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# Methodology for the improvement of the urban distribution process in a logistic operator based on Value Stream Mapping

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***Abstract:*** *The generation of standardized processes with better performance and efficiency for the opportunity to develop change methodologies in search of continuous improvement and that are applied in a prudent time, for this the Value Stream Mapping is coupled perfectly and even more yes it is presented in a logistics organization and in a matter such as the urban distribution, with the objective of reduce the novelties in the process of urban distribution of a logistics operator, to implement a methodology based on the mapping of the value chain (VSM).The waste that is presented in the operation is determined, which is identified in the news of the delivery, which means 29.3% of all the delivery news in distribution. The participation of the personnel in the percentage was determined and it was reflected with the application of the action plans in the decrease of these in a 9%.Based on the VSM tool, the standardization of the process was generated and the elimination of activities that did not add value within the urban distribution operation that generates the decrease in the news and the increase in management indicators.*

***Keywords****-Logistics, Lean manufacturing, VSM, reduction of novelties.*

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## I. INTRODUCTION

At present, logistic processes and land freight transport perceive the requirements and demands of customers, who are looking for a provider with excellence in operational management and adding value through the provision of services [1], which requires shorter operating times, an increase in service to the end customer and coverage in terms of quality, delivery and order fulfillment, since, in definition logistics considers the delivery of the correct quantities, on time and to the right customer of a product or service offered [2].

The study company is an integral Colombian logistics operator, whose transportation business unit provides service to customers operating 24 hours a day, 365 days a year. The urban distribution operation in the city of Bogota is centered on the Cross Docking platform, which is understood as a technique to shorten the product's time spent in intermediate stages of the chain, as well as a distribution system in which the goods received is not stored but prepared immediately for its next shipment [3], which explains that the flow of the product is continuous and storage is avoided.

In the case study, what is understood as indirect Cross Docking is carried out, where the distributor receives the load from the clients by shipment groups and this is deconsolidated and then it is grouped in orders to be delivered to different destinations [4], which indicates that the handling of the goods is greater than what could occur in a direct cross docking where the preparation of the products by recipient is no longer done in the warehouse of the distributor, but the customer does at the time of preparation before the goods are dispatched [3]. With Cross Docking, tasks are eliminated so that the product enters and leaves the distribution platform as soon as possible, which requires good coordination between the logistics operator and the customer, as well as being guaranteed:

- Handling of the correct product, neither quantity nor quality must be allowed to fail.
- Correct information, must comply with established delay times
- Correct means, transport and handling equipment
- Trained and motivated staff [5]

In these cases, having a rigorous process with the lowest level of failures establishes an added value perceived by the client. Given the importance of the operation in the organization is formulated the implementation of Value Stream Mapping, lean technique, which allows to detail in a very timely and complete flow of an entire process or value chain for the product to reach the end customer or a specific service in optimal conditions [6], this will provide an overview, leading to the generation of improvement opportunities at the process level, in addition to the objective of reducing novelties.

**1.1 Literary review**

A. VSM main features

This methodology is based on the visual representation of the current situation and the idea to reach in a productive process in which a lean manufacturing system is implemented where large flows are included: The operations of the process sequence, materials, products and information. In the context in which lean management considers the entire flow from the supplier to the final recipient and uses visual management tools, the VSM plays an important role. It should be noted that VSM tool, which is a graphic method of the flowchart of a process, seeks to illustrate, analyze and improve the steps required to reach the final stage of a product or service [8], the key element of its use in a Lean context is the identification of opportunities for improvement, where the current situation is used as a diagnosis and starting point for the design of the future situation, thus the VSM becomes a tool for standardizing flows, obtaining information for improvement [7]; because with this tool you do not reach the end but the beginning in the management of the value chain, in Deming's terms the Value Stream Mapping is the "P" in the PHVA cycle. [9].

B. VSM Case Studies

A solution methodology is presented that is recognized by its ability to know a process and find weaknesses to turn them into improvement opportunities and create a standardized process with the best flow that can be obtained.

In order to know about this methodology, a research of several articles and projects based on the implementation of Value Stream Mapping in business processes is presented in order to identify the multiple strategies that are presented with this approach and to encompass other points of view so that the process to be carried out is documented and developed as best as possible.

A current state of the system is elaborated through the use of the VSM, with the purpose of searching for improvement opportunities that can present the productive process of the company as an example of the implementation. [10], therefore, two proposals are generated for the improvement of the operation, in which a considerable reduction in lead time would be achieved, going from fifteen days to eight in the future. The time mentioned, with the improvements proposed, is also reduced for both small and large flows, achieving reductions between 25% and 27%.

The next step is to draw a map of the future state which is an image of how the production process should be established after the waste and debris has been removed. This final VSM is created based on answering a series of questions on issues relevant to efficiency, as well as the implementation of technical issues related to the application of lean techniques [11]. The results are presented in the form of mapping of current and subsequent processes and the improvement is shown in the reduction in value added and production time, the flow of information and communication between processing lines improved by pacemakers in the process, just as the process became from push to pull by the Kanban system.

Bottlenecks are identified in the operation to generate improvement opportunities that contribute to growth in process quality and cost reduction. The implementation of VSM on the PCB assembly line was demonstrated to reveal obvious and hidden residues that affected the productivity of smart label production. This hidden waste was related to the high changeover time in the PCB assembly line insertion process and induced high WIP [12].

The combination of Value Stream Mapping with process-oriented accounting makes it possible to calculate sustainability indicators in order to improve the efficiency of resources in the value flow of a process. Sustainability actions that increase costs and increase revenues are presented, as well as accounting for the energy used in the process and the waste presented [13].

## II. METHODOLOGY

Through the development of the study, a methodology is established based on the implementation of Value Stream Mapping, as a tool that aims to eliminate or reduce activities that do not generate value to the process observed, in order to optimize the operation, reduce costs and reduce the number of novelties in the process, following the step by step presented in Fig. 1.

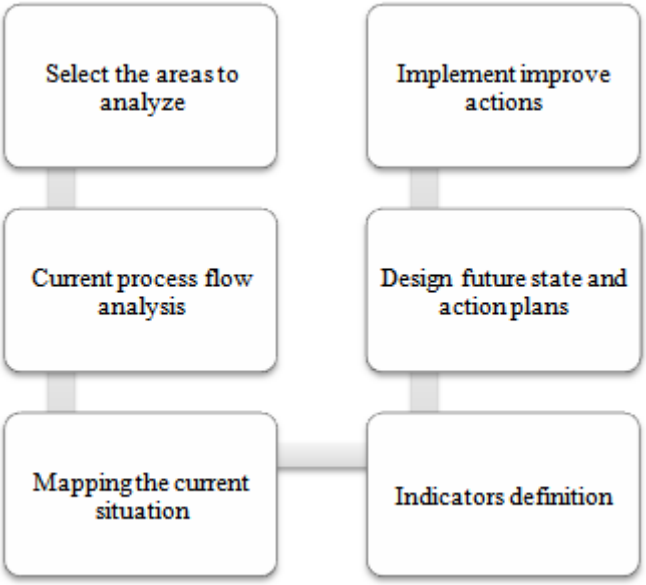


**Fig. 1**. VSM Implementation

A. Selection of areas to be analyzed. Diagnostic stage

This stage defines the area of analysis, which will be the flow of urban distribution operation in the city of Bogota.

Additionally, starting with the diagnosis, this process is developed during a prudential period of time, where both the periodic visit and the documentation process are used as a technique for field work through the use of the Value Stream Mapping methodology, living the daily routine of the work and finding opportunities for improvement, as well as monitoring the documentary methods that interact with the flow. Among the activities that were carried out, it is worth highlighting the accompaniment in distribution and collection of goods at an urban level and the work on the Cross Docking platform at night, participating in activities of loading and unloading of goods, according to the routing and orders by recipients as well as meetings with the operation team and the quality area of the company, because the dialogue with different actors allows the understanding of the vision of the operation.

B. Information and material flow analysis

At this stage, the operation is detailed and the process of urban distribution is described in general terms of the flow of goods, which comprises 3 main stages as shown in the Fig. 2.

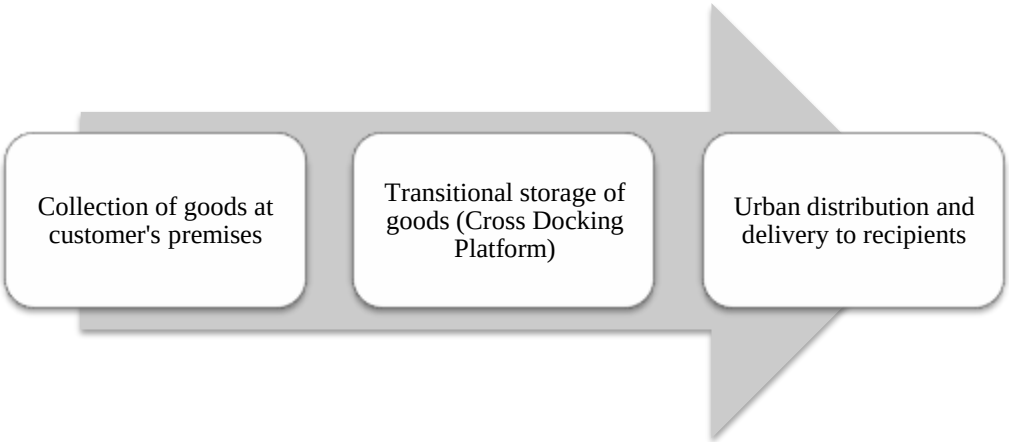


**Fig. 2.** Flow of goods in process of urban distribution.

The first stage consists of the collection of goods, which considers the accuracy in terms of quantities and information and the optimal conditions of the goods, considering this as the key stage as it is the cornerstone of the process not to be affected later on the flow of the goods. This stage ranges from the customer's request for the collection of goods to the unloading of the goods on the Cross-Docking platform. When goods are unloaded, the analysis and revision of the goods must be exhaustive, since, being a manual process, the quantities

described in the receipt document, which is not standard for all clients, are validated visually and by counting, but it must allow the verification versus the labels of the goods unloaded.

The second stage of the flow of goods corresponds to temporary storage on the platform, which is zoned according to the type of customer or the destination of the goods, for subsequent routing and preparation of orders, and loading the vehicle for delivery.

Within the platform must ensure proper handling and storage while preserving the optimal conditions of the goods, to perform the coordination of the route takes into account: priority, distance between delivery points, quantity and type of goods, whether dry cargo or cold chain, and this routing is reflected in the delivery sheet, the participants in the process must know exactly the zoning of the platform so that search times are reduced during the identification and readiness of orders Finally, the third stage is urban distribution and delivery to the recipient, which begins from the loading of goods to the delivery vehicle meeting the appropriate conditions, route opening, transit, unloading and delivery to the recipient. This stage requires that the interrelationship between actors considers adequate communication and preserves good practices according to different roles, such as loading and delivery. In addition, it considers the flow of information during the process consisting of physical papers that are supported by a company's own information system. The management of novelties throughout the process has its communication channel through the Customer Service area.

C. Mapping the current situation

With the application of the proposed methodology, the mapping of the value chain of the current state of the case is graphically presented in the Figure 3, where a detailed step by step of the operation is presented that makes the process understand and can show the problems or opportunities for improvement.

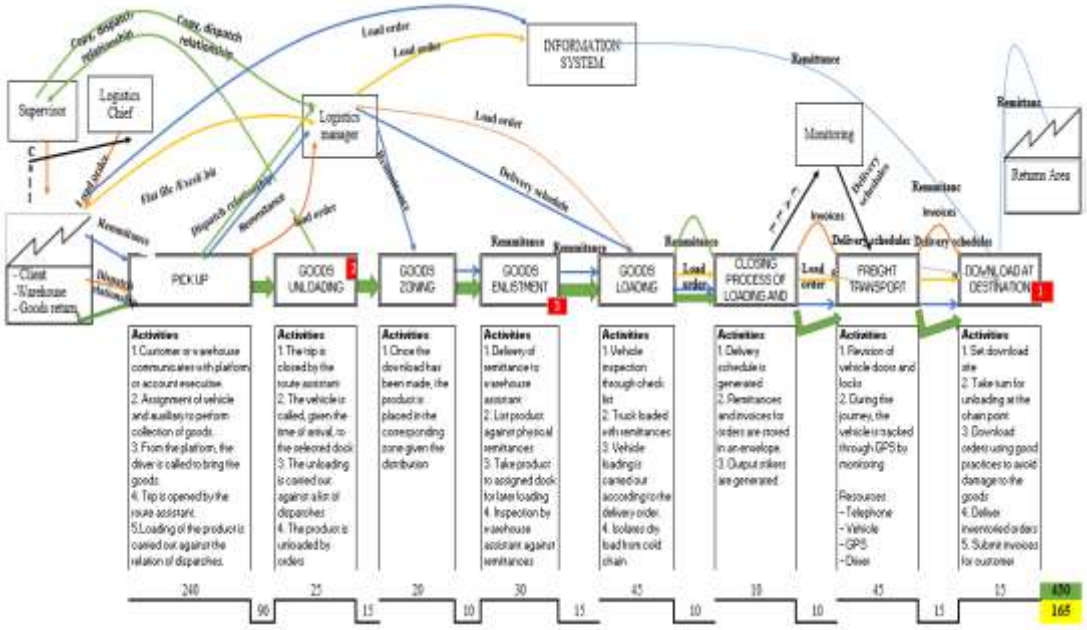


**Fig. 3.** Current status of value stream mapping

D. Indicators definition

This stage of the proposed methodology follows a structure that consists of the quantifiable definition of the problem as the presence of delivery novelties in urban distribution, which are understood as a failure in any of the 5 components of the perfect order defined by the company, documentation, quantity, time, correct place and goods without novelties, so the analysis of the operation is carried out based on the presence of these delivery novelties during the year 2017 the possible causes are established by answering the questions: how does the problem occur?, who influences the occurrence of the problem?, what causes the problem? and when does the problem occur?, After this, critical variables are defined that are presented as indicators, although different types of logistics indicators are known, such as financial, time, quality, productivity and logistical excellence [14] in the development of the methodology, the logistical excellence indicator associated with the level of service is taken and can be understood as the moment of truth of the operation in front of the client. In the case study, this indicator is called perfect delivery within the system of performance indicators that are currently handled called KPI (key performance indicators), these are based on the level of service, which is expressed as the level of compliance with the established service objective, as presented in (1).

SL=(p/T)X 100 (1)
Where:
SL = Service level expressed as a percentage
P = Perfect services quantity
T = Total amount of services ordered by the customer
According to the approach of [15] when analyzing the expression (1), P can be associated as the number of successful events and T as the total of planned events, so that SL will be the probability of perfect compliance in the operation.

E. Designing the future state and generating action plans

In the case of the generation of action plans aimed at the reduction and/or elimination of activities that do not provide added value and an increase in flexibility of the process that depends on the capacity and ease of change, and the versatility of the staff [16], after identifying opportunities for improvement are determined the waste in the process associated with each one that according to [17] for the case of distribution can adjust the 7 waste defined in the Toyota Production System with its acronym TPS and are presented in Table 1.

**TABLE 1**. Seven TPS wastes according to distribution

| No. | Lean Distribution Waste | Lean Manufacturing Waste |
|---|---|---|
| 1 | Faster distribution rate than necessary | Overproduction |
| 2 | Wait time | Wait time |
| 3 | Unnecessary transport | Unnecessary transport |
| 4 | Processing | Inadequate processing |
| 5 | Overstock | Unnecessary stock |
| 6 | Unnecessary movement | Unnecessary movement |
| 7 | Error correction | Defects |

Following the above adjustment, each waste is understood as, faster distribution rate than necessary, accelerate the chain or preparation of orders faster than those required by the customer, either internal or external. Wait time, presence of downtime due to lack of synchronization, materials, inputs elements or presence of bottlenecks; transport, losses due to excess internal transport or unnecessary transport; Processing, effort that does not add value to the customer's criteria; excess stock, material supplies or elements that exceed the requirements of the process and leads to unnecessary storage; unnecessary movement, activities carried out that are not relevant within the process, as well as misplacement or movements that do not contribute to added value; error correction, time and resources allocated to the attention of activities that do not meet the optimal conditions of quality, as well as to the inspection, reprocessing of activities.

This categorization facilitates the establishment of action plans under the lean methodology, in the context of continuous improvement, such improvements re-establish the activities that create value to the process, establishing how to provide the service in the correct way so as not to generate waste and make the creative stages of amount flow [18], which are presented in a result on the future flow of the expected operation after the elimination and/or reduction of waste, idle time and novelties in the process that is detailed in the final VSM, which is presented in the Fig 4.

F. Implement action plans and benchmark indicators

This last stage describes the changes presented between the VSM of the current state and the VSM of the future situation, as well as the impact of the action plans and the results obtained, which are reflected in the comparison of defined indicators, where there is a decrease in delivery novelties in the urban distribution process.

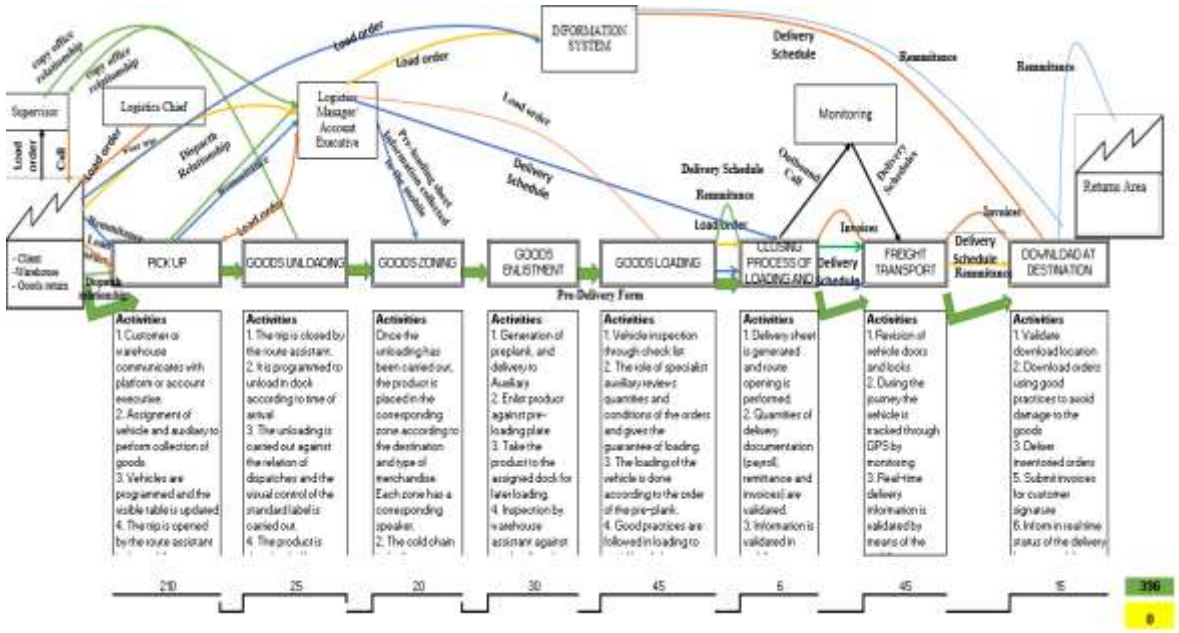


**Fig. 4.** Future status of value stream mapping

## III. RESULTS

A. Opportunities to improve the current situation

After the diagnosis made to the operation and presenting it in the VSM of the current state it is possible to evidence the following problems or opportunities for improvement:

- Delay in loading route start due to vehicle availability and verification There is no availability of manual stevedores or hydraulic jacks.
- Reprocessing in digitalization of remittances due to errors in delivery addresses.
- Non-standardized goods identification labels
- There is no standardization on the traceability of novelties or causes.
- Non-compliance with the pictograms of the boxes at the time of stowage
- Damaged goods by bad manipulation and launching of boxes in the unloading and loading of vehicles.
- High percentage of pallets in poor condition
- Delay in changing vehicles at loading docks
- Temporary storage is not properly detailed and there is confusion when looking for a product to proceed with loading.
- Delays in the process of verification of goods, unnecessary reprocesses and filters in the revision.
- Delay in the preparation of the goods due to lack of availability and appropriate order of the necessary inputs for the packaging.
- There is no order in the cubing of vehicles during loading in pick-ups.
- The report of novelties of delivery or pickups is not in real time
- Errors in the processing of client documents due to incorrect completion of delivery documentation.

B. Indicators definition

How does the problem occur?

From the follow-up to the deliveries presented during 2017 and reflected in the company's own information system with which traceability is maintained, it is determined that the delivery novelties are coded in 64 causes of return and classified in turn in 4 types, the first correspond to direct causes of the company where the operation has direct interference, the second correspond to causes of the customer, then there is the type of causes in which the recipient is responsible and finally there are external causes that correspond to those of force majeure.

Of the direct causal category of the company, this impacts on the service level of the operation which represents a 29.3% share of deliveries made in the same period according to figures obtained from the logistics operator's information system.

This group is made up of 35 different causals, in Fig. 5 the criticality is established according to their participation.

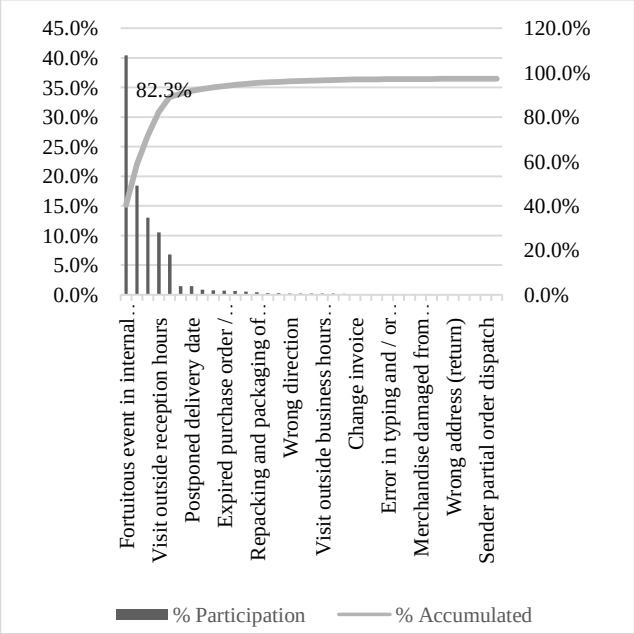


**Fig. 5.** Type of novelties presented in 2017

From Fig. 5, the causes of return or critical novelties are presented in Table 2.

**TABLE 2.** Critical return causes

| N. | Return reason (Novelty) |
|---|---|
| 1 | Fortuitous event in internal operation |
| 2 | Goods in poor condition and not suitable for delivery<br>Merchandise in poor condition not suitable for delivery |
| 3 | Visit outside reception hours |
| 4 | Goods outside distribution hours |

Who influences the occurrence of the problem?

In the urban distribution process, 299 collaborators participate, among them distribution assistants, loading and unloading assistants, platform supervisors, typists, documentation supervisors, route coordinators, operations coordinators, logistics managers and account executives, all being participants in the handling of goods, planning and preparation of deliveries in urban distribution. In this operation, there is a high rotation of personnel presented in Table 3, which leads to wear and loss [19]. In addition, considering the importance of the learning curve and experience versus productivity [20], it is not convenient to have a high rotation, especially of the warehouse assistants, who maintain an active role in the entire flow and handling of the goods.

**TABLE 3.** Staff turnover rate in 2017

| Month | Rotation Index |
|---|---|
| Jan | 11.41% |
| Feb | 5.15% |
| Mar | 5.31% |
| Apr | 2.64% |
| May | 7.89% |
| Jun | 9.35% |
| Jul | 5.33% |
| Aug | 8.54% |
| Sep | 10.79% |
| Oct | 3.13% |
| Nov | 6.18% |
| Dec | 12.79% |

What causes the problem?

In synthesis, of the opportunities for improvement found in the VSM of the current state, the following causes are presented:

- Goods handling in the following processes: collection of goods from customers, unloading on a platform, urban loading, delivery and unloading of goods to the recipient. The handling and processing of information in the system
- The manipulation of documents (remittances, spreadsheets, manifests, dispatch relationship, etc.) that accompany the orders
- Non-standardization of documents.

When does the problem occur?
However, there was a considerable increase in the last month of 2017, as shown in Fig. 6, December being the month in which the most novelties were reported, with a total of 4192.

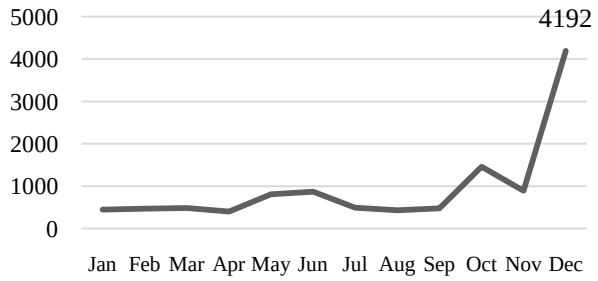


**Fig. 6.** New products performance month to month year 2017

In relation to the above, there is the participation between the amount of deliveries made in urban distribution versus the amount of novelties presented month by month, showing that the month of December presents 21% of deliveries with novelty, despite not being the month with the highest delivery volume, since that month is October with 54044 deliveries reflected in Table 4, it is worth noting that December is the month of greatest staff turnover as previously presented.

**TABLE 4**. Participation novelties and number of deliveries per month

| Month | Delivery | Number of deliveries with novelties | % Participation |
|---|---|---|---|
| Jan | 18885 | 445 | 2,4% |
| Feb | 24173 | 464 | 1,9% |
| Mar | 26650 | 479 | 1,8% |
| Apr | 22350 | 397 | 1,8% |
| May | 27060 | 808 | 3,0% |
| Jun | 25489 | 862 | 3,4% |
| Jul | 25518 | 491 | 1,9% |
| Aug | 26901 | 428 | 1,6% |
| Sep | 25711 | 475 | 1,8% |
| Oct | 54044 | 1452 | 2,7% |
| Nov | 27623 | 885 | 3,2% |
| Dec | 19596 | 4192 | 21,4% |

From the foregoing information, it may be noted that although December is not the month with the highest number of deliveries, it is the month with the highest number of new items mentioned above, and additionally in relation to this, there is the highest turnover of personnel in the operation, personnel being understood as the determining factor in the presence of new items.
After the analysis of the process information in Table 5, the defined indicators to be impacted are presented.

**TABLE 5.** Defined indicators

| INDICATOR |
|---|
| Total deliveries with novelty |
| Fortuitous event in internal operation |
| Goods in poor condition and not suitable for delivery |
| Visit outside reception hours |
| Goods outside distribution hours |

C. Waste and selection of disposal techniques

Table 6 presents the improvement opportunities or problems identified in the VSM of the current state in terms of the indicators already defined, each problem has the waste identified following the adjustment of the TSP waste for distribution of [17], according to the type of waste and in the context of the indicators defined, the lean techniques are established that facilitate the reduction or elimination of them.

**TABLE 6.** Waste and disposal techniques

| Indicator | Problem /Improvement opportunity | Identified waste | Lean technique |
|---|---|---|---|
| Visit outside reception hours | Delay in loading route start due to vehicle availability and verification | Wait time | Visual Control |
| Fortuitous event in internal operation | No manual stevedores or hydraulic jacks available | Waiting time | 5s – Set in order |
| | Reprocessing in digitalization of remittances due to errors in delivery addresses. | Error correction | Poke Joke<br>5s – Standardization |
| | Non-standardized goods identification labels | Processing | |
| | Loss or breakdown of delivery documentation (remittances) in loading processes due to non-standardization of loading document and enlistment. | Error correction | |
| | There is no standardization on the traceability of novelties or causes | Processing | |
| Goods in poor condition and not suitable for delivery | Non-compliance with the pictograms of the boxes at the time of stowage | Error correction | 5'S - Sustain |
| | Damaged goods by bad manipulation and launching of boxes in the unloading and loading of vehicles. | Error correction | Training |
| | High percentage of pallets in poor condition | Error correction | 5'S - Shine |
| Goods outside distribution hours | Delay in changing vehicles at loading docks | Wait time | Visual Control |
| | Temporary storage is not detailed and there is confusion when looking for a product to load. | Processing | |
| | Delays in the process of verification of goods, unnecessary reprocesses and filters in the revision. | Unnecessary movement | |
| | Delay in the preparation of the goods due to lack of availability and appropriate order of the necessary inputs for the packaging. | Wait time | Cell organization<br>5s – Set in order |
| | There is no order in the cubing of vehicles during loading in pick-ups. | Unnecessary transport | |
| Deliveries with novelties | The report of delivery or pickup news is not in real time | Processing | Poke Joke |
| | Errors in the processing of Client documents due to failure to complete the delivery documentation correctly | Error correction | 5s – Standardization |

D. Future situation and implementation

The proposed methodology of the future VSM proposes the creation of action plans to address the opportunities for improvement which are detailed below:

- Acquisition, use and management of benches for the loading and unloading of goods with their respective training plan and awareness of use.
- Acquire new conveyor belts that help minimize the passage of goods between collaborators train in their use.
- Plan for the marking of manual stevedores and the delimitation of the zone for their location.
- Establish a training plan for the operations according to the needs of the operation, which includes examples
- Carry out a program to reduce and eliminate nonconformities related to platform breakdowns, designating those responsible within the operation.
- Plan for change of pallets in poor condition
- Standardization of document for the enlistment of the orders and load of the vehicles different from the document of delivery
- Standardization of the goods identification label for all customers with their respective dissemination and implementation plan.
- Implement preventive signaling to delicate goods
- Implement an application for the management of documentation, tracking of orders and generation of returns in platform.
- Implement a visible table for operational staff and drivers presenting vehicle programming
- Determine the cubing order of the goods according to the type and destination in the collection process.
- Establish trainings for administrative and documentary processes of the operation for collaborators and clients of the organization.

As a recommendation to note that the aspect of training is key, when starting the operation with a new client this must perform technical training and inside the facilities of the platform, before the first delivery, to ensure proper handling.

Within the changes that were generated with the development of the action plans versus the initial situation of the process in context reflected in the future VSM versus current VSM situation:

- It develops the implementation of a mobile application for the completion, sending and receipt of physical documents that were handled in the process, in addition to being able to generate the report of developments through the same and in real time, connected to the operation and customer service area.
- Pre-planning document was generated, designed for the process of preparation and loading of the goods, which avoids reprocesses in the delivery documentation.
- Standardized goods information label
- The training matrix is updated and the training program was generated for platform personnel to reduce staff turnover and who have more expertise in the process in order to reduce product manipulation novelties.
- Vehicle programming, docks and timetables are presented visually
- Operation times are reduced thanks to the purchase of more hydraulic jacks and electric belts to facilitate the loading and unloading of vehicles impacting on the novelty "fortuitous case in internal operation".
- The role of Auxiliary Specialist is created to support the review of orders in the load.

Another key aspect that is achieved with action plans is to favor multiple skills (polyvalence), participation and empowerment of staff.

In addition, when establishing a good chain management this should seek, among other things, the possible improvement of the flow of information, since with little effort are obtained reductions in time and improvements in quality [5].

E. Indicators comparison

After the implementation of the action plans proposed to achieve the situation outside the process, the results are consolidated and presented in the comparison of the indicators as shown in Table 7.

**TABLE 7**. Comparison indicators

| INDICATOR | Result 2017 | Result 2018 | Variation | Interpretation |
|---|---|---|---|---|
| Total deliveries with novelty | 29.3% | 20.44% | -9% | Decrease |
| Fortuitous event in internal operation | 40.4% | 30.7% | -10% | Decrease |
| Goods in poor condition and not suitable for delivery | 18.4% | 14.1% | -4% | Decrease |
| Visit outside reception hours | 10.5% | 10.3% | -0.2% | Decrease |
| Goods outside distribution hours | 7% | 3.7% | -3% | Decrease |

## IV. CONCLUSION

The development of the VSM in the current operating situation, allowed to obtain a decisive diagnosis for the detection and analysis of failures and novelties that were presented, in terms of the type of waste generated, which led to improvement actions and lean tools, allows to approach what was designed in the VSM future situation.

It should be noted that the implementation of the VSM requires that the opportunities for improvement or failures found be interpreted and reflected in action plans covering the tasks to be developed to improve the processes, since it is considered that the tool itself does not correspond to an improvement mechanism.

This research has shown that by implementing the VSM there is a reduction in the number of deliveries with novelties of 9%.

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