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Increasing Customer Service Level in Distribution Operations

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Abstract

This work describes an approach to define a distribution strategy to increase the level of customer service of a Mexican Third Party Logistics company. This is based on the application of a scheme for increasing efficiency by eliminating waste in the distribution operations on a detailed level. The Total Operational Vehicle Effectiveness (TOVE) index is used as the main performance measure. Availability, performance and quality wastes are identified using a Transportation Value Stream Map (TVSM) of the transportation operation. The implementation of the improvement initiatives is still in progress but the projected and available results are provided.

Keywords
Transportation waste elimination, lean transportation, value stream map, transportation efficiency

1. Introduction
According to Christopher (1992), a key feature of present-day business is the idea that it is supply chains that compete, not companies. Fisher (1997) and Hill (1993) suggest that supply chains must acquire capabilities to become efficient and/or agile in accordance with the type of products they market. The concepts of order qualifiers and order winners were developed by Hill (1993) to link the definition of manufacturing strategy to the marketing strategy. This idea is extended by Masson-Jones, et al., (2000) to the delineation of the supply chain strategy. They also suggest that the lean based strategy is the best option when the order winner is cost, and that an agile based strategy should be preferred if the order winner is customer service. Masson-Jones, et al., (2000) and Christopher, et al., (2001) recommend approaches for the development of strategies for leagile supply chains, that is a chain in which both, leanness and agility, are sought and achieved. In fact, Christopher, et al., (2001) contend that lean methodologies are important contributors to the creation of agile systems.

The previous competitive context is similar to the one that a Mexican Third Party Logistics (3PL) company faces. This firm provides transportation and warehousing services to a Mexican brewing company. There is a high pressure to keep costs down and to improve significantly its customer service level. It has to be a leaner and more agile company to survive.This report consists of five sections. The next section deals with a brief review of the literature on the concepts of lean, agility and lean transportation. Then, a description of the scheme utilized is described in section 3. The application of this scheme is undertaken in section 4, and section 5 presents a summary of conclusions and recommendations.

2. Previous Research
Figure 1 shows a scheme provided by Villarreal, et al., (2015) to facilitate the definition of a strategy to obtain greater levels of supply chain agility. According to this model, agility could be achieved through strategies based upon waste reduction and flexibility along the chain and/or strategies defined to improve integration and synchronization. The focus is on the elimination of waste in the distribution part of the supply chain. More specifically, initiatives looking to eliminate waste on the transportation operations will be suggested to improve agility.

2.1 Literature on Lean Transportation
The literature research on the development of concepts, methodologies and applications of lean thinking in the transportation sector is rather limited. Most of the existing work concentrates on the definition of wastes specific to this process (McKinnon, et al., 2003, McKinnon, et al., 1999).

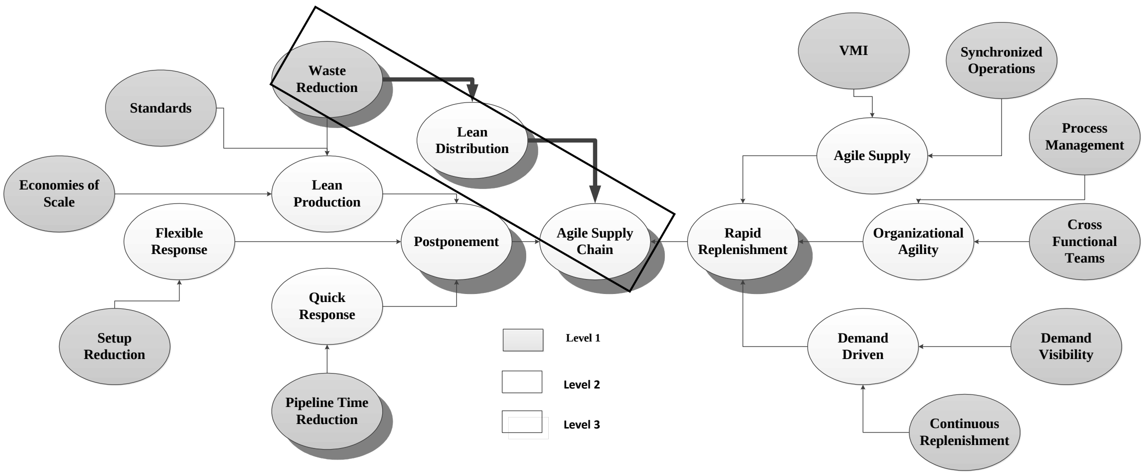

Figure 1 Scheme of initiatives to provide higher levels of supply chain agility

2.1 Literature on Lean Transportation

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Two main approaches based on waste elimination have been suggested for increasing transport efficiency: The first scheme was initially proposed by Simmons, et al., (2004). This contribution recommends a new measure called Overall Vehicle Effectiveness, OVE, to be used for improving the performance of truck transportation. This is an extended version of the Overall Equipment Effectiveness indicator employed in lean manufacturing to improve single equipment efficiency (Nakajima 1988). A modified version of the OVE measure is suggested by Villarreal (2012). This is called TOVE and considers total calendar time instead of loading time and includes additional waste concepts as shown in Figure 2. Under this approach, waste elimination is concentrated on achieving the highest truck efficiency, similar to what the OEE looks for in a manufacturing machine. Thus, operations mapping and waste identification is carried out following the truck.

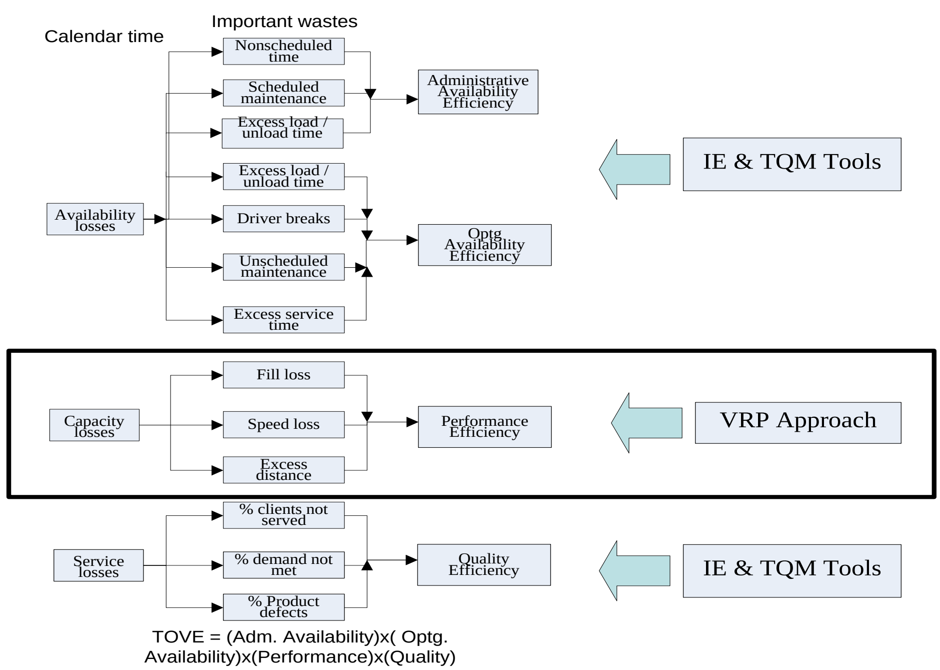

Figure 2 Structure of TOVE Measure

As illustrated in Figure No. 2, four components for the new efficiency measure are suggested; Administrative or strategic availability, operating availability, performance and quality efficiencies. The new measure would be obtained from the product of administrative availability, operating availability, performance and quality. There are several waste concepts associated with each efficiency factor. For example, fill loss, speed loss and excess distance travelled are wastes that impact performance efficiency. Wastes related to quality efficiency are the percentage of demand not satisfied or product defects originated by mishandling during transportation. Driver breaks, breakdowns and corrective maintenance, and customer excess service time affect operating availability efficiency.

The concept of vehicle administrative availability is important because it has a significant impact on the overall vehicle utilization and efficiency. It is mainly the result of administrative policies and strategies related to capacity or maintenance decisions. The main waste associated with this concept is nonscheduled time. It has been found that waste related to operating and administrative availability (Treviño, et al., 2008, Villarreal, et al., 2009a, Villarreal et al., 2009b) and fill loss values (Lohatepanonto, et al., 2006, Moore, et al., 1991, Nadarajah et al., 2007) are very important. As Figure 2 illustrates, the elimination of waste related to the performance efficiency factor can be done by the application of Operations Research (OR) techniques (Golden et al., 1988, Laporte, et al., 1995). Similarly, availability and quality related waste can be reduced applying Total Quality Management (TQM) and Industrial Engineering (IE) methodologies. The identification of improvement opportunity areas can be facilitated by a value stream map for transportation processes (TVSM) provided by Villarreal (2012) that concentrates on identifying waste related to transport efficiency.

The second scheme is provided by Sternberg et al., (2013). They propose the identification and elimination of transport wastes that are an extension of the seven wastes suggested by the Toyota Production System (TPS). Figure 3 (from Sternberg et al., 2013) illustrates a description of these wastes in a transportation setting. A case study carried out through in-depth interviews with experts from the transportation and the lean fields resulted in this adapted waste framework.The result of this study was that five out of the seven classical waste types can be applied in this waste framework, but two do not fit, namely waste of excess inventory and conveyance. Instead, two new waste types are included: resource utilization and uncovered assignments. As it is the case for manufacturing operations, under this approach, operations mapping and waste identification is centered in the operations process following the product, instead of the manufacturing machine or truck.

Waste	Description	Source
1. Overproduction	Producing reports no one reads or needs, making extra copies, e-mailing/ faxing the same document/ information multiple times, entering repetitive information on multiple documents and ineffective meetings	Definition by Tapping, et al., (2006) confirmed in the empirical study
2. Waiting	Employees having to stand around waiting for the next process step, such as loading and unloading, or just having no work because of lack of orders, processing delays, equipment downtime and capacity bottlenecks	Definition from production (Liker 2004), loading and unloading added as a common cause for waste of waiting noted from the emprirical study.
3. Incorrect processing	Consuming more resources for moving the goods than necessary due to inefficient routing or driving	Definition suggested based on the empirical study.
4. Unnecessary movements	Any wasted motion employees have to perform during the course of their work, such as looking for information, reaching for, or stacking goods, equipment, papers, etc. Also, walking and extra movement created by sequencing errors is waste. This was found to be synonymous with conveyance	Definition by Tapping, et al., (2006), movement due to sequencing errors added from the empirical study.
5. Defects	Waste caused by repairs, redelivery, scrapping, etc., due to damages on the transported goods or the equipment	Damages to the equipment added to the production definition, in alignment with the empirical study.
6. Resource utilization (new)	Waste due to excessive equipment and bad resource planning	Definition suggested based on the empirical study.
7. Uncovered assignments	Carrying out unprofitable transport work due lack of information or planning	Definition suggested based on the empirical study.

Figure 3 Description of seven wastes extended to transport operations

3. A Lean Routing Scheme

According to [15], routing activities could be defined as In-Tansit (IT), that is, while the transportation service is in process, otherwise it would be Non-In-Transit (NIT); i.e. loading or unloading product at a distribution centre. Let us define as the transportation journey (TJ), the time specified for the transportation activity for the team of operators and the vehicle. This may be a fixed period such as a shift of eight hours, or variable depending on the distance required to travel to the customer. We will assume that there always be 24 hours per day available for the service, and so, several routing journeys (or services) are during a day. An activity is defined as Internal if it is carried out during the TJ by the team of operators with the vehicle. If it is carried out off the TJ or by another organizational entity, the activity is called External. The ideal would be that NIT activities are also external, and IT activities are carried out internally.

A general procedure for reducing transportation waste that is adapted from the broad scheme suggested by Hines et al., (2000) is provided by Villarreal et al., (2009b) to apply a lean improvement approach. The scheme suggested by Villarreal (2012) to reduce waste in transportation that is illustrated in Figure 4. The first step is the description of the transportation activities in detail complemented by the estimation of the TOVE index and the elaboration of the corresponding TVSM. The structure of the map can be divided into the macro context and the micro analysis phase.

The following stage consists of identifying waste at the macro level and particularly looking for opportunities to improve administrative availability. The macro context is directed to identify the macro characteristics of the route, namely; Average journey duration, the modified TOVE index and its components, vehicle administrative availability utilization based upon calendar time, availability wastes occurring off the route (such as vehicle nonscheduled time and scheduled maintenance time) and the proportion of internal and external activity time. This part of the map may serve to guide the improvement efforts according to the values of the TOVE factors; Availability, performance and quality. At the same time, if all the transport activities are internal there will be an important opportunity to improve vehicle efficiency.

The following stage focuses on identifying waste at the micro level. Especially, waste that impact on performance, operating availability and quality factors. The micro analysis phase completes the analysis of the wastes that drive vehicle operating availability, vehicle and route performance, and important route quality wastes. In this phase, the availability wastes considered are driver breaks, excess load/unload time and excess time taken by the operating team to carry out administrative activities with the customer. Performance wastes include speed and fill losses and excess distance required to fulfill customers demand. Quality wastes in transporting could refer to administrative errors, product defect generation and route customers not served on time and/or fully.

Given the most relevant waste concepts identified, a strategy for their elimination is devised and implemented in the final stage.

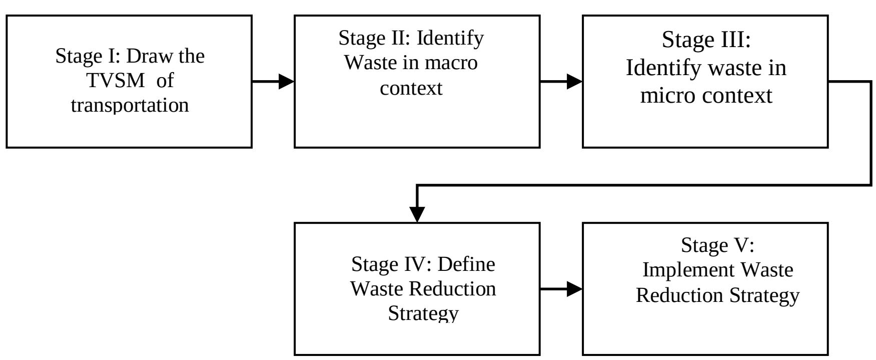

Figure 4 General structure of transportation waste reduction scheme

4. Applications of the Scheme

This section describes the application of the scheme in the distribution operations of the brewing company.

4.1 Waste identification stage

This section is devoted to describe the phases of waste identification for the 3PL company that distributes bottled beer. It is an important company located in the north of México. In particular, we will focus on the distribution from regional distribution centers (DC´s) to retailing points known as agencies of the brewing firm. The company has several regional distribution centers, and for convenience, the one located in Apodaca will be described.

This 3PL firm counts with a fleet of about 96 trucks. The DC serves about 38 agencies. The distribution of beverage is made daily through 38 fixed routes. The main strategic concern of the company in México refers to customer satisfaction without impacting the current distribution cost level.

Mapping the Transportation Process

The first step of the methodology is to map the transportation processes of interest which in this case correspond to the distribution from Apodaca DC to the brewing agencies. The macro TVSM for the distribution operation is shown in Figure 5.

Identify relevant wastes at macro level

As previously stated in section 3, waste identification at this level emphasizes the overall context of the routing process chosen to study. The average journey time for the distribution of goods from the Apodaca DC to the corresponding agencies is 30.4 hrs. All the deliveries are direct to each agency and with two fully loaded trailers. The journey initiates with the asignment of the required number of trucks with two trailers to satisfy agency orders. These are sent from the 3PL facility to the Distribution Center facility. These are loaded with product and returned to the 3PL facility, where they are assembled into one unit. The previous loop is done with a driving crew that has only this responsibility. After the truck and trailers are assembled, they are sent to the corresponding agency. This trip is carried out by another driving crew. Finally, they return to the 3PL facility once the product has been unloaded at the agency. The unit is checked at its arrival for any maintenance requirements. Then the unit is kept at this facility for about 8.3 hrs until it is programmed again. All the activities included in this process, from preparing the routes, serving the agencies until closing every route are executed during the journey, i.e. all are internal.

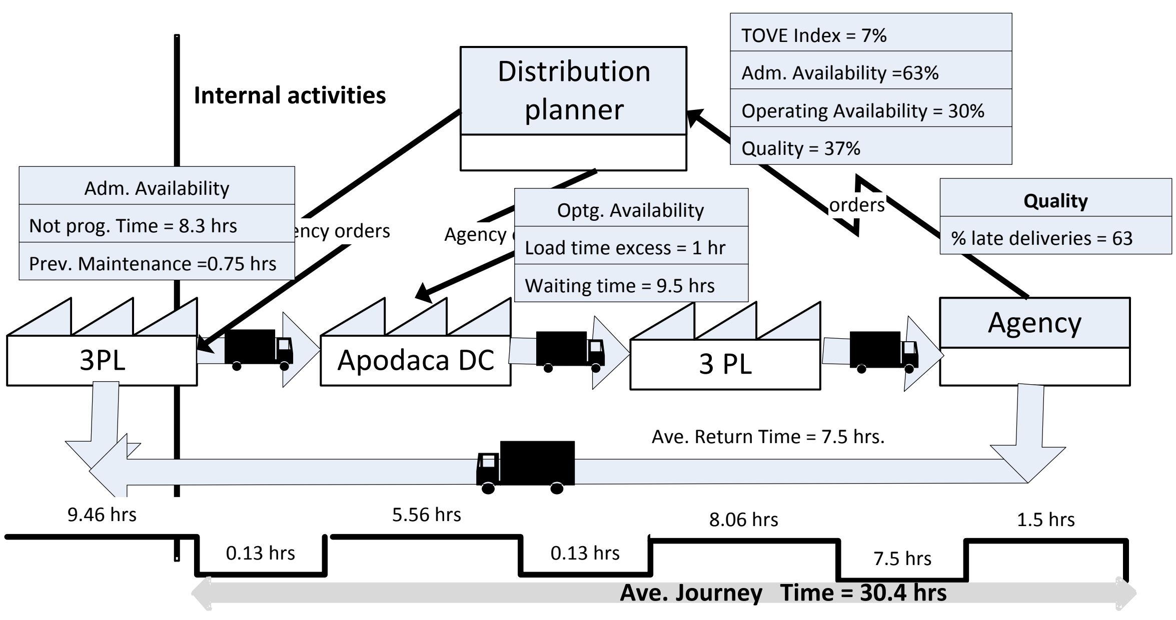

Figure 5 Current TVSM for transport operations

TOVE index is estimated at 7%. The factors with greatest areas for improvement are operating availability with 30% and quality factor is estimated at 37% due mainly to the high level of late deliveries (63%). Administrative availability is estimated in 63% as a result of a non-programmed time of the transport equipment of 8.3 hrs.

Identifying key wastes at micro level

This stage is concerned with the analysis and identification of wastes and their causes in detail. The main area of concern corresponds to the Quality efficiency of 37%. This level is due to a high level of 63% of late deliveries at the agencies. After analyzing the operations, it is found that it is a result of long waiting and wasteful time in the operations of the Apodaca DC and 3PL facilities. These findings impact also the level of operating availability efficiency.

A cause and effect analysis revealed the following root causes:

- An inexistent route program to satisfy agency orders on time.
- Driving units are loaded separately at Apodaca DC without coordination.
- Non-existent equipment tracking and control.
- There is not supervision and control of the loading and shipping operations at Apodaca DC and 3PL.
- Non-existent coordination between Apodaca DC and 3PL personnel.
- Inneficient 3PL layout and loading procedures in Apodaca DC.

The first three causes can be categorized as part of the planning and control area of the company. Even though there is a set of daily orders coming from the agencies, these are not properly used to assign and sequence trailers to satisfy them. Since deliveries must be done with two trailers, this condition is not met. Trailers are sent separately to Apodaca DC resulting in long waiting times to assemble the full delivery. This situation gets even worst with the inexistent equipment tracking and control.

The human side of the problem is shown by the next two causes. Lack of supervision and control of the loading operation in the Apodaca DC facility is a common condition. There are not supervisors from 3PL making sure that trailers assigned to specific orders are loaded in accordance to the required sequence to satisfy agencies demand. Therefore, there is not the required level of coordination between the operations personnel of 3PL and Apodaca DC.

Finally, Loading procedures at Apodaca DC are not optimized and standardized, and the actual 3PL layout is very inneficient.

4.2 Defining waste elimination strategy.

The definition of the strategy required for improving operations depends on the relevant wastes identified. The initiatives suggested for increasing the efficiency level of the distributing operations are:

- Defining an integrated operations planning and control system.
- Improving loading operations in Apodaca DC installation and re-defining 3PL layout.
- Re-defining organizational issues in Apodaca DC and 3PL.

An Integrated Operations Planning and Control System (IOPCS).

The IOPCS consists of the following elements: A backwards agency time window driven program, a transport equipment tracking and control system and an operational performance evaluation tool.

The backwards agency time window driven program is the first component. This program integrates the route schedules for the Apodaca DC and 3PL facilities with the specific time at which each agency requires the service. Figure 6 illustrates the times at which an order from any agency must be scheduled at each facility to satisfy its service time window. These are derived from the time windows set by each agency. Average times for each activity required to satisfy the agency demand are used to estimate the loading and dispatching times at each facility. The resulting program is updated periodically with the last average time values.

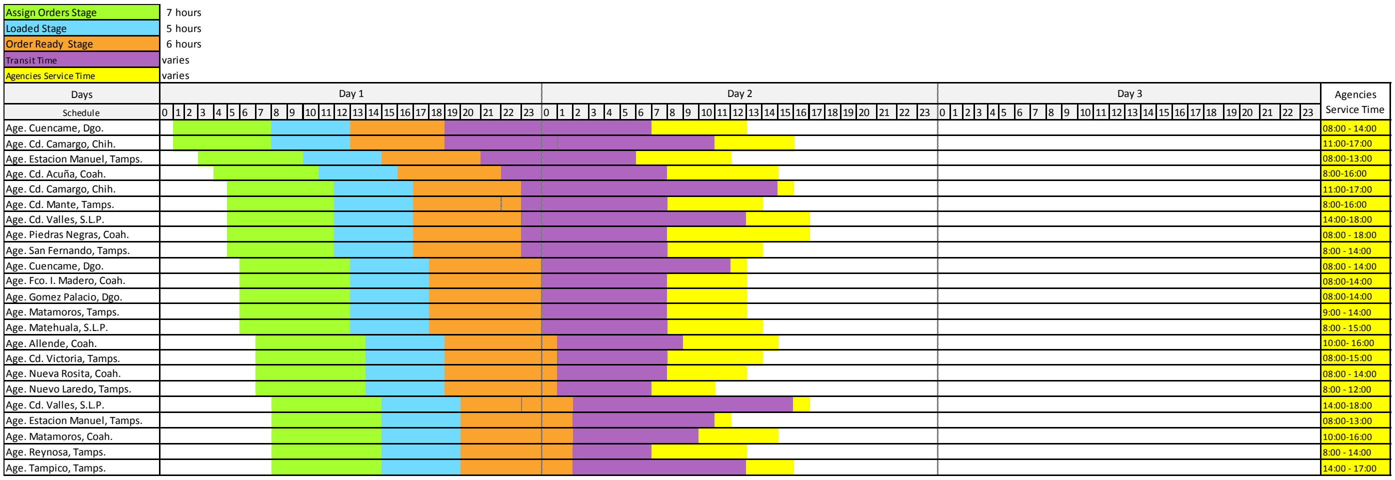

Figure 6 The backwards agency time window driven program

The transport equipment tracking and control system is another important element of the IOPCS. It is very important to identify where each truck and trailer of the company is at any time. This facilitates its assignment to agency orders and to identify potential operational problems that may impact a timely arrival at the agency. Figure 7 shows a screen of the system.

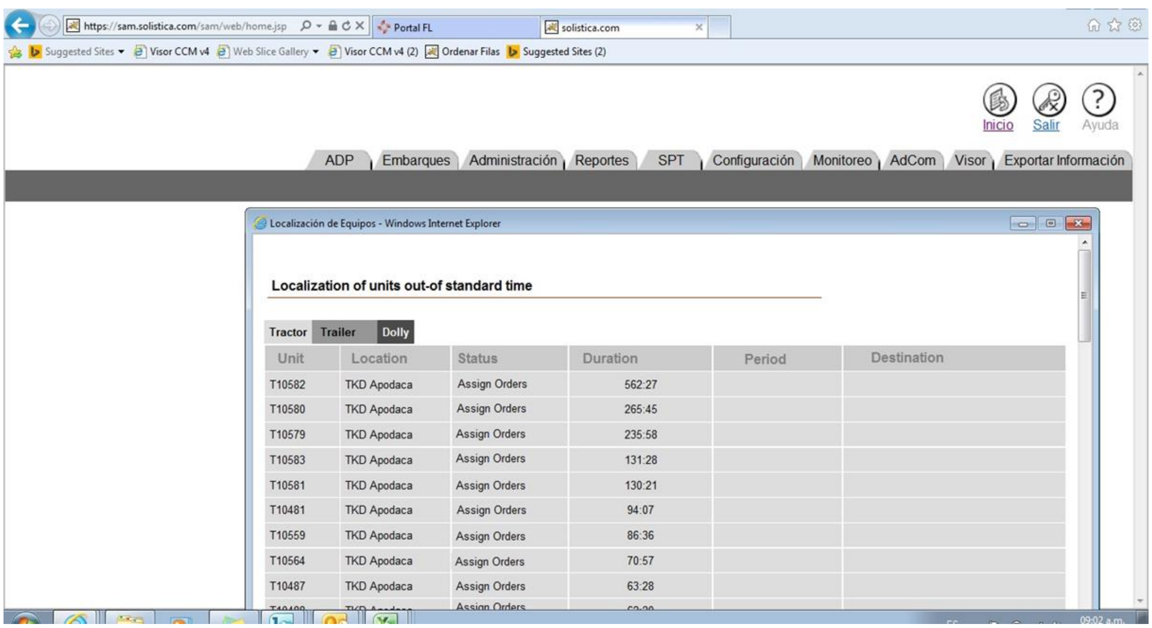

Figure 7 The transport equipment tracking and control system

The operational performance evaluation tool consists of a continuous improvement scheme that measures daily on time delivery indicator, identifies the root cause of each unfavorable incident and eliminates it. Figure 8 shows a sample of the behavior of daily on time deliveries.

Improving Apodaca DC loading operations and 3PL layout

The level of the operating availability efficiency factor of 30% is a result of a load time in excess of one hour and a total of 9.5 hrs waiting time in both the Apodaca DC and 3PL installations. Loading time in excess is a result of an inefficient and non-standardized procedure. There is also a lack of supervision of this operation from the 3PL personnel.

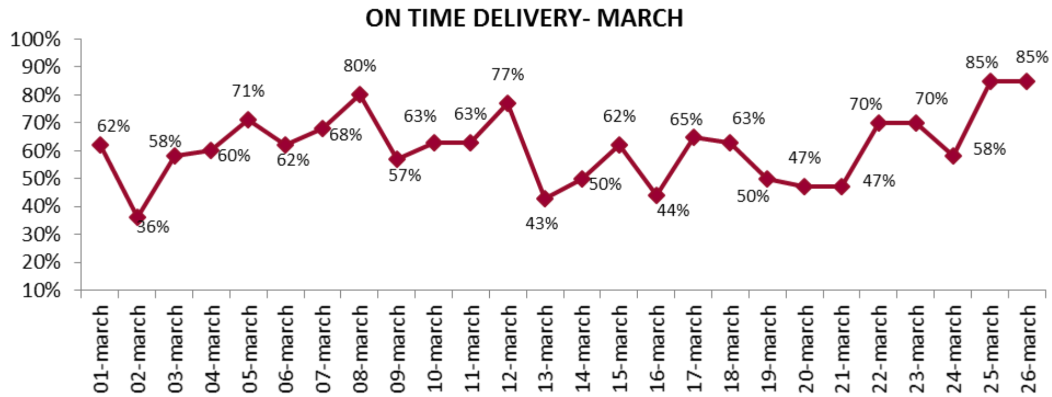

Figure 8 Illustration of the behavior of daily on time delivery

In addition to improving loading procedures, it was necessary to make some modifications on the existing layout of the 3PL facility. The actual layout presented several inefficiencies:

- Trucks, trailers and dollies were located anywhere.
- Aisles and areas for location of equipment did not satisfy the NOM-001-STPS-2008.
- An accident rate of 7% due to equipment mishandling.

Figure 9 presents the layout of the 3PL facility before and after the improvement. Average distance traveled per unit of transportation decreased 7%.

Re-defining organizational issues
The implementation of the previous initiatives required several changes in the roles and functions of some personnel of the 3PL facility. In summary, these are:

- The re-assignment of operations supervisors from the 3PL facility to the Apodaca installation. They are now responsible of insuring the correct sequencing of trailers for product loading.
- The programming and dispatching of transport equipment between 3PL and Apodaca DC, and between 3PL and agencies was assigned to operations supervisors
- The monitoring and control of the distribution operations was assigned to traffic coordinator

Figure 10 presents the layout of the TKD facility before and after the improvement. Average distance traveled per unit of transportation decreased 7%.

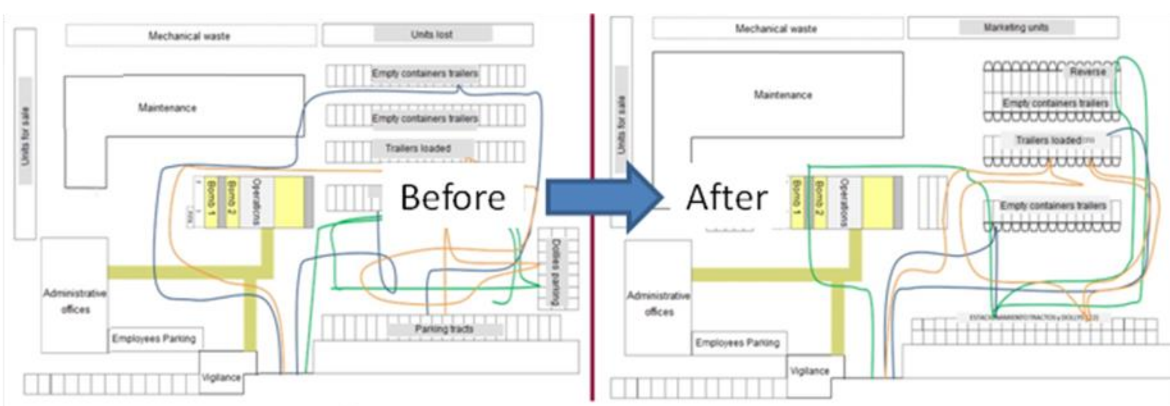

Figure 9 Illustration of before and after of the 3PL layout

5. Implementation and Conclusions

This work describes an application of the lean methodology extended to the transportation field. This is used to define a distribution strategy for increasing the level of customer service of a Mexican Third Party Logistics company. The lean scheme looks for increasing efficiency by eliminating waste in the distribution operations on a detailed level. The Total Operational Vehicle Effectiveness (TOVE) index is used as the main performance measure. Availability, performance and quality wastes are identified using a Transportation Value Stream Map (TVSM) of the transportation operation.

The factors with greatest areas for improvement were operating availability with 30% and quality factor is estimated at 37% due mainly to the high level of late deliveries (63%). Administrative availability is estimated in 63% as a result of a non-programmed time of the transport equipment of 8.3 hrs. The strategy required for improving operations included the following initiatives:

- Definition of an integrated operations planning and control system.
- Improving loading operations in Apodaca DC installation and re-defining 3PL layout.
- Re-defining organizational issues in Apodaca DC and 3PL.

The implementation of these projects has been completed. The results are very positive. On time delivery level has been perfect as shown in Figure 10 and the cost of distribution has decreased 16% to date. The impact on operations is illustrated on the projected TVSM in Figure 11. Lead times at both facilities: Apodaca DC and the 3PL installation improved significantly from 5.56 to 1.40 hrs and 8.06 to 1.10 hrs respectively. As a result, the new journey time was reduced 36.6%.

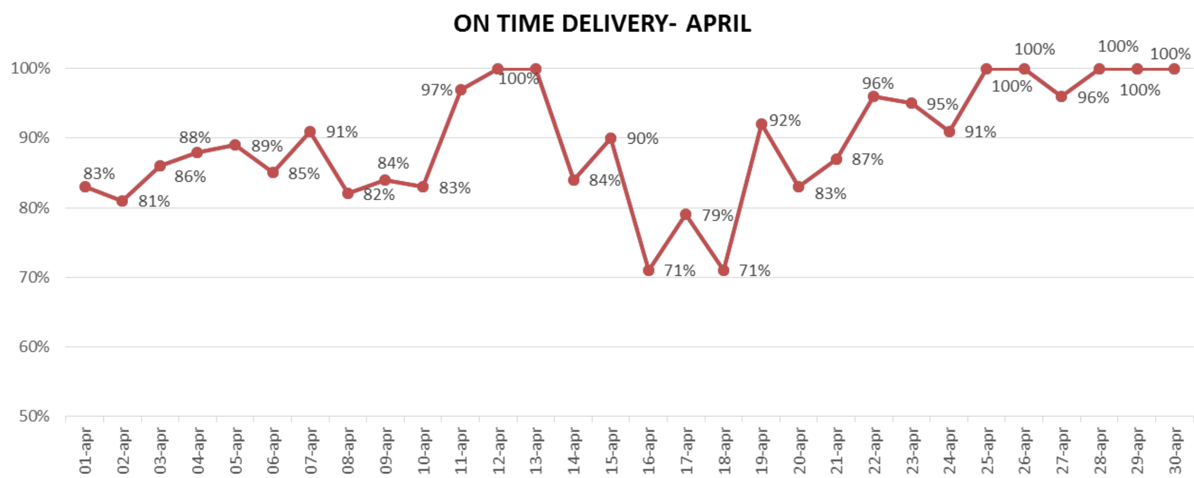

Figure 10 On time delivery performance improvement

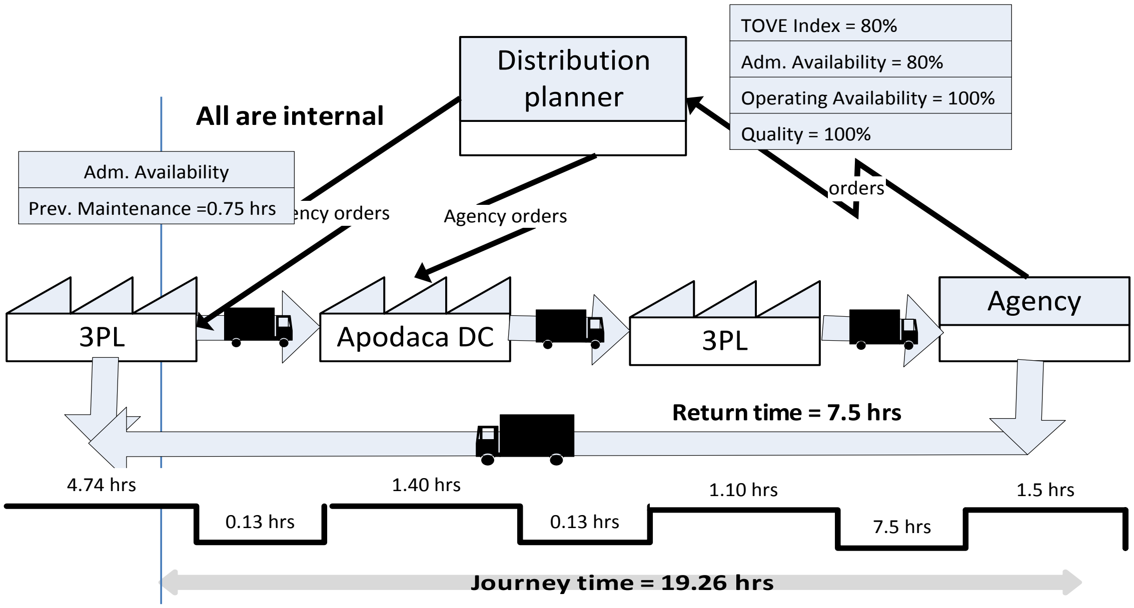

Figure 11 Future TVSM for distribution operations

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