Increasing Customer Satisfaction Through Lean Distribution

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Abstract
Current supply chains are in constant pressure to maintain market share. They need to satisfy higher levels of customer service in terms of on time and complete order deliveries. Distribution strategies definition and execution are fundamental to achieve these requirements. These determine the behavior and the size of order lead times and therefore customer order satisfaction. This paper presents a description of the design and implementation of a distribution strategy for a Mexican company located in Monterrey that needs to improve order delivery time to stay competitive. The suggested approach includes the application of waste elimination in warehousing and transport operations, and the re-definition of inventory control policies. The validation of the strategy through a pilot test is included and current performance results are illustrated.

Keywords
Lean and agile distribution, order cycle time, waste elimination.

1. Introduction
An important feature of current business competition is that success or failure is determined by both; the efforts carried out at the supply chain level, and in the marketplace by the end customer. Additionally, increasingly demanding customers have created a dynamic and volatile environment for many companies. Agility is a business-wide capability that is actually required to compete successfully under such conditions. Flexibility is the key characteristic of an agile supply chain. In fact, the concept of agility emerges from the development of flexible manufacturing systems (FMS). The idea of a manufacturing system being highly responsive to changes in product mix or volume was extended to a wider context at the supply chain level by Nagel et al., (1991). Today´s industry dynamics have influenced the design of supply chain systems by increasing emphasis on achieving improved levels of customer service, cycle time, quality of products and services, costs and flexibility of product offering to meet customer needs. Getting the right product/service, at the right price, at the right time to the customer is vital to competitive success and survival. Hence, customer satisfaction and marketplace understanding are crucial in the definition of a supply chain strategy.

This is the environment of a Mexican company engaged in the production and distribution of refrigerated food in the Mexican market. The company is experiencing a high pressure to improve its customer response time. This presentation describes the efforts of the company in implementing waste reduction and inventory management initiatives on the distribution operations for improving market responsiveness.

The remainder of the paper is structured as follows. The next section offers a review of the relevant literature. Section 3 describes the scheme used to improve delivery time and the application of such scheme. Finally, section 4 provides a description of relevant conclusions and results.

2. Literature Research
The concepts of agility and leanness have been related and confused. The concept of lean supply chain has its origins in the idea of lean manufacturing. (Jones et al.1997). Lean manufacturing can be traced to the Toyota Production System and its focus on waste reduction and elimination. Naylor et al. (1999) provide clear definitions of these two concepts. Agility concerns the use of market knowledge and a virtual corporation to exploit profitable opportunities in a volatile marketplace. Leanness means developing a value stream to eliminate all waste including time, and to enable a level schedule. Lean is about doing more with less, which is acceptable as long as customer satisfaction is met.

The design of a supply chain strategy requires the knowledge of the capabilities necessary to win an order in the market. Hill (1993) developed the concepts of order qualifiers and order winners 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. Christopher et al. (2001) and Masson-Jones et al. (2000)

recommend approaches for the development of strategies for leagile supply chains. These are chains 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. Naylor et al. (1999) have already shown the necessity for lead time reduction as a pre-requisite to agility. Four basic ways of achieving cycle time compression are recommended by Towill (1996): Remove processes, eliminate time within processes, integrate processes or operate them in parallel. Miltenburg et al. 1996 suggests a similar approach to cycle time compression. This is the concept of Cycle time management and reduction (CTM). This is the manufacturing philosophy that seeks to reduce the total time required to perform all the activities involved from the order placement to customer reception. According to Miltenburg et al. (1996), two types of approaches can be applied in searching the reduction of cycle time; an incremental approach, for which he proposes three models; a simple stochastic model, a markov model, and a queueing model; and the reengineering approach that looks for breakthroughs to achieve improved levels of cycle time.

The origin of waste elimination is associated with the concept of lean manufacturing. This system is based on a philosophy of continuous improvement where the elimination of waste is fundamental. The process of elimination is facilitated by the definition of seven forms of waste: production of goods not yet ordered; waiting; rectification of mistakes; excess processing; excess movement; excess transport; and excess stock. Jones et al. (1997) have shown that these seven types of waste need to be adapted for the supply chain environment. Hines et al. (2000) propose a methodology extending the lean approach to enable waste elimination throughout the supply chain and Rother et al. (1999) recommend the use of the value stream map (VSM) and the supply chain mapping toolkit described by Hines et al. (2000) as fundamental aids for identifying waste.
Transportation and warehousing operations represent good opportunities for the application of lean concepts in more detail. It is well known that both activities are classified as waste. However, when markets are distant, these are certainly necessary activities to attain competitive customer service levels. According to McKinnon et al. (2003) and Ackermann (2007) most distribution networks have significant waste and unnecessary costs. For the identification of waste between facilities and installations in a supply chain, Jones et al. (2003) recommend Value Stream Mapping for the extended enterprise.

When mapping at the supply chain level, unnecessary inventories and transportation become important wastes. Unnecessary transportation waste is related to location decisions for the improvement of performance at given points of the supply chain. Therefore, the solutions suggested for its elimination are concerned with the relocation and consolidation of facilities, a change of transportation mode or the implementation of milk runs. In addition to transportation, warehousing is another important part of a distribution network. Value stream mapping at the supply chain level emphasizes on the identification of inventory waste. This approach does not consider the elimination of waste in warehousing operations. However, it is important to realize that warehousing could have an important impact on the supply chain cost structure and on the capacity to respond to customer needs.

2.1 Transport waste elimination

Two waste classification schemes can be used as the basis for the waste elimination process in transport operations. One is focused on wastes adapted from the seven wastes defined by Toyota. The other is supported by the works developed by Nakajima (1988), Simmons et al. (2004) and Villarreal (2010). Under the later approach, Transport efficiency is originally suggested by Simmons et al. (2004). They made the measurement with the Overall Vehicle Effectiveness (OVE). This is similar to the estimation of OEE, where the availability, performance and quality efficiency factors are estimated and multiplied to produce an overall OVE percentage rate. This measure converted the OEE losses from manufacturing to transport operations. The previous factors are associated five transport losses or wastes. These are driver breaks, excess load time, fill loss, speed loss and quality delays. The previous measure has also been modified by Villarreal, et al. (2010). In this case, the OVE measure is adapted to consider total calendar time as suggested by Jeong et al. (2001). The proposed measure that is called Total Operational Vehicle Effectiveness and it is represented by the term TOVE. In summary, four components for the new efficiency measure are suggested; Administrative or strategic availability, operating availability, performance and quality. The new measure would be obtained from the product of these efficiency factors.

2.2 Warehousing waste elimination

The main warehousing operations, as described in Bartholdi et al. (2010), are receiving, put-away, order-picking, checking, packing and shipping. Previous work specialized on the application of the lean approach to warehousing operations is very limited. The works described in Ackerman (2007), Tostar et al. (2008) and Garcia (2009) are among the most important. The OEE measure is also adapted to analyze warehousing operations by Villarreal et al. (2011). The measure (represented as WOEE) considers total calendar time instead of loading time. Furthermore, since the interest is put on the warehouse efficiency as a system, it is also suggested a measurement based on the bottleneck or most constrained operation of the facility, similarly to the Overall Throughput Effectiveness (OTE) measure developed by Huang et al. (2003). Thus, improvement efforts will be focused on the warehouse bottleneck resource using a scheme based on Theory of Constraints. Similar to the definition of the TOVE measure, four components for the new efficiency measurement are suggested, being them administrative or strategic availability, operating availability, performance and quality. Waste identification is supported by the elaboration of a Value Stream Map (WVSM) for all warehousing operations including specific efficiency information for the bottleneck resource. The VSM considered for warehousing is suggested by Villarreal et al. (2011) and Garza et al. (2010). This tool includes the description of several types of warehousing waste related to improving efficiency as the relevant performance measure in operations.

3. Description and Application of Improvement Scheme

The company´s distribution network has a primary distribution network that sends product from plants to Central Distribution Centers (CDC´s), and from these to Regional Distribution Centers (RDC´s). It also includes a secondary network that takes the goods from the RDC´s to the retailing points or stores.

The primary network includes 34 plants, seven CDC´s and about eighty RDC´s located across México. It is divided into four geographical regions. This paper is concerned with the application of the project on the Northeastern region. This zone satisfies 20 percent of total national demand with nineteen RDC´s. The purpose in this document is to describe the efforts to improve customer responsiveness of the CDC. The waste elimination scheme applied follows the original one suggested by Rother et al, (1999).

The CDC has the role of consolidating product from plants and other CDC´s and distributing them to Northeastern RDC´s. The main activities in the CDC are: Unloading, receiving, put-away, storing, picking, packaging and shipping. It works three shifts with an average daily demand level of 440 pallets per day. Takt time is estimated at 3.27 minutes.

3.1 Analysis of customer service level

This paper is focused on solving the defficiency in the customer service level provided by the CDC. This CDC is designed to satisfy the requirements of the Regional Distribution Centers (RDC´s) located in the northeastern part of Mexico. Customer service of the CDC is measured by the firm in terms of on-time delivery and complete orders. The original level of on-time delivery of the CDC is 89.9%. Similarly, the level of orders delivered complete is estimated in 92%. The company is willing to improve these levels to increase the potential of future sales.

3.1.1 Analysis of on time service level

In order to obtain insight into the causes of the inadequate service levels, it was necessary to review in detail all de customer orders sent to the CDC for the last six months. In particular, those orders that arrived late to the customer were of great interest. As shown by Figure 1, most of these orders were of lot size smaller than one ton. Furthermore, an additional analysis of the causes of this situation yielded that the CDC was releasing the trucks late. Figure 2 presents a value stream map of the operations of the CDC. Two material flows are identified: One corresponds to complete pallets, and the other to mixed pallets.

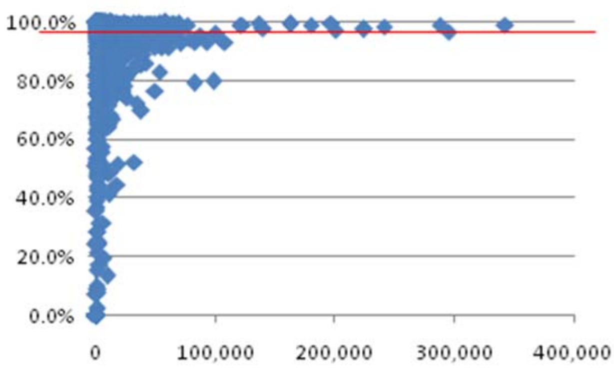


Figure 1 Lot size of orders delivered late

Complete pallets contain only one high volume product. On the other hand, mixed pallets include up to ten different types of products. The demand of these items is low. The orders delivered late correspond mainly to mixed pallets. Thus, it is very important to pursue an analysis of the mixed pallet flow process.

Following in detail the warehousing process for mixed pallets, one can identify the high values of truck waiting time to be unloaded, the unloading time, handling, depalletizing and storing time, and finally, of picking, palletizing and truck loading time of orders requiring products in mixed pallets. Thus, the main type of waste found in this process consists of truck and/or operator waiting time, operator idle time, and there is a lack of coordination and communication among the warehouse areas to insure a fast and stable flow of product throughout the installation. These wastes impact significantely on the performance and availability efficiency factors of the mixed pallet process.

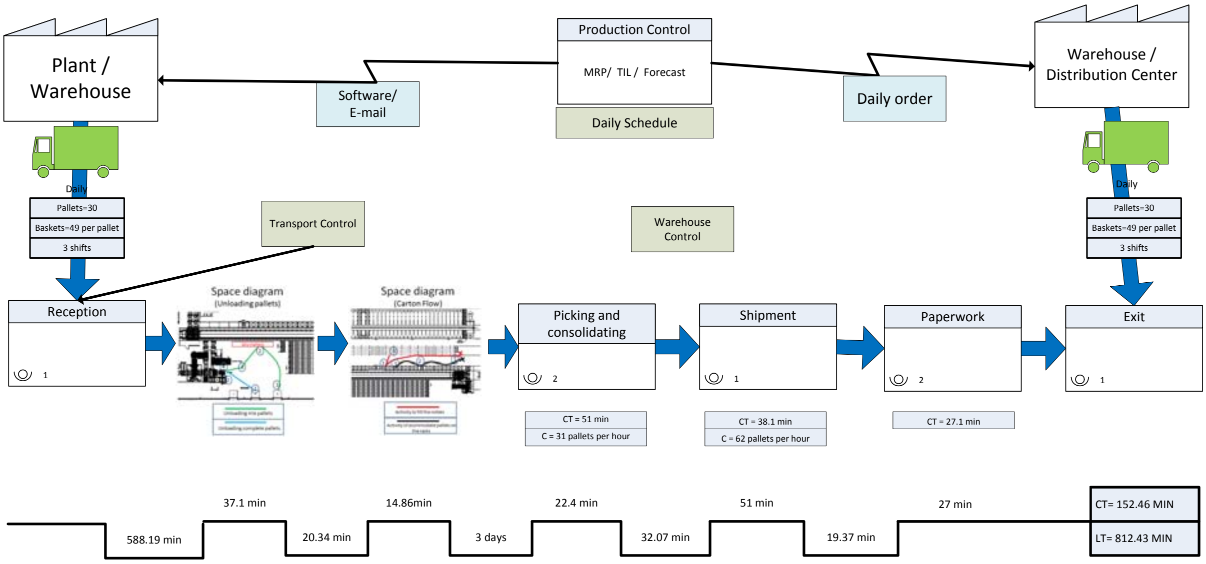
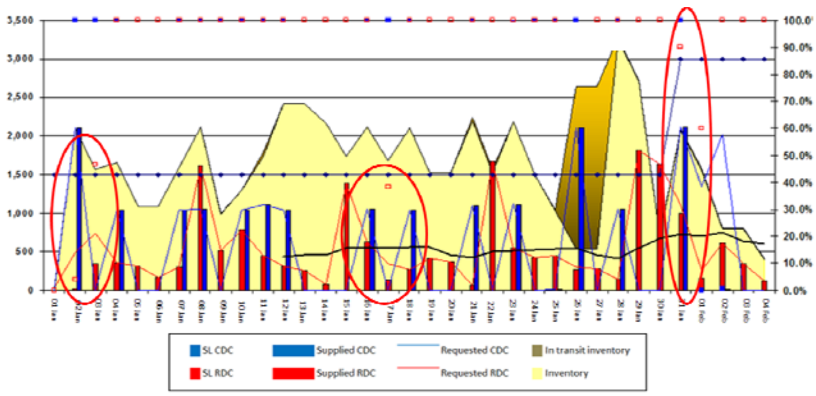


Figure 2 Value Stream Map of the mixed pallet operations of the CDC

3.1.2 Analysis of complete order service level

After the analysis of incomplete orders, it was found that frozen meat, yogurt and cheese are the items with the highest level of unavailability. Frozen meat represents 51.28%, yogurt 20.14% and cheeses 17.36%. Reviewing exhaustively the incomplete orders that included these items, it was also found that the main causes of the deficient service level are inventory stockouts and imprecise inventory recording (as illustrated in Figure 3).



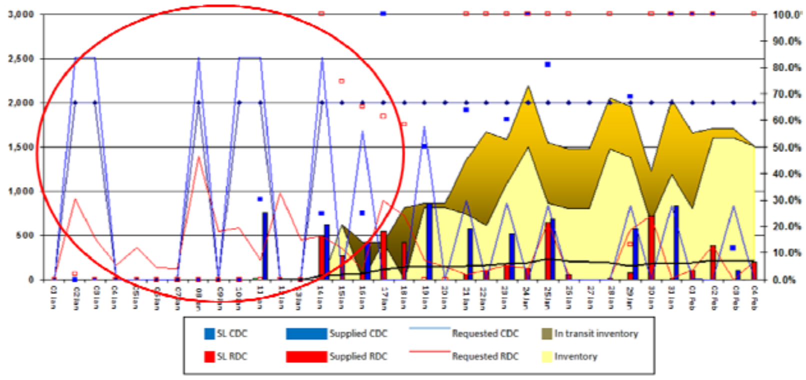


Figure 3 Example of Inventory Stockout and Imprecise Inventory Recording

From an analysis of the inventory control system parameters (safety stock, reorder points and so on) it was found that these had not been updated since a long period of time. As for inventory recording, it was identified that the people responsible for this activity was not executing it correctly, timely nor in a standardized manner.

3.2 Description of improvement initiatives.

The previously described causes for deficient service level are summarized. The improvement initiatives designed and implemented are also described in this section. In summary, on-time delivery service will be improved with the implementation of a new standardized mix pallet process and a daily transport plan. The complete order service level will also increase with updated inventory control system parameters and a new inventory transaction process.

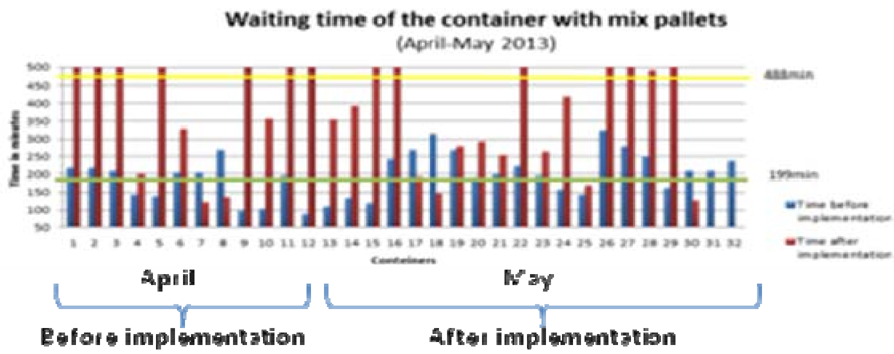
Table 1 Summary of Improvement Initiatives

Description of Initiatives	Impact on
Design of daily transport plan	On-time delivery service level
Mixed pallet process redesign	
Redesign of inventory control system parameters	Complete order service level
Redesign of inventory transaction process	

3.3. Implementation and results.

The daily transport plan, the redesigned mixed pallet process and inventory transaction recording process are the first initiatives fully implemented. The redesigned inventory control system parameters are partially implemented with a pilot test of a sample of products.

The impact of implementing the daily transport plan and the mixed pallet process is very significant. Mixed pallet unloading waiting time and productivity have increased substantially as shown in Figure 4.Waiting time have decreased 60% and productivity increased 400%. The impact of these improvements on on-time delivery service is very positive. This measure increased 5% and it is projected to reach 98% as illustrated in Figure 6. On the other hand, implementing the redesigned inventory control recording process has also a positive impact on inventory recording precision. The difference between real on-hand inventory and what is on the system has decreased 50% as shown in Figure 5. Similarly to the on-time service, the level of complete order service goes up 3% and it is estimated that it will achieve a level of 98% as observed in Figure 6.



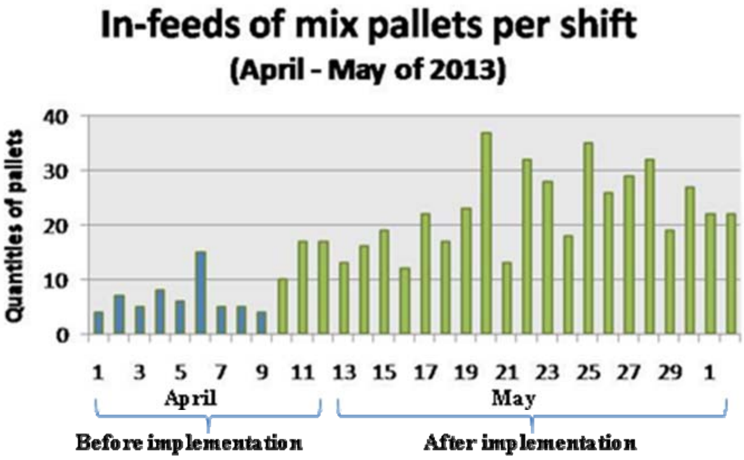


Figure 4 Impact on Mixed Pallet Waiting Time and Productivity

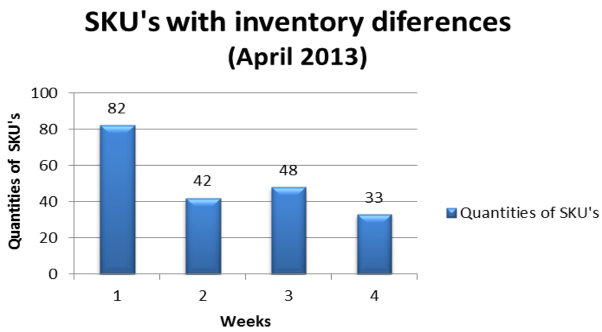


Figure 5 Average Difference Between Real and On-System Inventory Levels

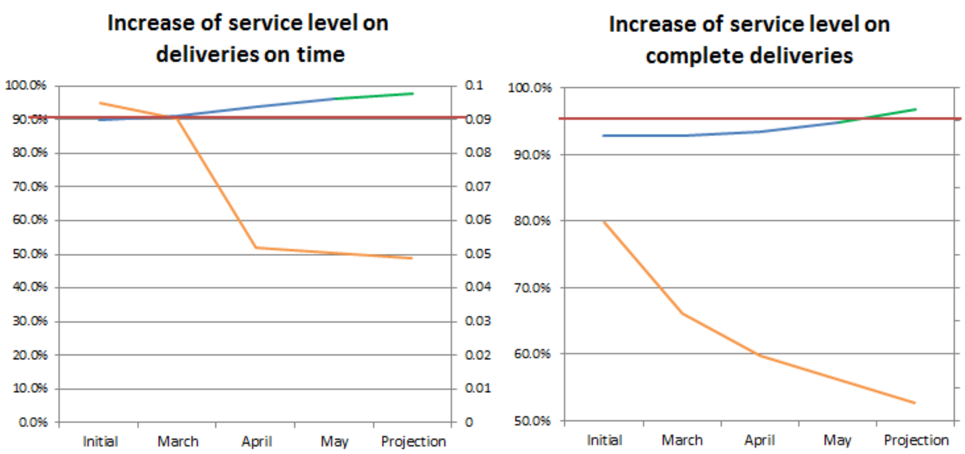


Figure 6 Summary of Results of Implementation of Initiatives

4. Conclusions.

The project described in this document was born from a real necessity of a company client that was experiencing problems to satisfy customer service from the distribution center located in Apodaca. They needed to improve order on-time delivery and completeness. In order to achieve this goal, a project was set up to identify areas of improvement. The project followed a scheme with the application of lean solutions to the warehousing operations. After an exhaustive analysis of the orders and activities executed in the installation, several improvement initiatives were found. The design of a new daily transport plan of the distribution center and the redesigned mixed pallet process helped to increase on-time delivery service. In addition, The redesign of the inventory record transactions process is fundamental to insure high levels of complete orders. This initiative together with the update of inventory control system parameters are very important to increase and keep this measure at the desired levels.

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