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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, according to the theory of the Service science. Starting from a short literature review about the port supply chain approach and the Service science, a new comprehensive framework is provided to better understand the 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 systems. Both theoretical and practical implications are provided to enrich the literature about the port supply chain and to support the port operators.

**Keywords:** Smart service systems, Service systems, Service Science, Port Supply Chain Management

## 1. Introduction

The growing importance of the role of the seaports in the supply chain made the port as a principal actor capable to create 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 the interaction and the cooperation the basis of a value co-creation process [3,4,5,6,7,8]. Among these theories, one of the most important perspective is the Service Science [9], that 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 advancement in technologies provides "smarter" solutions to manage the service systems. This is the reason why nowadays they are called *smart service systems* [10].

Although a few authors conceptualize the port as a network of actors sharing resources [11,12], little research considers the port supply chain as a complex system [13].

This paper aims to fill this gap, by trying to answer the need to implement a logistic frameworks, through the re-conceptualization of the port supply chain according to the lens of the Service Science perspective. The authors intend to reconfigure the port as a smart service system, providing a new comprehensive framework to better understand the seaport dynamics and the creation of competitive port supply chains. In particular, the case study of the port of Salerno is analyzed. This port adhered,

a year ago, to the smart tunnel project: an intelligent platform of services with the aim of support the chain of port logistics and road transport of goods, mainly in the urban area.

The paper offers both theoretical and practical implications. Theoretical implications enable to enrich the literature about the re-conceptualization of the port supply chain, according to the Service Science perspective, and support many reflections for future research, in particular on how the use of ICT make the port supply chain efficient. Moreover, this paper entails practical implications for the port operators.

## 2. Theoretical background

### *2.1. The theory of the Service Science*

Service Science represents a multidisciplinary approach that concerns computer science, operational research, industrial engineering, management and social sciences and regards the study of the planning, distribution and evaluation of services. Thus, the Service Science deals with the development of that kind of expertise needed by an economy based on services [14].

Spohrer and Maglio [15], 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.

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 of those guaranteed by the manufacturing sector. The second, instead, concerns the absence of suitable methods of measurement for the effects of investments in services [14].

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

On this trail, [16] highlight how Service Science, as an interdisciplinary scientific proposal, intends to investigate the dominant factors for the service systems. The emphasis is on the new active role of both the subjects operating in that systems and also of the shared information or technologies, with crucial importance for customers role. Clients are considered not merely participants, but real prominence actors in the production processes.

From all these evidences, clearly emerges the focus of the Service Science on the role of knowledge and technologies, as an incitement factor to accomplish the value co-creation and, at the same time, as a results of a process.

The theory orients the decision making of companies and organizations toward a stronger cooperation and interaction among the different social actors, characterized by turbulence and uncertainty, in line with the recent markets tendencies [17]. This scenario make 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 [18] for new information and communication technologies, in creating and developing suitable networks of relationships. In this way, the Service Science become an interdisciplinary approach able to define corporate models founded on network theory [4] and 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 though the relationships [19] (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 the resources and the positive effects deriving by the collaboration and cooperation strategies [20].

#### *2.1.1. From the service systems to Smart service systems*

Recent evolution of the Service Science emphasizes the role of technology and, in particular, the importance of the ICTs for the implementation of a new vision of the service systems in line with the continuous and persistent changes of the surrounding environment. Spohrer et al. [10] introduce the concept of "smart service systems", focusing on the need to adapt firms management to the changing conditions of the environment in particular the cities where they reside, that become more and more "smart" [21,22].

Thus, the ICTs play the important role to enhance organization's competitiveness and survival. They are able to reconfigure the old systems of services, by ensuring real-time relations and better learning processes. The development and deployment of such a systems allows to ensure greater participation of the social actors in the creation of services, while ensuring a high level of customization. Besides, ICTs offer the opportunity to improve the reaction to the context changes, as well as leads a higher level of service quality. These implications allow to define the "smart service systems" [10] 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, the 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 the outside relationships and the overall management business. 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; consequently, to increase the survival chances of firms and organizations.

### *2.2. Port Supply Chain: a brief review*

During the past years, the concept of the port has evolved from being considered as a single entity of actors and resources to the conceptualization as a network that cooperates to the value co-creation [23].

In line with these conceptual changes, the idea of the port efficiency has changed. In fact, traditional indicators of efficiency and performance of the ports are usually oriented to emphasize the connection with access to the sea, rather then to give sufficient prominence to the land-side connections, which also could allow a better coordination to improve the efficiency of port performance [24]. Nowadays, the activities of the ports are generally measured by 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 [25].

Several studies [26] propose alternative models to measure the efficiency and the performance of ports, by focusing on the single container terminals. Similarly, also [27] proposes an approach that paid once again attention to the activities of the ports made during loading / unloading of goods, while ignoring all the operations that, before and after, take place in the back of the harbor. Other scholars [28,29] believe that the fragmentation of the management approach for the ports depends on the organizational complexity of port facilities, even if the recent privatization process of the harbor allows to make easier their logistics management. Moreover, according to Fleming and Baird [30] the absence of a real community with a competitive spirit depends on the same lack of an integrated management for the port activities.

Starting from these considerations, it is clear in the literature the awareness to achieve a greater integration for the supply chain. In fact, also Sheffi and Klaus [31] emphasize the importance to achieve an adequate integration of all the actors involved in the supply chain. At the same time, Christopher and Towell [32] highlight the importance of managing in a way, as much as possible harmonic, the entire logistics chain. In light of these considerations, it seems reasonable to believe that the institutional fragmentation characterizing the port facilities make it difficult to achieve satisfactory measurement for the port performance. In this sense, the adoption of a systems approach may help to improve the port management, trying to steer the port activities towards a greater propensity for collaboration and interaction [33]. In this way, the port system, in addition to direct its activities in the transport operation, 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 center for the flow of goods (cargo) and people (passengers). The port acts also as a key site for the management of commercial traffic, as it is able, on the one hand to connect the outside flows and, on the other hand, to create adequate flows within the port itself. Such a shift from a traditional to an integrated management system, allow to highlight the new role played by the port in ensuring a greater ability to link the flows and the commercial channels with the actors operating within itself.

## 3. Research Methodology

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

Starting from 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 the Service Science's assumptions.

We first collected information about the stakeholders and the dynamics among them within the port of Salerno through secondary source: the official site of the port of Salerno. Afterward, we analyzed the role of every single actor and their interactions with the other members of the port system. Lastly, we identified the similarity within these theories and analyze the port supply chain of Salerno through the lens of the Service Science.

This allow us to re-configure the port of Salerno as a smart service system, following the framework of Sporher et al. [10]. Finally, we provided a new framework to better understand the seaport dynamics.

This paper is based on a qualitative approach; in particular, it is used the case study methodology [34]. The case study approach allows to better understand the "dynamics present within single setting" [35], examining in depth the phenomenon characteristics within its context. This research strategy can involve many levels of analysis, many cases and many point of view [36], but in this case we consider the only level of analysis of the port as a network within every single actor who collaborate to co-create value [2].

However, the only limit of the case study approach involves concerns the absence of specific procedures to assess validity and reliability in experimental research design [36].

## 4. The case study: the port of Salerno and the Smart tunnel project

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

The port of Salerno is a commercial harbor and it represents a critical nodal point for the logistics in import export business of several kind of goods. Particularly, new cars produced by the FGA, Fiat Group Automobile, or by other international primary industries. The port has capacity for

storageabout 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: Nola interport. The interport is located in peripheral districts and it is assigned to the 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 a quicker and simpler communication among every actor of the port supply chain, starting from March 2014, Port Authority of Salerno adheres 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 technologies and innovative systems of communication and intends to improve the interoperability of information systems, logistics and maritime mobile information systems, urban and road through ICT solutions. Moreover, it concerns the online control of material and intangible goods flow for the urban distribution chain of goods (smart urban freight transport).

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

Smart tunnel project intend to support the innovation of maritime, urban, road and rail mobility through the development of ICT solutions and technologies. The aim is the improvement of interoperability of logistics systems for maritime information and among maritime, urban and road infomobility systems.

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

Smart tunnel project indeed implements smart software solution to support the participation, collaboration and interoperability among different Port Authority actors through the data accessibility with the heterogeneous point of view of the relative implicated roles.

Moreover, this initiative is in agreement with the enter into force of recent italian (Art. 29 DL n.133 of the 12 of september 2014) and european normative (european regulations 65/2010). According to these laws, future port structures will equip innovation tools to manage the sea-heart traffic, while defending a poised balance sheet between safeguard of urban composition and the development of port infrastructure and the logistical transport services, especially of hinterland.

## 5. The re-conceptualization of the port supply chain as a smart port service system

Starting from the considerations discussed above, concerning 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 of all we intend to highlight the similarities between these two approaches, namely between the port and the smart service system. Both the service science and the port supply chain approach 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 know-how [11]. At

the same time, the concept of smart service system [10] plans to implement the service system [17] by the use of technologies. Therefore, the smart service system acts to integrate all the resources in a whole system of work and with a specific supply chain, to favor the qualification of the expertise, for instance the knowledge, the know-how, the people, the goods, the materials, the finances [15].

One of the common aspect of the port, as a network, and the smart service systems is the adoption of a systematic and holistic approach to the reorganization of the territory and the context within the industry works. This allows the integration, promotion and the instructions to achieve common objectives, solutions and interventions that merely evaluated together can lead to the value co-creation [37]. To make this possible, all the actors that belong to the systems, even if with different roles and decision-making powers, should have equal rights, because of the membership of every company in the supply chains.

In both the kinds of system it is possible to highlight the overtaking of inner verticalization of the administration, in favor of a landing place toward the horizontal dimension of government. This allows to interpret in a whole manner and in an harmonized way the different vertical functions (for instance smart energy, smart house or smart building activities, etc.). Lastly, both the approaches are focused on the central role of the ICTs.

In light of these convergences, it is possible to combine the four dominant characteristics of service systems (people, organization, shared information and technology) with the port supply chain management. The port supply chain is viewed according a supply chain integration (SCI) perspective [2] in which the organizations communicate through the people who create value, sharing information, by the technology. The port, already configured in literature as a service system [12], in the ICT era, becomes a smart service system, namely a system able to improve the quality of the offered services, smart essentially because of the proactive nature due to the technologies employed, the rational use of the resources and the effectiveness of organization, complying with the planning and the anticipation [38].

The smart port service system is composed by many stakeholders that communicate quicker and with more effectiveness, by activating processes that make the port and the city who host it smart, as shown in figure 1. Every actor of the port is represented in the process of value creation, together with all the other actors, thanks to the ICTs

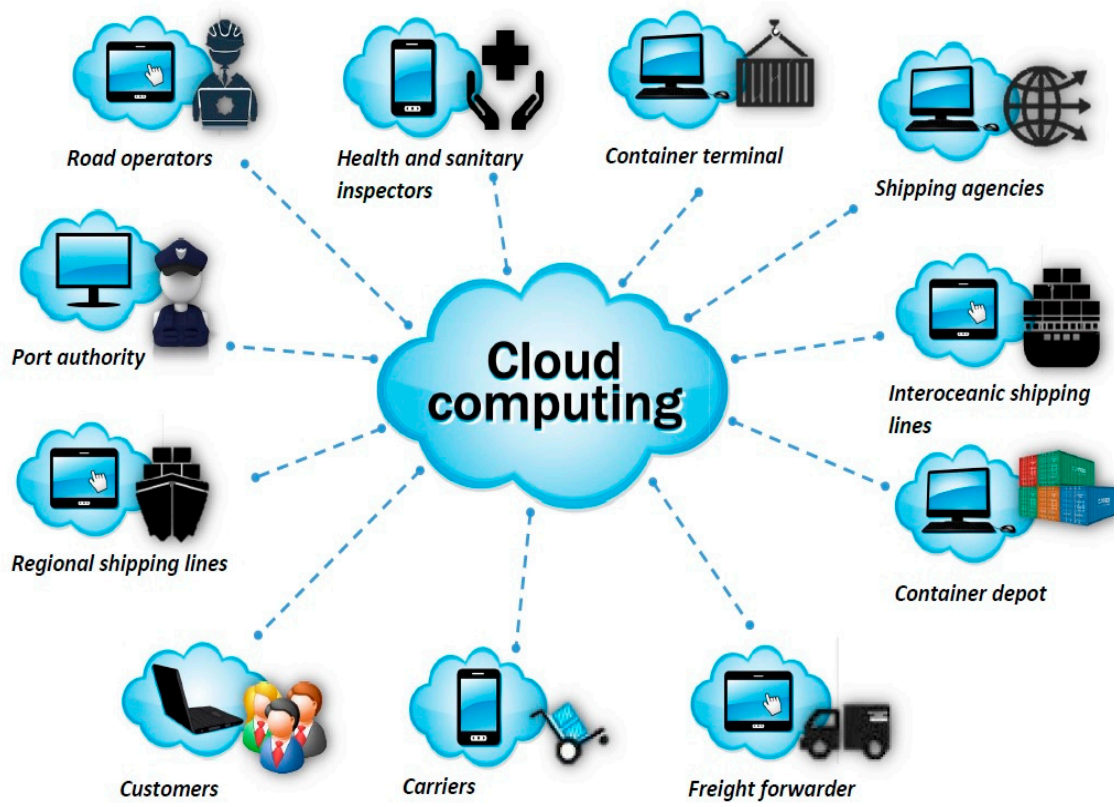


**Figure 1.** The Smart Port Service System

*5.1. The port of Salerno as a Smart service system*

The port of Salerno can be properly view as an integrated port supply chain. The necessity to make use of an inland port, as confirmed by the literature [39], together with the need to accelerate regionalization processes and the interoperability, in fact, 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 a first prototype to provide a government tool for future port processes, through the novel perspective of Port-Regionalization. This concept belongs to the segment of P.C.S. (Port Community Systems) and facilitates the interoperability among platform administration (A) and institutional organization (Ag Dogane, Port Authority, Maritime Health, UIRNet), but also business actor platforms (terminal operators and carriers).

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

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

The shared information for the port of Salerno, through the massive use of ICT, particularly cloud system, makes the port of Salerno a smart port service system where the interaction supported by the technologies creates new value. As Hakansson [40] said, we can consider the inter-organizational 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 [41].

## 6. Implications and Conclusions

The conceptualization of the port in literature has recently changed by passing from a fragmentary point of view [28,29], 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." [42].

This new integrated vision for the port supply chain allows the conceptualization of the port as a service systems [12], according the theories of Service Dominant logic [3] and the Service science (Maglio e Spohrer 2008). This latter theory highlights the growing role of the ICTs in the management of services. In fact, thanks to the contribution of ICTs, services become smart services; thus, the service system converts to smart service system [10].

From all these considerations on service science, together with the recent development of the port supply chain management approach, this paper configured the port as a smart service system. We provided a comprehensive framework for the planning of the creation to making competitive the port supply chains.

The present work proposes theoretical and practical implications for the novel framework. It represents both a theoretical progress for the service science literature and for the port supply chain management, given that the port was never configured until now 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 a reality in a 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].

Moreover, we highlight the critical role of the ICTs, in particular the cloud computing, that allows every operators to connect with all the other actors of the port system, to reduce the costs per node of the system (actor), through an efficient use and the democratization of the resources, to access in an equitable way to the common resources trough every kind of device [43].

Limitations of this work lie in the methodology. The case study approach, despite of quantitative technique, doesn't allow the maximum soundness in terms of attendibility and reliability [36].

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

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