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The vision of Lean Six Sigma to reduce costs in logistics practices by modal shift

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Abstract

The Lean Six Sigma (LSS) is one philosophy important for helping you map out the activities of the service chain on the organizational point of view of automakers companies with best practices of modal shift. The proposal involves for managing value responsibility in each service for reducing inventory in transit.

Key words: Lean Six Sigma, cost, logistics, services, transport, multimodal.

1 Introduction

The needing for new paradigms of control in management and logistics services is a reality in many companies. However, the vision Lean in the early years of the 1950s was found in a specific way, through production from the automobile industry.

Nowadays, new paradigms have emerged for managing production through innovations that add value to the manufacturing process and allow for more productive conditions for a leaner manufacturing chain.

Sinclair, Phelps, and Sadler (2005) show that, in the industry, Lean production is due to the rebuilding of the new Japanese manufacturing model, which comes from the postwar period and whose way of producing has provided opportunities to envision an environment with numerous changes.

Sinclair, Phelps, and Sadler (2005) argue that the principles of Toyota sustained for many years the ideal model of a production system, which has been "reinvented" and "caught"

with a view of Lean manufacturing (Lean) currently applied to the industrial organization of Western markets.

The concept Lean after had been developed in other segments nowadays is been developed in logistic services. In the internal process of an extremely innovative system, basically, the goals are made necessary for their being variable according to the level of the operational complexity as to the several local characteristics in the *Modal Shift* operation (Modal Displacement) by means of the Brazilian transport infra-structure.

Accordingly, it can be said that the issue of logistics is all about with these requirements of a new order through forms of control and management of international operations (Gonçalves, 2011).

In many companies Lean Six Sigma is reflected by innovations from organizational changes in businesses that add value to processes, which necessarily depend upon the hiring of services to eliminate waste and maximize shareholder value.

The main objective is to find companies that provide the best customer satisfaction and the best level of service more quickly and safely. In the case study it is essential to review Kaizen improvements to reduce the costs of logistics services in the use of multimodal transport.

Industries have used the services of railway companies to share space and frequency of trains to the state of São Paulo, Brazil. For that, customs process and system of transport by modal shift that for Brazilian companies are necessary to establish the company's vision by creating innovations and the main steps to be observed with the mapping of spatial priorities in management control this system of transport. The LSS is the method used to identify waste costs internalized in this kind of services, mainly to reduce total logistics costs.

The environmental of research where researchers have used technical of observation participating to collect and verify information, photos and documents acquired of logistic operator by study case was the port of Santos.

Considering the processes manufacturing and business management environments also seek continuous improvement of processes to reduce inventory throughout the supply chain.

In this paper is demonstrated how LSS can decrease lead time by logistic process by Port of Santos. The proposal LSS is a form direct to manager with responsibility each service in multimodal logistic for reaching the better level of inventory in transit, comparing the costs of storage.

The LSS management identified that when used the custom process called DTA¹ PATIO MULTIMODAL the productivity necessary is keeping for the railway logistics.

The research concluded that the Lean Six Sigma (LSS) can be an important philosophy which helps on map the activities of service chains on the organizational, specially, for logistics by automakers with practices in cargo distributions with Modal Shift in transportation.

2 Methodology

The ratings are opinions on the importance and value of a particular type of performance, act, or result. The structure of a test evaluation can be an option on the main recommendations that allow both an external view and an analysis of internal processes. However, the case study seems more accurate in more complex scenarios. The level of service may differ substantially even in operational tests on problems and decisions.

¹ **T.N. (Translator's Note):** DTA stands for Declaração de Trânsito Aduaneiro (Customs Transit Declaration [CTD]); DTA - CARGA PÁTIO means CTD - YARD CARGO, that is, cargo destined to immediate handling through of custom area.

A case study is expected to capture the complexity of a single case, and the methodology which enables this has developed within the social sciences. Such methodology is applied not only in the social sciences, such as psychology, sociology, anthropology, and economics, but also in practice-oriented fields such as environmental studies, social work, education, and business studies.

The first stage in the case study methodology recommended by Yin (1994) is the development of the case study protocol. This stage is composed of two subheadings: *Determine the Required Skills* and *Develop and Review the Protocol*. The case study is ideal because it can be adapted to reality even in the test condition evaluation, where the understanding differs by proper construction under various circumstances. The reason to represent any phenomenon for a case study is the same as a play carefully tested in a well-formulated theory (Yin, 2008).

Yin (1994) suggested that the researcher must possess or acquire the following skills: the ability to ask good questions and to interpret the responses, be a good listener, be adaptive and flexible so as to react to various situations, have a firm grasp of issues being studied, and be unbiased by preconceived notions. The investigator must be able to function as a "senior" investigator (Feagin, Orum; Sjoberg, 1991).

As a case study, the explanatory model revealed in this article outlines the results from a literature review of concepts from an exploratory survey of Lean Six Sigma, where for the model "statement and proof" we say "how" and "why" and think about a phenomenon (Yin, 2008). The case study attempts to predict and explain phenomena that, taken together, comprise the ever-changing administrative environment (Hair, 2005).

The preparation of this research was done to collect data that we used in the literature research, document review, interviews, and direct observations in the research environment,

which was the Port of Santos. In the final stage, considerations of the draft case study are geared to contribute to the effective understanding of the issues presented in the logistics sector.

Therefore, the outline of a third party is required to obtain a pragmatic view of the concept of Lean Six Sigma. People merely represent the stakeholders in the chain, which must seek the participation of a process of value creation for continuous improvements.

3 Theoretical Reference

According to Queiroz (2007), Lean Manufacturing originated from the Toyota Production System (JIT) after the Second World War.

George (2004) states, Lean Manufacturing was first applied only in production because it was seen as more appropriate than the other dimensions of business organizations, thus resulting in an enterprise view of Lean thinking.

From the viewpoint of Sinclair, Phelps, and Sadler (2004), Lean Six Sigma (LSS) emerges as a model of excellence to the forefront of production. In practice, innovations in business management with the LSS occur because:

- *Six Sigma is headed for a strong relationship with the reduction of process variability, acting on the variation of production by avoiding rework that is usually represented with cost and quality, which are crucial to delivering business value without adding value to logistics service,*
- *Lean concomitantly focuses on eliminating waste to shorten cycle times of services and aims to accelerate the flow of the lead time logistics situation with the definition of system analysis.*

Continuing, Phelps and Sadler (2005) highlight this understanding of Lean Six Sigma (LSS), with some characteristics inherent to this philosophy, reporting that in a complementary way:

- *The client sets the value. A Lean company thinks more about creating value for its customers than about accelerating machines to absorb labor and overheads,*

- *Focus remains on process to understand the activities, flow paths and connections that need to produce a specific product, the process to align with customer needs,*
- *Continuous improvement is necessary to achieve their goals. The improvement activities must progress beyond the projects daily work,*
- *Lean production requires the engagement of all people at all levels of business,*
- *In this respect, it is stated that only people can provide continuous improvement,*
- *The pursuit of resources in pursuit of perfection is infinite in finding opportunities for the systematic elimination of waste.*

The preparation of KAIZEN DMAIC for intermodal transport logistics

For logistic operator the Kaizen is a method for accelerating the pace of process improvement in any setting. To measure the variations of these results, organizational models are often broadcast on the companies obtained with administrative tools for management control.

In general, the Kaizen is applied as an improvement event where people work intensively and it is exclusively focused on improvements over a period of time within or outside the organization. Some experts explain that employees assemble per continuous days to complete organizational study. During this kind event, employees following the DMAIC method, referring to a matter of high priority for instance: “...operator must make the materials reach the logistics platform faster and in the better transit time” (GEORGE, 2004).

For organizational practices of Kaizen, everyone can be involved in the value chain. However, must be willing to negotiate a set of principles in the context of the Lean initiative.

As George (2005) comments the characteristics of a Kaizen approach is a corporative term used for any intensive project where employees are pulled off their regular function to creating solutions for company vision unless to avoid wastes in uncertain process.

Henceforth, to identify what are the main measures in the logistic services. It's necessary to understand the current state of the process and collect reliable data on process speed, quality, and costs that it will use to expose the underlying causes of problems (GEORGE et al.p.8, 2005).

Price (2005) reveals that for developing or conduct clearly a KAIZEN DMAIC is necessary follow some premises:

1. Define the Kaizen objective;
2. Select a Kaizen leader; Select and notify participants;
3. Preparing training and materials;
4. Assemble background information;
5. Complete logistic planning;
6. Arrange for coverage during participants' absence
7. Arrange for management/sponsor participation;
8. Contact departments/ functions whose support you will need during the week.
9. Preparing the Kaizen Protocol

Typical Plan for Kaizen	
Prep	BB and sponsor DEFINE project, select Kaizen leader (usually group leader), ID participants. BB and leader assemble background material, prep training, secure logistics.
Mon	(Often start midday) BB and Kaizen leader brief team on Define decisions. Deliver training if needed. Resolve questions about charter. Begin MEASURE by creating/validating value stream map (including process observation).
Tues	MEASURE continues until all data collected, move into ANALYZE as soon as possible to identify and verify root causes.
Wed	By Wed, afternoon should be in IMPROVE, working on solutions (developing criteria, evaluating alternatives, conducting pilot).
Thurs	Finish IMPROVE and move into CONTROL (develop new documentation, develop plans for full-scale implementation).
Fri	Usually by midday, team is prepared to present results to management. Get approval for plans, resolve questions.
Follow	BB, Kaizen leader, and process owners (as appropriate) help guide full-scale implementation and monitoring of solutions. Adjustments made as necessary.

Source: Typical Plan or Action Protocol for Kayzen (GEORGE et al. 2005).

The measures depends fully of developing current-state of value stream map because when identifying variables at process after start up the service operations it will be useful check in alternatives one basic process map to eliminate variables com waste options.

The OTIF - "On time in full" is widely used as indicator to measure the performance of logistics customer service. According to Oliveira and Araújo (2008), the OTIF is an indicator of a strategic initiative; it should be aimed at corporate strategic planning.

As provided by Oliveira and Araújo (2008), the method to construct OTIF is established by the DMAIC, whose initials stand for the following explanations:

- D** - Define the problem and the impact of the organization
- M** - Measure the performance of the organization
- A** - Analyze and identify the causes of the problem with performance
- I** - Improve the process to attack the causes of problems
- C** - Control the process to sustain the improvement

In the analysis of Lean Six Sigma services, one vision addresses interests and needs and identifies how to establish the concept innovation with OTIF to the business. OTIF guides the care of intermodal transportation services. The application OTIF is flexible as aim and can be used to analyze the suppliers, customers, or internal processes, so modulated. In philosophy, Lean Six Sigma, and in a complementary way the OTIF, plan the structure of DMAIC and are used to approximate the processes of Lean Six Sigma for improvement and problem solving. Normally, the team works three to five days full time and the resources are dedicated for all participants who spent their time looking for alternatives of logistic saving during the Kaizen Event.

The quality of KAIZEN is related to the ability to minimize the transit times for modal between expectations and perceptions of customers and suppliers in the operational management of the total lead time of the customs procedure in question. Therefore, an indicator of observations establishing criteria to maintain adequate service to the customer's needing.

Lead time and speeding the process

To analyze the lead time (time) in transport services in logistic we can consider the time it takes to deliver the container from determinate port up to destiny of cargo or service

the request after being shot. By means of the equation known as Little's Law (apud George, 2004), we can define with the equation (1):

$$\text{Lead time} = \frac{\text{Amount of Work in Process}}{\text{Average Completed}} \quad (1)$$

George's (2004) equation can reveal the lead time, that is, time that any item of work can be completed, by simply counting how much work is still in one place until it is concluded from the data that there is a work in process (WIP), that is, how many things we can conclude (work in progress) every day, week, etc. (average completion rate). As George (2004) states, when there is a WIP process, there will be work to be completed. In Lean language, this means that the work will always be "in line"; waiting time is the "timeline."

According to George (2004), it is inferred that any period of time during which a running process remains in the queue should be considered a delay in the Lean philosophy, no matter what the cause or underlying factor. It is important to understand that some activities add value to customers, and value-added effectors may be a change in the process that customers are willing to pay.

The numbers represent the Six Sigma² as the distribution of effective output that matches the range of acceptable values (customer specifications). Below this normal distribution, the highest concentration of values portrayed is one that lies symmetrically around the mean (GEORGE,2004) . See Figure 1 below:

² According George, (2004) having "Six Sigma capability" means having a process that produces only 3.4 defects per million parts.

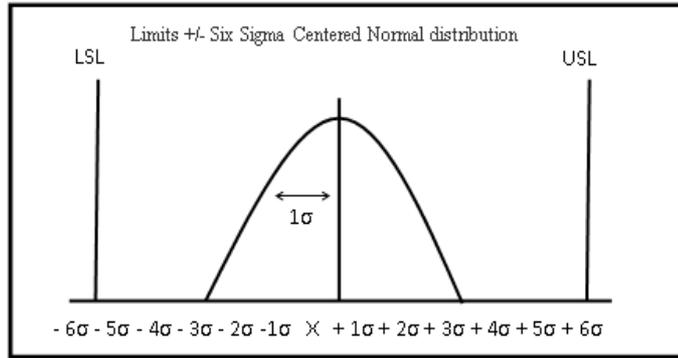


Figure 1 - Limits mean normal distribution centered.³
 Source: George (2004).

A defect is any value that falls outside of customer specifications. The more the distribution fits within specifications, the higher the sigma level.

To ensure that different processes can be compared, it is usual to standardize reporting of an "index" of defects (defects per million opportunities) rather than absolute numbers (George, 2004), described in Table 1 below:

6	3.4		100.00%
5	233		99.98%
4	6.210		99.38%
3	66.807		93.32%
2	308.537		69.20%
1	690.000		31%

Table 1 - Defects per million by Sigma¹
 Source: George (2004).

In others words, it is possible to create value-added to the client and the production process decreasing the quantity of failed in working process by logistic service by transport, it performance will can measured as demonstrated vide- Table 1. However, if customers refuse to pay an additional option for a new logistics system and remain in the existing system, without testing the proposed method because the new cost, it is possible, may not create

³ Normal curve (George (2004, p. 34)) is the distance between the centerline and the inflection point (where the curve begins to flatten). It is called sigma (σ), the standard deviation. Sixty-eight percent of the data fall between one standard deviation above and below the average, 95% within 2σ and 99% within 3σ . (Thus, the range between - and $+3\sigma$ represents 99% of the data.)

value-added to the client and the production process that customer, or the innovation does not reflect the efficiency of the new process.

Process efficiency of the cycle

For this it is extremely important to involve factors such as availability of vehicles at the scheduled time for port terminals, minimizing delivery time to reduce the cycle time of the request, and other aspects of productivity indicators for modal scenarios complexity.

George (2004) states, the critical measure of waste to any process of service is discovering what percentage of the total cycle time is spent on value-added activities and how much is wasted.

The measurement used is the process cycle efficiency (PCE), which relates to the amount of time value-added to the total lead time of the process, according to equation (2):

$$\text{Process Cycle Efficiency} = \frac{\text{Time Value Added}}{\text{Total Lead Time}} \quad (2)$$

To analyze the process cycle efficiency with less than 10% indicates that the process has wasted many opportunities to non-value-add. As George (2004) states, it is extremely important to consider the following assumptions:

1. *Most cases are considered "non-Lean," that is, has an efficiency of process cycle under 10%,*
2. *A primary goal of Lean is certainly a reduction in control of the WIP (WIP if it cannot control time),*
3. *The entire process from the perspective discussed must operate in and not push the system to eliminate variation in lead time,*
4. *Usually the vision shows Lean in only 20% of the activities causes 80% of the backlog,*
5. *Consider the invisible work (intangible) or service cannot be improved; we need visual management, based on data,*
6. *Create a value stream map of complexity on top of the generator selected value to capture the workflow and quantify waste and delays,*
7. *Determine the largest time trap - Ishikawa Diagram,*
8. *Identify projects to eliminate time traps (using Lean tools, Six Sigma, and/or reduced complexity) - set the CPM - Critical Path Method.*

For LSS functional applicability in logistics it takes the commitment of every manager, and they are especially familiar with the concepts to be defined in the training of employees classified as leaders or champion Black Belts. These leaders are extremely important because they have the technical attributes that accredit management in the analysis of so-called time trap processes in more detail - otherwise they lack rigor in the final link between strategy and logistics projects to be implemented in light of the knowledge of the practices of organizational Lean Six Sigma (George, 2004).

As the production sector as service sector in logistics and essential to accomplish performance measure results quantitatively. The Six Sigma is a tool that allows the monitoring of these results by means of controlling the goals desired time, for example, transport services, regardless of the modal.

This integrated vision of Lean and Six Sigma envisions increasing customer value in the use of products or services to a certain inherent logistical supply chain.

On the other hand, in logistics networks it is demonstrated that Lean Six Sigma when combined can successfully integrate a broader framework and can be used to support the business value based on organizational processes used by the operator's logistics services. In fact, when combined, LSS seek continuous improvement to meet customer needs in the internal and external environment for administrative systems that identify methods for monitoring and process control in various forms of management tools that we can mention: KANBAN, KAIZEN, and organizational philosophies of Just in Time.

Concepts of intermodal transport for understanding of modal shift practices

According to Gonçalves (2011), the complexity and interdependence of the internationalization of operations require an adequate infrastructure for transport, for adequate control of resources, given the continued attention to landmarks, regulatory barriers, and

protectionist tariffs and non-tariffs that necessarily involve attention toward larger issues of ethics and social and environmental responsibility.

In transport system some operations are used to reduce costs. For instance, the intermodality can be conceived as a transition from one mode of transport to another and is organized around concepts Rodrigue (2005), such as:

- a. The basic nature and quantity of goods transported;
- b. The modes of transport used;
- c. The locations of origins and destinations;
- d. The transport time and costs;
- e. The value of goods and the frequency of boarding.

Multimodal transport network - A set of transports offering a set of connections between origins and destinations where intermodal transport may not necessarily occurs in an integrated manner (Rodrigue, 2005). This is shown in Figure 2, below.

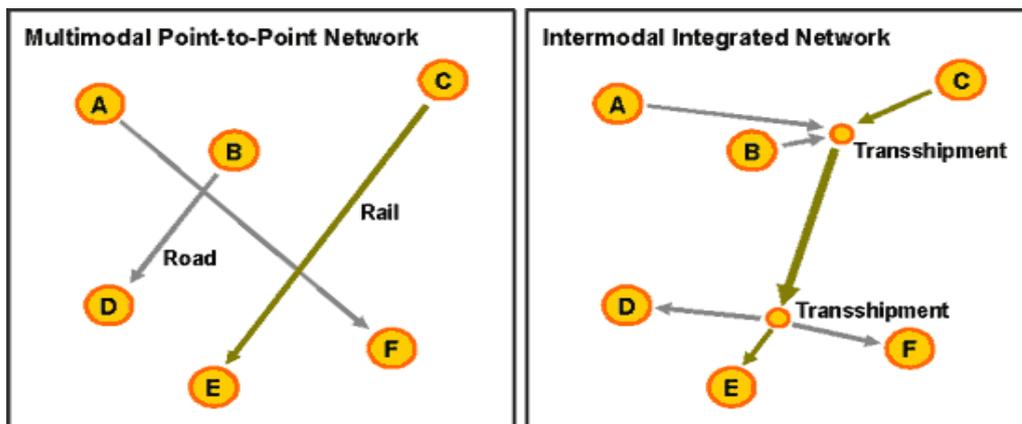


Figure 2 - Network of intermodal and multimodal transport.
Source: Rodrigue, Jean Paul, Hofstra University (2005).

The figure 2 illustrates two alternatives to the charge distribution. The first is a conventional multimodal network. Point-to-point sources (A, B, and C) are independently linked to the targets (D, E and F). In this case, two modes (road and rail) are used. The second alternative involves the development of an integrated intermodal transport network. In other words the traffic converges at two points, transshipment in rail terminals where cargo is consolidated (Rodrigue,2005).

Intermodal transport network - One way logistic systems connect between two or more modes using different modes of transport charging a fee. Modes are common features of a transportation system that saves loads (or people) transferred during movement between origin and destination (Rodrigue, 2005).

Normally, this organizational model can obtain a larger amount of cargo/transport, or more frequently, especially between the port terminals. In such circumstances, the efficiency of the network lies mainly in the transport capacity of transshipment terminals inside or outside the organized port. The reason for the investigation of applicability of this concept in organizational practices is because LSS aims to meet the difficulties of eliminating the port environment and the methods used by unnecessary movements in the intermodal "workplace."

When the barriers of time and the differences between the propose system and the transportation model, the organization may propose continuous improvement in several ways.

In general, focus on the time factor, on account of the short deadline for supply chain attendance. In this circumstance some exporter, inside of dry ports with has railway.

According to Gonçalves (2011), to gain competitive advantage, an exporter will store your goods in dry dock. Armed with a Certified Customs Deposit (CCD) issued by proving dry port, the exporter gets accepted and an external customer can deduct its value in the financial system internally or externally, using international rates and strong currency, with a great reduction in the amount of working capital. For other hand, the importer can bring the goods from the outside and leave them deposited in a dry dock. Based on this strategy, nationalization will be done in installments by the importers and the taxes are collected at the time, and the proportion of plots taken from the dry dock or LCIC will be considered in logistics.

Method of forming analysis to create a value stream complexity

Womack et al. (1996) states that one of the major consequences of Lean thinking is to reduce losses by eliminating activities that do not add value to the product/service end. Reflected in this work is the conviction that the elimination of waste focuses on achieving a target cost based on the perception of customer value. For that, George (2005) has indicated the Value Stream Map to capture all key flows to construct workflow for transportation system and important process metrics.

Value stream map complexity (CVSM) is a tool that combines three elements (as cited in George, 2004):

- Process flow.
- Data on how time is spent.
- Data that reflect how many different types of services/products flow through the value stream (the complexity).

A map of traditional value stream mapping (VSM) depicts the (s) file (s) base (s) in a value stream, with activities classified in two or three categories: value-added work (VA), job-add value (NVA), and work non-value-add to the business (BNVA).

According to George (2004), *added value to the customer* is the work that contributes to what your customers wants your product or service (and for which they paid if they knew of its existence). The distinction matters to this stage are:

- Does the task add a function, a shape, or a desired characteristic to the product or service?
- Does the task allow a competitive advantage (price reduced delivery: faster or fewer defects)?
- Would the client be willing to pay for this activity or would the client prefer us over the competition to know that we are performing this task?

Non-add value to the business (BNVA) are the activities for which your client does not want to pay (does not add value in his eyes) necessary for some reason (often for accounting, legal, or regulatory)? In addition to value-added activities to the client, business

or regulatory agencies may require carrying out some functions that do not add value from the customer perspective (George, 2004):

- Is this task required by law or regulation?
- Does this task support the requirements of financial statements?
- Would the process be interrupted if the task is deleted?

Non-value-added (NVA) as George (2004) states, there is work that adds no value in the eyes of customers and which they are not willing to pay, and it is not necessary for purposes of BNVA.

- The task includes some of the following activities: rework, shipping, multiple signatures, counting, handling, inspection, setup, downtime, transport, handling, delay, storage.
- Adopt an overview of supply chain once you have made these improvements. The shorter lead time and lower costs will create more revenue and consume existing capacity. If not, the excess capacity is not-value-added and must be eliminated.

There are several ways to visually separate value-added work and non-value-added in the process map that will be the foundation of a value stream map of complexity. One method is to use color coding; other methods include dividing the page into columns (VA versus BNVA versus NVA) and the placement of icons representing the steps in the appropriate columns. In the analysis the data after the construction of the DMAIC framework, shows that process improvement is the use of a dry port, or the Logistics Center Industrial Customs (LCIC), as the interest of customers using intermodal transport system.

4 Study case applications LSS management to find out VA by intermodal transport

First of all, the ITRI - Rodoferrovia is one company that offering alternatives by road-rail transportation service and provider this kind of service as Multimodal Transportation Operator (Operadora de Transporte Multimodal [OTM]), and duly certified by the Agência Nacional de Transporte Terrestre (ANTT) (National Agency of Haul Transportation) to perform such an activity that operates as 3PL Third Party Logistic to automakers in a Santos

Port in Brazil. The company ITRI is used exclusively for a railway line within an intermodal terminal located in Suzano (LCIC Crazea).

In this case study, the researchers observed that ITRI serves as a multimodal logistics operating company and aims to operate condition of a dry port or LCIC for the removal of customs cargo in transit through a process called DTA multimodal yard. The company separated this point of view to construct VA for client - See Table 2 below.

Table 2 – Method of analysis for the use of a LCIC - Logistics Center Industrial Customs analysis of the division in columns (VA versus BNVA versus NVA)

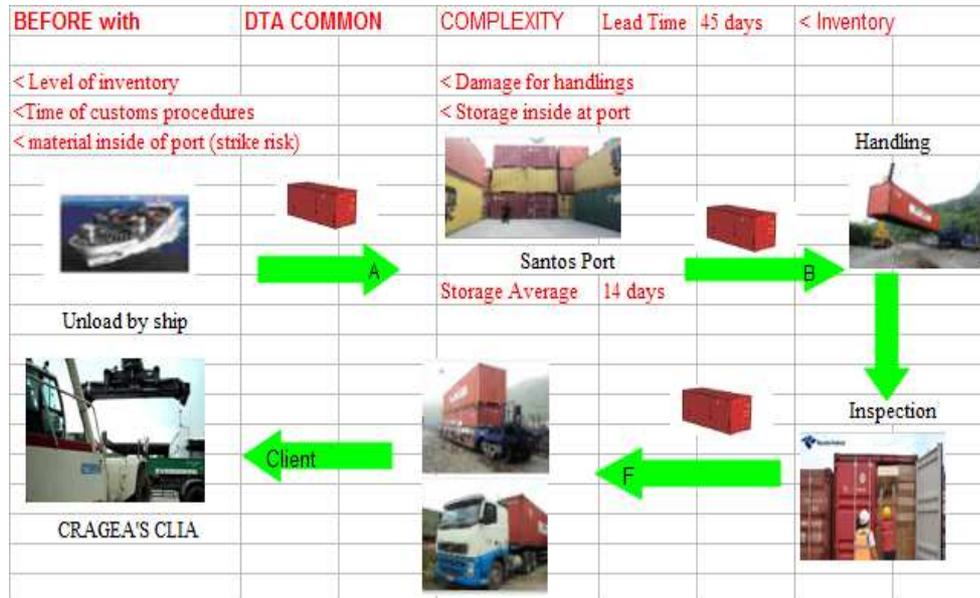
INTERMODAL TRANSPORT		D	M	A	I	C
Bound Shares		Define	Measure	Analyze	Improve	Control
D	The Problem	Performance Targets	Lead Time	Multimodal Transport	Logistic	Time
M	The Performance	Priorities	Process Cycle Efficiency	Cash Assets in Process (WIP)	Complexity	Productivity Indicator
A	Analyze the Process	Waste	Port Costs	Port Regulations	Bureaucracy	Process OTIF
I	Propose Improvements	Critical Path	Time Clearance	Supply Chain	Flows	Projects
C	Sustain the Improvement	Collaborative Logistics	Eco-efficiency	Several Indicators	Process	Innovations

Source: KAIZEN held in the training room of ITRI (2007).

Thus, it is clear that rates added to the service road can be minimized with the use of rail and intermodal logistics, because the railroad reduces costs to the carrier, such as: rates of tolls, rates of scales, parking, and as well as the differentiation of port costs by type, in the preparation of cost by the customs process.

This allows the transport logistics intermodal train to run express trains daily with pre-set, enabling customers the ability to use the concept "Just in Time" proposed in Kaizen. Based on data collected from ITRI participation of representatives who report activities of LSS, Kaizen aims to identify practices that can generate added value or value-added processes from customers, which leads to an efficient intermodal transportation system.

The proposal of the customer who prefers to remain anonymous is demonstrated in this copy of the slide shown in Kaizen shown in Box 1 as follow:



Box 1 – Result of stocks in transit with DTA COMMON before Kaizen DMAIC.
Source: ITRI (2007)

In this KAIZEN was demonstrated the intermodal strategy using two kind of modals in customs process on comparison DTA COMMOM versus DTA PATIO. For this type of customs process, importers consider important service performance as the lead time of the process, like the price difference in the composition of the freight. The inventory of operating costs makes evident the reduction of costs in intermodal transport logistics service.

The modal road and rail are investigated from the operational performance and costs standpoint inherent in the activity of removal from the customers areas that is proposed. On the way investigated, proposes eliminate the wasted time in activity which may not result in reduced lead time to the activities related to the critical path, by controlling the time of the process, from the origin of the cargo from the Port of Santos (SP) to the destination in the LCIC Cragea of Suzano (SP) as follow on Box 2:



Box 2. Result of stocks in transit with DTA PATIO after improvements of Kaizen DMAIC.
Source: ITRI (2007).

OTIF - Calculation based on requests handled in lead time rather than volume of services by type, according to the equation (3) - Quant. Orders Served OTIF versus Quant. Predicted Order in Lead Time as follow:

$$\text{KPI/Modal} = \frac{\sum \text{Number of Requests Served}}{\sum \text{Number of Requests under Lead Time}} \times 100 \% \quad (3)$$

Source: George (2004).

In this case, a solution is the application of the DTA process - "Freight Yard." The choice of the customs process is essential to the effectiveness of the modal, which may favor a strategy of changing modal freight to rail, thus avoiding wasted time with the option of nationalization of the load in the secondary zone. The railway compared to road transportation is only impaired in the end when lead time depends on the static capacity of railway lines, which include the port terminals and depend on trucks to move the containers inside the yard so the operators cannot minimize the queue times to the desired Key Performance Indicators (KPI) on the OTIF.

In the comparison below of the process cycle efficiency, the customs process in question is named DTA 1 - COMMON, as shown in Table 3 and 4.

Table 3 - CPM: Critical Path Method by Lead Time for Customs Process by DTA Common

Removals in transit customs Action activities in a DTA 1 - common	Activities predecessor	Duration in H / useful	Time limit
a. Maximum time (medium) in the release of cargo		0	960
b. Preparation of the order of a Common DTA	A	48	912
c. Conference on Primary zone (stored charge)	B	480	432
d. Other entrants requirement of fiscal organ interviniente	C	76	356
e. Analyze the process (clearing) impaired	D	72	284
f. Requirement of the procedural document for review	E	120	48
g. Carregamento to the vehicle at the port (wagon)	F	116	24
h. Release of load AFNT	G	24	0
i. Transporte railroad	H	24	0
TOTAL		960	
		importer ITRI	

Source: Smith (ITRI, 2007)

The critical path method (CPM) can be applied to identify targets and waste time on tasks BNVA, before choosing the customs process DTA multimodal yard. So you can detail in more structure customer bottlenecks in existing operational process between modes of transport.

Table 4. CPM: Critical Path Method by Lead Time for Customs Process of DTA PATIO

ACTIVITIES	Activities predecessor	Duration in H / useful	Time limit
a. Analyze the documents (BL invoice) dispatch		0	48
b. Preparation of the DTA - over patio	A	4	44
c. Analyze the process (custon) automatic	B	12	32
d. Removal of the area of the operator for the area of port	C	12	20
e. Loading wagons	D	6	14
f. License for the release of the physical of the AFTN	E	4	10
g. Rail transit in the custon	F	10	0
TOTAL		48	0
* Custon, Port operator		importer ITRI *	

Source: Smith (ITRI, 2007).

The figure 5 shows the comparison of the impact of the implementation of the DTA - Patio load factor in reducing the time by truck transport.

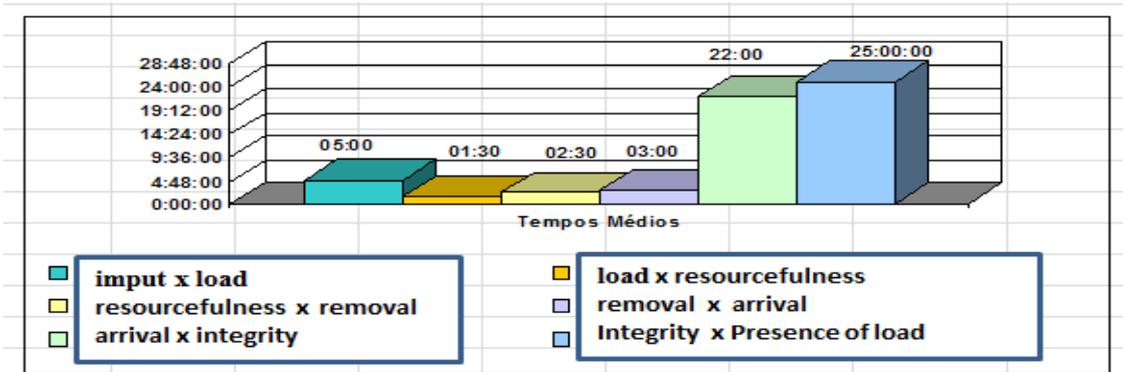


Figure 5. – Analysis of reducing the "lead time" by modal road from port up to LCIC.
Source: Smith (2007c).

In the Table 5 shows the analysis of inventory costs with the implementation of DTA - Freight Yard and can see the cost reduction based on the use of railroad system. All thought the modal rail in the operational aspect is not as flexible in terms of time in the operation of customs procedures.

Table 5 - Analysis of inventory costs with the implementation of DTA to see the reduction factor "cost" - based on the use of rail

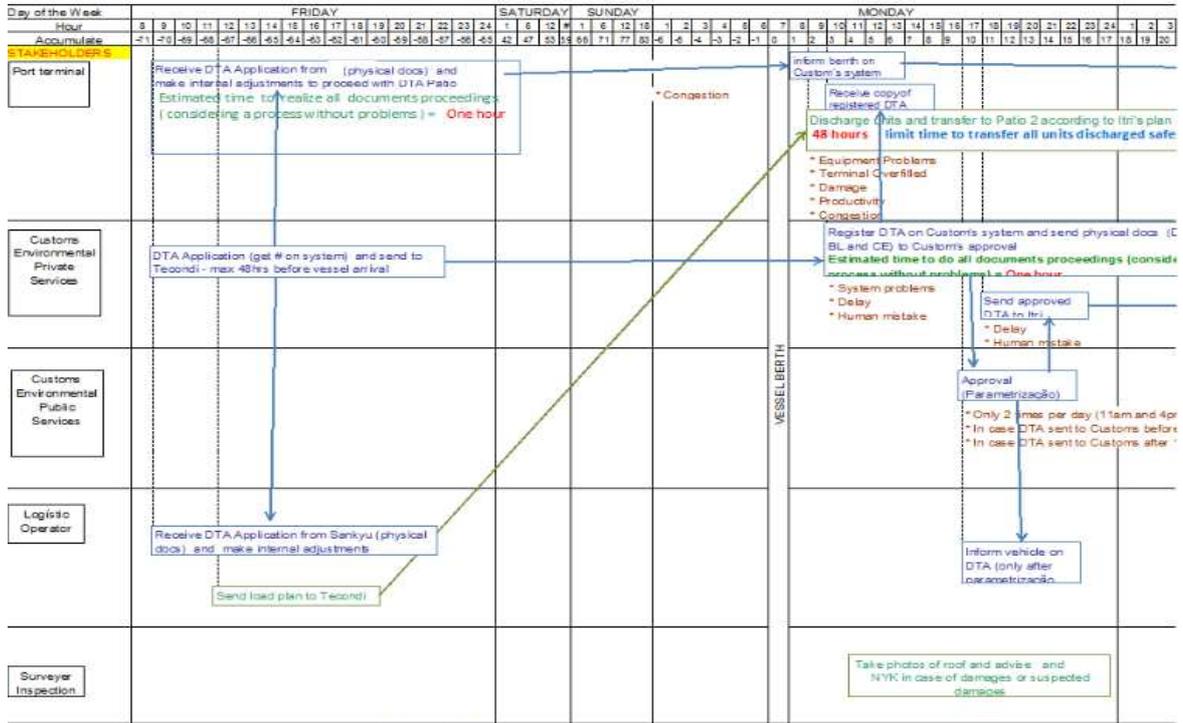
DTA MODE- TREATMENT WITH DIRECT LOAD PORT TERMINAL		
LOGISTICS TRANSPORT APPLIED TO ROAD TRANSPORTATION		
EXPENDITURES FOR REMOVING LOAD CONTAINER 40'	Value	US\$ 1,466.90
LOGISTICS TRANSPORT APPLIED TO RAILROAD TRANSPORTATION		
EXPENDITURES FOR REMOVING LOAD CONTAINER 40'	Value	US\$ 1,037.17
COMPETTIVE DIFFERENCE IN DOLLARS		US\$ 429.73
FORECASTING OF MOVING CONTAINERS		6
COST REDUCTION PER PROCESS		US\$ 2,578.38

Source: ITRI (2007).

It is very important to construct the value stream map at focal point by start-up DTA PÁTIO inside of port area – Look at the model of workflow in Box 3 as follow.

Obs: In case units leave from patio 1, units get weighted and return to patio 1, not going to patio 2
 Documental Flow Chart
 Operational Flow Chart
 Potential Problems:

International Logistic Importer Flow Chart



Obs: In case units leave Tecondi from patio 1, units get weighted and return to patio 1, not going to patio 2
 Documental Flow Chart
 Operational Flow Chart
 Potential Problems:

Box 3 - Workflow of Value Stream Map
 Source: ITRI (2007)

Effectiveness in negotiation with port terminals is essential with the contractor services BNVA to explore an infrastructure, public or private, within the port environment.

The structural factors in the management of the port intermodal have an impact on costs in different areas of the port of removal. In addition, strategies may differ in the modal control of KPI lead time of the production process of the port terminals, based on OTIF, especially when changes are applied through the railroad to reduce time and costs in intermodal logistics.

5 Conclusion

In the control system applied to the LSS, a vision was realized that the analysis of time wasted by NVA storage services is likely to be verified in stages, continuously, to reduce the residence time of the charge within the primary zone, the Port of Santos.

Following the proposed structure of DMAIC and by imposing performance targets of VA activities to the customer, you can define organizational ways to minimize the risk of variability of intermodal logistics with Lean culture at every customs process.

The concepts of organizational improvements and checking every process of Kaizen made directly with customers should be tested for best results and continuous improvement to sustain the process of DTA Patio and to reduce safety stock inventory given the greatest attention in the supply chain when nationalization of import cargoes inside the port. The results with the implementation of the methodology of Lean Six Sigma should be based on increased customer satisfaction and loyalty, after the acceleration of the supply chain through the VA increased synchronization between processes. Stakeholders as logistics service providers focus on a customs process for Lean and aim to optimize service logistics to minimize operational risks that may cause variability in process times (Six Sigma) customs in question.

The complexity is monitored by the logistics manager to demonstrate the most economical modal logistics, which can impair significantly the comparison of costs between the modes of road and rail. The limitations of the modes are investigated considering performance indicators because the railroad depends on the release of the railway terminal adjacent to the port due to receipt of wagons. To add value to multimodal, the logistics operator should avoid any barrier to the circumstantial restrictive customs clearance process to get the OTIF desired by customers.

Concomitantly, the phases of the inventory of operating costs and reduction in service costs of intermodal transport, particularly through the removal of customs import cargoes in the process of DTA multimodal yard toward the port "dry," may support the strategy of modal shift in modal choice.

It is inferred that with the organizational philosophy of Lean Six Sigma to establish the performance by OTIF modal, you can adjust the process to minimize variability by losses, provided there is a decision about customs procedures and appropriate use of the modal characteristics, especially when there is interest in innovation in the use of intermodal transport systems.

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