Digital Innovation in the Port Sector: Barriers and Facilitators

Valentin Carlan*, Christa Sys**, Thierry Vanelslander***, Athena Roumboutsos****

Abstract: This article identifies the barriers of digital innovation from initiation through to implementation, as well as assessing the impact of facilitators of ICT innovation. To do this, the present research applies four quantitative instruments. The research conducted within the BNP Paribas Fortis chair Transport, Logistics and Ports firstly indicates that alignment exists between company strategies and degree of success in the port sector, as compared to non-ICT initiatives. The ICT innovation initiatives also are profit-driven. Secondly, the port sector should be more open to disclose cost and benefit info, and should conduct more such analyses. Next, there are conditions that improve the degree of success. Overall, terminal alignment with the right ICT infrastructure proves key. But too many diverging interests among the stakeholders entail that digital innovation challenges the ability to cooperate. An important finding: regulation was identified neither as a barrier nor as a facilitator.

Digital Innovation Change Gradually the Port Sector

Starting from Schumpeter (1939), innovation is "'doing things differently' in the realm of economic life", where "new combinations" of resources bring about five different types of innovation: new products or a new quality of a product, new methods of production, new markets, new sources of supply of raw materials and intermediate goods, and new methods of organizing the economic process. All take place within the realm of economic life. Within the context of the present research, "change" was considered vis-a-vis economic, environmental and social added value.

Under digital innovation, combinations of information, computing, communication, and connectivity technologies are considered (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013). The port sector can also expect cost savings, increased quality and further growth by implementing digital innovation. However, the speed at which digital innovation is reshaping the port sector is lower than in other industries.

Three categories may be considered the key innovation domains in the port sector with respect to digital technology. The first category 'electronic data interchange' (21 cases analysed) focuses on barriers and success/failure oriented to paperless administration process. New technologies are being used, standardisation has materialized and information flows faster. Regarding IT innovation supporting cargo flow, five innovation cases are analysed. Differently from the previous category, the second cluster focuses on innovation initiatives that are enhancing the cargo flow. Intelligent traffic optimisation solutions, for both freight and vessels, are being compared (5 cases analysed). Moreover, mobility and delivery times are targeted as key factors that should be improved by computer-assisted planning solutions. The main goals of these initiatives are to optimize the traffic, to develop a planning algorithm and to avoid conflicts on navigational ways. The third category (6 cases analysed) brings together innovation initiatives which are focused on better monitoring vehicles and cargo.

Given the trend towards collaborative innovation in the maritime supply chain, the question becomes what are the barriers, who has a facilitating role, and whether there is a role for regulation? That is the main research question that this paper answers for digital port-related innovation.

A key feature of the methodology applied is the fact that it combines four approaches to provide in combination the

* Valentin Carlan is a PhD researcher at the University of Antwerp, , Department of Transport and Regional Economics with experience in port innovations. Email: valentin.carlan@uantwerp.be

** Christa Sys is holder of the BNP Paribas Fortis Chair Transport Logistics and Ports, hosted at University of Antwerp, Department of Transport and Regional Economics with a particular interest in the container liner shipping industry as well as maritime and port innovation. Email: christa.sys@uantwerpen.be

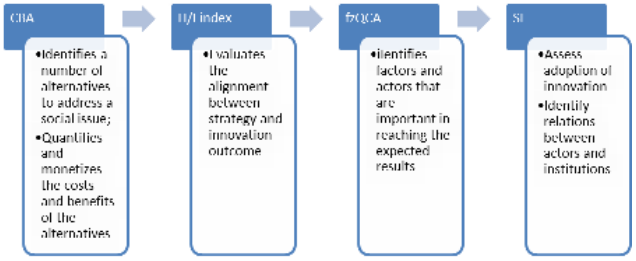
*** Thierry Vanelslander is research professor at University of Antwerp, Department of Transport and Regional Economics. He has more than 10 years' experience in port economics. Email: Thierry.vanelslander@uantwerpen.be

**** Athena Roumboutsos is Associate Professor, University of the Aegean, Department of Shipping, Trade and Transport. Her research interests in Public Private Partnerships include risk analysis & management, stakeholder management, change management and innovation. Email: athena@aegean.gr

The full article was awarded with the 'best paper award' and presented at the 5th Conference on Regulation of Infrastructure on 24th June 2016 in Fiesole, Italy.

key factors influencing successful implementation[1]. The combination of the four approaches sheds useful light on the factors that stimulate or hinder port-related digital innovation. (Figure 1) In particular, the need for infrastructure standardization and regulation, and the dominance of certain players through hard-institutional (e.g. regulation) or soft-institutional (e.g. actor culture) issues or strong or weak networking are brought to light.

Figure 1: A holistic approach to research



The analyses followed are complementary and inter-linked. Firstly, cases are viewed with respect to their cost-benefit analysis (CBA). Notably, apart from the level of alignment with company strategies, the adopted innovation should be ex-ante efficient and its feasibility validated. The second method decides whether the innovation cases align with the companies' strategies and the level of alignment. Then, the fuzzy set Qualitative Comparative Analysis (fsQCA) looks for the combination of actors and conditions leading to better results. Finally, the Systems of Innovation (SI) approach determines whether basic concepts are valid, through pattern recognition.

Identifying the Strategies, Barriers and Facilitators

Digital innovation will change the business model of the actors along the maritime supply chain. In previous decades, forward thinking companies along the maritime supply chain invested in stand-alone IT systems to enhance their operations and maintain competitiveness (i.e. support new business models and deliver new services). A number of software companies specialized in the port sector and developed and adjusted various innovative concepts to the needs of a particular stakeholder. With respect to integration in the maritime supply chain, those stakeholders find themselves in a lock-in situation. Moving to cloud-2-cloud applications will make it possible to move forward faster. Inevitably, integrating such systems carries a price tag. Small and medium sized companies should also embrace the move to digital innovation. How to create positive awareness among those companies? What barriers are on the way, and what role can regulation play?

First, alignment exists between company strategies and success degrees in the port sector, and efforts should be made to improve the strategic processes that lead to integration in the maritime industry. Economic objectives appear to be ranked higher in terms of importance than the other objectives such as environmental and social, which in many cases are imposed through regulation or through the social responsibility mandate of the initiating entity.

Next, no unique 'recipe' for innovation success does exist. However, some combinations of variables can be identified that lead for certain groups of cases to a higher chance of success. (Figure 2) Overall, important variables turn out to be infrastructure, soft-institutional and hard-institutional issues at the initiation stage, and infrastructure at the development and implementation stages.

Figure 2: fsQCA success conditions

fsQCA success condition / ICT Innovation cluster	fsQCA 1	fsQCA 2	fsQCA 3	fsQCA 4
Electronic data interchange innovation (information flow)	APCS			
	Administration (EDI)		Administration (EDI)	
	IT data management			
	SEAGHA - port community system			
			eTransit (prior to the Extended GATE)	Port Single Window
				Extended-GATE 1.0
IT innovation supporting the cargo flow	3PL - Primary Gate of Leixões Port			
Monitoring innovation - vehicles & cargo	Autotrakker			Truck Appointment System

Furthermore, it was identified that capability building and early inclusion of actors that may provide respective capabilities is important for the successful adoption of digital innovation.

Financial support was absent in most cases and in the majority of cases self-financing was the preferred /adopted solution. In depth investigation of exceptions and failed cases highlighted the impact of "lack of market demand" and "port competition" and most importantly "innovation

1 A detailed description of the four above-mentioned methods is available through Sys et al (2016).

competition". The latter is also responsible of a lock-in effect and deserves further research, as well as the effect innovation systems have on each other.

In addition, market demand is equally important to bring about the change introduced by the innovation. This condition is, also, connected to market readiness and requires further research.

Fostering coopetition within the port is an important prerequisite for the successful adoption of innovation. This consists of managing to achieve cooperation with respect to application of ICT in ports. Such coopetition, in many cases is targeted between ports. The innovation champion in this case is of significant importance.

In the present research and context, initial attempts at working with an upstream and downstream stakeholder often failed. Just a few were subsequently successful, but only in a closed innovation approach. Hence, co-innovation is expected to be the most important challenge for the port industry in the decades ahead. Co-innovation is a new form of innovation whereby the various stakeholders jointly acquire new expertise and create opportunities in the supply chain for new partnerships. In the long term, this will lead to a balance between costs and profits as well as a greater competitive advantage. In this context, the concept (and definition) of innovation widens and includes the cost reduction and improvement of service within a wider system.

It is noted that regulation and standardization (or hard institutions) was not identified as either being a significant barrier or a facilitator to the process. If anything, within the port environment, existing ICT solutions are often considered "standard" bringing about a lock-in effect and creating hindrances for new applications. In combination to the need for co-opetition and co-innovation within the port sector, there is an issue for further research as to whether regulation and standardization will be favourable for the uptake of ICT innovation, especially as technology trends are in support of more open access systems.

Research is furthermore required to validate the findings from this paper more in depth. The set of ICT cases analysed within this research effort may be considered adequate in number allowing for comparisons and potential transfer of lessons learnt. However, it is also important to state that the sample may have a potential bias. For example, a great share of the cases within our sample is considered successful. Another point of interest is the market position of the innovation champion and the fact that all the analysed cases were self-financed. Finally, only a minority of cases involve small and medium-sized enterprises. It would be useful to verify whether the findings of this paper still hold in sets of cases that are more diverse.

Joint Lessons for ICT related Port Innovation

During the data collection phase already, interviewees indicated the following barriers to port-related ICT innovation: lack of collaboration with other actors, need for further integration along the maritime supply chain, uncertainty about legislation, and drifting apart of the local needs and the strategic decisions made by headquarters as a result of globalization. These preliminary observations show that regulation does not get immediate attention among chain stakeholders, if only that there should be consistency.

The case analysis with the four methods suggests first of all, through the CBA, that there are benefits and costs for every stakeholder. However, the benefits are not always readily visible, often resulting in a low willingness to pay. At the same time, concern about the cost elements definitely plays in a sector where margins are narrow. Hence, from a game-theoretical perspective, there is no willingness to co-operate (comparable with co-operation between ports). This is easily explained by formalizing the cost and benefits of adopting an IT application in a payoff matrix. The choice is simple: either to continue with the own IT system or to integrate systems. Unlike the innovation champion (e.g. trucking company, carrier…), the follower faces an entry cost that outweighs the benefits, and consequently the game stops. There could be a role for regulation here, to the extent that entry costs may be built excessively high by incumbents. The latter is also supported by the importance attached by port chain decision makers to economic objectives, including optimizing operations and minimizing costs in the first place, as shown by the objectives-success analysis.

Entry costs may also be the driver behind observed potential for imitation (Roumboutsos, 2015). The innovation initiative fails or ends in endless discussions about data (ownership, availability, accessibility and modifiable). Opposed to that, if the cost is lower than the benefit or if everyone is in it from the start (cf. openness and trust), an innovative concept is likely to achieve greater success (Sys et al., 2015).

The latter weakens the role of the innovation champion on its own in the process: according to the fsQCA analysis, only in a minority of cases, that actor manages to push through the innovation in a key role on his own. The role of partners like terminal operators and shipping lines,

in particular in their alignment with infrastructure, are key. That is also confirmed by the Systems of Innovation approach, where capabilities of all involved partners, market demand and avoiding lock-in effects on behalf of the innovation champion are important. First, innovation carries "newness" both in application and the knowledge which is needed to implement it. Respective capabilities are important to be included in the process from the earlier stages, when this knowledge does not exist in-house. Second, limitations and set-backs may be overcome given the level of market demand that may exist for a specific innovation or the need to improve on efficiency. Third, the "port environment" includes many interlinked and interrelated actors, who may not always share the same interests or their interests may not be achieved in the same way. It is therefore important to both motivate all actors involved and facilitate their involvement in the implementation of the innovation. To this end, a number of issues may arise connected to both existing technology, and thus lock-in effects, for actors as well as competition issues.

A strong role of the innovation champion has been identified through many previous studies (Schon, 1963; Howell, Shea, & Higgins, 2005). However, there is a particular interest in the port sector where market leaders may exist within the group of actors involved in the implementation of a particular innovation. Here, the combined effect of market leaders (hence representing to a large extent market demand or bearing knowledge of market needs) and the power position within the "port environment" may be witnessed. Hence, the combination of the above findings supports the need of stimulating co-opetition in order to support the successful adoption of innovation. That is again supported by the objectives-success analysis, as integrating with other chain actors is shown to be a key objective by chain stakeholders.

Hard institutions (including regulation) moreover only appear as important in a minority of cases, according to the fsQCA analysis. Soft institutions (including informal standardization) are much more important. Of course, in such case, regulation of the market to support the free flow of information among actors and to give the best chances to the best standards becomes important.

The confrontation of objectives and success finally shows that the objectives that typically require public intervention (environmental and social) are not valued high. Clearly, the role for public policymakers in this field is not key.

References

1. Bharadwaj, A., El Sawy, O., Pavlou, P. A., & Venkatraman, N. (2013), 'Digital business strategy: toward a next generation of insights', Mis Quarterly, 2(37), 471–82.
2. Howell, J. M., Shea, C. M., & Higgins, C. A. (2005), 'Champions of product innovations: defining, developing, and validating a measure of champion behavior', Journal of Business Venturing, 20(5), 641–61.
3. Roumboutsos, A. (2015, April 23), 'Comparative Analysis of Cases: Systems' Innovation Approach', BNP Paribas Fortis innovation event, Antwerp.
4. Schon, D. A. (1963), 'Champions for Radical New Inventions', Harvard Business Review, 41(2), 77–86.
5. Sys, C., Vanelslander, T., Acciaro, M., Ferrari, C., Roumboutsos, A., Giuliano, G., … Lam, J. (2015), 'Executive summary'. Retrieved from http://anet.be/record/opacirua/c:irua:127919
6. Sys, C., Vanelslander, T., Roumboutsos, A., Giuliano, G., & Acciaro, M. (2016), 'Port related innovation: the answer to today's constraints and challenges in seaports related operations', in review.