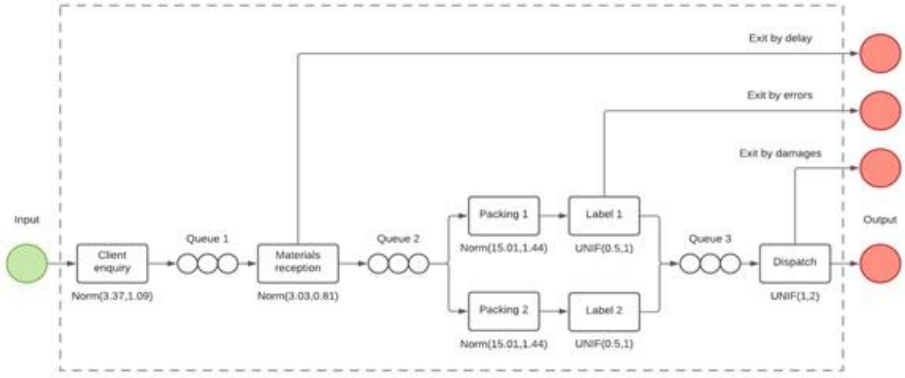

Fig. 2: System Representation.

4.3. Improvement-Proposal Simulation

To elaborate a correct simulation, the collection of the input data was necessary, for this the company provided information about all their operations and a sample of 500 orders were provided this data covered the lead time that each order had for every process in the supply chain. Then it was decided that a confidence level of 90% which also dictates a margin of error of 10%.

With the collected data and the values of confidence level and margin of error the input analyser tool was used to determine the number of repetitions the Arena simulator would do. For this case study it was determined that the optimal number of repetitions was 30. This from the lead time values found for each process shown in the table below.

Table 2: Distribution values

Process	***Distribution***
Client enquiry	NORM (3.37, 1.09)
Materials reception	NORM (3.03, 0.81)
Packing	NORM (15.01, 1.44)
Label	UNIF (0.5, 1)
Dispatch	UNIF (1, 2)

The results obtained after the simulation were a reduction in the cycle time of the entire process from 158.53 hours to 154.81 hours, an improvement that reduced the cycle in 2.35%. Also, the return indicator had a very good result going from 10.5% to 5.74% reducing the returns to almost half of its initial value, surpassing the expected value of 7% by a big margin.

On the case of the DDMRP tool the results for the indicator for stock outs was almost the same as the expected values going from 7.62% to 5.07% only 0.07% away from the target value. This can be interpreted as a good application of the tool and a minor adjustment could mean that in a future simulation this value could surpass the expectations.

On the other hand, the results for the returns over errors and the returns over damages did not reach the expected values of 1% and 5% respectively, that means that there is room for improvement in the application of the Standardized Work and Poka Yoke tools. Nevertheless, the results obtained in the simulation show an improvement in these indicators going from 3.16% to 1.92% in returns over errors and going from 11.58% to 7.69% in returns over damages. With this information it can be said that the values were improved, and the implemented tools do help in these areas, but there is still potential for further development and adjustment in the implementation would be recommended.

Finally, these results were translated to the cost of returns which was improved from 8.71% to 6.33% that meant a decrease in 27.32% from the initial situation which is very positive for the company meaning it can bring more revenue. But the expected mark of 3% wasn't reached. This isn't a great concern because if the previous adjustments mentioned are applied this value will surely reach the expected objective of 3% or in the contrary at least be lower than the industries maximum level of 5%.

Table 3: Comparison matrix of the current situation and the improved situation

Indicator	***Current Situation***	***Expected***	***Improved Simulation***
Cycle time	158.53 hours	155 hours	154.81 hours
Returns	10.5%	7%	5.74%
Stock outs	7.62%	5%	5.07%
Return over errors	3.16%	1%	1.92%
Return over damages	11.58%	5%	7.69%
Cost of returns	8.71%	3%	6.33%

5. Conclusions

The results from this investigation can proof that the application of a Lean and DDMRP Model can reduce the order returns in 45.33% thus reducing the cost of opportunity and providing a better service.

After all the analysis, it can be deduced that the indicator that was closest to the expected value was the stock outs, meanwhile the returns over errors and returns over damages didn't satisfy the expected values that's why the Standardized Work and the Poka Yoke tool need to be revised and improved.

In the future, it is recommended to adjust the implementation of the Standardized work and the Poka Yoke tools to obtain better results and mitigate the problems that are still present after the simulation.

6. References

[1] Sociedad del Comercio Exterior del Perú – COMEX Perú, "El sector comercio: Un mercado atractivo en medio de la incertidumbre," 2020. [Online]. Available: https://www.comexperu.org.pe/articulo/el-sector-comercio-un-mercado-atractivo-en-medio-de-la-incertidumbre.

[2] INEI, "PBI de las actividades económicas,por años," Presidencia Consejo de Ministros, 2021. https://www.inei.gob.pe/estadisticas/indice-tematico/economia/ (accessed Sep. 29, 2021).

[3] S. Gu, B. Ślusarczyk, S. Hajizada, I. Kovalyova, and A. Sakhbieva, "Impact of the COVID-19 Pandemic on Online Consumer Purchasing Behavior," J. Theor. Appl. Electron. Commer. Res., vol. 16, no. 6, pp. 2263–2281, Sep. 2021, doi: 10.3390/jtaer16060125.

[4] EL COMERCIO, “Ventas por internet crecerá 110% en el mercado peruano hacia 2025, según estudio,” 2021, Accessed: Sep. 29, 2021. [Online]. Available: https://elcomercio.pe/economia/comercio-electronico-ventas-por-internet-crecera-110-en-el-mercado-peruano-hacia-2025-segun-estudio-nndc-noticia/.

[5] A. Shabani, G. Maroti, S. de Leeuw, and W. Dullaert, “Inventory record inaccuracy and store-level performance,” Int. J. Prod. Econ., vol. 235, May 2021, doi: 10.1016/j.ijpe.2021.108111.

[6] R. M. Difrancesco, I. M. van Schilt, and M. Winkenbach, “Optimal in-store fulfillment policies for online orders in an omni-channel retail environment,” Eur. J. Oper. Res., vol. 293, no. 3, pp. 1058–1076, 2021, doi: 10.1016/j.ejor.2021.01.007.

[7] M. Urzúa, A. Mendoza, and A. O. González, “EVALUATING THE IMPACT OF ORDER PICKING STRATEGIES ON THE ORDER FULFILMENT TIME : A SIMULATION STUDY,” pp. 103–114, 2019, doi: 10.22306/al.v6i4.129.

[8] Y. Xie and L. L. Zhang, “Customer satisfaction with order fulfillment in e-retail supply chains in China: An empirical study,” IEEE Int. Conf. Ind. Eng. Eng. Manag., vol. 2020-Decem, pp. 475–479, 2020, doi: 10.1109/IEEM45057.2020.9309914.

[9] T. Waterbury, “Fulfilment time performance of online retailers,” Eletronic Libr., vol. 34, no. 1, pp. 1–5, 2018.

[10] M. Shakoor, N. Jaber, W. Abu Jadayil, M. Qureshi, and S. Jaber, “A novel model for benchmarking the performance of retail stores for retail operations using lean manufacturing approach,” Int. J. Appl. Eng. Res., vol. 12, no. 17, pp. 6686–6692, 2017.

[11] E. A. Kotlyarova, K. F. Mekhantseva, L. S. Markin, and M. O. Otrishko, “Application Possibilities and Standardization Features for Lean Methods in Service Industries,” IOP Conf. Ser. Earth Environ. Sci., vol. 666, no. 6, 2021, doi: 10.1088/1755-1315/666/6/062132.

[12] L. B. M. Costa, M. Godinho Filho, L. D. Fredendall, and G. M. D. Ganga, “The effect of Lean Six Sigma practices on food industry performance: Implications of the Sector’s experience and typical characteristics,” Food Control, vol. 112, no. November 2019, p. 107110, 2020, doi: 10.1016/j.foodcont.2020.107110.

[13] J. Caldas-Miguel, E. Carvallo-Munar, C. León-Chavarri, N. Mamani Macedo, and R. Dominguez, “Purchasing and Quality Management Lean Manufacturing Model for the Optimization of Delivery Times in SMEs in the Food Sector,” in Advances in Intelligent Systems and Computing, vol. 1209 AISC, 2020, pp. 478–485.

[14] A. Kortabarria, U. Apaolaza, A. Lizarralde, and I. Amorrortu, “Material management without forecasting: From MRP to demand driven MRP,” J. Ind. Eng. Manag., vol. 11, no. 4, pp. 632–650, 2018, doi: 10.3926/jiem.2654.

[15] M. J. Shofa, A. O. Moeis, and N. Restiana, “Effective production planning for purchased part under long lead time and uncertain demand: MRP Vs demand-driven MRP,” IOP Conf. Ser. Mater. Sci. Eng., vol. 337, no. 1, 2018, doi: 10.1088/1757-899X/337/1/012055.

[16] G. Carbajal-roman, C. Lopez-vela, G. V. B, and J. Quiroz-flores, “Reducing Waste in Fast-Food Restaurants,” pp. 1–8, 2021.

[17] M. Pekarcíková, P. Trebuna, M. Kliment, and J. Trojan, “Demand driven material requirements planning. some methodical and practical comments,” Manag. Prod. Eng. Rev., vol. 10, no. 2, pp. 50–59, 2019, doi: 10.24425/mper.2019.129568.

[18] M. María and E. Debrosse-Carballo, “EVALUATION OF LOGISTICS CUSTOMER SERVICE IN A MARKETING COMPANY,” 2013.