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The influence of digitalisation on the port choice behaviour – An analysis of decision-makers in South-West Germany

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Abstract. In the order process of maritime container transports multiple actors take over specific tasks planning and executing the corresponding transport process. Sophisticated inter-organisational information systems become increasingly important with regard to standardisation and automation of the complex transport order process. However, these potentials of improvement can only be exploited with a consistent digital integration throughout the involved actors of the transport chain, which is not the case today. Therefore, the development of digitalisation and the influence of inter-organisation information system (IS) integration as an item of the port performance factor are investigated in the paper at hand. In order to analyse this development and influence of digitalisation on the port choice behaviour an exploratory research study with 25 decision-makers (shippers, forwarders and carriers) of South-West Germany is conducted. The results of the study reveal that the degree of digitalisation will accelerate in the next years at all decision-makers, but carriers assessed themselves as the most digitally developed actors. With regard to the port performance factor other items, e.g. reliability of the port, still remain more important compared to digitalisation on the port choice behaviour.

1 Introduction

Digitalisation has recently become one of the most important topics for researchers and practitioners of the transport sector because of the high potential to improve transport processes of goods and information flow [1]. This is attributable to the high fragmentation of the sector and the strong interdependencies between actors. However, it can be shown that the transport sector is still lagging behind in terms of inter-organisational IS integration compared to other industries (e.g. finance or retail) [2]. Since the overall efficiency of the transport process can only be as good as the weakest link in the chain, it is essential to encourage fully digital integrated processes along the transport chain [3].

In the maritime containerised transport chains the port is the central connection between the hinterland and the sea side. Thus, a good connection between the port and the hinterland becomes a source of competitive advantage for the fiercely contested container volume [4]. Therefore, decision-makers of the hinterland and their perception of the port performance determine through which port the container volume is directed.

Shippers are one of these decision-makers. They have different opportunities to decide how to compound the maritime transport chain for containers. They can plan and organise the transport on their own or they can specify expected conditions of the transport and allocate decision-making authority to either forwarders (merchant's haulage) or carriers (carrier's haulage) [5]. This makes in this case shippers, forwarders and carriers the relevant decision-makers. In literature the port choice behaviour of these decision-makers is considered either isolated [e.g. 6, 7, 8] or only two directly connected actors (shippers and forwarders or shippers and carriers) [e.g. 9, 10, 11, 12], but not all three together. However, extending the port

performance factor with the digital dimension it is valuable to broaden the focus, in order to gain an overarching view of similarities and differences between the decision-makers.

These two research gaps, considering the choice behaviour of all three decision-makers and the influence of digitalisation on the port choice behaviour, are addressed in this paper. Hence, the paper aims to analyse differences of the decision-makers regarding the development of digitalisation as well as the overall influence of digitalisation, in terms of the inter-organisational IS integration as the item of the of the port performance factor, on the port choice behaviour. In order to achieve this, an exploratory research study is conducted interviewing decision-makers from South-West Germany (Hesse, Rhineland-Palatine and Baden-Wuerttemberg). This region is selected, firstly, because of the high container volume (over 2 Mio. TEU (twenty-foot equivalent unit)) and secondly, because of the uncertainty which port of the North Range (Hamburg – Le Havre) should be chosen [13, 14]. For North-East Germany it is clear that the north ports (here: Hamburg or Bremen) are chosen because of lower lead times and costs. However, for South-West Germany the decision, which port to choose, is not obvious because lead times and costs might be in favour of the west ports (here: Antwerp or Rotterdam) but still the north ports are chosen.

The remainder is structured as follows: In the next section the research methodology is described in detail. After that, selected results of the research study are presented. The paper at hand ends with conclusions and further research opportunities.

2 Methodology

The qualitative research design is selected to explore the development of digitalisation as well as to adopt and analyse the influence of digitalisation on the port choice behaviour, which is novel in this research field. Therefore, the study is based on 25 decision-makers, including 16 shippers, six forwarders and three carriers (representing a high variety of goods transported and a high share of container volume in South-West Germany). The interviews are executed with the corresponding strategic purchasing or logistics managers (at shippers) and operations manager (at forwarders and carriers) for sea freight and hinterland transportation between December 2016 and July 2017. Due to the fact that the interviews were conducted by different researchers a structured questionnaire was developed to receive comparable results. The questionnaire covered the categories:

I. General information about the company
II. Information about the transport order process regarding transport organisation and shipping order allocation
III. Evaluation of the choice behaviour

In the evaluation of the port choice behaviour various items related to the port performance factor are evaluated by the decision-makers. All of them are extracted from former research studies [e.g. 6, 9, 12], except the item inter-organisational IS integration, representing one of the major aspect and challenge of digitalisation [3]. The items of the port performance factor are defined in Table 2.

Table 2. Definition of items related to the port performance factor [according to 6, 9, 12].

Items	Definitions
Efficiency (Effic.)	Cycle time of container handling at the port (from port entrance to loading on vessel)
Reactiveness (React.)	Capability to react fast to customer requirements (customer service)
Inter-organisational IS Integration (IS Int.)	Inter-organisational IS integration at the port and connectivity to actors in the hinterland
Reputation (Reput.)	Port reputation related to damages and safety
Infrastructure (Infra.)	Related to the port and terminal layout and facilities
Qualification (Quali.)	Qualification standards of employees at the port
Storage (Stor.)	Storage capacity of terminals
Reliability (Reli.)	Punctuality as the capability to adhere to the planned schedule

3 Results

The interviewed strategic purchasing, logistics, or operations mangers are mostly from large companies with more than 1.000 employees (shippers 100%, forwarders 83% and carriers 67%) handling more than 30.000 TEU per year (shippers 38%, forwarders 83% and carriers 100%). Additionally, most of them are responsible for both import and export processes (shippers 88%, forwarders 100% and carriers 100%). In Table 3 the percentage of the total TEU per year allocated to north or west ports confirms that there are further decision criteria besides lead times and costs.

Table 3. Allocation of container to the north or west ports [in % of the total TEU per year].

Decision-makers	North Ports	West Ports	Others
Shippers	43%	54%	3%
Forwarders	57%	42%	1%
Carriers	47%	50%	3%

Strategic decision-making (e.g. selection of transport chains) is rather mid- or long-term oriented based on contracts with a duration over 6 or even 12 months (shippers 47%, forwarders 61% and carriers 92% of the total transport volume). However, the shipping orders are transmitted on short notice, usually with a range from two weeks until a few days before the transport (shippers 75%, forwarders 86% and carriers 67% of the total TEU

per year). This shows the high forecast uncertainty, which makes planning and capacity utilisation one of the major challenges of the transport sector [15].

Regarding the degree of digitalisation of the transport order process the study reveals an overall high potential for improvement with huge initiatives during the next years. Carriers have and expect a higher digitalisation degree compared to shippers and forwarders (see Figure 1). By comparison, the degree of coordination effort will decline but not to the same extent (see Figure 2). This shows that digitalisation can reduce the manual coordination needed in the transport order process but cannot replace it. Changes are usually complex and require the expertise of dispatchers. However, carriers see the highest potential to reduce effort due to digitalisation because of the higher degree of standardisation and bundling of their transport volume. According to the decision-makers most of the shipping orders will be transmitted electronically in the next years with decreasing manual involvement. However, the manual booking channel including email, phone and fax is still mostly used nowadays (shippers 52%, forwarders 39% and carriers 48%) but will overall decrease by more than 20% in the next five years, whereas EDI will increase by more than 10% and web portals below 10%. In Figure 3 the average change of the booking channel usage overall and for each group of decision-makers comparing today and the expected distribution in five years is illustrated.

In the third part of the questionnaire the port performance was evaluated as one of the influencing factors on the port choice behaviour. At that the decision-makers evaluated the general impact on their choice behaviour (from 1 = very high to 5 = very low). Reliability of the port is hereby rated as the most important variable, followed by the reputation of the port related to damages and safety. The inter-organisational IS integration is rated as important but not highly prioritised in this context with large variation between the decision-makers disclosed in the high standard deviation (SD) (see Table 4). In Figure 4 the box-and-whisker plots further illustrate these deviations, where for IS integration 50% of the ratings are between very high (1) and low (4) showing the discrepancy between respondents. For reliability and reputation 50% of the ratings are between very high (1) and high (2). The whiskers (lines) for these two variables indicate the modest variability outside the first and third quartiles (boxes) excluding the outliners (asterisk). The shippers and forwarders evaluated the importance of the port performance factor very similar. However, for carriers the reputation and the IS integration is the most relevant item of the port performance factor.

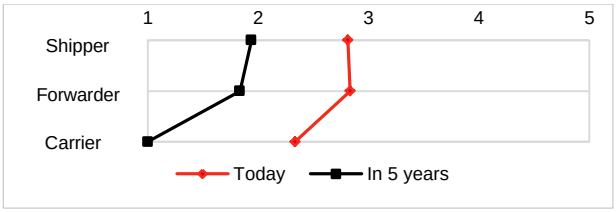

Figure 1. Degree of digitalisation in the transport order process (from 1 = very high to 5 = very very low).

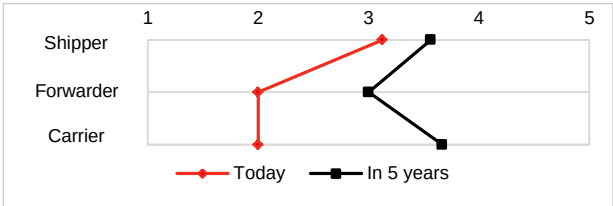

Figure 2. Degree of coordination effort in the transport order process (from 1 = very high to 5 = very low).

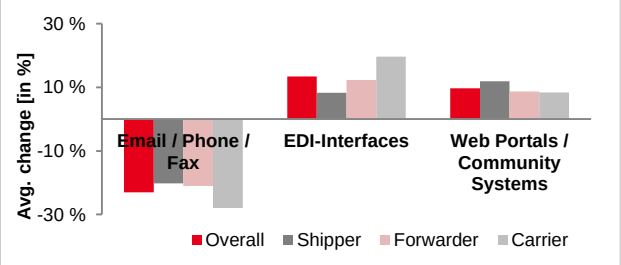

Figure 3. Average changes of booking channel usage comparing the share of today and in five years.

Table 4. Descriptive statistics of each variable

Var.	N	Mean	SD
Effic.	25	2,04	1,27
React.	25	2,20	1,46
IS Int.	25	2,28	1,46
Reput.	25	1,72	1,06

Var.	N	Mean	SD
Infra.	25	2,32	1,25
Quali.	24	2,38	1,25
Stor.	24	3,21	1,41
Reli.	25	1,56	0,96

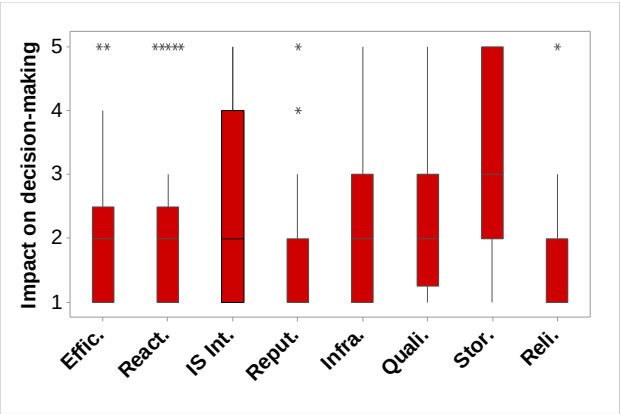

Figure 4. Box-and-whisker plots of the impact on decision-making for each variable (from 1 = very high to 5 = very low).

4 Conclusions

The exploratory research study has shown the differences between shippers, forwarders and carriers concerning the development of digitalisation and the relevance of different decision items of the port performance factor influencing the port choice behaviour. Regarding digitalisation the study reveals that it certainly is a relevant topic for all decision-makers and that the degree of digitalisation in the transport order process will continue to gain momentum with a tendency towards EDI-interfaces compared to web portals or community systems. The evaluation of the items regarding the port performance factor revealed that inter-organisational IS integration has an influence but is not the most important item which is rather reliability and reputation of the port (at least for shippers and forwarders). For carriers inter-organisation IS integration has a very high impact on the port choice behaviour. This highlights the relevance for researchers to explore and describe items and patterns of the behaviour and for practitioners to understand and foster relevant variables.

A limitation of the research is that the results are dependent on the selected decision-makers and only descriptive statistics are applied so far. In the future further statistical tests should be applied. Additionally, other influencing factors, e.g. hinterland connection, need to be considered in the analysis to draw further conclusions of the choice behaviour of ports and transport chains as a whole. To identify the underlying utility of the relevant items the application of a discrete choice model can be useful to complete the interpretation of the choice behaviour of the decision-makers.

References

1. A. Perego, S. Perotti, R. Mangiaracina: ICT for logistics and freight transportation: a literature review and research agenda. In: *International Journal of Physical Distribution Logistics Management*, **41**(2011)5, pp. 457-483, (2011).
2. B. Almotairi, J. Flodén, G. Stefansson, J. Woxenius: Information flows supporting hinterland transportation by rail: Applications in Sweden. In: *Research in Transportation Economics*, **33**(2011)1, pp. 15–24, (2011).
3. I. Harris, Y. Wang, H. Wang: ICT in multimodal transport and technological trends: Unleashing potential for the future. In: *International Journal of Production Economics*, **159**(2015), pp. 88–103, (2015).
4. P. W. De Langen: Port competition and selection in contestable hinterlands: the case of Austria. In: *European Journal of Transport and Infrastructure Research*, **1**(2007)7, pp. 1–14, (2007).
5. J. S. L. Lam: Patterns of maritime supply chains: Slot capacity analysis. In: *Journal of Transport Geography*, **19**(2011)2, pp. 366–374, (2011).
6. J. L. Tongzon: Port choice and freight forwarders. In: *Transportation Research Part E: Logistics and Transportation Review*, **45**(2009)1, pp. 186–195, (2009).
7. A. B. Steven, T. M. Corsi: Choosing a port: An analysis of containerized imports into the US. In: *Transportation Research Part E: Logistics and Transportation Review*, **48**(2012)4, pp. 881–895, (2012).
8. L. C. Tang, J. M. W. Low, S. W. Lam: Understanding Port Choice Behavior – A Network Perspective. In: *Networks and Spatial Economics*, **11**(2008), pp. 65–82, (2008).
9. P. R. Murphy, J. M. Daley: A comparative analysis of port selection factors. In: *Transportation Journal,* (1994), pp. 15-21.
10. W. K. Talley, M. Ng: Maritime transport chain choice by carriers, ports and shippers. In: *International Journal of Production Economics*, **142**(2013)2, pp. 311–316, (2013).
11. W. K. Talley: Maritime transport chains: Carrier, port and shipper choice effects. In: *International Journal of Production Economics*, **151**(2014), pp. 174–179, (2014).
12. M. T. Nugroho, A. Whiteing, G. de Jong: Port and inland mode choice from the exporters' and forwarders' perspectives: Case study—Java, Indonesia. In: *Research in Transportation Business & Management*, **19**(2016), pp. 73-82, (2016).
13. Institut für Seeverkehrswirtschaft und Logistik (ISL), K. Holocher: Analyse der Seehafenhinterlandverkehre der bremischen Häfen bis zum Jahr 2030. Report, Bremen (2015).
14. Institut für Seeverkehrswirtschaft und Logistik (ISL), IHS Global GmbH: Prognose des Umschlagpotenzials des Hamburger Hafens für die Jahre 2015, 2020 und 2025. Band 1: Umschlagpotenzialprognose, Report Bremen (2015).
15. T. Notteboom, J. P. Rodrigue: Containerisation, box Logistics and global supply chains: The integration of ports and liner shipping networks. In: *Maritime Economics & Logistics,* **10**(2008), pp. 152–174, (2008).