Assesment of Logistic Information Systems: The Contribution of Lean Management–Application Case in the Maritime and Port Sector

Barbara Lyonnet
University of Nantes, LEMNA, Chemin de la Censive du Tertre, 44300 Nantes, France

***Abstract*—We propose to assess the use of information systems through the Lean philosophy in various maritime and port companies. Interviews were conducted with shipping agents, consignees and port authorities of the major maritime port of Nantes-St-Nazaire in France. We demonstrated that there are sources of waste in the use of port information systems. The evaluation guide proposed can be generalized to all types of businesses using information technology. Highlighting potential savings deposits with the Lean approach should improve the flexibility of port information systems.**

Keywords-lean management; information system; logistic; maritime transport

I. INTRODUCTION

Given the increase of international maritime traffic and port capacity, shipping sector actors need to become more reactive. The adoption of information systems has become a major factor in improving companies' performance and flexibility. Shipping information systems are emerging as essential to the proper functioning of logistic operations involving multiple complex supply chains actors. Against this background, to strengthen the capacity and accuracy of port logistics processes and to maintain a high level of service, information systems must be used optimally. Thus, several key factors for success have been proposed. One of these factors contributing to the success of the use of information systems is flexibility and infrastructure capacity expansion [1].

Furthermore, one of the characteristics of port logistic chains is the contribution of a multitude of public and private actors such as port authorities, customs, ship owners, shipping agents and freight forwarders. For these different actors, information systems needs appear to be different [2]. Thus, in a study conducted in China in a container terminal, customs authorities wished to prioritize real-time secure data transmission and customs operations optimization while shipping companies particularly favored computerizing logistics activities of the terminal and data sharing to coordinate their flow [2]. These different expectations, in terms of information systems, could be a stumbling block for optimizing their port information systems.

In the field of production, over the last thirty years, a new approach to organizational innovation, the Lean system, has emerged as an ideal solution to improve performance. This approach aims to optimize the flexibility and organizational responsiveness of logistic flows. According to Womack and Jones, five principles could define the Lean approach: value, value chain, flow by eliminating waste, pull flow and pursue perfection [3]. The concept of value refers to the value perceived by the customer. The value chain is based on the visualization of creative elements and wastes. The flow concept is based on the processing of non-value-creating elements to ensure a continuous flow. The pull system is based on production according to actual demand for internal and external customers. The concept of perfection is to seek a process of continuous improvement. All Lean principles could reveal potential deposits of significant gains [3].

Lean principles, originally developed in the field of production, could be transposed to information systems [4; 5]. Thus, to respect the principle of "value", an information system must be in line with the needs and expectations of users. The value chain consists of the visualization of all activities delivering information. The flow principle refers to the availability of real-time information flows and the optimization of "non value-creating" elements as regards eight types of waste. For example, waste related to "unnecessary delays" could correspond to information delivered too late and waste related to "non-quality" for the transmission of incomplete or erroneous information.

In this paper, we propose to assess the use of information systems through the Lean philosophy in various maritime and port companies. Do sources of waste exist in port information system use such as, for example, data redundancy or a multiplication of input spots? Do the different maritime sector actors experience information exchange difficulties? Highlighting potential saving deposits could improve the flexibility and relevance of port information systems. To do this, semi-structured interviews were conducted with shipping agents, consignees and port authorities of the major maritime port of Nantes-St-Nazaire in France.

II. METHOD

A. Information System Evaluation Questionnaire

To assess the level of integration of logistic information systems by the various maritime and port sector actors we developed a questionnaire around 5 Lean principles defined by Womack and Jones [3]. The definition of the five lean principles, applied to information systems, is presented in Table 1. We developed an information systems evaluation model based on these five key principles. The evaluation

questionnaire is based on the use of the IEMSE method of responding to the question with one of five responses [6] :

- I: Non-existent - This point is not dealt with by the information system

- E: Existent - There is an answer showing that the information system has taken this point into account

- M: Method - The Lean approach is dealt with based on a method that is likely to become generalized

- S: Systematic - The approach is dealt with methodically and on-site application is effective and systematic (sustainable)

- E: Exemplary - The method, its application and results should be externalized as they are effective, efficient and simple.

A score is assigned to each response. 1 is assigned when the point is not processed within the company (Not present) and 5 is given when method application is exemplary.

TABLE I. INFORMATION SYSTEM EVALUATION BASED ON LEAN MANAGEMENT PRINCIPLES

Lean principles	Description of the lean principle applied to the information system	
Value	User considered customer Information system in line with the needs and expectations of users	
Value chain	All activities that deliver information issued by the information systems Visualization of internal processes, the company's internal processes (purchase, sale, logistic), external processes of the company (customs, suppliers, partners)	
Flow by eliminating waste	**Availability of real-time stream** **Optimization of "non value-creating" elements as regards eight types of waste :**	
	Over production	Creating unnecessary information, duplication of information
	Waiting	Information delivered too late or too early, waiting for validation
	Unnecessary transport and handling	Unrecognized information format, incompatible software, transfer failures
	Over processing	Unnecessary operations, too many corrections of information
	Inventory	Excessive amount of information
	Motion	Lack of ergonomics of the information system
	Defects	Transmission of incomplete and / or erroneous information
	Skills	Information system does not take into account the views of users
Pull flow	Information is issued by the system only upon request of the user	
Perfection/ continuous improvement	Updated information system, fast in line with the general organization of the company	

Furthermore, additional questions such as the size in number of employees, the level of maturity of the logistic organization, information systems used and the industry have identified the types of organizations surveyed. Other problematic issues and expected challenges of an information system were also set out.

III. RESULTS AND DISCUSSION

A. Data Collection

Ten branch managers were asked about their perception of information systems used in the maritime and port sector. We chose to collect responses from different organizations representing different maritime and port sector typologies and logistic activities. Shipping companies are divided into two business sectors: bulk maritime transport and container shipping. Our sample includes six companies specializing in maritime container transport and 4 companies working mainly in bulk shipping. All of these companies carry out management activities and monitor goods for import and export, customs operations such as customs procedures and port handling. Some companies stand out as they provide multimodal transport offering customers door-to-door shipping (now 1, 2, 4, 5, 6 and 7). Companies specializing in container transport apply fleet management and transit and storage management. All the respondents belong to large international maritime groups of more than 250 employees; six of the companies surveyed have more than 500 employees while 4 of them have a total of between 250 and 500 employees. Turnover for these companies stands at between 6 million and 6 billion euros for the major players in maritime transport. These companies all use information systems to manage their logistic activities, ranging from 2 to 7 systems. The information systems used are: AP +, GIMNAUTE, TIMAD, ICS / ECS, DNA +, Prodouane and personalized EDI systems (see Table 2. Description of information systems).

TABLE II. DESCRIPTION OF KEY INFORMATION SYSTEMS USED IN THE MARITIME AND PORT SECTOR

Information system	Activities	Description
AP+	AP+ Port Community System covers all port transit operations of the goods, since its announcement until the exit of the port area.	AP+ is the 1st Cargo Community System (CCS) trimodal integrating the shipping process, air and land
GIMNAUTE	Computerized management of ship movements with technology use Extranet	Reception and central pole open information sent to port operators and ship owners, notably used to perform dockside space request via the captaincy.
TIMAD	Computerized processing of dangerous goods	System for dangerous goods declaration to the captaincy
ICS (Import Control System) ECS (Export Control System)	Information system for international trade (imports and exports of goods)	Customs declaration system for containerized cargo or bulk
Private IS	Personalized information system management and cargo tracking	Internal logistics management information system and external goods. System of exchanges of data between logistics, purchasing, sales, quality .
Prodouane Delta	Online Clearance System for Automated Transmission available in part from the portal Prodouane	System of customs clearance procedures
ADN+	Information system of port dues	Information system of calculation of port dues

B. *Maritime Logistic Information Systems Maturity Level*

The general Lean information systems (IS) level of the 10 agencies is equal to 3.07 (SD = 0.8) (see Table 3). In our sample, only one of the organizations surveyed achieved a strong operational Lean maturity level of its IS (higher than 4). Note that this company, specializing in shipping containers, uses only two IS which could explain why their use is more optimally controlled. Moreover, the use of 2 IS that reduce multiple entry-related waste compared to companies using a lot of IS. Conversely, the general level of the Lean IT systems in both companies is drastically below the "method". Both companies belong to the bulk maritime sector and have respectively 4 and 6 different IS.

The more detailed analysis of IS maturity level reveals that there is little or no waste caused by poor quality of information in companies (average = 4); 80% of the companies have a level greater than or equal to 4 as regards practice. When companies were questioned specifically on this point, all agreed in recognizing the robustness and reliability of the IS they use. Some emphasize in particular the stability of their IS. It should also be noted that the IS generate little waste related expectations (level = 3.6). The majority of companies believe that information provided by their system is issued in time, that is to say neither too early nor too late. One of the weaknesses identified by IS in our sample regards the non-consideration of user needs and expectations (level = 2.6), and not taking into account the different formats of information to optimize the incompatibility between software (level = 2.5). The weakness related to lack of consideration of user needs and expectations may reflect a lack of flexibility in information systems design. This lack of flexibility would limit the inclusion of different business specificities. For example, a company carrying out a dangerous goods transport activity highlights the lack of reference concordance between IS used for customs formalities for certain dangerous goods.

C. *Key Information Systems Challenges*

When we asked companies about the main challenges to be met by logistic information systems in the port sector, the responses were varied. However, two major components were identified: compatible use between IS a company and the development of a single IS adapted to different types of traffic. The development of a single IS or a common portal for companies, bearer of progress.

Thus, the use of a single IS or portal would generate less data duplication and re-entered information. For example, at present, companies are forced to re-enter the wording of the goods transported, the quantity, weight, container number, origin or destination of the goods on the different types of IS.

Finally, all companies highlight the importance of having a reliable information system that uses IT to improve the traceability of goods and safety. In general, 60% in our sample is met by the use of their information. The latter consider their information in line with the regulatory requirements imposed. Conversely, companies that are not satisfied by their IS argue argument, the high cost of using IS, the training time to master the IS and lack of suitability of several IS bulk carrier sector .To the question of the impact of the use of IT in their workload, the companies surveyed gave mixed responses. Half of them consider that a reduction in their workload is observed while the other half note, conversely, a heavier workload. These companies report the need to have to use an extra person dedicated to managing the IS as well as staff training on the IS. Finally, the question of the benefits of using IT in relation to customers, 60% of companies report that little or no profit was gained. Businesses underline the high costs of systems that are difficult to charge the customer. However, other companies wish to state that IS allow them to provide customers with reliable real-time information.

D. *Overall Information System Performance*

A key objective of the use of IS is to improve business performance. So, we asked companies how they perceived the impact of their information on their performance. Today, performance is defined as a multidimensional concept that can be associated with the following dimensions: organizational, operational, financial, commercial, social and environmental. Regarding the organizational dimension of performance, a majority of companies believes that the use of IS improves organizational performance. As such, several arguments are advanced, the use of specific IS customs formalities, for example, offers greater flexibility in terms of schedule. IS enable companies to perform customs formalities remotely and, as such no longer require inputs to be made in the working schedule. Others point out the time savings gained. In contrast, some companies consider IS as harmful to their organizational effectiveness, citing a loss of productivity. Regarding financial performance businesses are mixed. As previously mentioned, the companies believe that the use of IS generates significant costs particularly related to billing statements made and as regards the training tools required. Regarding operational performance businesses report improvement related to accessibility of real-time business needs, while others stress the redundancy between the input IS.

To the question of commercial performance, businesses report that IS are useful for tracking goods information and thus lead to more market gains. Others, however, state that the data provided in IS is not accessible by customers. Regarding environmental performance, the majority of companies believe that the use of IS generates a positive impact for extensive data dematerialization and reduced travel between customs and the business. No company has identified benefit on social performance.

TABLE III. RESULTS

Principles	Value		Value Chain		Flow								Pull flow	Continuous improvement		
Companies	User like a customer	Support activities	Internal process	Extenal process	Waiting	Over production	Transport	Inventory	Over processing	Motion	Defect	Skills	Pull information	Frequency update	Facility update	Mean
1	4	5	4	5	5	5	4	5	5	4	5	4	4	5	5	4,60
2	4	4	5	4	4	2	2	2	4	3	4	3	4	3	1	3,27
3	1	1	1	1	2	2	1	2	2	2	2	1	2	1	1	1,47
4	3	4	3	3	1	5	3	4	5	3	4	3	2	3	3	3,27
5	1	4	4	4	4	4	3	4	1	2	2	4	3	4	4	3,20
6	3	2	4	4	5	2	4	2	3	3	4	3	2	2	2	3,00
7	4	5	3	4	4	4	3	3	3	2	5	3	3	3	3	3,47
8	2	2	3	3	3	1	1	4	4	4	5	2	3	4	3	2,93
9	3	2	2	2	5	4	3	4	4	4	4	3	3	2	4	3,27
10	1	1	3	2	3	1	1	5	1	2	5	2	3	2	2	2,27
Mean	2,60	3,00	3,20	3,20	3,60	3,00	2,50	3,50	3,20	2,90	4,00	2,80	2,90	2,90	2,80	**3,07**
Mean	2,80		3,20		3,19								2,90	2,85		

IV. CONCLUSION

Our avocation study to assess the performance of information systems in the shipping sector. To do this, we used common lean concepts covering all lean practices approbation in literature. We demonstrated that there are sources of waste in the use of port information systems such as, for example, data redundancy or a multiplication of input spots. The evaluation guide proposed can be generalized to all types of businesses using information technology. Highlighting potential savings deposits with the Lean approach should improve the flexibility and relevance of port information systems.

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