Achieve Routing Leagility by Increasing Its Efficiency

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ABSTRACT

This work describes a suggested strategy for a Mexican convenience store firm to simultaneously increase its level of agility, and reduce its transportation cost in its distribution network. This is based on the application of a scheme for increasing efficiency in its routing operations on a detailed level. The Operational Equipment Effectiveness index used in Total Productive Maintenance (TPM) is adapted to be used as the main performance measure. Availability, performance and quality wastes are identified using Value Stream Mapping of the routing 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, vehicle routing problem

RESUMEN

Este trabajo describe una estrategia recomendada para una empresa Mexicana de tiendas de conveniencia para que simultáneamente incremente su nivel de agilidad, y reduzca su costo de transporte en su red de distribución. Esta estrategia se basa en la aplicación de un esquema para incrementar la eficiencia de sus operaciones de ruteo. El índice de Efectividad Operacional de Equipos usado en el área de Mantenimiento Productivo Total (TPM) es adaptado como una medida de desempeño del transporte. Desperdicios de disponibilidad, desempeño y calidad son identificados a través de un mapa de flujo de valor de las operaciones de ruteo. La implementación de las iniciativas de mejora está en proceso pero se proporcionan resultados reales y proyectados.

Palabras clave: Eliminación de desperdicios de transporte, transporte esbelto, mapa de flujo de valor, eficiencia del transporte, problema de ruteo de vehículos.

1. INTRODUCTION

A key feature of present-day business is the idea that it is supply chains that compete, not companies (Christopher, 1992). According to Fisher 1997 and Hill 1993, supply chains must acquire capabilities to become efficient and/or agile in accordance with the type of products they market. In particular, an efficient supply chain is suitable for selling functional products. As suggested by Fisher 1997 and Hill 1993, the order winner factor in this market is cost, having quality, lead time and service level as order qualifiers.

The Mexican convenience store industry is rapidly growing along with the evolution of Mexican society. Mexican young families are changing customs, habits and roles. Now, both: husband and wife work and stay most of the day outside home. Time has become a very valuable asset to manage. This new environment has favored the emergence of the convenience stores. Location, fast response and 24/7 time availability have become key characteristics for the success of this format. According to Amador 2013, about 12,720 stores were installed in 2012. Cadena Comercial OXXO with 76% followed by Seven Eleven with 12% of the market share are the main participants. The important factors for competing are price, product availability and customer service.

The project described in this document was borne by the need of OXXO to become more competitive in terms of price and customer service. Thus, OXXOs management determined that they require to be more efficient and agile (leagile) to support its aggressive growth goals of reaching 12,000 stores by year 2015 as described in Amador 2013. Therefore, the problem of concern in this paper is twofold: the reduction of routing cost and the improvement of customer service.

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

The design of a supply chain strategy requires the knowledge of the baseline to enter the competitive arena and the capabilities necessary to win an order in the 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. Christopher et al., 2001 and Masson-Jones et al., 2000 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 idea that lean precedes agile is established.

According to Towill et al., 2002, time compression (i.e. the collapsing of all cycle times within a supply chain) would enhance business competitiveness to the advantage of all members in a supply chain. Particularly when coupled with open information flow, time compression can multiply to have an even greater effect on supply chain competitiveness. Today, it is no longer sufficient to be a competent business in isolation: it is also necessary to be associated with world-class supply chains if we are to survive. So we conclude that the supply chain process is greatly improved by concentrating on the streamlining of material, information and cash flow, simplifying decision-making procedures and eliminating as many non - value added activities as possible. As suggested by Towill et al., 2002, time compression can be achieved via industrial engineering, production engineering, information technology and operation engineering routes.

Without any doubts, Seven Eleven Japan represents the world benchmark in the convenience store industry. Its supply chain distribution system is the world´s most leagile in this economic sector. According to Chopra 2005 some of its basic characteristics are:

- Automatized, paperless and real time ordering system.
- Flexible transportation media containing trucks, motorcycles, helicopters.
- Daily multiple visits to stores (9).
- Super fast service to stores (approximately two minutes).
- Multiple dedicated crossdocking centers.

The system enables the company to adjust very fast to customer demand changes and operates very efficiently with very little waste.

2.1 LEAN ROUTING

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 and McKinnon et al., 1999). A new measure called Overall Vehicle

Effectiveness, OVE, to be used for improving the performance of truck transportation is provided in Simmons et al., 2004. This is an extended version of the Overall Equipment Effectiveness indicator employed in lean manufacturing to improve equipment efficiency. 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. As illustrated in Figure No. 1, 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.

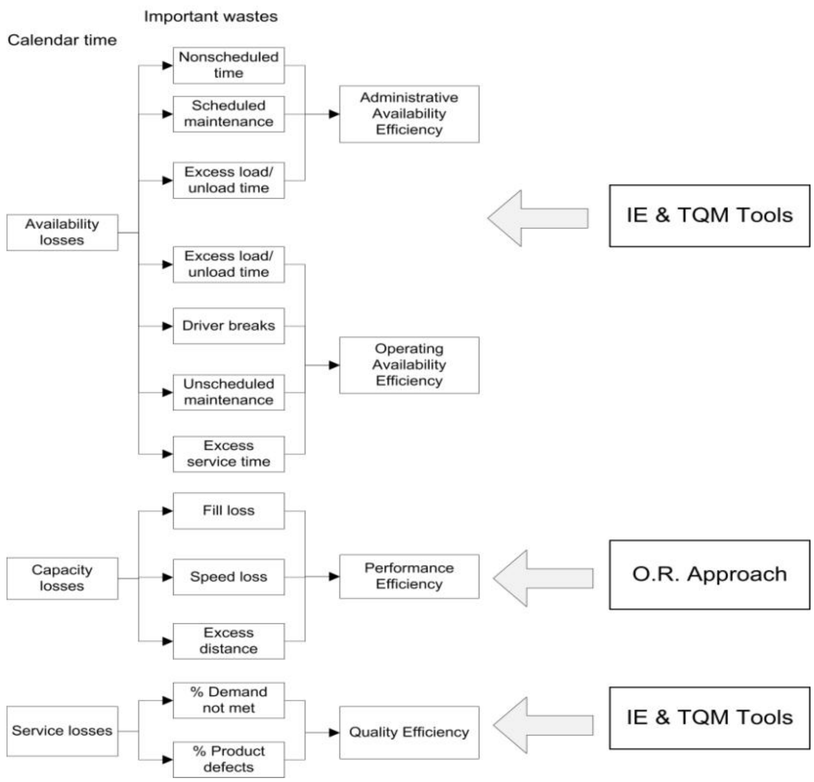

Figure No. 1 Structure of TOVE Measure

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 and Villarreal et al., 2009b) and fill loss values (Lohatepanonto et al., 2006, Moore et al., 1991 and Nadarajah et al., 2007) are very important.

As Figure 1 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 and 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 et al., 2009b that concentrates on identifying waste related to transport efficiency.

3. CONCEPTS AND METODOLOGY

A general lean procedure for reducing transportation waste is provided in Villarreal et al., 2009a, Villarreal et al., 2012 and Villarreal et al., 2010. This is adapted from the broad scheme suggested by Hines et al., 2000 and Jones et al., 1997 to apply a lean improvement approach. Another scheme to reduce waste in routing operations is given by Villarreal 2012.

The first step in this scheme is the description of the transportation activities in detail complemented by the estimation of the TOVE index and the elaboration of the corresponding TVSM. It is also recommended to establish a company goal or objectives to be achieved by the intervention.

The transport activities to be analysed 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 possible 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.

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.

4. IMPLEMENTATION AND RESULTS

This section is devoted to describe the application of the previous scheme suggested by Villarreal et al., 2012, in the routing operations of the leading Mexican convenience store company, OXXO. In particular, we will focus on the operations located in the Guadalajara metropolitan area. Table 1 shows a comparative analysis between OXXO (Guadalajara) operations and its main Mexican competitor.

Three concepts stand out from the analysis: The time per store visit. Seven-Eleven uses 9 minutes and OXXO (for MT truck) 56 minutes. The number of stores per route for Seven-Eleven is 50 and 9 for OXXO with MT trucks. Finally, every Seven-Eleven store is visited daily. On the other hand, OXXO stores are visited twice per week by

RE trucks and three times per week by MT trucks. Therefore, the previous conditions determine that the Competitor has a higher level of leagility than OXXO.

The project described in this paper consists of the application of a lean strategy to achieve an improved level of transportation cost and of customer service. The goal is to obtain levels similar to its competitor.

Table 1 Comparative Analysis of OXXO and Competitor

Concept	**OXXO**	**Competitor (Monterrey)**
Truck type	Refrigerated (RE) and multi-temperature (MT)	Multi-temperature
Store visit frequency	RE: twice per week MT: Three times per week	Daily
Stores per route	RE: 18 MT: 9	50
Route duration (hours)	13	12
Time per store visit (minutes)	RE: 13 MT: 56	9

4.1. MAPPING THE TRANSPORTATION PROCESS

The first step of the methodology is to map the transportation processes of interest. Two types of route are identified for this purpose: routes with refrigerated trucks and routes with multi-temperature trucks. The current TVSM for the routing operation with MT trucks is shown in Figure 2. Similarly, Figure 3 illustrates the TVSM for RE trucks.

4.2. IDENTIFY RELEVANT WASTES AT MACRO LEVEL

As previously stated in section 3, waste identification at this level emphasizes the overall context of the transport process chosen to study. Table 2 presents a summary of the macro indicators.

Table 2 Summary of macro indicators

Concept	**Multi-temperature truck route**	**Refrigerated truck route**
TOVE (%)	9	24
Operating Availability Efficiency (%)	31	66
Performance Efficiency (%)	54	69
Quality Efficiency (%)	99	99
Fleet size	47	16
Store serving time (minutes)	56	13

The weighted average journey time for the distribution of goods is 13 hrs. All the activities included in the process, from loading items, serving installations until unloading items are executed during the journey, i.e. all are internal NIT activities. Total fleet size includes 47 MT trucks and 16 RE trucks. The current average number of installations visited by an MT truck route is nine. An RE truck route serves 18 stores on average.

The MT routes are performing very deficiently. TOVE index is estimated at 9%. The factors with greatest areas for improvement are performance efficiency with 54% and operating and administrative availabilities with 31% and 56% respectively. Worth to notice is the serving time of 56 minutes of MT trucks. The efficiency factors with more area for improvement in both routes are the operating availability and performance.

4.3. IDENTIFYING KEY WASTES AT MICRO LEVEL

This stage is concerned with the analysis and identification of wastes and their causes in detail. In this stage, we will focus our attention in the MT truck routes. The wastes that impact the most operating availability efficiency are those associated to serve stores. Trucks and their crews spend service times in excess of 35 minutes per store. The procedure for serving stores includes the following activities considered as waste: Counting items received to verify that orders are complete, filling out reports, identifying, counting and packaging obsolete items. The first two activities account for about 50% of the time in excess and those related obsolete items the rest.

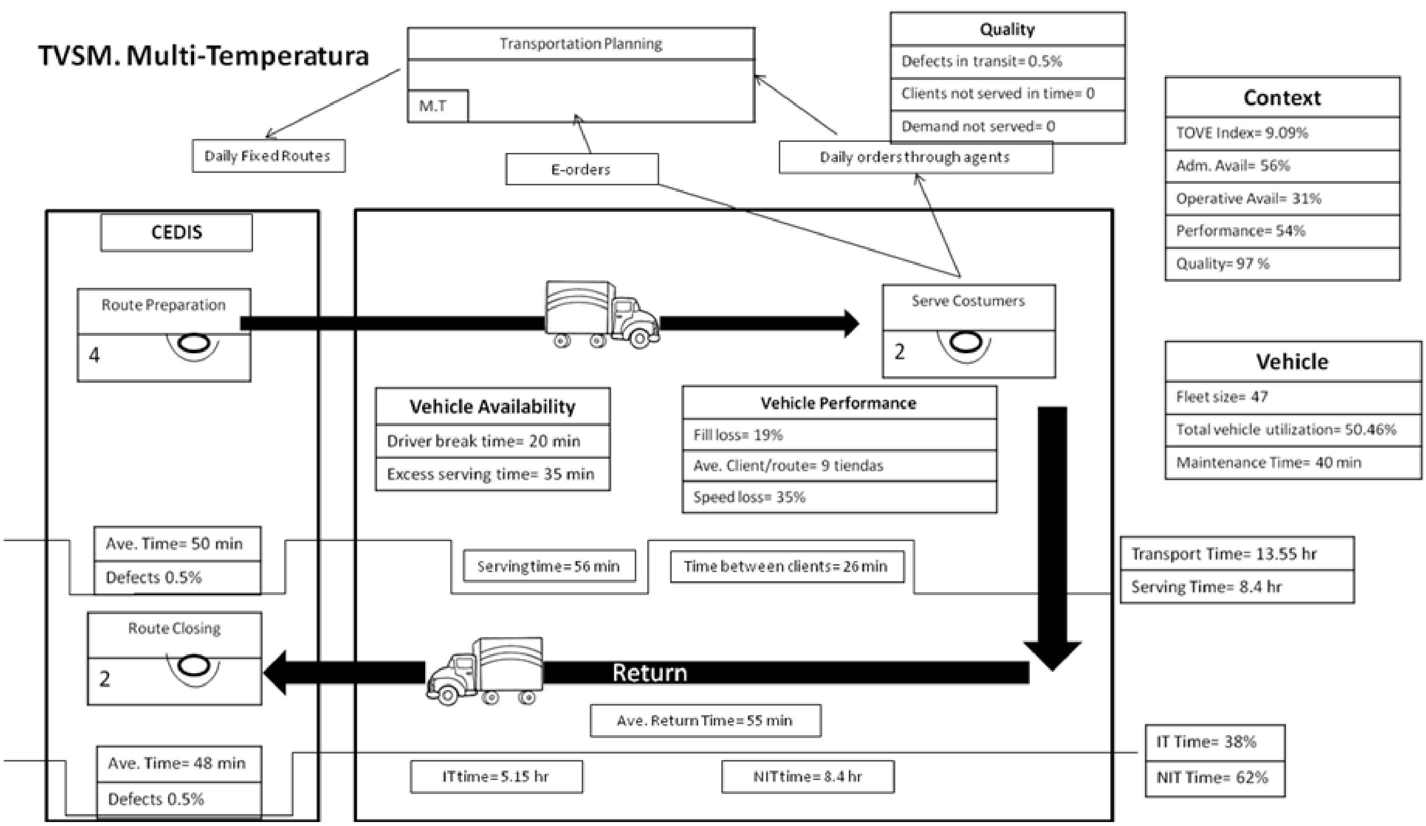

Figure 2 Current TVSM for Multi-temperature routing operations

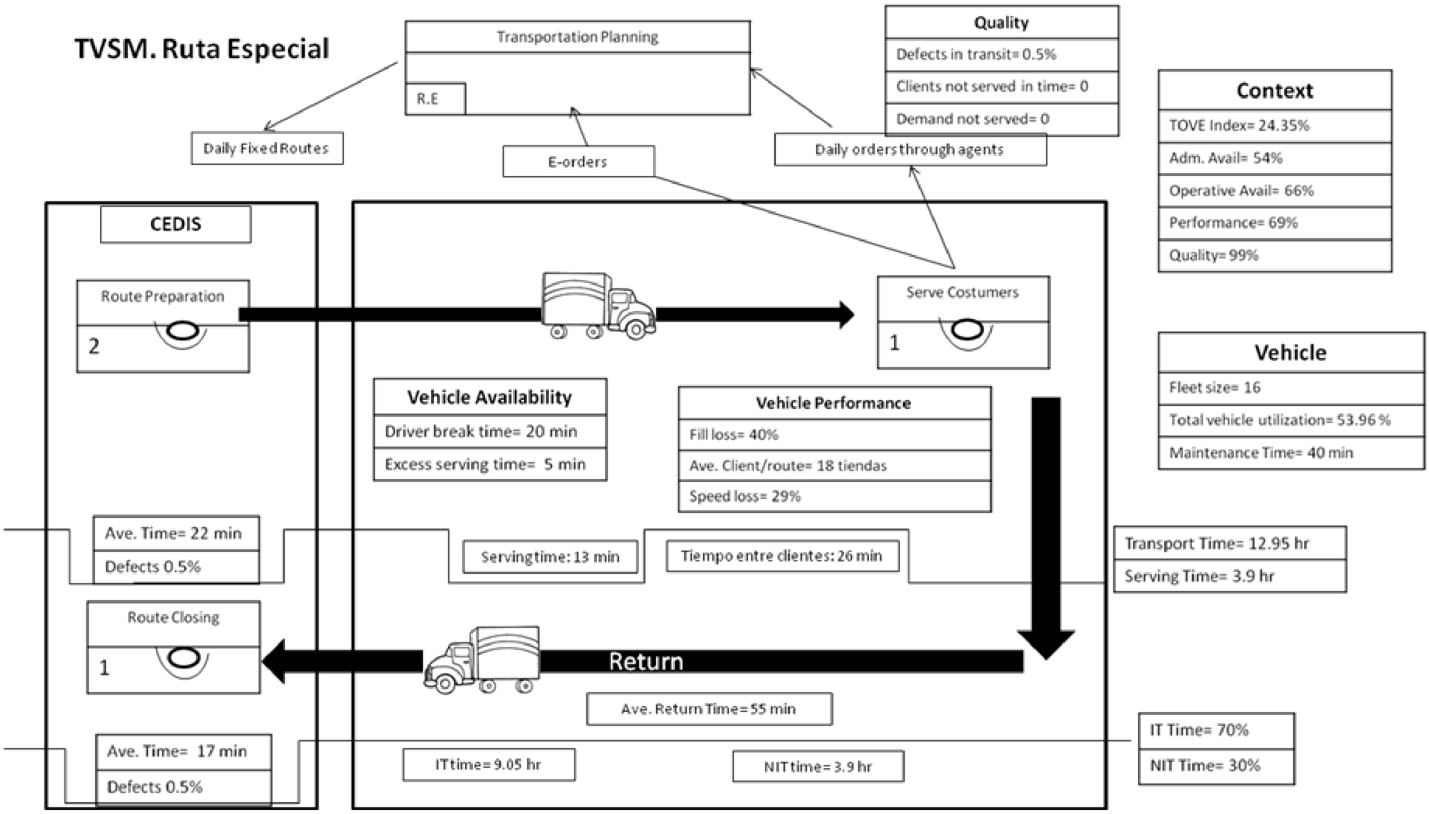

Figure 3 Current TVSM for Refrigerated routing operations

The root cause for the need to verify if orders are complete is the distribution center inspection procedure. The original procedure considers a very "loose" inspection sampling. This originates that the driving crew has to inspect what is loaded onto the truck. Then, every store responsible does not trust what is sent and requires a verification to authorize the reception of the order. The generation of items out of date is due to the store visiting frequency. These are mostly food items such as pizza, donuts, cheese and frankfurter.

The best option to increase performance is to decrease distance travelled in excess, and fill loss wastes. Both wastes are originated by both: an incomplete and inefficient use of the routing software that the company owns, and the impossibility of serving more stores determined by the journey duration and the high store service times. OXXO currently has the UPS Roadnet suite for designing routes. However, the personnel assigned for this responsibility is not exploiting its full potential. Additionally, a service time of 56 minutes per store is an obstacle to actually increase the number of stores to serve, and therefore, of utilizing more truck capacity. Fill loss will be reduced by decreasing store service time and allowing the service of more stores during the journey.

The main waste associated to the quality efficiency is food scrap. The main items that account for 80% of the scrap are bread, pizzas and frankfurter. Expired or perished food is the principal cause of scrap. A more frequent resupply of food to stores would practically eliminate scrap.

4.4 DEFINING WASTE ELIMINATION STRATEGY

The strategy established to decrease the main wastes identified is defined in stages as follows:

Stage I: This stage is aimed at improving operating availability and performance. The current route frequency is maintained.

- Apply 100% inspection procedures in the Distribution Center (DC).
- Redefine customer service procedures to enable deliveries based on trust.
- Apply software to design routes according to demand.

Stage II: This stage has the goal of increasing the levels of operating availability and quality. Here, route frequency is daily.

- Apply software to design daily routes according to demand.

The main initiatives included in stage I are 100% inspection at the DC and enabling deliveries based on trust. Implementing 100% inspection to the Distribution Center will enable a trust relationship between DC operators, drivers and store managers. Eventually, the time dedicated to count and verify orders will be eliminated. Customer service procedures are redefined without these activities. It is expected that this initiative will decrease store serving time from 56 to 20 minutes. Along with this initiative, customer serving procedures will be modified to consider the elimination of order inspection by the store representative and the truck crew. We would have deliveries based on trust.

The daily delivery initiative is mainly designed to increase operating availability and quality efficiencies by developing daily routes according to demand. Increasing store visit frequency will reduce store order size. The reduced order size and the smaller serving time per store pushes up the number of stores to be visited significantly. Fill loss and distance traveled in excess should decrease as a result. A collateral impact of daily routing is on the freshness of products sold, and in particular of food items. This improved freshness practically eliminates food scrap. Serving time includes the required for identifying, counting and packaging food returns. This time is estimated in ten minutes on average. Thus daily routes will decrease serving time from 20 to ten minutes.

4.5 STRATEGY IMPLEMENTATION AND PROJECTED RESULTS

The implementation of the previously described strategy is under way. This has been divided into two fronts: The first front is concentrated on improving inspection procedures at the DC and customer service procedures to achieve a “trust based delivery” at each store. The second front will consist of achieving daily deliveries to each store. The current plan considers that the first phase will be fully implemented during the first semester of 2014. Once this goal is attained, the daily delivery project will start. It is estimated that this will be done and stabilized by the end of the year.

Table 3 presents a summary of key operating indicators of OXXO´s total routing operations in Guadalajara. These are projected figures and consider the full implementation of both improvement stages I and II. It is important to notice that the analysis and projection to be described is obtained from the use of the routing software Viamente **(20).** After implementing the first improvement stage, it is estimated that both the operating availabi.lity and performance efficiencie should have an important increase. The number of stores per route increase 100% for MT trucks and 33% for RE trucks. The required operating fleet size is reduced significantly. The necessary MT trucks to satisfy the Guadalajara area are 17 instead of 47. The number of RE trucks for this case is 11 instead of 16.Service time per store is now 20 minutes if MT trucks are used and 8 minutes for RE trucks.

For the second stage of improvement, two cases were analyzed: Using only MT trucks or RE trucks. The best option is the alternative with routing RE trucks. Under this scenario, OXXO´s routing operations could become very competitive in terms of efficiency and agility. Stores will be supplied daily with service times of 8-10 minutes, similar to the competitor´s performance. Further, the required number of RE trucks for this case is estimated in 11. Trucks are able to carry out up to three routes per journey. Daily delivery will also enable total elimination of scraped food and furthermore the time dedicated to its control.

The last scenario that includes the implementation of all the improvement initiatives is required to obtain a level of leagility similar to OXXO´s main competitor.

Figure 4 illustrates the projected impact on routing operations cost after the implementation of both stages of improvement. The actual average cost level is reduced 32% with the implementation of stage I. This is then reduced an additional 10% after modifying routing frequency to every day using only MT trucks. If RE trucks are instead used, routing cost is further decreased 14%. The concepts of cost that are impacted the most are scrap, labor and capital costs. This is mainly due to the significant reduction of trucks required to fulfill store demand.

5. CONCLUSIONS

This paper deals with an application of the lean thinking methodology to the field of routing operations. The current work deals with the distribution of goods from the Monterrey DC to its corresponding customers (convenience stores) of a firm leader of the Mexican convenience store sector.

Table 3 Summary of key operating indicators of OXXO´s total routing operations in Guadalajara

Concept	Actual MT&RE	Stage I MT&RE	Stage II	
			MT	RE
TOVE (%)	9MT,24RE	16MT,28RE	49	**52**
Operating Availability (%)	31MT,66RE	56MT,76RE	76	**78**
Performance efficiency(%)	54MT,69RE	54MT,69RE	65	**67**
Quality efficiency (%)	99MT,99RE	99MT,99RE	100	**100**
No. Routes	93	93	21	**51**
Journey time (hrs)	13.1	13.1	10.2	**9.2**
Journeys per day	1	1	2	**2**
Routes per journey	1	1	1	**3**
Distance per route (kms)	138MT,213RE	138MT,205RE	297	**157**
Stores/route	9MT,18RE	18MT,24RE	27	**11**
Weekly visits per store	2MT,3RE	2MT.3RE	7	**7**
Service time per store (mins)	57MT,13RE	20MT,8RE	10	**8**
Total number of trucks required for daily operation	47MT, 16RE	17MT,11RE	11	**11**

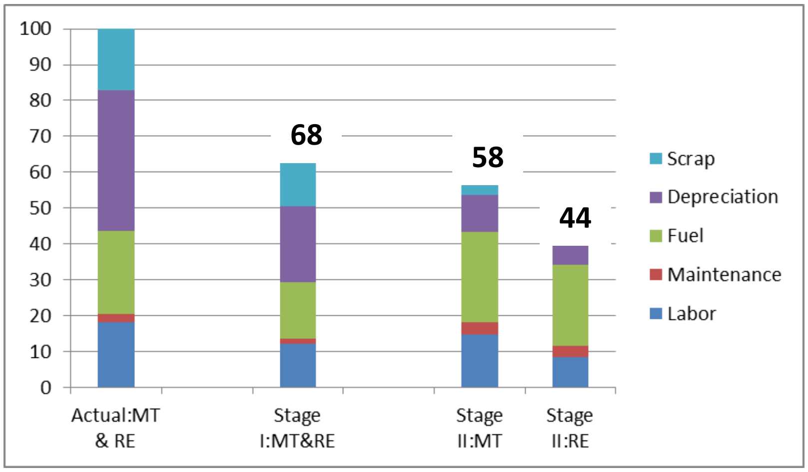

Figure 4 Projected routing cost under both improvement scenarios

After mapping transport operations, the main areas for improvement consisted of the performance and operating availability efficiencies. The main initiatives developed and applied were the redesing of the inspection procedure at the DC, and the procedures used to serve every store. Also, the redesign of distribution routes considering daily deliveries is fundamental to achieving the level of leagility required by the company. It is recommended to fully exploit the potential of the UPS Roadnet suite that the company already owns for the redesign of routes.

It is expected that the firm should be as leagile as its main competitor by the end of this year 2014, after implementing the improvement strategy delineated previously.

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