Assessment of innovation in the port sector – Case study: Port of Sines

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Abstract

The goals of this thesis are twofold: to describe in detail the innovation in the port sector, focusing on infrastructure and to analyze the relation between means of transport (especially ships and trains) and infrastructure (platform, wharf, terminal), and the administrative tasks (orders, authorizations); and to analyze the impact of innovation. Port of Sines was chosen as a case study. There were three innovative initiatives taking place at Port of Sines in recent years: the Geographic Identification and Information System (SIIG), the Port Single Card (CUP) and the Port Single Window / Logistics Single Window (PSW-JUP/LSW-JUL). By the end of this research and assessment work, it was concluded that all innovations have been successfully implemented: the goals proposed were achieved – even though some of them aren't measurable – and innovation is contributing positively to the evolution of Port of Sines and increasing their competitiveness on the European scene. Furthermore, it's proposed a new methodology for the assessment of innovation.

1. Introduction

Freight transport has been studied in the past years in several sectors, not only due to its growth, but also due to its impact in the supply chain and in the final product. Consumers' needs are more demanding every day – they require for more quality in products, less cost, a shortest delivery time – and associated with that, new technologies and easy communication have leading to an increase of the international trade and logistics needs. Based on that, the supply chain (some authors even use the term supply network) are longer and more complex, bringing more uncertainty and sophisticated information flows (Bowersox e Closs, 1996, p. 166). The maritime sector allows to overcome obstacles unobtainable by truck or train (oceans) and it is cheaper than the air transportation. On the other hand, what seems to be an advantage on the long distance transportation, acts like a generator of problems and delays concerning regulatory requirements – in order to transport freight by sea, it is mandatory the agreement between several countries and subsequent approval by several certifications entities (InnoSuTra, 2010).

The main idea behind this paper is the assessment of innovation in port infrastructure, more specifically, in port container terminal. The port was seen as source and object of ongoing improvement. Innovation plays a critical role concerning efficiency maximization, and it should be integral part of company's growth strategy. The main goal of this paper is to analyze innovation in port's activity, considering recent initiatives in Port of Sines as case study.

Innovation is described, analyzed and evaluated concerning its innovative nature and effectiveness. This study. This study arises from the detection of the lack of an explicit suggestion of a methodology for evaluating innovation in the literature. Based on the contribution of several authors, the work suggests a new methodology to assess innovation in seaports (Chapter 3).

2. Concept definition

1.1. Innovation

Contributions from ten different studies were collected in order to properly define the concept of innovation.

Arduino *et al.* (2013) and Vanelslander *et al.* (2013a) quote Schumepeter (economist, 1883-1951), who was one of the first authors defining innovation, and state that innovation is a new and different way of doing something, in order to produce a gain for the economy, reducing costs and introducing innovation improvements in transport. Goswami and Mathew (2005) put together several other definitions, matching the first definition presented. Vanelslander *et al.* (2013a) presents Drucker's (1985) concept, who add on innovation as a new dimension of performance assessment.

Innovation must not be treated as a linear, homogeneous and time-static concept. In fact, it has been seen the concept depends on the area of studies, and specifically to the port sector, it is not taken as an absolute truth. Elaborating on this, within the context of port sector, the following definition is proposed:

> *Innovation is the implementation of a groundbreaking change within the system, necessarily leading to an improvement. A groundbreaking change is the one which brings something new (brand new or new to the sector itself) to the system, impacting products, processes, services or the market.*

An innovation can be classified based on:

(i) the object – product, process, marketing, organizational (Arduino *et al.*, 2013; Fagerberg *et al.*, 2003; Goswami e Mathew, 2005; and Vanelslander *et al.*, 2013a);
(ii) its predominant component/aspect – technological, cultural public policy (Arduino et al, 2013; and Arionetis *et al.*, 2012);
(iii) implementation 'speed' – incremental, or radical
(iv) the actor who benefits the most – public, or private(Arduino *et al.*, 2013; and Vanelslander *et al.*, 2013b);
(v) its source and/or availability – open, or closed (Australian Government, 2010; Dahlander and Gann, 2010; and Vanelslander *et al.*, 2013b).

1.2. Innovation in transport

Specialists in this field have been studied innovation in different ways. In this section the main goal is to present the innovations that provided inspiration for the development of this study.

The literature review was performed in international specialist journals within the past decade[1].

Innovation was analyzed in terms of infrastructure (physical and virtual), the relationship between means of transport related and the interface where they are based, and relationship between the actors involved in the transportation process. There were left out the ones that focuses explicitly on innovations in transport itself (ships, trucks, aircraft and rolling stock) or its components. Studies were gathered as the classification suggested by Vanelslander *et al.* (2013a): regulation, organization or technology. Table 1 presents some studies developed in the recent years.

Table 1: Literature review – innovation in transportation

THEME	SUB-THEME	SECTOR	AUTHOR
Organization	Port Strategy	Port	Cahoon *et al.* (2013)
	Port Logistics		De Martino *et al. (*2013)
	Port Government		Hall and Jacobs (2010)
	Information Systems (PCS)		Keceli (2011)
	Sustainable transport	Road	Hyard (2012)
	Transshipment	Rail	Wiegmans *et al.* (2007)
Regulation	Regulatory reforms	Public transportation	Ongkittikul e Geerlings (2006)
	Sustainability	Pot	Acciaro *et al.* (2014)
	Sustainability	Public transportation	Michaelis (1997)
	White Paper on Transport		Comissão Europeia (2011)
	Port infrastructure project	Port	Ravesteijn *et al.* (2014)
Technology	Scientifical and technological activities	Scientifical and technological activities	European Commission, Eurostat
	Literature review	Port	Vanelslander *et al.* (2013)
	European Projects		TRIP
	European Project - FANTASIE	All	Zuylen e Weber 2002

In the literature review, is frequently referenced three areas of study on innovation (De Martino *et al.*, 2013; Hyard, 2013; Ravesteijn *et al.*, 2014; and Zuylen e Weber, 2002). In the port sector, innovations related to the organization stand out the following authors Cahoon *et al.* (2013), De Martino *et al.* (2013), Hall e Jacobs (2010), Keceli (2011).

Keceli (2011) studied the Port Community System (PCS), a platform that allows efficient data transfer, as tool to bridge the remaining gaps in Turkish port network. On the White Paper on Transport (Comissão Europeia, 2011) it is mentioned SafeSeaNet and Regional Innovation System (RIS), two technological based innovations, which were developed in order to improve the current information and communication systems . The success of these innovations leads to a decreasing of time spent on operations related to information sharing.

Cahoon *et al.* (2013) studied port innovation from the outside highlighting the importance of port's integration in its hinterland (where the supply network and relations between innovation actors plays a crucial role for the success of the innovation). De Martino *et al.* (2013) also studied the importance of relations between actors, considering the port as an open system to its hinterland (Cahoon *et al.*, 2013; and Hall and Jacobs, 2010), where the innovation must be promoted and developed (Cetin and Cerit, 2010, in De Martino *et al.*, 2013). In fact, this urge demand for good relations between innovation actors, where communication and cooperation among them are promoted is one of the most seen conclusions in the literature (Arduino *et al.*, 2013; Hall and Jacobs, 2010; De Martino *et al.*, 2013; Zuylen e Weber, 2002; Michaelis, 1997; Keceli, 2011; and Ravesteijn, 2014). The agreement between all the involved parties is an important factor on the process of choose and/or develop certain innovation, and clear rules and modes of action must be settle. The concept of 'network' is also mentioned by the majority of the authors, either concerning the integration of all parties involved in the innovation, either in the importance of the port's integration in its hinterland (Zuylen and Weber, 2002; Hall and Jacobs, 2010; Keceli, 2011; Cahoon *et al.*, 2013; De Martino *et al.*, 2013; and Arduino *et al.*, 2013).

Figure 1 shows the main ideas among the authors who studied innovation as a whole and innovation in transports. Twenty two studies were considered.

[1]Research in Transportation Business & Management, Maritime Policy & Management, Journal of Transport Geography, Transport Reviews, Technological Forecasting and Social Change, Transportation Research, Research in Transportation Economics, Transport Policy, Journal of Transport Geography e Energy Policy

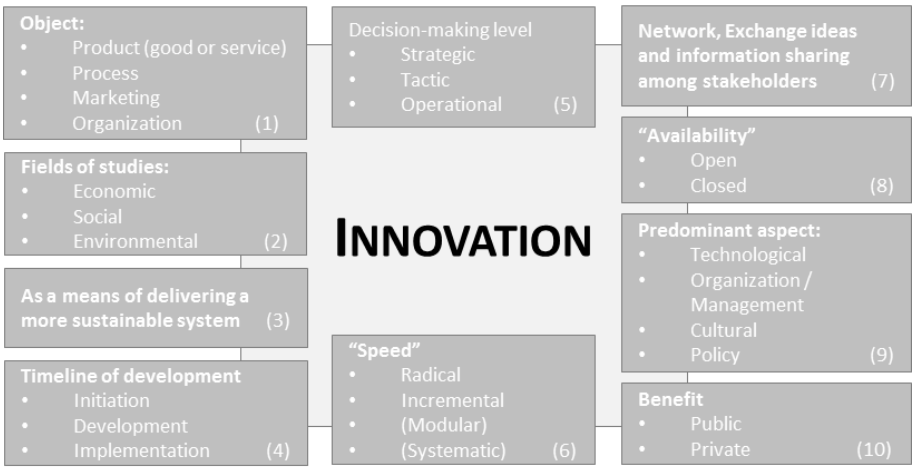

Figure 1: Characterization of innovation - summary

(1) Arduino *et al.* (2013) ; Goswami e Mathew (2005); Hyard (2012); Vanelslander *et al.* (2013a)
(2) Hyard (2013); De Martino *et al.* (2013); Ravesteijn *et al.* (2014); Zuylen e Weber (2002); Scarpellini *et al.* (2013);
(3) Hyard (2013); Scarpellini *et al.* (2013); Michaelis (1997); Acciaro *et al.* (2014);
(4) Arduino *et al.* (2013); Arionetis *et al.* (2012); Vanelslander *et al.* (2012);
(5) De Martino *et al.* (2013); Gunasekaran e Kobu (2007)
(6) Arduino *et al.* (2013); Arionetis *et al.* (2012); De Martino *et al.* (2013); Morris (2008); OECD e Eurostat (2005); Ongkittikul e Geerlings (2006); Scarpellini *et al.* (2013); Vanelslander *et al.* (2012);
(7) Arduino *et al.* (2013); Cahoon *et al.* (2013); De Martino *et al.* (2013); Hall e Jacobs (2010); Keceli (2011); Michaelis (1997); Vanelslander *et al.* (sem data); Zuylen e Weber (2002);
(8) Australian Government (2010); Dahlander e Gann (2010); Vanelslander *et al.* (2012);
(9) Arduino *et al.* (2013); Arionetis *et al.* (2012);
(10) Arduino *et al.* (2013); Vanelslander *et al.* (2012)

1.3. Indicators, metrics and methodologies

Literature review revealed the use of performance measures on transport sector (Gunasekaran and Kobu, 2007; Langen and Sharypova, 2013; Kim et al., 2011; e Zuylen and Weber, 2002), as well as in companies and business (Arturs et al., 2009; OECD and Eurostat, 2005; Morris, 2008; and Australian Government, 2010; Langen and Heij, 2013).

A well succeed implemented innovation is worthless if that success is not perceived, measured and validated by the stakeholders. Performance measures are the basis of most of the analysis and must take into account the achievement os the strategical and operational goals of the processes under analysis (Del-Río-Ortega et al., 2013; and Popova and Sharpanskykh, 2011). The classification (performance measure, indicator, metric) is once more nonconsensual among the authors reviewed: Kim et al. (2011); Arturs et al. (2009); OECD and Eurostat (2005); Gunasekaran e Kobu (2007); Langen and Sharypova (2007); Langen and Heij (2013); Popova and Sharpanskykh (2011); Del-Río-Ortega et al. (2013); and Australian Government (2005). It was adopted the Gunasekaran and Kobu (2007) approach, considering also contributions from other authors (Langen and Sharypova, 2007; Langen and Heij, 2013; del-Río-Ortega et al., 2013; Australian Government, 2005; Popova and Sharpanskykh, 2011; and OECD and Eurostat, 2005), in which indicator (the same as performance indicator) is treated as a tool to measure the efficiency or effectiveness of a certain process – it allow to draw conclusions about the processes/activities itself and to project those results on the performance of a company or organization. Metrics include the indicator but also the data related information such as the responsible entity, estimated value, or how to collect and treat data.

It is important to point out the inexistence of a stablished set of key indicators (Key Performance Indicators) regarding the assessment of innovation in the port sector able to analyze with no doubt port performance or port innovation. This is based on the fact that ports are complex clusters and because each port is different from the other (in terms of cargo, administration model, area, hinterland), there is no common model capable of rule the operations.

It is essential to carefully choose the performance measures not only because of its results but, most importantly, because of its fitness for what has to be measured, in order to properly demonstrate the evolution of a certain task or activity. It strengthens the importance of setting the right goals and the practical implementation of measures that fits these objectives

In addition, the use of indicators must not be an end in itself – the assessment of innovation should be filled with other methodologies' outputs, providing an analysis as detailed as possible.

Four valuable studies contributed to develop the methodology adopted to assess innovation in seaports: Cost-Benefit Analysis (CBA); Delphi; System of Innovation Approach (SIA); method of Acciaro et al. (2014). The definition of indicators/performance metrics was the basis for all of them.

CBA allow to compare costs (inputs and negative outputs) and benefits (positive outputs) (Vanelslander *et al.*, 2013a).Generically, this type of analysis confine the study to the economic feasibility of the proposals excluding the financial, social and environmental assessment. Beyond that, to determine the discount rate is a complex and nonconsensual issue among the stakeholders– it must take

into account the social opportunity cost[2] (rather than financial opportunity cost) of the resources and it depends on the stakeholders (Vanelslander *et al.*, 2013a). There is also another limitation which has to do with the complexity of translate environmental impacts or other externalities by monetary values (Eliasson e Lundberg, 2011).

Delphi method is used to organize the agreement and commitment of ideas and concepts from different sources. This method promotes the information and knowledge share and exchange within a certain topic (Schuckmann *et al.*, 2012) and aims to define a set of consensual ideas and concepts among the stakeholders (Meesapawong *et al.*, 2014; and Schuckmann *et al.*, 2012). The major constrains it faces are related with human hand – because it is a method which depends on the human view, it is hard to guarantee an unbiased analysis (Dinwoodie *et al.*, 2014). It results should be complemented with statistical information and other performance measures able to overcome such a qualitative analysis (Vanelslander *et al.,* 2013b).

System of Innovation Approach (SIA) was firstly introduced in the 90's and aims to analyze innovation process and identify benefic interventions to the system under study (Arionetis *et al.*, 2012).

Going methodologically through a set of steps, is it expected to assess under which conditions an innovation is more likely to be well succeed (Arduino *et al.,* 2013). This methodology introduces "time" as a variable, requiring for a characterization in terms of the innovation stage of development (initiation, development or implementation). By doing that, it allows to monitor the development of the innovation, which brings benefits in the reaction time, in case anything goes wrong (Arionetis *et al.*, 2012; and Roumboutsos *et al.*, 2011 in Vanelslander *et al.*, 2013b). It is limited to commercial and incremental innovations (Arduino *et al.*, 2013). The proper identification of the stakeholders and areas affected takes time, and that a requirement that can be an obstacle and delay the assessment of innovation (Arionetis *et al.*, 2012).

Table 2 presents the main contributions from each author to this study and more specifically to the definition of the methodology adopted.

Table 2: Contributions from other authors to the methodology proposed

METHODOLOGY	AUTHORS	CONTRIBUTION
CBA	Vanelslander *et al.* (2013a), Eliasson e Lundberg (2011), Martens (2011), Tseng *et al.* (2012), Damart e Roy (2009).	The main idea behind the use of CBA is to identify and list the costs associated with the analysed processes. It shoud be used as a complementar study to the methodology proposed, not being part of its integrant framework.
Delphi	Schuckmann *et al.* (2012), Meesapawong *et al.* (2014), Acciaro *et al.* (2014), Vanelslander *et al.* (2013a), Dinwoodie *et al.* (2014), von der Gracht e Darkow (2010), Schuckmann *et al.* (2012), Chamorro *et al.* (2012), Vanelslander *et al.* (2013b), Arduino *et al.* (2013).	Delphi point out the relevance of the correct identification of the stakeholders as well as its role in innovation process, in terms of responsibilities and benefits.
SIA	Arionetis *et al.* (2012), Arduino *et al.* (2013), Vanelslander *et al.* (2013b), OCDE e Eurostat (2005), Roumboutsos *et al.* (2011).	Innovation must be properly characerized; Barriers should be identified.
Acciaro *et al.* (2014)	Acciaro *et al.* (2014)	The importance of stablish clear goals to guide innovation process and upon what terms an innovation aimed to achieve those goals.

3. Methodology

Due to the lack of an appropriate methodology to the evaluation that was intended to do, a new methodology was drawn, considering the contributions listed above. This new methodology analyses the innovation and tried to find out the reasons behind its implementation and which goals does it propose to attain. On the other hand it analyses all the processes of port's activity, explaining in detail the sequence of activities that are part of it. After a detailed characterization of the processes taking part in the port, critical activities must be identified. With these two branches characterized, both innovation and processes, one shall compare (i) the activities that benefited the most from the implementation of the innovation , and (ii) the critical activities of the processes. By doing so, the methodology proposes to identify which real critical activity was impacted by the innovation, in order to assess its impact. In the end, performance measures of those simultaneously critical and impacted activities should be analyzed and one can draw some conclusions.

Figure 2 and the following description show the methodology step by step, based on the assumption of the availability of all the required data.

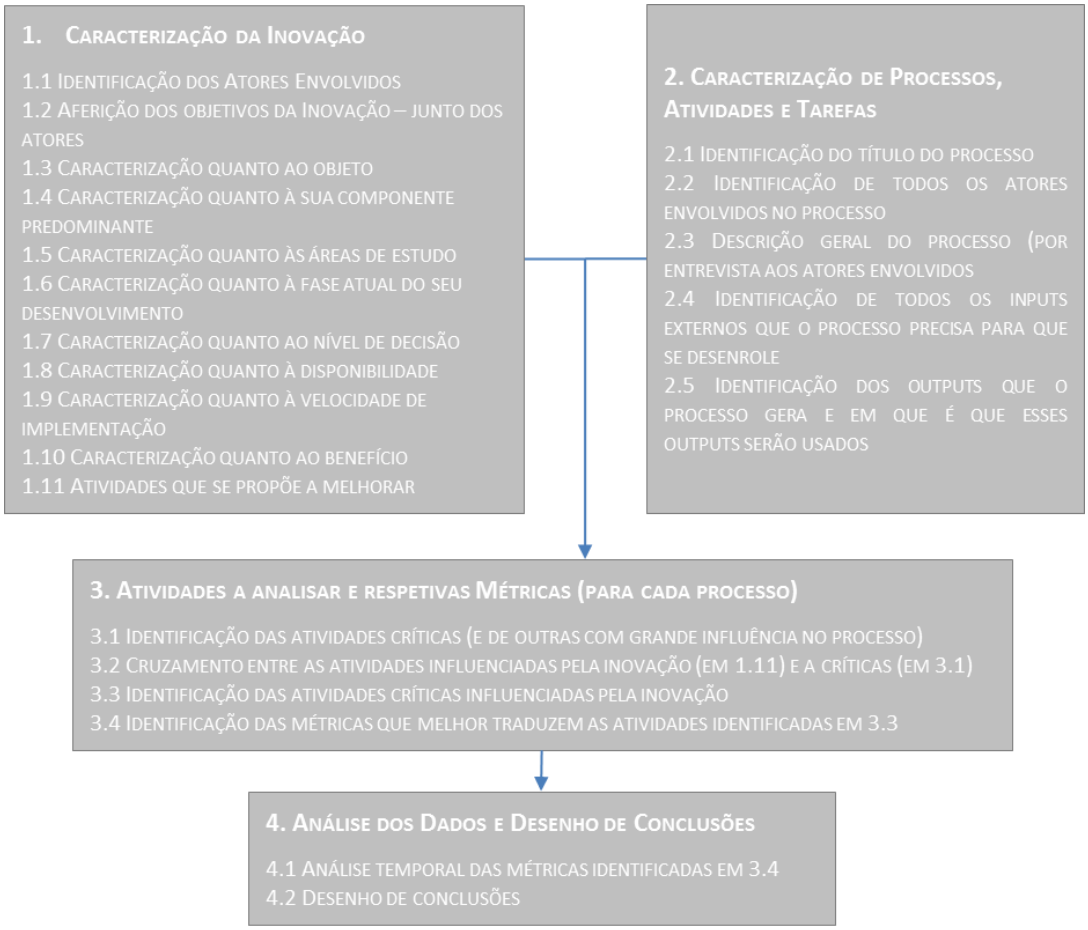

Figure 2 presents the methodology step by step. Step 4 – Data analysis and Conclusions - should be pointed out. With the activities identified, as well as the performance measures used to measure them, a time analysis of those measures must be performed. By doing so, four scenarios can occur, considering also the effect of eventual externalities:

I – Improvement and no externalities identified – The activity shows improvement in its performance and there is no proof of the existence of another externality source able to cause that improvement. In this case, unless proved otherwise, it can be stated the innovation was well succeed.

II – Improvement and at least on externality identified –– The activity shows improvement in its performance and there is at least one other possible source responsible for that improvement – an externality. This case requires for special analysis because it may be that other variable the responsible for the improvement. So, a conclusion cannot be drawn in terms of success of the innovation and it is further essential to isolate the most the influence of that externality in order to properly analyze the impact of the innovation.

III – No improvement and at least one externality identified – the activity doesn't show any improvements but there is at least one other possible cause for that. In this scenario, it is necessary to develop a detailed analysis on that other possible cause (externality) because its occurrence may be masking the positive impacts of the innovation. It is not possible to conclude about the success or failure of the innovation and to do so, it is necessary to guarantee the isolation of the effects of that externality.

IV – No improvement and no externalities identified – The activity does not show improvements in its performance and there is no other identified variable masking he effects of the innovation. In this case, unless proved otherwise, it can be concluded about the innovation failure.

The advantages of using this methodology in relation to the other investigated are as follows:

- It allows integrating qualitative and quantitative analysis, while all the others are almost exclusively qualitative or quantitative;
- It minimizes the impact of externalities in relation to other methods studied in two phases: first, by analyzing activity by activity, reducing the number of variables acting simultaneously as the innovation; and second, considering scenario's analysis that reassess the existence and subsequent impact of externalities on the performance of a certain activity;
- It allows the identification of particular improvements in the process chain. These improvements can easily go unnoticed on a comprehensive analysis of innovation in the complete process, or port's activity as a whole – it allows debunk some improvement that is not visible in the overall process ;

- It minimizes biased information which can happen when an exclusively qualitative analysis is taking place, due to the involvement of all the stakeholders.

Otherwise, some handicaps brought by the use of this methodology can be pointed out:

- Step 2 can be time-consuming and it depends, in large part on the complexity of the port itself (in terms of cargo, stakeholders policies, area of jurisdiction);
- The complexity of the problem increases exponentially when performance assessment of the port as a whole is the goal to achieve. It requires the analysis of every process, every stakeholder and every activity. Therefore, this methodology is not suitable when we want to analyze port performance as a whole.
- Its implementation involves al the stakeholders of the innovation and sometimes that can be hard to achieve and brings delays and entropy to the methodology;
- It involves many different work times, in several fronts simultaneously so the results' analysis is not affected by the impact of the delay on data collection.

Regarding a preliminary validation of the methodology, it was developed a case study on a particular process. That case study consists on the assessment of the impact of Port Single Window/Logistics Single Window in the process of containerized cargo. The case study is presented on the following section.

4. Analysis of port case – Port of Sines

Three innovative initiatives were analyzed: Geographic Identification and Information System (GIIS); Port Single Card (PSC); and Port Single Window/Logistic Single Window (PSW/LSW). Recalling the methodology proposed, three main steps were developed: 1-Innovation Characterization; 2- Activities' characterization; 3-Activities to be analyzed 4- Analysis of results and Conclusions.

STEP 1 – INNOVATION CHARACTERIZATION

By developing this step, it was found out that all entities operating the port are involved in innovation, either because GIIS, PSC or PSW/LSW. Innovations are all different but there are some common goals as increasing competitiveness, security levels, functionality, effectiveness and efficiency of the port, or reducing waiting periods and the complexity of the administrative processes, aiming to achieve a much more fluid transfer of cargo and information. The characterization of these three innovative initiatives, as it it proposed on Figure 1,can be investigated on Table 3. Table 3 also shows similarities between PSW and LSW and that is the reason why it was decided to assess them together.

Table 3: Characterization of the innovation in the port of Sines

	GIIS	PSC	PSW	LSW
DECISION LEVEL	Tactic / Operational	Operational	Strategic	Strategic
FIELD OF STUDIES	Social, Economic	Economic, Environmental	Social, Economic, Environmental	Social, Economic, Environmental
OBJECT	Product, Organization	Product, Organization	Organization	Organization
TIMELINE OF DEVELOPMENT	Implementation	Implementation	Implementation	Implementation
PREDOMINANT ASPECT	Organization / Management	Technological and Organization/Management	Organization / Management	Organization / Management, Policy
BENEFIT	Public	Public	Public	Public
'SPEED'	Incremental	Incremental	Incremental	Incremental
'AVAILABILITY'	Closed	Open	Open	Open

Regarding those specific activities influenced by innovations, it will only be analyzed PSW/LSW, due to the horizontal nature of GIIS and PSC, which make it hard to define in detail which activities benefits the most from its implementation.

In matters of PSW/LSW, thanks to the meetings with the Port's Administration and by scanning all the available public news, it is possible to determine which activities it proposes to improve. These are: vessel's entry/exit into port; authorizations (cargo load/unload, transport, assembling trains, other), customs clearance.

STEP 2 – PROCESSES AND ACTIVITIES CHARACTERIZATION

It this step, the chosen process to be analyzed was transportation of containerized cargo, entering in the port by vessel. It is described in the following steps (Fórum para a simplificação de procedimentos no Porto de Sines, 2011) describe it

1. Vessel unloading confirmation
2. Cargo Manifest
3. Vessel unloading report
4. Customs clearance
5. Container entry guide
6. Train Schedules
7. Train loading order
8. Transit authorization
9. Train loading confirmation
10. Consignment note
11. Terminal exit report
12. Train Position

The required inputs so the process can be developed are: arrival of the vessel in port's advance – so the countermark can be assigned; cargo general declaration - it should

identify the type of manifest, summary of the cargo by agent, unload (and load if necessary) license application, cargo manifest – document that describes in detail cargo attributes (container list, its value, origin and destination).

The main output identified was the authorization for the cargo to enter the port so it can be shipped by rail to its destination. Administratively speaking, the process generates na authorized cargo manifest which is the base for train assembling and shipping.

STEP 3 – ANALYZED ACTIVITIES AND ITS INDICATORS

The activities considered and critical were as follows:

- Vessel unload confirmation
- Cargo manifest
- Customs Clearance
- Transit authorization

Comparing the activities that benefits the most from the innovation (Step 1) and those identified above, Table 4 was elaborated.

Table 4: Activities most impacted by the innovation VS. Critical activities of the process

ACTIVITIES MOST IMPACTED BY THE INNOVATION	CRITICAL ACTIVITIES OF THE PROCESS
• Vessel entry/exit in port, including its crew • Authorizations (cargo/crew load/unload, transport, train assembling) • Customs clearance	• Vessel unload confirmation • Cargo manifest • Customs clearance • Transit authorization

From the analysis of Table 4, it can be pointed out that the left column are more general than the one on the right column. Conformity is checked between the two sets of activities so it can be said, in a general way, that PSW/LSW served its first purpose, acing upon critical activities on the containerized cargo transport. By pursuing the analysis, the activities simultaneously critical in the process and impacted by the innovation are as follows:

- Vessel entry into port (including unloading cargo authorization, cargo manifest, customs clearance, crew's entry authorization);
- Transit authorization within the port.

Related with this activities, the following indicators were identified:

- Average time ships waited to dock;
- Average time crew waited to obtain authorization to land;
- Average time to obtain authorization to unload the vessel;
- Average time to obtain authorization to handle the cargo inside the port;
- Wharf occupancy rate;
- Average length of stay in the wharf (standardized considering the availability and the total amount of cargo)
- Total amount of paper used in administrative activities.

STEP 4 – ANALYSIS OF RESULTS AND CONCLUSIONS

From the performance measures identified above, only a small part was analyzed because of the lack of information on the publicly available on the subject and also because of the difficulty on obtaining data among the stakeholders. Therefore, in order to get a preliminary validation of the methodology proposed and to achieve the goals proposed on this research, two performance measures were analyzed: average time of billing; average time to obtain unload license considering anchorage point. Table 5 shows the progress of these two performance measures in the following years to the implementation of the innovation.

Table 5: Performance measures analyzed in the process of containerized cargo in Port of Sines

MÉTRICA	OBSERV.	BEFORE PSW	2009	2010	2011	2012	2013	2014
Average time of billing	hh:mm	356:02	205:26	106:19	88:22	134:52	82:43	82:52
Average time to obtain unload license considering anchorage point	hh:mm	199:21	68:05	75:56	71:55	92:22	105:43	71:31

Figures 2 and 3 shows in graphic these information. Looking at Figure 2, it is clear that average time of billing (administrative activity) has decreased since the PSW came into effect, from approximately 350 hours, two weeks, for less than 96 hours, approximately four days. This decreasing is more than 60% below the value it had before PSW. No other externality was identified as source of this severe decreasing.

From the analysis of Figure 3, it can be stated that average time to obtain unload license considering anchorage point decreased by almost 150% since PSW was firstly introduced in the system, from approximately eight days, in 2008 to three days, in 2014. Since 2009, its value is always less than 50% of the value it had before the implementation of PSW.

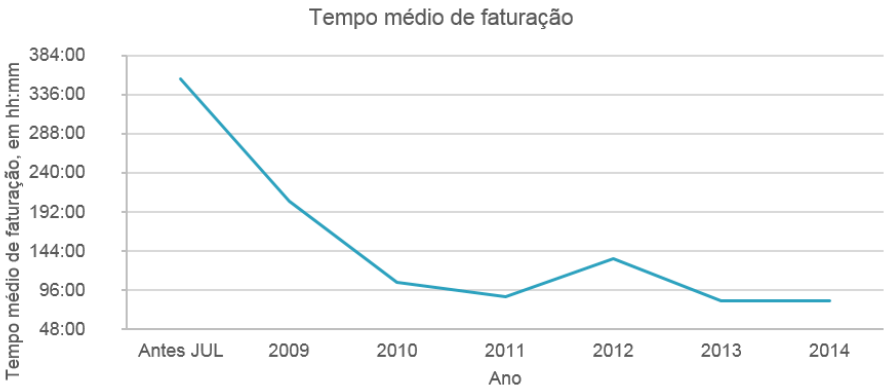

Figure 2: Average time of billing

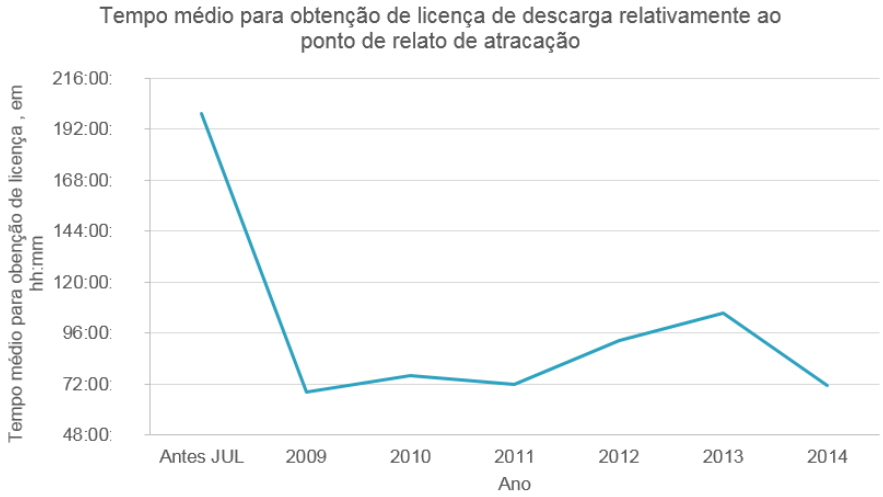

Figure 3: Average time to obtain unload license considering anchorage point

In 2012, although the general picture of the port was positive, both indicators increased, contrarily to the expected. This lack of efficiency can refer to:

- The system might not be able to efficiently meet he market growth (553 063 TEU, in 2012), nevertheless growth rate had not increased comparing to the previous years so this might not be a plausible reason;
- Either construction works taking place in Molho Leste of Port of Sines, either the opening of a new part of the container terminal may have interfered in the administrative tasks related to containerized cargo.

Also with regard to Average time to obtain unload license considering anchorage point, there is an increasing in 2012 and 2013. However, it has not been possible to relate this increase to an externality and this specific situation must be analyzed in detail so conclusions can be drawn - see Administração do Porto de Sines (2013).

Considering the Scenarios explained above, this situation matches with Scenario II – improvements are visible, but it was also detected some possible sources of externalities impacting the same activities that innovation does. Yet, it should be noted that those externalities acts contrarily to the innovation – this may explains the improvement as not as profound comparing to the other years analyzed. Thereby, all instances support a successful implementation of the innovation.

The travel time related with the administrative process was one of the main areas where PSW aimed to intervene in a positive way, by simplify the process for a single platform where information can be shared. With the implementation of the innovation, such physical movements ceased to exist enabling the streamlining of the process. Generally speaking, and taking into account the limitations of information, it can be concluded that innovations are integrated and work as a whole, and this linkage was crucial to the smooth operation of the port and success of the innovative label given to port of Sines. Whereas it has not been developed a detailed research on the impact of GIIS and PSC, it can be said that these two innovative initiatives have also brought advantages to the process:

- GIIS, by monitor all the infrastructure and the stakeholders, allows a quicker answer in case of emergency and supports all the management activities related to the containerized cargo.
- PSC, by allocate each person to a personal card and summary, streamlines all the process.

The advantages of these two innovations go beyond the scope of containers - advantages have been identified in

other activities, mostly related to security, accessibility planning and management.

5. Conclusions and recommendations

The main goal of this research work was to analyze innovative measures implemented in ports, as well as evaluating its impact on the port's performance. The implementation of recent initiatives in Port of Sines was taken as a case study. It was also proposed also the identification of the resources (human, financial, etc.) involved in the implementation of innovation. Beyond that, as a result of the lack of an explicit methodology suggestion for the assessment of innovation in the literature, it was suggested a new methodology based the contributions of several authors. The originally proposed goal was achieved and an analysis of the innovative nature of the measures implemented in the port of Sines was developed. A complex characterization of the innovation was carried out and its effectiveness was partially assessed considering specifically activities in the process of containerized cargo, entering into port by vessel. To reach these conclusions, it was necessary to develop a new methodology, as those identified in the literature have proved not to be suitable for the type of analysis projected.

Literature review led to 63 different research studies which contributed in some way to a proper knowledge on the matter. In terms of topics covered, it has been noticed an evolution of the concept of innovation. Regarding the case study, and despite a full characterization was not possible to be carried out, thirty-three sources of news, publications, reports and other materials were selected in order to describe innovation as well as possible. Considering the two goals that led to the development of the innovation in the port, it can be said that innovations were successfully implemented, contributing in a positive way to the competitiveness of the port (economically, socially and environmentally speaking).

In order to examine the measures implemented in the port of Sines, it was necessary to develop a new methodology - built considering contributions from other visited methodologies and authors - because none of the existing ones was designed to achieve the goals proposed in this research. More specifically, it was the intention of the author to assess whether a measure is in fact an innovation and its impact on the development of a port: if it had responded to what was asked, what resources that answer involved, or if the problems were fully solved.

The methodology designed permits to assess whether a measure is in fact innovative - by its detailed characterization – and to find out which resources (human, financial, technological) were in fact involved. Besides that, by matching (i) activities influenced the most by innovation and (ii) the critical activities of the processes in a port, it allows to allocate the real impact of an innovation to its implementation, considering the existence of externalities, minimizing them in some cases. Two performance measures were analyzed, supporting the thesis that the activities measured have been improved in relation to its prior state (before PSW) and so that the collected data demonstrate that the innovation was successful.

The case study was also developed as a preliminary validation of the methodology proposed.

Even considering all the limitations associated with the case study, it was possible to preliminarily demonstrate the validity of the methodology. Its success and the level of the conclusions depends largely on (i) the correct identification of the activities for which innovation acts on the one hand, and on the other, the identification of critical process activities, (ii) the collection and analysis of performance measures that reflect the activities resulting from the crossing of the previous two. However, the methodology has yet to be applied in other case studies (other ports, other innovations) in order to properly validate it. So, further evidence is needed to support is applicability. Besides that, the usage of the methodology is as conclusive as the closeness to the stakeholders and the number of fronts simultaneously studied, especially in the initial phase to reach among the stakeholders the main objective of implementing some innovative measure. The methodology would be more profitable if data access had been provided and the stakeholders cooperated with the data collection so the activities were unambiguous, and the success of innovation was clear.

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