

Logistic Management Optimization in the Ports

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Abstract: The aim of this paper is to show the results obtained and the methodology used to achieve better logistic organization of Mediterranean ports and logistics areas. Recently, we introduced a new methodology in the ports of Naples and Algeciras Bay in order to improve their logistics processes. This methodology was implemented as a part of the INTE-TRANSIT project, cofinanced by the MED Program with the aim to improve logistic processes and increase technological integration in Mediterranean ports. The methodology used in the ports of Naples and Algeciras Bay consists of four parts, two of which include a tool called VSM. VSM stands for “Value Stream Mapping”, a tool to analyze and understand the flow of material and information that allow a deep knowledge of a process and identify the wastes. “Waste” in this context, is defined as something anything that adds cost to a product or service without adding value. The use of this methodology has allowed us to identify in detail the problems in both the information flow and material flow. It was detected that the acquisition of new technologies could facilitate and expedite the process of receiving, the location, the internal movements and the vessel loading.

Key words: logistics; lean; port; optimization; model

JEL codes: L99

1. Introduction

Maritime transportation is the backbone to international trade and the global economy. Around 80% of global trade, by volume, and more than 70%, in value, is transported by sea and passes through ports world-wide.

The United Nations Conference on Trade and Development (UNCTAD) has recently published their report on 2014 Maritime Transportation (UNCTAD, 2014) that reflects on the progress and challenges which are facing this sector. This is a publication that has been published since 1968 with the aim of encouraging the transparency of the maritime market and analyzing the development and tendencies in the international maritime trade field, transportation by sea, global fleets, ports, freight markets and the legal and regulatory framework of the transportation.

Among the most highlighted results in the 2014 Report, it notes the growth of international maritime trade that for 2013 registered an increase in volume of 3.8%, increasing the total world volume to almost 9.6 billion tons. The reason for this upward trend would be fuelled, according to UNCTAD, “by growth in dry car-go flows, in

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particular bulk commodities that grew by 5.5 percent”. Dry cargo, containerized trade, and general cargo/breakbulk made up 70.2% of worldwide trade, while tanker trade accounted for 29.8%. Furthermore, it estimates the global port traffic in containers increased 5.1%, reaching 651.1 million units.

The importance of ports as links in the logistical chain and transportation is supported by the following numbers: close to 60% of exports and 85% of imports pass through them, accounting for 53% of Spanish foreign trade with the European Union and 96% with non-member countries. In addition, the activity in the national port system contributes for close to 20% of GDP (Gross Domestic Product) in the transportation sector representing 1.1% of Spanish GDP. It also generates a direct employment of more than 35,000 jobs and some 110,000 indirectly.

The ports are important intermodal centers, yet there has existed a historic neglect towards the intermodality with the land modes (rail and road) that are now being corrected. This shift has been caused by factors such as the intention to expand the ports hinterland, the promotion of new services of short distance maritime transportation (SDMT) and, in general, is the result of the increased competition among ports (Fundación CETMO, 2005).

The ports are essential for transportation activity and competitiveness of Europe and have enormous potential in the creation of jobs and investments. The European ports are the gates to the European continent. 74% of non-European Union goods are sent through these ports. They are also important to inter-European trade: with 37% of European Union freights passing through these ports annually and 385 million passengers.

In the 70,000 kilometres of coasts in the European Union are where over 1,200 trading ports are located. Europe is one of the regions with highest density of ports in the world. It is forecasted that the traffic of goods that pass through these ports of the EU will increase 50% by 2030. This increase is an opportunity of economic growth and job creation: The Commission has estimated by 2030 they can create between 110,000 and 165,000 jobs in the ports. But the European ports must be adapted to face this increased traffic (European Commission, 2013).

On the base of this context, this article describes the methodology and first results obtained during the INTE-TRANSIT project, co-funded by the Regional European Development Fund under the MED Program. INTE TRANSIT aims to achieve a better logistical organization in the Mediterranean (MED) ports and their areas of logistical activities through the use of modern technology and to establish a frame-work of cooperation between stakeholders in MED countries for the ex-change of better practices, cooperation and the personnel training.

One of the basic objectives of INTE-TRANSIT is to improve the information management systems used that are currently used in the ports and their logistical activities zones, through an integrated management model that involves public and private organizations and the production of both processes as a map of harmonized and common Mediterranean indicators. In addition, INTE-TRANSIT also will promote an information and communication technology (ICT) as solution to improve the traceability, visibility, and transparency in the transportation of good in the MED zone. Specifically, this article will make reference to the work carried out in the logistics area of the Algeciras Bay and in the Napoli port (the terminal CONATECO).

2. Methodology

There exists in business literature a wide consensus on the positive impact of Lean in the operating results of the organizations that implemented, so we decided to use this tool for the analysis of port processes (Cua, McKone & Schroeder, 2001; Flynn & Sakakibara, 1995; Martínez & Pérez, 2001; Soriano-Meier & Forrester, 2002; Shah & Ward, 2003; Narasimhan, Swink, Kim, 2006). Although the Lean methodology is widely known

and has been implemented in various industries like automotive, construction, healthcare, aeronautical, pharmaceutical, and even public enterprises, it still remains a methodology rarely applied in other sectors or even unknown. One major reason why companies do not decide to adopt Lean Management is the misconception that it is too costly to implement and there is no need for the organization to get better results. It is therefore vital that prior to the adoption of Lean Management, companies are aware of the potential benefits of its implementation (Sohal & Egglestone, 1994). For this reason, work teams participating in this methodology are trained before starting the VSM. Thus the criteria for the identification of waste were unified. Waste in this context, is defined as anything that adds cost to a product or service without adding value. It can include: Transportation, Defects and Rework, Inventory, Waiting, Over processing, Overproduction and Motion.

In this project, the novelty of the methodology is based on the combination of tool VSM (Value Stream Mapping) with numerical modelling of the process by using the MATLAB tool (Simulink and specifically the SimEvents module).

Upon review, evidence of the application of these tools in a complementary way was not found; these tools are currently applied independently. In the port of Chennai (India) the VSM tool was used to identify the causes of downtime and losses on existing operations associated with the load of goods. The article concludes that after the study was not failed to reach consistent results (Akila & Thangavel, 2011).

There are references to the applicability of Lean in ports and its benefits, but it is not always referred to by this name. However, because of the method's description and content of the paper, it is easy to determine that they are talking about the Lean philosophy, especially at the mention of an "agile" concept. On the subject of benefits, the reference mentions that it allows ports to be able to anticipate the services desired by the markets, resulting in the creation of proactive ports. It is claimed that by implementing this philosophy in ports, they become more efficient and effective, causing a reduction in operating costs and increased profitability, and allowing investment in more advanced technologies (Lun, Lai, Cheng, 2010; Marlow, Paixão-Casaca, 2003). Another benefit is that with mapping, ports are able to identify the real information needs between the various actors involved, facilitating the identification of the most appropriate technologies to use or develop in port processes for the exchange of information (Coronado et al., 2011).

Regarding the simulation phase or time study, it is evident that for any process there are different tools, theoretical studies, algorithms and software.

For reference, in port processes were identified that used specific software, such as ARENA or Witness; however there was no evidence detected regarding the use of MATLAB (Zunfeng Liu et al., 2013; Kotachia et al., 2013; Zhuo Suna et al., 2011; Alarcon-Hernandez et al., 2012; Almaz & Altiok, 2012).

This leads us to provide a new methodology based on the combination of these two tools which independently provides good results, and of which the combination can bring good results for decision making in any port process.

3. Case Study

The application of these two techniques (VSM and MATLAB) was conducted in the Logistics Area (LA) of the Bay of Algeciras (El Fresno) and in CONATECO. The process chosen for the study in Algeciras was Ro-Ro good (both full load units and trailers), in the export process. In CONATECO the study was limited to the container terminal and analyzed the dry cargo in the export process. The stages of the work methodology were:

(1) First, a kick-off meeting was held developing the following activities:

- Selection of the coordinator and a multidisciplinary team.
- Selection of a product family and definition of the project scope.
- Visit and direct observation of the process.
- Training and planning of the next steps.

(2) Second, different activities were performed in order to become familiar with the details of the current process of the selected product family:

- Observation and collection of information and relevant data.
- Elaboration of the current VSM.
- Analysis of the information and identify identification of the wastes and bad practices.
- Development of the time study via MATLAB, comparison between the outcomes of the timing study and the VSM performed.
- Identification of the indicators more representative of the process.

(3) Finally the optimum flow was designed, through the following activities:

- Elaboration of the future VSM.
- Identification of the potential improvements.
- Identification new technologies to acquire or develop, in order to optimize the flow of information and material.

To collect the initial data, several methods were used:

(1) A questionnaire was prepared to collect data from port operators and logistics companies about their internal logistics management processes, their operational properties and the quality level of their current systems as well as about the possible issues or bottlenecks they are facing.

(2) Technical meetings with the project leaders in Algeciras and Naples were organized. Furthermore, a visit or a survey was conducted in each pilot area.

(3) Interviews with the stakeholders (port operators, customs, companies, etc.), from each partner's geographical area, were conducted in order to comprehend and analyze in depth the specific needs of each pilot area, taking specific geographical and socio-economical parameters into consideration among others.

The two techniques applied in order to analyze all the information gathered were:

- Value Stream Mapping (VSM) is a visual management tool that represents the sequence of all operations and the flow of information and materials, as well as the main features of the whole process, from the raw material supplier to delivery to the customer, if it is the case. The analysis of the VSM along with the review of bibliography, norms and regulations, in addition to information from interviews and work meetings, have led to the identification of KPIs (Key Performance Indicators) associated with the studied logistics processes in CONATECO and Port of Algeciras. Within the process, two types of VSMs are used: current and future. The current VSM analyzes the current processes and represents the current statuses of the chosen processes. The future VSM represents the ideal situation once any current waste is reduced or eliminated. Once a current VSM and waste is identified, the future VSM is used to create an Improvement Plan to define which wastes will need to be reduced first, and how these wastes will be reduced or if possible, eliminated.
- Numerical modeling. The MATLAB application was used to analyze the timing and queues associated with the logistics processes selected in CONATECO and the Port of Algeciras Bay, within the framework of the INTE-TRANSIT project. These studies have outlined the behavior of these processes by performing the

corresponding simulations for varying parameters of each of these processes. This has allowed us not only to confirm the results and conclusions obtained through the VSM technique, but also to complete them. Specifically, they have been useful in identifying and confirming the KPIs. The database provided by CONATECO contained approximately 140,000 arrival records within 2012, where truck arrivals, movements in yard, inspections and boarding times have been detailed. At the same time, a study in the Port of Algeciras had a total of 3,566 registered within April and May 2013.

4. Results

Several improvement proposals were suggested for both ports. With regards to identification technologies, both ports needed to acquire them (Optical character recognition (OCR), Radio-frequency identification (RFID), General Packet Radio Services (GPRS), etc.) in order to speed up and avoid errors and delays in the different managements Documentary. A common factor detected in the processes was the lack of a common information system in which all stakeholders could share and view information and data needed for their daily work.

In CONATECO, the need of improvement the service at gate was identified via VSM. On the other hand, the time study developed with MATLAB involved the design of five models with the aim of simulating solutions to the congestion problem. The first model reproduced the current situation (and it was based on the VSM that represented the current situation), and the modifications in the servers were evaluated through the rest. It proved that all processes inside the terminal are strongly dependent. The study shows (Table 1) that the solution should consider the decreasing simultaneously the time of service in the access gate and in the yard (Veloqui et al., 2014).

Table 1 Results of Each Scenario Analyzed with MATLAB in CONATECO

Scenario	Servers in access	Servers in yard	Mean (Q_a) units	Mean (Q_b) units
1	1	1	38.09	0.50
2	2	1	0.88	37.80
3	3	1	0.55	38.06
4	1	1	38.09	0.50
5	2	2	0.88	0.50

Source: Authors on the base of Veloqui (2014).

Due to that, the implementation of an OCR system integrated to a dashboard was planned and different terminal operations systems (TOS) to improve the yard management were analysed. The functional requirements linked to the technology to be implemented at the gate were: (a) Management of the flow of goods in order to monitoring and control the arrivals and departures; (b) Truck and cargo recognition at port terminal gate.

On the other hand, in the study of time carried out in the port of Algeciras, it was found important that some vehicles stayed over 24h (14%) in the port. After analysing this information, it was determined that these vehicles were using the terminal as storage; therefore an improvement proposal was made to offer these vehicles a location in an area outside the port, for example in a close logistic area. Additionally, it is important to mention that a study on the optimal route connecting the LA El Fresno and the Port of Algeciras Bay has been developed. This study has identified the origin and final (destination) point and has categorized critical sections (traffic volume, public/private ownership, length, estimated travel time, infrastructure, etc.). This information has been very useful in extracting the geographical parameters of the area between the Port of Algeciras Bay and its LA.

Finally the functional requirements for the technologies to be implemented in Algeciras were defined as the

following: (a) An integrated platform that ensures that the cargo has not been tampered with when leaving the LA in route to the port and vice versa; (b) Licence plate recognition allowing the shuttle carriers to control the exit hour and entry hour in the LA and the port; (c) External vehicles identified when entering and also when exiting for safety reasons and process controlling. The system will have to be adapted to all type of vehicles. This way a system based on a Monitoring and Control System, with a warning system and an Automatic Vehicle Location (AVL) Communication System linked to a GPRS signal was installed in the LA.

A dashboard capable of integrating the data provided by these systems (based on OCR and GPRS technologies) was planned to be implemented in both organizations, CONATECO and APPA. A common requirement was the use of open-source software.

In both cases, all players were involved in the presentation of the final results, and they found them both satisfactory and consistent. The improvement of the logistics organization was recognized by managers on the base of the availability of real-time information and the improvements achieved in the waiting times and the less impact in the environment.

5. Conclusions

The combination of the techniques VSM and MATLAB was applied in Algeciras and Naples following the recommendations found in the literature. Although the training of the people was reduced to a session, it was enough to develop the VSM efficiently. The processes mapping obtained via VSM was used as input for the study developed with MATLAB. The results obtained with MATLAB validated the ones derived from the application of VSM and complemented them, providing quantitative data to support the making decisions process concerning the implementation of improvements on the base of technologies.

There were two key difficulties encountered in the development of the project:

- The difficulty of gathering all stakeholders in order to share their experiences, mainly due to the complexity of combining the agendas of all of them.
- The lack of registration of some data, this meant having to estimate some data in order to perform the time study. The managers and the staff experts in the studied process were the responsible for this estimation to ensure their coherence and adjustment to the reality.

These two difficulties already have been highlighted in different studies developed in other sectors in some way. Dal Forno et al. (2014) highlight that the time spent to obtain data for the construction of the VSM compromises the use of this tool. Additionally, they conclude that the continuous data measurement can facilitate the VSM implementation and provide important benefits to increase the processes productivity.

The integration of the two modelling and simulation tools (MATLAB and VSM) has allowed us to simulate the project operations taking place in real time in the ports under study without interfering with day to day activities. Like any simulation tool, it will allow us to further explore all alternatives and variants of processes, using only those elements for improvement and modification.

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