# Improving On-Time Delivery Eliminating Routing Waste: A Case Study

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## Abstract
This work describes the strategy of a Mexican package delivery firm to improve its on-time delivery level. This is based on the application of a transportation waste elimination approach on its routing operations on a detailed level. The company has an extended national network with an important private fleet. The current level of on-time delivery is estimated on 75% on average which is considered as poor by the management. The approach applied is built on the improvement of the Overall Vehicle Effectiveness (OVE) and/or Total Overall Vehicle Effectiveness (TOVE) indexes. These are extensions of the Overall Equipment Effectiveness (OEE) index used to improve manufacturing machine efficiency. Under these approaches wastes related to the availability, performance and quality efficiencies are identified and eliminated. A description of the application of the scheme and results from pilot projects is provided.

## Keywords
Lean Transportation; transportation wastes; vehicle routing; package delivery

## 1. Introduction
According to The Mexican Transportation Secretary (Subsecretaria de Transporte 2014), 55.5% of the total tonnage moved in 2014 was carried out by trucks. However, despite its importance, road transportation has traditionally been stated as inefficient in terms of customer service level in Mexico by the Instituto Mexicano para la Competitividad (2004) and a study elaborated by A.T. Kearney. The problem of improving on-time truck delivery in truck routing operations has been treated exhaustively in the academic literature. Two approaches have been used to achieve the goal of reducing transportation cost; the mathematical modelling approach and the efficiency improvement approach.

Under the first approach an important volume of algorithms of The Vehicle Routing problem have been developed. These models have the objective of minimizing time or distance. The efficiency improvement approach is based on the idea of eliminating waste and it is an emerging area of research.

This work describes the strategy of a Mexican package delivery firm to improve its on-time delivery level. This is based on the application of a transportation waste elimination approach on its routing operations on a detailed level. The company has an extended national network with an important private fleet. The current level of on-time delivery is estimated on 75% on average which is considered as poor by the management.

This report consists of five sections. The next section deals with a brief review of the literature on lean transportation. Then, a description of the scheme utilized to decrease waste is described in section 3. The application of this scheme is undertaken in section 4, and section 5 presents a summary of conclusions.

## 2. Previous research

The improvement of transport operations has been traditionally approached with the use of mathematical modelling, operations research, and simulation methods (Sternberg *et al*., 2013). Under these, several classical transportation problems that include the transportation problem (e.g. Yu *et al.*, 2015; Faulin, 2003; Zhang and Yun, 2009), the vehicle routing problem (e.g. Yu *et al.*, 2013; Lam and Mittenthal, 2013; Zhong *et al.*, 2007), among others, have been addressed. Using mathematical modelling, operations research, and simulation methods, the main approach used by researchers to improve transport operations has been mainly based on minimising cost, time or distance, and optimising resource utilisation, routes, and transportation/delivery schedules. In addition, the improvement of actual road transport operations and activities to gain efficiency is rarely considered under the mathematical modelling, operations research, and simulation methods (Fugate *et al.*, 2009).

Since significant waste and unnecessary costs are normally present in most transportation networks (McKinnon *et al.*, 2003), the application of lean thinking, alongside its principles and tools, has emerged as an alternative method to address the improvement of road transportation. In line with the traditional lean's philosophy of waste elimination, the focus of the so called "lean road transportation movement" lies on identifying and eliminating non-value adding activities, specifically relevant to transport operations, in order to improve the overall productivity and efficiency of a company's logistics operations. Generally, the focus of research within the lean field has been on production activities related to quality improvement and the quest for increased efficiency. Although a research stream has also studied the application of lean thinking in supply chains (e.g. Mohammaddust *et al.* 2015), specific research on the utilization of lean in the road transportation sector is scarce and in early stages (Villarreal *et al.*, 2009). In this context, only a handful of articles have proposed methods or reported a case where transport operations have been improved through the elimination of non-value added activities (Villarreal *et al.*, 2013; Villarreal, 2012; Villarreal *et al.*, 2012; Hines and Taylor, 2000). The narrow research on lean road transportation is particularly evident when compared with the vast amount of research on lean's application in other industries such as manufacturing (Taj, 2008), processes (Lyons *et al.*, 2013), and services (Sternberg *et al*., 2013).

Within the limited research undertaken in the field of lean road transportation, two research areas can be identified, with also a limited number of papers published around those streams. These areas are: Extending manufacturing wastes to the transportation area; and designing improvement schemes of road transport operations

### 2.1 From production to transportation wastes

The origins of lean can be traced back to the 1930s when Henry Ford revolutionised car manufacturing with the introduction of mass production techniques. However, the biggest contribution to the development of lean thinking principles and tools over the last 50 years came from the Japanese automotive manufacturer Toyota. The central objective of the lean philosophy is the elimination of non-value added activities (Pettersen, 2009), which consequently contributes to the reduction of costs (e.g. Monden, 1998) and increases value for customers (e.g. Bicheno, 2004). In this context, Sternberg *et al*. (2013) adapted the original Toyota's seven common forms of production wastes for the specific application to road transport operations. In this case, Sternberg *et al*. (2013) concluded that only five of the Toyota's wastes applied to motor carrier operations, but waste due to *excess conveyance* and *excess inventory* did not. Instead, Sternberg *et al*. (2013) included *resource utilisation* and *uncovered assignments* as part of the transportation wastes derived from Toyota's original production wastes. These wastes will be called the "Seven Transportation Extended Wastes" (STEWs) hereafter.

Furthermore, Mason *et al.* (2001) and Simmons *et al.* (2004) adapted and extended the Overall Equipment Effectiveness (OEE) (Nakajima, 1988) metric, used by the lean's Total Productive Maintenance (TPM) (Nakajima, 1988) approach to measure equipment effectiveness, and developed a new metric called Overall Vehicle Effectiveness (OVE). This metric was used by Simmons *et al.* (2004) for measuring and improving the performance of truck transportations. Later, Villarreal (2012) proposed a modified version of the OVE measure called Transportation Overall Vehicle Effectiveness (TOVE). Unlike OVE, TOVE considers total calendar time instead of loading time. This is due to the fact that waste identification and elimination is related to the transportation vehicles utilised to move products. A comparative illustration of the structures of the OVE and TOVE measures is presented in Figure 1. In summary, although both measures broadly classify transportation wastes into three mutually exclusive elements (i.e. availability, performance and quality losses), TOVE adds the administrative availability element. Hence, it divides the availability component into administrative and operating availability.

## 2.2 Improvement of road transport operations

It is well known that transportation is an activity classified by the lean movement as waste that should be, if possible, eliminated (Womack and Jones, 2003; Ohno, 1988). However, in the current globalised market, transportation is a necessary activity to deliver goods to customers. Thus, when mapping a supply chain, unnecessary transportation becomes an important waste to identify, measure, and eliminate. According to Fugate *et al.* (2009) and McKinnon *et al.* (1999), unnecessary transportation problems and waste can be addressed by increasing the efficiency of transport operations. In this context, Hines and Taylor (2000) proposed a methodology, consisting of four stages, to eliminate waste in transport operations. Villarreal *et al.* (2009) reported the application of this methodology in the logistics operations of a Mexican firm leader in the production and distribution of frozen and refrigerated products.

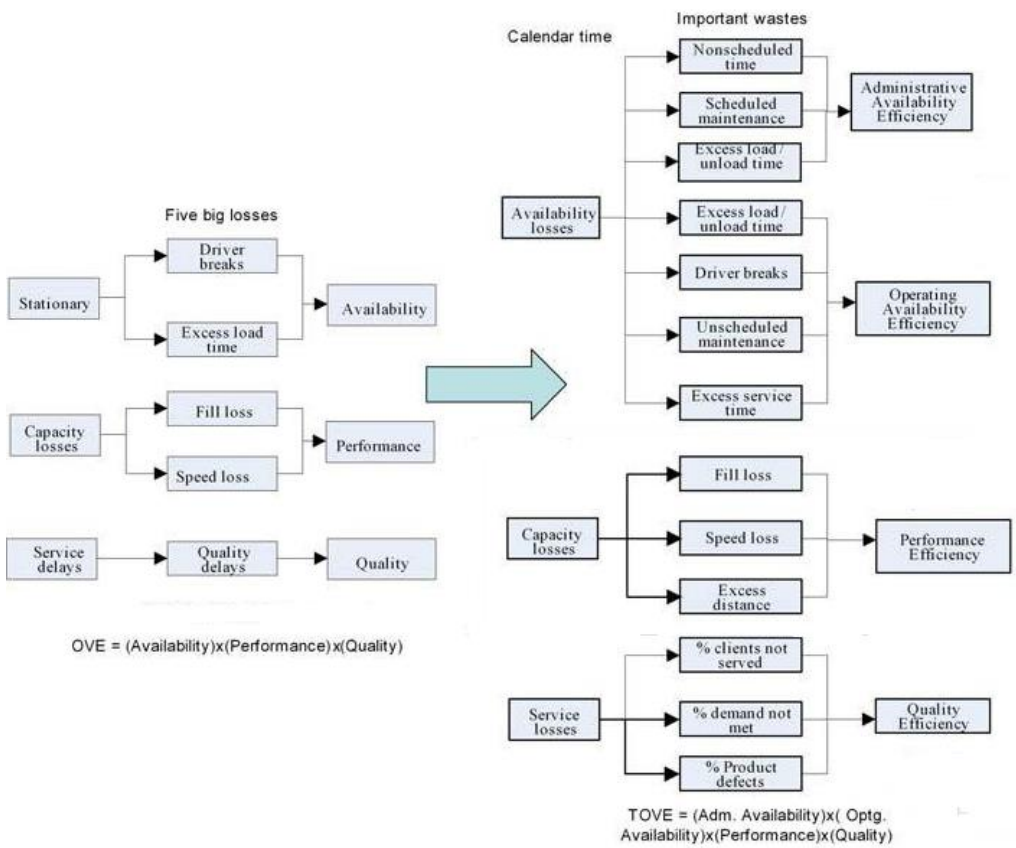


Figure 1. Comparison of the OVE and TOVE structures and components (Adapted from Simmons *et al.*, 2004 and Villarreal, 2012)

Villarreal *et al.* (2012) also developed a methodology to reduce transport waste by integrating the Just-in-Time approach of milk runs with the traditional operations research approach of developing algorithms to optimise vehicle routing. Additionally, Villarreal (2012) adapted the lean's Value Stream Mapping (VSM) tool to support efficiency improvement programmes in transport operations. He called this adapted tool Transportation Value Stream Mapping (TVSM).

### 2.3 Brief description of waste elimination scheme

The waste elimination scheme that is applied to the Mexican package delivery firm to improve its on-time delivery level corresponds to the one developed by Villarreal (2012).
The initial step of the scheme is the description of the transportation activities in detail complemented by the estimation of the TOVE index. This is achieved by elaborating the Transportation Value Stream Map (TVSM). Once the TVSM is elaborated, the following stage consists of identifying waste at the macro level and particularly looking for opportunities to improve Administrative Availability. The macro context is required to identify the macro characteristics of the route, namely; average journey duration, the current TOVE index level and its components. It is very important to analyze vehicle Administrative Availability utilization based upon calendar time. Identify 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 stage may also serve to guide the improvement efforts according to the values of the TOVE efficiency factors – i.e., 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. Given the most relevant waste concepts identified, a strategy for their elimination is devised and implemented in the final stage. As previously mentioned, the strategy may consist of initiatives designed with tools and methodologies from the Industrial Engineering and Total Quality Management disciplines and/or the Operations Research area.

## 3. Implementation and Results

The scheme is applied to the distribution operations of a Mexican package delivery firm to improve its on-time delivery level. This is based on the application of a transportation waste elimination approach on its routing operations on a detailed level. The company has an extended national network with an important private fleet. The current level of on-time delivery is estimated on 75% on average which is considered as poor by the management.

The Project for increasing the level of customer service was divided into two stages; The initial step consists of analyzing and defining an improvement strategy for the operations serving the Monterrey metropolitan area. This operation serves 30% of the national market of the company and it is the area with 41% of the services delivered after the promised date. The next and final stage would consist of extending the analysis approach to the rest of the national operations. The system of interest is described in Figure 2.

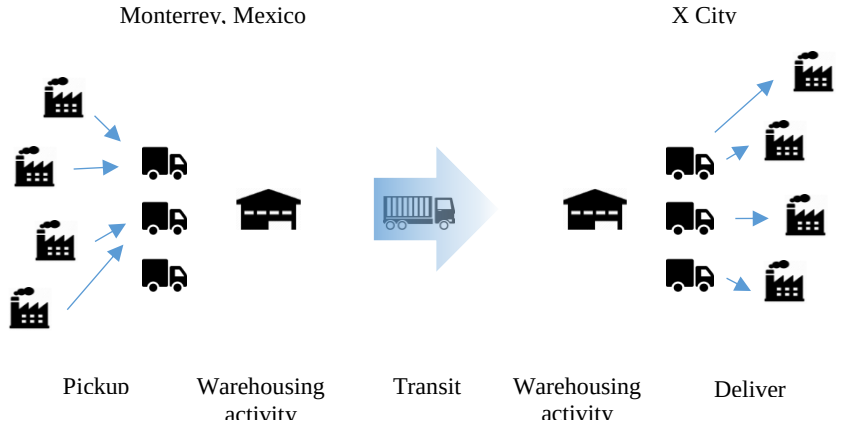


Figure 2. Description of supply chain system of interest

Product deliveries originate throughout every city of the country with a destination to Monterrey metropolitan area. All of these deliveries are consolidated at each city and sent to the Distribution Center located in Monterrey. These are then unloaded and sorted according to the different routes in charge of distributing them to the end customer. Once the fleet finishes delivering items to the clients, it starts the collection process of items that will be sent to other cities of the country. After an exhaustive analysis of the deliveries made during the last twelve months, it was found that 93% of the late deliveries to the customers was due to the Monterrey metropolitan operations, and in particular to the routing operations.

## 3.1 Mapping the distribution operations

The first step of the methodology is the mapping of the operations. The Transportation Value Stream Map for the current routing (distribution and collection) operations is shown in Figure 3. Total Not-In-Transit (NIT) activities take 63 minutos per journey. In-Transit (IT) activities consist of delivering items to an average of four customers per route and collecting items from an average of three customers per route. Total transit time is 5.7 hrs.

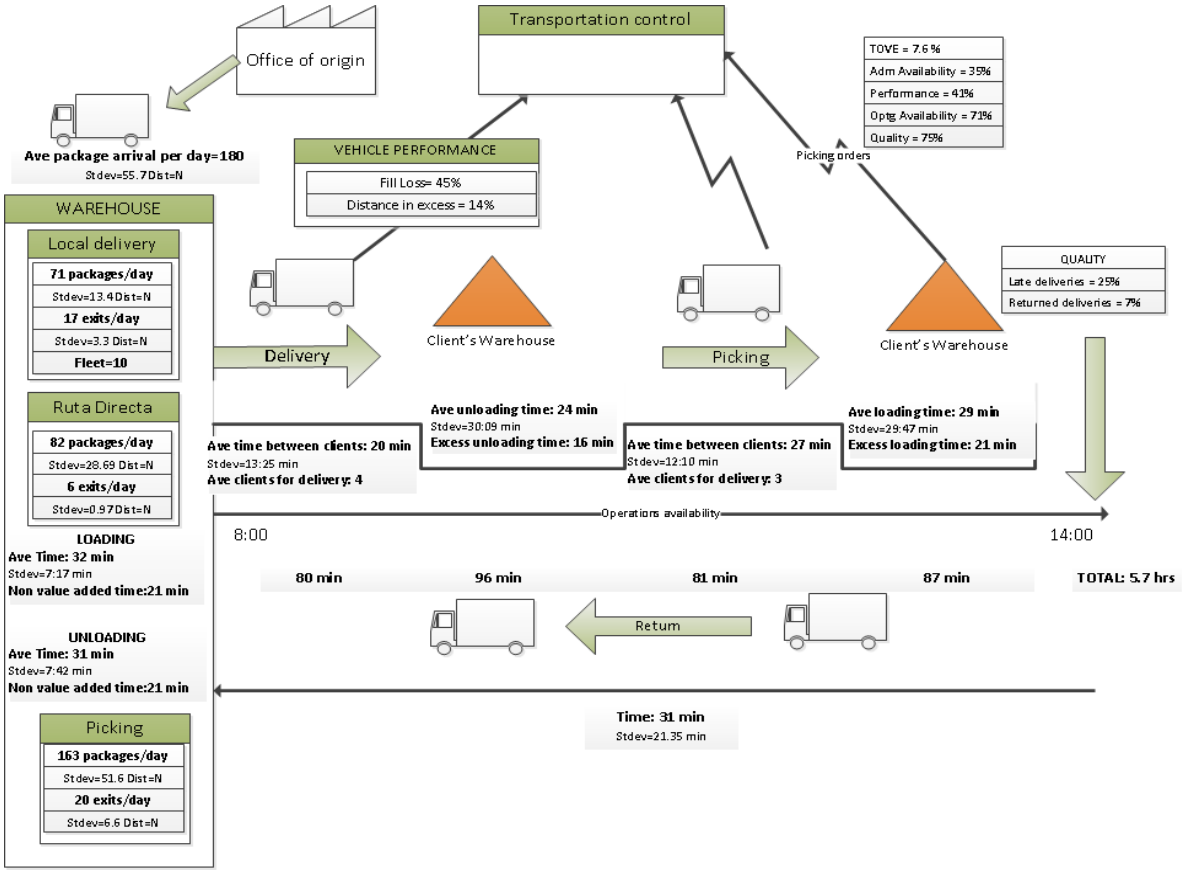


Figure 3. Description of TVSM for the Delivery Operations in Monterrey Metropolitan Area

## 3.2 Identification of route efficiency and main wastes

The value of the average route efficiency is given by the TOVE value of 7.6%. The Performance and Administrative Availability efficiencies are the factors with the biggest area for improvement with 41% and 35% respectively. However, the company was very concerned with the current level of non-satisfied customers. About 25% of the deliveries are late, including that 7% of the total deliveries, per route, are being returned to the DC every day. The company experienced that an important level of customers did not returned for business after having such a customer service level.

As a result, the company decided to undertake an improvement effort to reduce significantly the level of late deliveries. After an exhaustive field work, the following causes for being late were identified; There was not enough time to service the customers because it was necessary to collect new deliveries for others destinations, damaged merchandise and administrative mistakes. Therefore, it was necessary to delineate an improvement strategy to attack the previous causes.

The most important wastes that impact the Performance efficiency are the Fill Loss of 45% and the distance traveled in excess of 14%. Figure 4 illustrates an example of the fill loss waste and it also shows how routes overlap presenting symptons of deficient route design.

As previously stated, the low level of customer service is due to insuficient time for delivering items to customers. Therefore, a strategy based on reducing time by improving the Performance efficiency to then use it to serve customers is delineated.


| | Unidad | Zona asignada | | Unidad | Zona Asignada |
|---|---|---|---|---|---|
| | 507 | Comodín | | 520 | Centro |
| | 508 | Guadalupe | | 522 | Santa Catarina/SP/García |
| | 512 | San Nicolás/Escobedo | | 524 | Monterrey (Poniente) |
| | 518 | García | | 525 | Comodín |
| | 519 | Apodaca | | 1027 | Santa Catarina/García |

Figure 4. Illustration of fill loss and deficient route design

## 3.3 Defining improvement strategy

The strategy for improving performance consists of three initiatives: the first one is the assignment of the trucking capacity throughout the day. The second initiative is the application of a route design tool to define everyday the required routes necessary to satisfy customer demand. Finally, several administrative actions were defined and implemented to avoid the administrative mistakes that originated the return of certain item deliveries.

The initial step consisted of modifying the truck assignment schedule throughout the day adjusting it according to the trucking capacity requirements. The current private fleet of the company assigned to the Monterrey metropolitan operations consisted of fifteen 10-ton trucks. The second step for improving performance consisted of using a route design software. First, the current customer database was updated. Then, a pilot test for 30% of the fleet was carried out during two weeks. Daily route design was carried out to satisfy customer delivery demand. This activity was done twice per day; the first one considered the arrival of items from all the Mexican cities but Guadalajara and México, D.F. This run also included item pickups already programmed from the day before. The second route design run was executed to design delivery services for the items coming from Guadalajara and México (see Figue 5 for an example).

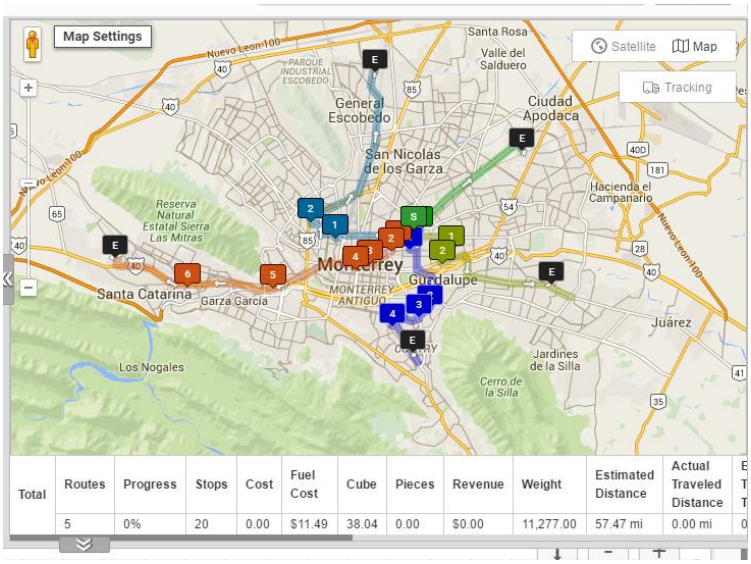


Figure 5. Description of route design

The initial results obtained from the pilot work were very promising. The company decided to apply the routing tool to design all the daily delivery routes. In addition to the implementation of the new daily truck assignment schedule and the route design tool, the company redefined its organization, designed a checking list and a motivation campaign to insure that the new procedures are followed.

### 3.4 Description of Results

The results obtained from the application of the improvement strategy were very important. As shown in Figure 6, the On-Time delivery concept was increased from 74% to 100%.

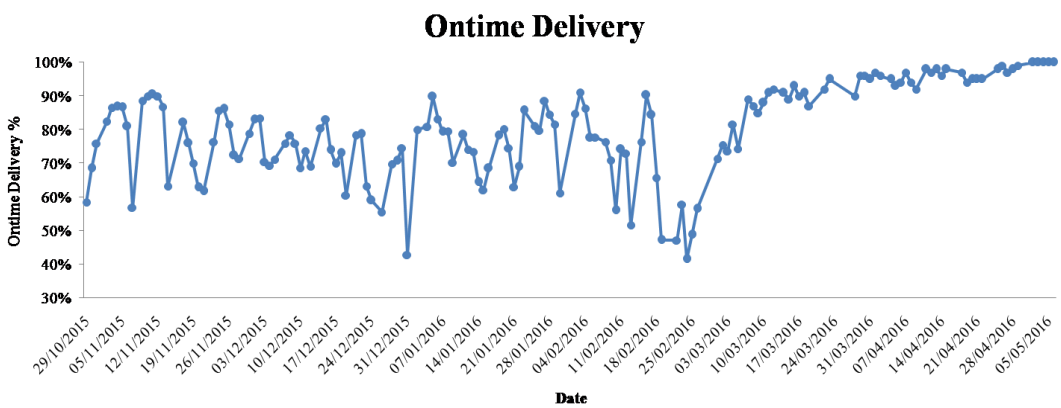


Figure 6. Illustration of Daily On-time Deliveries

Table 1 presents a summary of additional results achieved with the implementation of the previous initiatives. Distance per route decreased 31%, the number of clients visited per route increased from 29% and the utilization of truck capacity increased from 55% to 79%. The cost per delivery decreased from 35.1 to 16.1 Mexican pesos (1.90 to 0.87 US dls per delivery).

Table 1 Summary of results with new initiatives

| **Concept** | **Initial Situation** | **New Situation** |
|---|---|---|
| Distance/Route (kms) | 39.2 | 27.1 |
| Clients/Route | 7 | 9 |
| Journey Time (minutes) | 342 | 167 |
| % Fill Loss | 45 | 21 |
| MXN Pesos/Delivery | 35.10 | 16.06 |

## 4. Conclusions

This work describes the strategy of a Mexican package delivery firm to improve its agility measured in terms of the on-time delivery level. This was achieved based on the application of a transportation waste elimination approach on its routing operations on a detailed level. The initial level of on-time delivery estimated in 74% on average was increased to 100%. Based on the previous results, the firm decided to spread the implementation of the initiatives to the national level during the rest of year 2016. In addition, the logistics operations management of the company had a very positive reception of the lean approach taken to improve the performance.

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## Biography

**Ilse-Valeria Benavides-Peña** is a SUMA CUM LAUDE Industrial Engineer just graduated from Universidad de Monterrey (UDEM). She has participated on several projects such as the Improvement of the routing operations of a soft drink bottling firm. She also applied Lean Thinking principles for Improving the Productivity of several assembly lines for a Mexican toy company. Nowadays, she has started graduate work for a master degree in management at UDEM. Ilse is a member of the IIE, ASQ and APICS Societies.

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