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The Re-Conceptualization of the Port Supply Chain as a Smart Port Service System: The Case of the Port of Salerno

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Abstract: This paper proposes a re-conceptualization of the port supply chain as a smart service system, in accordance with the theory of service science. Starting from a short literature review about the port supply chain approach and service science, a new comprehensive framework is provided to better understand seaport dynamics and the creation of competitive port supply chains. The methodology used is the case study approach. The Authors examined the Port of Salerno (Italy) and re-conceptualized it as a smart port service system. The originality of the work lies in the application of service science as a lens to re-conceptualize the port supply chain, that allows the implementation of a logistic framework. Both theoretical and practical implications are provided to enrich the literature about port supply chains and to support port operators.

Keywords: smart service systems; service systems; service science; port supply chain management

1. Introduction

The growing importance of the role of seaports in the supply chain is making the port a principal actor capable of creating value both for the stakeholders involved in the process of the port supply chain and for the country where the port operates [1]. The port is increasingly viewed as a network of actors, resources and activities, which interact to co-produce value by promoting a number of interdependencies within the port supply chain [2]. This integrated port supply chain approach is in line with some recent theories that focus on the importance of the relationships among the actors of a network, by considering interaction and cooperation as the basis of a value co-creation process [3–9]. Among these theories, one of the most important perspectives is the service science [10], which focuses on the combination of human and technology knowledge, by highlighting the role of the information technologies (IT). According to this view, every service could configure a *service system* that is the result of the interaction of a series of integrated elements. Moreover, the continued advancement in technologies provides “smarter” solutions to manage such service systems. This is the reason why nowadays they are called *smart service systems* [11].

Although a few authors conceptualize the port as a network of actors sharing resources [12,13], little research considers the port supply chain as a complex system [14].

This paper aims to fill this gap, rereading the port supply chain through the concept of smart service system, a complex service system in which the role of the technology is underlined. In the port supply chain, viewed as a network, the presence of many structural and bureaucratic interconnections can cause inefficiencies that can be reduced by the crucial role of technology. This consideration encouraged the Authors to re-conceptualize the port supply chain as a smart service system, in accordance with the lens of the service science. The paper reconfigures the port as a smart service

system, providing a new comprehensive framework to better understand seaport dynamics and the creation of competitive port supply chains.

In particular, the case study of the port of Salerno is analyzed. One year ago, this port adhered to the Smart Tunnel Project: an intelligent platform of services with the aim of supporting the chain of port logistics and road transport of goods, mainly in the urban area.

The originality of this work lies in the application of service science as a lens to re-conceptualize the port supply chain, allowing the implementation of a logistic framework.

The paper offers both theoretical and practical implications. Theoretical implications enable us to enrich the literature with a re-conceptualization of the port supply chain, according to the service science perspective, and support many reflections for future research, particularly concerning how the use of ICT (Information and Communication Technologies) may make the port supply chain more efficient. Moreover, this paper entails practical implications for port operators.

2. Theoretical Background

2.1. *The Theory of Service Science*

Service science represents a multidisciplinary approach that concerns computer science, operational research, industrial engineering, management and social sciences, with regards to the study of planning, distribution and evaluation of services. Thus, this theory deals with the development of a certain expertise needed by an economy based on services [15].

Spohrer and Maglio [16], in fact, affirm that the goal of service science is to focus on the continuous and evolving research of three components: effectiveness, efficiency and sustainability. The first refers to the right supply of services, the second is about the identification of a set of appropriate activities and the third stands for the capability of establish lasting and strong relationships with the other service systems. These three elements are necessary conditions to the achievement of the balance of conditions which ensure the survival of enterprises and organizations. According to these considerations, several scholars [17,18] emphasized the need to achieve a balance between human, technical and professional resources to increase the growth and the development of organizations. Thereby, these authors highlight the relationship between the concepts of efficiency, effectiveness and sustainability and the theoretical approach proposed by service science.

Service science aims at filling the two great gaps of service research. The first is represented by the productivity levels of services. In fact, until now, these levels lie below those guaranteed by the manufacturing sector. The second, instead, is concerned with the absence of suitable methods of measurement for the effects of investments in services [15,19–21].

Consequently, the focus of service science is the continuous research of scientific methods for analyzing and finalizing the productivity with the aim of solving the critical issues deriving from the particular connotation of the service (in terms of heterogeneity, intangibility, inseparability and perishability). In other words, the goal is to realize both the engineering and the standardization of services distribution processes, in line with the present changes of a contest, that pays serious attention to the role of knowledge, to the strategic management of human resources, and to the arrangement of technological tools to be able to create and spread innovation.

On this trail, Bitner et al. [22] highlighted how service science, as an interdisciplinary scientific proposal, intends to investigate the dominant factors of service systems, which are dynamic value co-creation configurations of people, technology, organizations, and shared information. The emphasis is on the new active role of both the subjects operating in those systems and of the shared information or technologies, alongside the crucial importance of the customer's role. Clients are considered not merely participants, but real, prominent actors in the production process.

From all of this evidence clearly emerges the focus of the service science on the role of knowledge and technologies, as an incitement factor to accomplish value co-creation and, at the same time, as a result of a process.

This theory orients the decision-making of companies and organizations toward stronger cooperation and interaction among the different social actors, characterized by turbulence and uncertainty, in line with recent markets tendencies [23]. This scenario makes more perceptible the importance of the activation of suitable relationships and efficient exchange flows between the stakeholders involved in the processes of value creation. This highlights the relevance of the incitement role of the literature [24] for new information and communication technologies, in creating and developing suitable networks of relationships. In this way, service science becomes an interdisciplinary approach able to define corporate models founded on network theory [4], oriented to the creation of real interconnections of relationships and networks, as well as other service research approaches. These networks represent the connections of social resources and techniques that create and spread knowledge value through the abovementioned relationships [25] (p. 5).

The final goal of these systemic entities is indeed to generate value, by pursuing constantly the improvement of the interactions among the involved actors, to optimize the allocation of resources and the positive effects deriving from collaboration and cooperation strategies [26].

2.1.1. From Service Systems to Smart Service Systems

The recent evolution of service science emphasizes the role of technology and particularly the importance of ICTs for the implementation of a new vision of service systems in line with the continuous and persistent changes of the surrounding environment. Recent developments in service theory [11] introduce the concept of “smart service systems”, focusing on the need to adapt firm management to the changing conditions of the environment, in particular the cities where they reside, that become more and more “smart” [27,28].

Thus, ICTs play an important role in enhancing an organization’s competitiveness and survival. They are able to reconfigure old systems of services, by ensuring real-time relations and better learning processes. The development and deployment of such systems ensure greater participation of the social actors in the creation of services, as well as a high level of customization. Besides, ICTs offer the opportunity to improve reactions to context changes, as well as lead a higher level of service quality. These implications allow us to define “smart service systems” [11] as systems that can improve the quality of services through a more efficient allocation of resources. At the same time, these systems are able to ensure a more efficient use of resources and to implement more effective business strategies.

For these reasons, smart service systems are so called because they are able, through appropriate continuous learning process, rational innovation and social responsibility, to enhance the effectiveness of both outside relationships and the overall business management. Thanks to the spread of smart service systems, it is possible to realize any kind of service, (i.e., public, medical, tourism, commercial, etc.) in a sustainable and effective way, and consequently to increase the survival chances of firms and organizations.

2.2. Port Supply Chain: A Brief Review

In recent years, the concept of a port has evolved from being considered as a single entity of actors and resources to a network involved in the co-creation of value [29].

In line with these conceptual changes, the idea of port efficiency has changed. In fact, traditional indicators of efficiency and performance of ports are usually oriented to emphasize the connection with access to the sea, rather than to give sufficient prominence to landside connections, which also indicates that better coordination could be a factor to improve the efficiency of port performance [30]. Nowadays, the activities of ports are generally measured in reference to the load of outgoing goods, the productivity of the overall loading of cargo and, consequently, a whole series of aspects exclusively related to the production function [31].

Several studies [32] propose alternative models to measure the efficiency and performance of ports, by focusing on single container terminals. Similarly, Leonard et al. [33] proposed an approach that once again paid attention to the activities of ports during the loading/unloading of goods, while ignoring

all the operations that, before and after, take place in the back of the harbour. Other scholars [34,35] believe that the fragmentation of the management approach for ports depends on the organizational complexity of port facilities, even if the recent privatization process of the harbour allows for easier logistics management. Moreover, according to Fleming and Baird [36], the absence of a real community with a competitive spirit depends on the same lack of integrated management for port activities. The community is intended as an economic space where the those involved (customers, suppliers, partners) are considered “resources integrators” that feed future prospects of growth and development of the entire system [37,38]. In line with these considerations, Lun et al. [39] highlighted how the agility and the resilience of the port play an important role to improve the efficiency and effectiveness of the port supply chain.

Taking into account these considerations, the literature clearly reports an awareness of the need to achieve greater integration in the supply chain. In fact, Sheffi and Klaus [40] emphasized the importance of adequate integration of all actors involved in the supply chain. At the same time, Christopher and Towell [41] highlighted the importance of managing the entire logistics chain in a harmonic fashion. In light of these considerations, it seems reasonable to believe that the institutional fragmentation characterizing port facilities makes it difficult to achieve satisfactory measurement for port performance. In this sense, the adoption of a systems approach may help to improve port management, trying to steer the port activities towards a greater propensity for collaboration and interaction [42]. In this way, the port system, in addition to direct its activities in transport operations, would also be able to represent a real under-production and logistics system. In fact, in terms of logistics, ports represent important nodes that ensure both intermodal and multimodal transport. Moreover, ports can function as a logistics centre for the flow of goods (cargo) and people (passengers). The port also acts as a key site for the management of commercial traffic, as it is able on the one hand to connect outside flow and, on the other hand, to create adequate flow within the port itself. Such a shift from a traditional to an integrated management system [29] highlights the new role played by the port in ensuring a greater ability to link flows and commercial channels with the actors operating within itself.

3. Research Methodology

This study analyzes one of the most active and efficient seaports of the Mediterranean Sea, in which relations and interactions among the actors play a key role: the Port of Salerno.

Starting with a short literature review about the port supply approach and the fundamental concepts of service science, the aim of the paper is to provide a re-conceptualization of the port supply chain of Salerno according to a service science perspective.

We first collected information about the stakeholders and the dynamics among them within the Port of Salerno through a secondary source, the official website of the Port of Salerno. In particular, we used official documents. Afterward, we analyzed the role of every single actor and their interactions with the other members of the port system. Lastly, we identified the similarities between Service science and the port supply chain approach and analyzed the port supply chain of Salerno through the lens of service science.

This allowed us to re-configure the Port of Salerno as a smart service system, following the framework of Spohrer et al. [11]. Finally, we provided a new framework to better understand the seaport’s dynamics.

This paper is based on a qualitative approach; particularly it uses the case study methodology [43]. The case study approach allows us to better understand the “dynamics present within a single setting” [44], examining in depth the phenomenon characteristics within its context. This research strategy can involve many levels of analysis, many cases and many points of view [45]. However, in this case, we only analyzed the port as a network system involving each actor who collaborated to co-create value [2].

The only limit of the case study approach is the absence of specific procedures to assess validity and reliability in the experimental research design [45].

4. Case Study: The Port of Salerno and the Smart Tunnel Project

The Port of Salerno is located in the gulf of the Tyrrhenian Sea. It has a strategic position in the Mediterranean Sea, since it is easily reachable from many middle and southern Italian regions, such as Lazio, Abruzzo, Molise, Puglia and Calabria. This is also the case of many ports in the surrounding countries: Setubal, Bristol, Cork, Esbjerg, Wallhamn, Anversa, Southampton, Malta, Pireo, Izmir, Ashdod, Limassol, Alexandria, Algeciras, Valencia and so on.

The Port of Salerno is a commercial harbor, and represents a critical nodal point for the logistics of import/export businesses dealing with many different goods. Particularly, new cars produced by the FCA (Fiat Chrysler Automobiles) and by other international primary industries pass through this port. The port has a capacity for storage of about 4000 automobiles. In addition to the traditional port actors (port authority, shipping agencies, container depot, freight forwarder, carriers, customers), the harbor make use of a dry port: the Nola Interport. The interport is in peripheral districts and is used for commercial exchanges. The Port of Salerno, together with the corresponding dry port, generates an integrated system in which a railway passageway and a paved road connect each node of the network.

To allow for quicker and simpler communication among every actor of the port supply chain, starting from March 2014, the Port Authority of Salerno adhered to the project "Smart tunnel: intelligent integrated transport network." This is an intelligent platform, composed of logistical services dedicated to the port cities and aimed at the maximization of security and effectiveness of the port-dry port passageway (smart port regionalization). Essentially, this project is characterized by the integration of IT and innovative systems of communication, and intends to improve the interoperability of information systems, logistics and maritime mobile information systems, as well as urban roads, through ICT solutions. Moreover, it initiates the online control of material and intangible goods flow for the urban distribution chain of goods (smart urban freight transport).

This project allows the Port Authority to remove inefficiencies of structural and bureaucratic interconnections; this means better levels of efficiency and sustainability of urban transport of goods.

The Smart Tunnel Project intends to support the innovation of maritime, urban, road and rail mobility through the development of ICT solutions. Its aim is the improvement of interoperability of logistics systems for maritime information and among maritime, urban and road info-mobility systems.

The new proposed technologies seek to improve service quality and accessibility, to guarantee high standards of interoperability among different cloud systems, to promote the implementation of open source solutions, and to reduce the cost of the adoption of new ICTs by the industries, all while incrementing the investment returns and reducing the time to market of goods/services.

The Smart Tunnel Project indeed implements a smart software solution to support participation, collaboration and interoperability among different port supply chain actors through data accessibility with the heterogeneous point of view of the relative implicated roles.

Moreover, this initiative is in agreement with recently passed Italian (Art. 29 DL n.133 of the 12 September 2014) and European normative regulations (European regulations 65/2010). According to these laws, future port structures will be equipped with innovation tools to manage marine traffic, while also balancing the safeguard of urban composition, the development of port infrastructure, and the logistics of transport services, especially to destinations farther inland.

5. The Re-Conceptualization of the Port Supply Chain as a Smart Port Service System

Understanding the theoretical development of service science and the port supply chain approach, it is now possible to configure the port as a smart service system.

To do so, first we intend to highlight the similarities between these two approaches, namely between the port supply chain approach and the smart service system. Both the service science and port supply chain approaches present a systemic setting. In fact, it is now known that the

port represents an integrated system of resources based on partnership and collaboration strategies, in which the parties interact for the co-creation and production of innovation, through the acquisition of new knowledge [12]. At the same time, the concept of a smart service system [11] involves the implementation of a service system [23] by the use of novel technologies. Therefore, the smart service system acts to integrate all the resources in the whole system with a specific supply chain, therefore pooling the expertise, qualifications and resources of all parties involved in the network [16].

One of the common aspects of the port as a network and the smart service system is the adoption of a systematic and holistic approach to the reorganization of the port territory and industry. This allows for achievement of common objectives, solutions and interventions that, evaluated together, can lead to value co-creation [46,47]. To make this possible, all actors that belong to the system, even those with different roles and decision-making powers, should have equal rights, representing the membership of every company in the supply chain.

In both kinds of system, it is possible to highlight the danger of inner verticalization of the administration, rather than working toward the horizontal dimension of government. This allows us to interpret different vertical functions in a harmonized way (for instance smart energy, smart house or smart building activities, etc.).

Lastly, both of the approaches are focused on the central role of ICTs.

In light of these convergences, it is possible to combine the four dominant characteristics of service systems (people, organizations, shared information and technology) with the port supply chain management. As Sphorer and Maglio [16] said, the interdependencies between people and organizations co-create value since they share information through the use of technology. At the same time in the port supply chain, viewed according to an integrated perspective [2,29], the interdependencies promoted by the actors of the port (people and organizations) co-produce value thanks to the exchange of resources and knowledge (shared information), through ICT solutions (technologies). The integration of resources through smarter ICTs allows management to address problems in a smarter and more reactive way, and finally permits the industry to re-read the port as a smart service system.

The port, already configured in literature as a service system [13], becomes a smart service system in the recent ICT era, namely, a system able to improve the quality of the offered services; smart essentially because of its proactive nature due to the technologies employed, the rational use of resources and the effectiveness of organization, complying with plans and strategies [48]. The port re-conceptualized as a smart service system, through the lens of service science is thus called: Smart Port Service System.

The smart port service system is composed of many stakeholders that communicate quickly and more effectively by activating processes that make the port and its host city “smart,” as shown in Figure 1. The figure below represents the port as an interconnected system of resources that exchanges knowledge to co-create value and innovation. For each actor of the port (port authority, road operators, health and sanitary inspectors, container terminal, shipping agencies, interoceanic shipping lines, container depot, freight forwarder, carriers, customers and regional shipping lines), a different kind of ICT tool is depicted, depending on the role performed.

If the actor works in a fixed office, the figure shows a desktop PC (for example Port Authority or container depot); if the actor is a mobile worker (for example carriers or freight forwarder), the figure shows mobile devices (smartphone, tablet, laptop). Through the ICTs, particularly thanks to cloud computing, they exchange knowledge and information in real time, allowing cost reduction [49], resources democratization [50], innovation [51], flexibility and scalability [52]. New technologies allow the actors of the system to reduce inefficiencies and work in a symbiotic way in order to co-create value and shape the smart port service system. In this system, the role of ICTs is crucial, as they represent the enablers of success of the smart port service system.

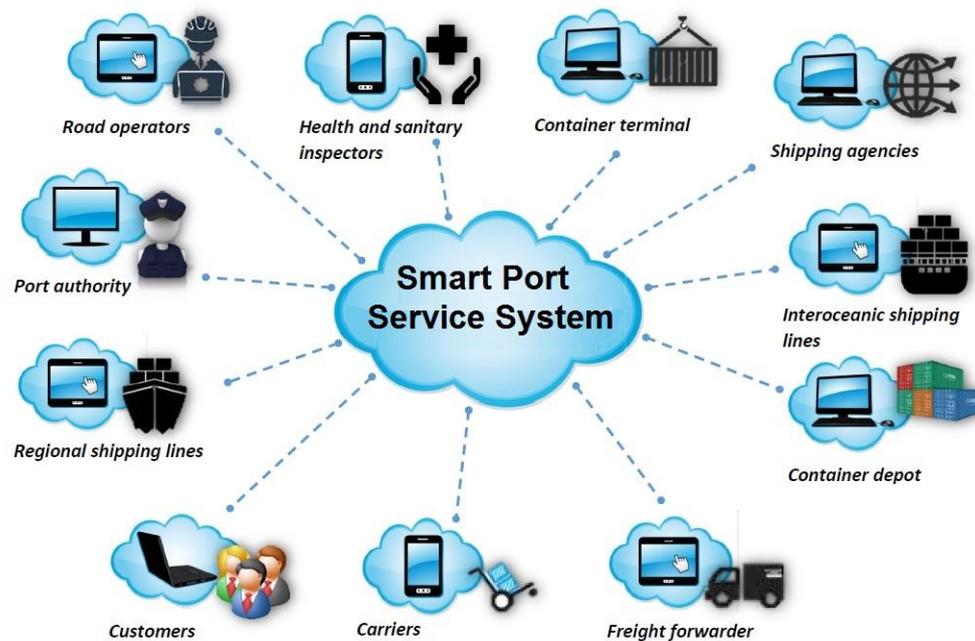


Figure 1. The smart port service system.

5.1. The Port of Salerno as a Smart Service System

The Port of Salerno can be properly viewed as an integrated port supply chain. The necessity to make use of an inland port, as confirmed by the literature [53], together with the need to accelerate regionalization processes and interoperability led the Port of Salerno to adhere to the aforementioned Smart Tunnel Project. It is now about a year since the port joined the Smart Tunnel Project. During this year, it was realized as a prototype to provide a governmental tool for future port processes, through the novel perspective of Port-Regionalization. This concept belongs to a segment of P.C.S. (Port Community Systems), and facilitates interoperability between platform administration (A) and institutional organizations (Ag Dogane, Port Authority, Maritime Health, UIRNet), as well as business actor platforms (terminal operators and carriers).

VITROCISSET company realized the prototype and equipped the port with technological structures that actors use to access to the smart tunnel platform, allowing for more efficient communication.

The efficiency maximization take place through a greater and quicker information exchange that allows for the elimination of negative externalities (i.e., reduces pollution due to ship parking, improves occupational safety, reduces energetic waste or ship pollution, prevents and manages accidents or gridlocks in road transport).

The shared information for the Port of Salerno, through the massive use of ICT, particularly through a cloud system, makes the Port of Salerno a smart port service system where the interactions supported by novel technologies creates new value. As Håkansson [54] said, we can consider the interorganizational relationships as “bridges of value.” This expression implies the strategic relevance of relationships among the actors of a network and the shared resources among them that strongly contribute to value co-production [55].

6. Implications and Conclusions

The conceptualization of the port in literature has recently changed by passing from a fragmentary point of view [34,35], due to the complex organizational structure and management of ports, to a network approach that considers the port as a net of actors that collaborate and share different resources to achieve their goals [2]. The strength of the effectiveness for this kind of organization is the collaboration among the network nodes. “The higher the level of collaboration (integration) among

actors, the greater the benefits that they will perceive in promoting interdependencies also among various supply chains" [56].

This new integrated vision of the port supply chain allows for the conceptualization of the port as a service system [13], according to the theories of Service-Dominant logic [3] and Service science [10]. This latter theory highlights the growing role of ICTs in the management of services, and for this reason appears to be the best theory to re-conceptualize the port supply chain, in which the use of the ICTs is growing ever more important. Thanks to the contribution of ICTs, services become smart services; thus, the service system converts to a smart service system [11].

From all these considerations of service science, together with the recent development of the port supply chain management approach, this paper configured the port as a smart service system, through the lens of service science. The adoption of this perspective to port supply chain management enables the identification of a system of value co-creation and competitiveness through new technologies, which are viewed as enablers of the system. We provided a comprehensive framework for the planning and creation of the new, competitive port supply chains.

The present work proposes theoretical and practical implications for the novel framework. It represents both a theoretical progress for service science literature and for port supply chain management, given that the port was never before configured by any other authors as a smart port service system.

From a practical point of view, the paper is useful to port operators to understand how the port is in continuous evolution, and how it has a growing relevance in the supply chain. This phenomenon regards not only the stakeholders involved in the process of the port supply chain, but also the country where the port operates [1]. Service science is useful to represent the complex port environment including all the possible interactions among actors, replacing the concept of a port supply chain with a network concept that referred to a supply chain as a complex service system, in line with the literature review [2,40–42].

Moreover, we highlight the critical role of ICTs, particularly cloud computing, that allows every operator to connect with all the other actors of the port system, in order to reduce the costs per node of the system (actor) through efficient use and democratization of resources, and to access common resources in an equitable through every kind of device [57].

Limitations of this work lie in the methodology. The case study approach, despite being a quantitative technique, does not give maximum soundness in terms of reliability [45].

From all these considerations, future studies should try to improve the proposed framework in other case studies to prove the advantages of this interpretation of ports as smart service systems.

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