# Lean Logistic and Supplier Relationship Management to reduce stockouts in a Graphic Industry

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***Abstract*— The publishing sector in recent years experienced problems in the supply of its main raw material due to its scarcity, paper, considerably affecting production and meeting market demand, generating losses for SMEs in the sector. Based on this, reducing the levels of raw material stock breakage was essential to be able to meet customer demand. Therefore, this research has as its main objective to improve the rate of stock breakage of raw material in a publisher, which is currently 22%, being higher than that of the sector which amounts to 12%. In this sense, a model based on the Lean Logistic and SRM methodology is proposed, applying a demand-based planning system (DDMRP), supplier relationship management (SRM) and standardized work. The application of the model manages to reduce by 16.04% the rate of breakage of raw material stock.***

***Keywords*—Stockout, Demand driven, Supplier management, Standardized work, Planning requirement.***

## I. INTRODUCTION

Globally, the shortage of various supplies significantly impacted various manufacturing sectors, so that in different continents the prices of raw materials such as paper rose significantly, in North America by 23%, the East by 30% and Asia and Oceania between 25% and 45% in 2021 [1]. Likewise, imports in Peru showed an increase compared to 2020, with an increase of 38.9%, a percentage with which a value of 51 million dollars is economically evident [2], it should be mentioned that Chinais Peru's main import country. However, in the year 2021, it prohibited the import of recovered paper which led manufacturing companies in Latin America to not be able to manufacture paper for export and for the domestic market causing an effect on the price increase of 20% to 30%, repercussions severely in the continents of America and Europe since they had to face the shortage of paper and the risk of being affected by stock shortages or breakdowns. [3]

For these reasons, stock breakage is a problem that considerably afflicts companies in the publishing sector. In this sense, among the main problems in the supply of paper to publishers, according to the literature, is the extension of delivery times, poor selection of suppliers and delays in internal processes, for which several companies in the sector chose to have several suppliers to reduce this risk. However, it would be a momentary measure due to the significant increase in the price of paper, since otherwise the stock breakage index would increase markedly [4]. In similar situations, the use of a demand-based material planning model managed to improve the level of service and between one and 52%, reducing storage costs, to recover the expected investment in 14 months being beneficial for a company [5]. On the other hand, stock breakage can be generated by deliveries out of time and without the required quality. In response, previous researchindicated that supplier management activities improve performance through long-term cooperation with key suppliers and constant evaluation of them [6]. Finally, the application of the lean logistic methodology, permit and diagnose waste and unnecessary activities, allowing to propose significant improvements [7].

Despite the above, there is a large amount of research related to the problem of maintenance of machines in publishers, however, the amount of research on the problem of stock breakage in the publishing sector is very small, so there is a need to address new solution models, to encourage the development of new methodologies and / or proposals for improvement in the field. Through both quantitative and qualitative research, based on the Lean Logistic and SRM (supplier relationship management) methodology, to improve the indicator of stock breakages which is at 22% and to meet the fluctuating market demand.

The current project is developed in the following way, in section II, is where the analysis and review of the literature will be carried out. Section III will address the contribution and design ofthe model. Section IV will address the validation of the proposed solution developed. Finally, in section V they will visualize the conclusions obtained from the current project.

## II. LITERATURE REVIEW

### A. *The problem and its causes*

The supply chain in the paper industry requires proper supply management, which in a post-COVID-19 environment where multiple problems have arisen, which are reflected in the level of efficiency of the processes. In addition, the impact of responsible purchasing and sourcing on supply chain responsiveness achieved 20% process improvements, as well as reduced transaction costs, inventory cost, and uncertainty in cycle time[8][9]. On the other hand, deliveries out of time by the supplier were recurrently the cause of the lack of raw material, since the actual delivery time was inevitably affected by various uncertainties, so it was determined that it can be stochastic and fluctuating causing The operations of the chain in front of them were complex. In this sense, the use of certain approaches can mitigate them, reducing the risk and impact on the supply chain, being the forecast of the delivery time a fundamental part of the companies, for a better performance of the supply chain [10] [11] [12]

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### B. Supplier Management

According to several authors, careful consideration of direct and lower-level suppliers was required for effective sustainable supply chain management. In this sense there is extensive knowledge of selection techniques in supplier criteria, where commitment is a key condition for the success of buyer-supplier relationships. Therefore, it was determined that committed suppliers benefit the purchasing company by expanding its knowledge, improving products and developing new ones, evidencing that investing to obtain the commitment of suppliers does give returns in terms of performance at the category level [1 3][14][15] . At the same time, studies considered important the impact of industrial relations between buyers and suppliers, as well as the attractive role of the customer in the supply chain and how their performance improved even more if purchases of so-called incoming suppliers were reduced by assigning these purchases to those who were that are already part of the supply chain[16]. On the other hand, another research indicated that the attractiveness of buyer-supplier relationships positively affected customer performance, in relation to a certain purchasing category, in addition, the relationship with innovation of performance, cost and visibility. [17] [18].

### C. Standardization of work

In the paper industry, according to previous research, observation and direct documentation was used to properly develop a standardization model, it was also necessary to take into account the time spent in each activity of the process, as well as the establishment of new work procedures, especially in industries that lack production methods, in this sense the visualization methods such as VSM and the combined work box were not stopped [19][20][21]. On the other hand, in order to establish a correct standardization approach, it was necessary to keep in mind continuous improvement, since activities can always be improved. It should be noted that standardization achieved significant improvements in the social capital of the teams and therefore facilitated activities, concluding that its application would increase productivity [22][23][24]

### D. Material Planning

It is important to recognize the fields of Operations and Supply Chain Management are increasingly turbulent and dynamic. Consequently, there is a need to develop and evaluate alternative systems and approaches that can help companies and their management better cope with the challenging demands of this new environment. Several investigations mention that since Orlicky's MRP material planning, the use of DDMRP is effective in new fluctuating and/or variable scenarios since this approach allowed to opt for a planning system that is based on day-to-day demand, that is, real-time demand, in order to adapt to new manufacturing environments [25][ 26]. On the other hand, Industry 4.0 is directly affected by the SC, where the DDMRP brought together those existing methods and incorporated new and innovative features to be able to manage the flow of materials, still managed to affectthe flow of materials. Affecting the company's integrated culture and work habits, however, the likelihood that the transition will become essential and provide a sustainable competitive advantage was higher. [27] [28]

## III. CONTRIBUTION

### A. Rationale of the model

The proposed model is developed based on several proposals that design a model positioning the planning system as the first component, and other tools distributed consecutively, including inputs and outputs in its model [18] [29] [30]. Based on the Lean Logistic philosophy, which according to studies when using a raw material planning model, properly manages raw material purchases in conjunction with the support of other tools, such as with the use of the ABC classification to prioritize products [31][32] E Based on this, it was unthinkable to position the DDMRP planning system as the first component, since it will allow us to meet the current raw material requirements in real time. SRM and forthe company's supply process to be more efficient, a reduction in quality review times will be sought, for this the work standardization tool will be used.

### B. Proposed Model

In Figura 1 you can see the proposed model based on the philosophy Lean Logistic and Supplier Relationship Management, which consists of 3 main components: Demand Driven MRP, SRM and Standardized Work to reduce stock breakages of paper raw material, the main resource for production in printers. To carry out the development, the main points of the different methodologies were taken into account, which would allow proposing a new solution framework for future research.

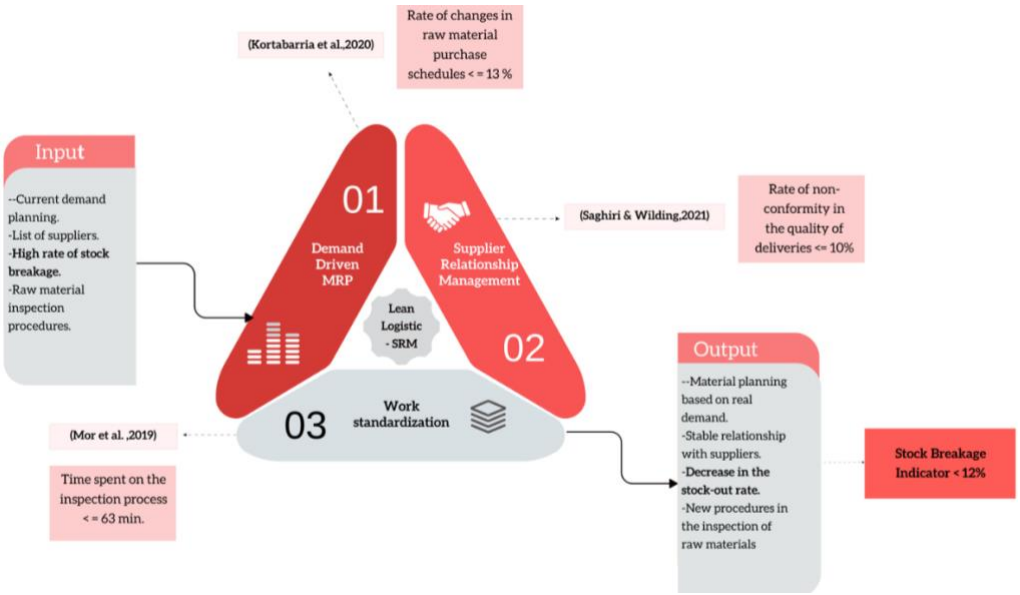
### C. Model detail

Based on the proposed model, where the first component has the purpose of establishing a planning system based on real demand, the DDMRP tool is used, which consists of 5 phases: (1) Define the strategic inventory level, (2) Buffer profiles and levels, (3) Dynamic adjustments, (4) Carry out planning based on demand and (5) Visible and collaborative execution. To do this, no instrument as such will be needed since it is only necessary the stock levels and the current planning that the company carries out, to estimate the buffer levels.

The second component aimed to improve relations with suppliers, as well as define new criteria for a better selection of suppliers and a new contract model at the time of negotiation. For this, the SRM tool is used, however only 2 of the 5 phases of this model will be developed, which are: (1) purchasing strategies and (2) supplier selection and negotiation. The main instruments to be used are the following:

- Vendor registration tokens
- Supplier evaluation sheets
- Model contract for flexible quantity and penalties

Finally, the third component seeks to reduce inspection times of raw material supplied by suppliers




Note. Adapted from [18][29][30]

Fig 1. Proposed model

For this, the standardized work tool will be used where the following phases will be developed: (1) the spagetti diagram to visualize the current flow of the process, (2) the definition of the Takt time, (3) measurement of times, (4) elaboration of the ECRS matrix, (5) standard work boards, (6) elaboration of documentation and indicators and (7) training. The main instruments to be used are the following:

- Standardized work boards
- Procedure manuals
- Time measurement sheet

### *D. Proposed process*

In Figure 2, you can see the flow to follow for the implementation of the proposed model.

### *E. Model indicators*

Next, the indicators to be used in the model will be displayed. It should be noted that they are related to the proposed improvements to reduce the high rate of breakage of raw material stock.

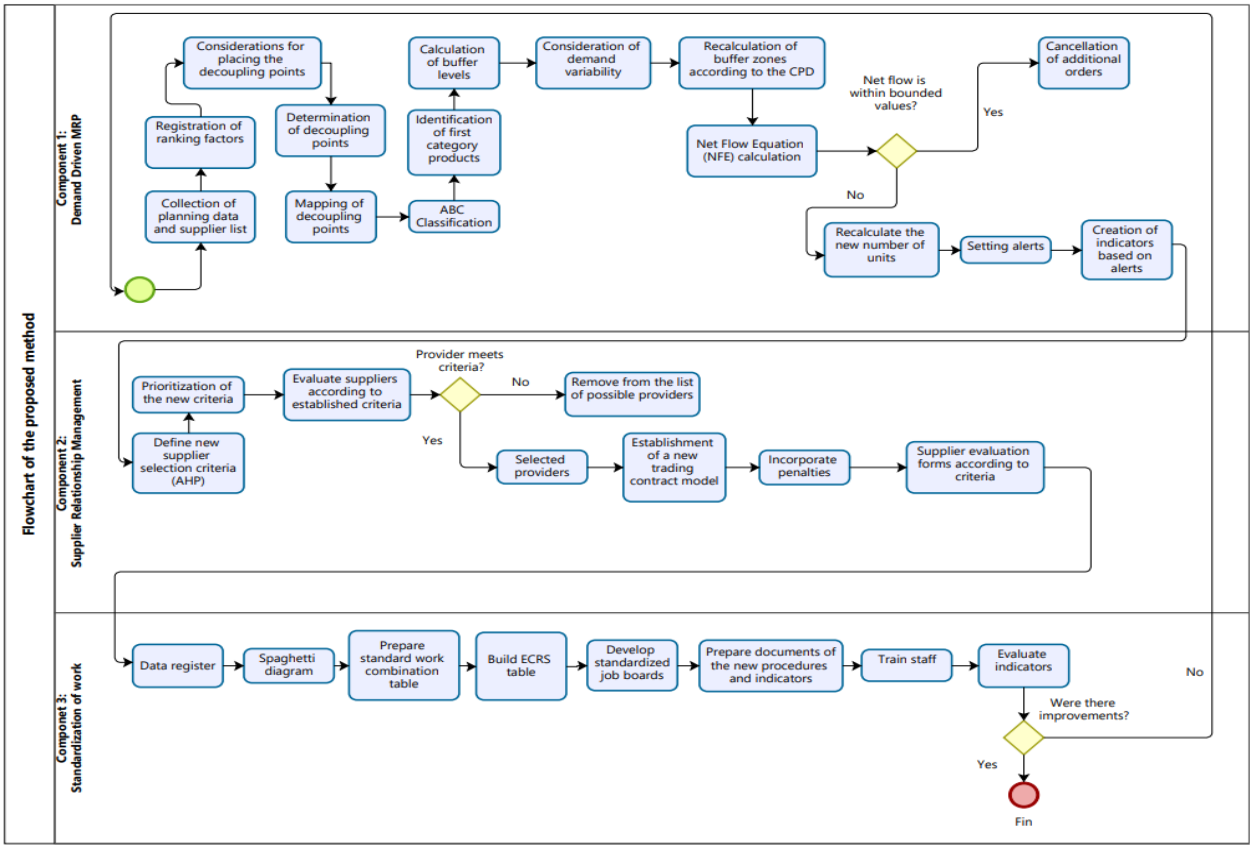



Fig 2. Flowchart of the proposed method

*a. Rate of stock breakage (RS)*

It measures the number of unfulfilled orders by the company over the quantity demanded by the customer. According to studies, they indicate that this indicator can be reduced to a value of less than 12% [3 3]

$$RS\ (\%) = \frac{Unsatisfied\ orders}{Total\ Orders} x\ 100$$

*b. Rate of changes in raw material schedules (N)*

Measures the number of times changes or variations are made to raw material purchase schedules over total planned orders. Studies indicate that this indicator can be reduced to less than 13% [34]

$$RS\ (\%) = \frac{Number\ of\ changes\ to\ schedules\ orders}{Total\ planned\ orders} x\ 100$$

*c. Non-conformity in quality of deliveries (CN)*

It measures the number of times that raw material deliveries by the supplier do not meet the quality specifications on the quantity of raw material supplied. Studies indicate that this indicator can be reduced to less than 10% [35]

$$NC\ (\%) = \frac{Quantity\ of\ raw\ material\ outside\ quality\ specifications}{Quantity\ of\ raw\ material\ received} x100$$

*d. Time spent in the inspection process (Tinsp.)*

Measures the time spent on the total inspection process. According to studies indicate that this indicator can be reduced to a value less than 63 minutes. [20]

$$Tinsp = \sum_{SP=1}^{3} \text{SP}$$

SP= Inspection thread lifetime

## IV. VALIDATION

### A. Understanding the validation scenario

In order to validate the proposal, pilot plans were carried out in order to demonstrate the effectiveness of the model when carrying out a real implementation. For this, the planning process of the material requirements, the supply process, emphasizing the reception of raw material by the supplier and the inspection process of the raw material supplied by the supplier were taken as scenarios.

### B. Initial diagnosis

Based on the company's data, it was identified that, in the school textbook production line, there is a high rate of raw material stock breakage that amounts to 22.62% in 2021, which in monetary terms is reflected in an economic loss of S / 94 392 representing 4.20% of the total turnover in the same year. In this sense, the study determined the main root causes, these three being: changes in the raw material purchase schedules, which refers to unexpected requests to request from the supplier that were not in the initial planning. The second cause, suppliers do not meet quality requirements, that is, what is supplied does not meet the required characteristics in its entirety. Finally, the third cause, the delays in the raw material inspection process which delays the identification of the raw material that meets all the requirements to be used in production. All the above, would cause a high rate of raw material stock breakage of 22.63%, where its initial values of each root cause can be visualized in Table 1, at 36.84%, 33.33% and 93min respectively.

TABLE I
INITIAL SITUATION

| Indicator | As Is |
|---|---|
| Stock Breakage Rate | 22.62% |
| Rate of changes in raw material schedules | 36.84% |
| Rate of non-conformity in the quality of the raw material supplied | 33.33% |
| Time spent on the inspection process | 93 min. |

### C. Design of validation and comparison with diagnosis

Initially, the time needed for the pilots to be carried out to demonstrate the validity and reliability of the results was calculated, with 3 months being the time spent in the 3 pilots to be carried out.

$$n = \frac{1.975^2 * 77000 * 0.5 * 0.5}{0.02^2 * (77000 - 1) + (1975^2 * 0.5 * 0.5)}$$

$$n = 47558.70\ thousand\ school\ books \approx 3\ months$$

Subsequently, between the months of August to October, the pilots were carried out, the first being the DDMRP tool through the installation of buffers and alerts, to make the requests for raw material at the right time . Finally, the NFE (net flow equation) was calculated to know exactly when new raw material purchase requests should be generated as shown in Figure 3 in conjunction with buffer levels.

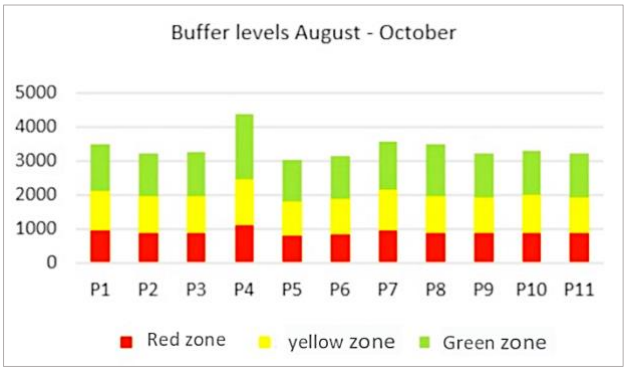



Fig 3. Buffer Levels

Meanwhile, the Supplier Relationship Management (SRM) through new contract models and the AHP matrix, was able to define the new criteria for the selection of suppliers and a new guideline at the time of negotiation, to finally evaluate them as shown in Figure 4, with a supplier evaluation sheet, which evidenced the quality of its service and what was supplied in the 3 months.

| Aníbal Paredes | VENDOR PERFORMANCE EVALUATION FORM | Code: 00156978<br>Page 1 of 1<br>Version:1<br>In force since 31/10/22 |
|---|---|---|

Supplier Name: Papelera Nacional S.A Review period end date: 31 / 10 / 22
Order / Contrac 32165
Criteria to be evaluated once the delivery of the agreed products has been completed.

| Criteria | Description | SCORE RANGE | | | Score |
|---|---|---|---|---|---|
| | | Excellent | Satisfactory | Poor | |
| Overall Quality of material | The contractor delivered what is required in the purchase orders with the technical specifications established in the contract | 10 | 5 | 0 | 5 |
| | The contractor complies with the legal regulations for the products specified in the purchase order. | 10 | 5 | 0 | 10 |
| After-Sales service | The contractor monitors the conformity of what is supplied to the company. | 10 | 5 | 0 | 10 |
| | Supplier's ability to solve non-conformities | 10 | 5 | 0 | 10 |
| Quality of material upon delivery | The contractor fulfilled the delivery on the dates agreed in the contract | 10 | 5 | 0 | 10 |
| | The contractor delivered the goods in the quantities agreed in the contract | 10 | 5 | 0 | 10 |
| Management | The contractor performed the invoicing in the time stipulated in the contract | 10 | 5 | 0 | 10 |
| | The supplier's management is qualified in the fulfillment of the guarantees if the agreement does not comply with the provisions of the contract | 10 | 5 | 0 | 10 |
| Overall Score | | | | | 75 |

| Qualification criteria | SCORE | RESULT |
|---|---|---|
| | Greater than or equal | Excellent - Reliable and improved supplier, can stay one more period with the company |
| | Between 50 and 69 | Acceptable - It can be considered in future periods, as a reliable alternative. |
| | Less than 50 points | Unreliable - Unreliable provider. Remove from supplier list for future tenders |

**Remarks:** According to the qualification criteria, the evaluated supplier will continue to supply the companyuntil February 2023 and its performance will continue to be monitored every 3 months.
**Note:** Append the document in the provider's history and generate a copy of the present format.

Purchasing Supervisor

Fig 4. Supplier evaluation form

On the other hand, the application of the last tool, the standardized work was applied in the process of inspection of the incoming raw material, using takt time and ECRS, it was possible to schematize the new process flow and establish the time that should be used not to exceed the takt. Figure 5 shows the work boards that together with the documentation and training served as a guide for the operators when carrying out the new flow of the inspection process and operating the new machines incorporated in the sub-process of humidity, opacity, and thickness.

At the conclusion of the implementation of the model, the new improved values were determined and how it managed to impact the stock breakage levels. Table 2 shows the results obtained after deployment.

TABLE II
RESULTS

| Indicator | As Is | Objective | To Be |
|---|---|---|---|
| Stock Breakage Indicator | 22.62% | 12% | 6.58% |
| Rate of changes in raw material purchase schedules | 36.84% | 13% | 6.88% |
| Rate of non-conformity in the quality of deliveries | 33.33% | 10% | 5.03% |
| Time spent on the inspection process | 93 min | 63 min | 60 min |

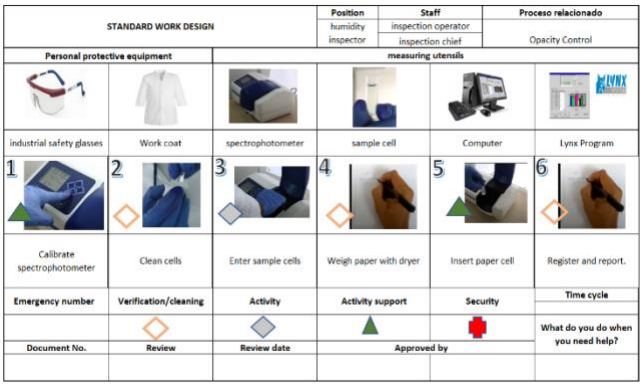



Fig 5. Standardized work board

The application of each tool allowed to reduce the rate of stock breakage that afflicted the company decreasing by 16.04%, varying from 22.62% to 6.58%, fulfilling the objective established according to the literature. In addition, to reduce changes in raw material purchase schedules by 29.96%, from 36.84% to 6.88%. , as well as decreased the non-conformity in the quality of deliveries by 28.30%, from 33.33% to 5.03%. Finally, a reduction of 35.40% was obtained, going from spending 93 minutes to 60 minutes in the inspection process.

## VI. CONCLUSIONS

The model based on the Lean Logistic and SRM philosophy in a company in the publishing sector was successfully applied, managing to reduce the high levels of raw material stock breakage, this avoiding shortages in the company, since it decreased in just 3 months of application of the model by 16.04% the rate of stock breakage of raw material. Likewise, it was possible to reduce changes in raw material purchase schedules, non-conformity of the quality of deliveries by the supplier and the time spent in the inspection process of raw material supplied by 29.96%, 28.30% and 35.40% respectively.

The effectiveness of the model showed that Lean Logistic and SRM can be applied in different areas and that it would allow not only to reduce the rate of stock breakage, but to improve the supply process.

On the other hand, it serves as a basis in the literature the effectiveness in the application of the model and how through the use of different instruments the performance and optimization of the processes involved were improved.

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