

Digitalization of Supply Chains: Focus on International Rail Transport in the Case of the Czech Republic

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Abstract

The digitalization of supply chains presents a complex subject for research based on different geography setups, legal policy frameworks and a focus on technology. The paper discusses potential and issues in regards to the digitalization implementation in supply chains of the future with a focus laid on rail transport as one of the transport modes in freight distribution. The authors analyze empirical data for the Czech Republic as a geographically scoped case study by analyzing interviews with business practitioners that are active in the rail transport market. The research outcomes interlink the development of the legal framework in international rail transport with the emergence of electronic transport documentation as an important practical aspect of digitalization. Finally, it raises questions related to the critical preconditions of digitalization of supply chains.

1. Introduction

Regarding international trade and its dynamics, ongoing innovation in supply chains plays a vital role in its facilitation. Such development is identified, assessed, planned and implemented by technological innovations of transport infrastructure or new ways of applying, communicating or distributing information. Concerning the development of infrastructure, one key is to invest and modernize seaports, inland freight terminals and its connecting links mostly in terms of their quality and not just their capacity [1]. The innovation in information approaches represent business-to-business electronic communication of transport documentation or modernization of information distribution in international trade procedures, including customs [2]. Therefore, it appears necessary to study and examine the physical components of digital supply chains of the future. Without analyzing and addressing (physical) transport infrastructure challenges, company standards, business culture or other relevant issues - preventing the business processes

from their streamlining - it seems impossible to realize the digitalization value added in the economy. Such transport infrastructure challenges, including, i.e. capacity constraints, insufficient investment in development or maintenance of port infrastructure, highway network or rail corridors or market structure, as well as its excessive regulation, information distortions or non-understanding of process management represent permanent obstacles for increasing efficiency of supply chain businesses. Ongoing issues related to the cross-border data flow (especially for customs procedures) represent significant bottlenecks for the digitalization of supply chains [3].

Freight transport is one of the primary logistics services components for the supply chain management. Rail transport provides a compelling and illustrative case for one of the transport modes in the context of enabling increased efficiency and resilience in multimodal supply chains [4]. Besides, rail transport as a transportation mode is highly relevant when it comes to the requirement of global freight distribution being greener and more sustainable [5]. There is a high degree of legal restrictions that are currently often neglected when discussing the digital environment of supply chains.

The digital economy [3] creates new vital determinants for global sustainable economic growth and social development. Technological innovations such as tagging of physical items, mobile business-to-business applications, electronic commerce platforms or cloud data storage in the era of 'datafication' [6] allow sampling big data sets of all kind easily. Analysis of them makes it possible to gather deeper insights regarding the performance and prediction of physical and information processes that shape global manufacturing, distribution chains and consumption models. As a result, they enable the transformation of complex supply chains [7]. However, it is difficult to provide a universal or straightforward definition framework in supply chain management when the terminology is so blurred or overlapping [8]. Therefore, the authors separate two different stages. The 'digitization' is the conversion of analog into digital

data for further processing by electronic means including collection, storage and distribution of information as well as an automated sampling of big data sets for further analysis. The ‘digitalization’ is then the overall development of applied digital technologies within different industries. In the authors’ comprehension, the terms ‘digitalization’ or ‘logistics 4.0’ stand for this emergence of different digital services and automation of business operations driven by technological innovations in the context of digitization. Finally, ‘digital transformation’ is the application of digital technologies for the development of new business models and the transformation in supply chain management [9]. In this respect, ‘digitization’ is the foundation of this transformation. It boosts the change from analog to digital data while replacing analog/manual by electronic/automated data collection, storage and distribution. Turning services or documents into digital counterparts makes data capturing, its sharing or the automation of processes more efficient and less error-prone.

The value of the presented research study resides in the analysis of empirical data, which is lacking in research related to the emergence of digitalization [3], [8], and the impact of digitization on the current and future global economy [10]. The authors seek to set a research agenda that will drive the empirically-based policy and industry-oriented applied research.

The authors question if and how there is a linkage between the emerging importance of digitalization and rail-related transport services. For the necessary geographical narrowing, we focus on rail corridors between Far East Asia and the EU with the case of the Czech Republic, where empirical data was collected and analyzed.

The study elaborates on the role and importance of transport policies. There is a constant need for bridging trade, cross-border data flows and development of skills and knowledge by policymakers required for the digital economy at the local, regional and global scale.

The remainder of this paper is organized as follows. In Section 2, the authors first discuss general issues of digitization and the related legal aspects in freight transport and particular rail mode. Section 3 deals with the case study as the research study following the focus topic. Section 4 provides an overview of qualitative analysis outcomes with Section 5 concluding the paper with merging the research outcomes, stating research limitations and further research potential directions.

2. Freight transport law and institutional framework review – rail transport scope

Multinational conventions are the legal framework of international transport law. They focus on one mode

of transport with the application for freight transports between those countries that ratified or adopted them on a national level [11]. Generally, these conventions cover most aspects of transport operations and commerce, including necessary regulations about rights and obligations of shippers, consignees and carriers involved in transport operations, safeguard implementation of safety and security standards as well as proper transport documentation.

2.1. Transport law and digitalization

When it comes to the ‘digitization’ of transport documentation from a legal point of view, first it matters whether it is necessary to issue a specific consignment note (CN). It is an evidence of a contract of carriage closed between consignor or consignee and carrier including all information necessary to enable smooth transport operations. The formal requirements of such CNs may require a document in written form. Electronic equivalents are possible too. Furthermore, signature requirements to demonstrate the authenticity of a document are another challenge to the electronic trade environment. They have to be resolved, especially when the CN shall be negotiable as a document of title. Finally, this negotiability makes a CN valuable. It is used later on as security for payment transactions such as documentary collection (DC) or in connection of a letter of credit (LC).

Regarding the ‘digitalization’, the eligibility of a CN for DC or LC purposes or its evidentiary value at court post a problem in jurisdictions because of the Rule of Hearsay [12], [13]. Other issues are related to time and place rules of a contract formation and liability for failure or error of communication. The trade stakeholders have to address such challenges whenever they process the documents in an electronic trade environment. Yet, all these challenges of ‘digitalization’ are always subject to a national or local procedural law adopting suggestions made by United Nations Commission on International Trade Law (UNCITRAL) in connection with UNCITRAL Model Law on Electronic Commerce (MLEC) [14], UNCITRAL Model Law on Electronic Signatures (MLES) [15], Electronic Communications Convention (ECC) [16] and Model Law on Electronic Transferable Records (ETR) [17] – an ongoing struggle since 1997. Only a few resources in past years tried to address the legal framework adoption regarding e-trade innovations and rail [18].

Regardless the mode of transport, international transport law tried and still tries to catch up with a rising demand for transport documentation in paperless trade environments, but with different pace concerning the need for issuance of transport documents, their formal requirements [18] and approved ways to sign them (see

Table 1 for rail transport related conventions). In the case of international rail transport, such legal regulations rely on uniform multinational conventions. Virtually all countries with rail transport activity adopted them. In some cases, they even serve as a basis for their national rail transport law without any alternations.

In the following, a CN is regarded to be a transport document accompanying the cargo. It can be issued in form a paper-based waybill (WB) is considered to be non-negotiable with all their electronic counterparts denoted by an ‘e’ in front.

Table 1. The e-friendliness of legal framework relevant to rail transport

Lawful Source	Need to Issue	Formal need	Signature
CIM 1980	Art.1(1),12: CN necessary, otherwise no legal basis	Art. 12(1),13(4): except for Art.8(4)	Art. 11(3): stamp, accounting machine entry possible
CIM 1999	Art. 6(2): CN not necessary, except for a case of Art. 6(7)!	Art. 6(9): electronic form possible as explicitly mentioned	Art. 6(3): same as CIM of 1980 or in any other appropriate manner
RR 2009	Art. 1(14): transport document just as evidence of a contract	Art.1, 35-42: transport document or electronic transport record	Art. 28: explicit allowance of electronic signature
SMGS 2015	Art. 7: CN just confirms contract of carriage	Art. 8(4): eCN is equivalent	No explicit requirements mentioned

2.2. Rail transport

Looking on Europe-Asian railway transport, there are two groups, namely the Organisation concerning International Carriage by Rail (OTIF) and the Organisation for Cooperation of Railways (OSJD), which are in charge of transport law regulations for their respective member countries [19], [20]. Accordingly, present rail freight transport law is codified in the Uniform Rules Concerning the Contract of International Carriage of Goods by Rail (CIM, Appendix B to the Convention Concerning International Carriage by Rail (COTIF) as of 03/06/1999 for OTIF as well as the General Provisions on the Contract of Carriage of Goods in International Traffic (SMGS, Annex 1 to the Convention on International Through Railway Traffic) as of 20/03/2015 for OSJD (latest version including some minor amendments and supplements as of 01/07/2018). With CIM of 1999, a former stipulated need in CIM of 1980 to issue

a paper-based CN was relaxed, and SMGS of 2015 followed this in a constant joint effort by OTIF and OSJD to harmonize their regulations to foster European-Asian railway transport operations [21]. When it comes to practical particularities of transport documentation, the manuals distributed by the International Rail Transport Committee (CIT) are a reference for WBs as well as other types of CNs and procedures coming along with an international railway transport of goods. There you can find formal requirements of a combined CIM/SMGS CN, which can be issued in electronic form, too.

Based on the content of this section, it is possible to formulate the first research question (RQ 1):

What approaches (big data analytics, common CIM/SMGS consignment note – bill of freight for rail shipments, e-customs, SCM data sharing, etc.) within ‘digitization’ or ‘digitalization’, are used by the related transport chain (railway operators, freight forwarders, carriers, multimodal transport operators (MTOs) or even policymakers)?

3. The Czech Republic case study

After having introduced the complex context of a legal transport environment with the focus on rail and formulating the RQ 1, the research shifts with the emphasis on the Czech Republic as a case to provide more substantial (empirical) data using the qualitative analysis from the interviews.

Therefore, the authors add RQ 2:

How to assess the current digitalization development for the Czech Republic as the intermodal and rail freight market showcase while concerning the role of market actors active in the intermodal transport chains and policymakers providing its institutional and legal framework for its development and facilitation?

3.1. Case study methodology

The authors conducted all semi-structured interviews with open-ended questions from May to August 2018. The interviewer explained the research objective together with its design. At the start of the conversation, the interviewer asked grand tour questions related to the keywords such as ‘Trans-Asia Railway (TAR)’ as the land-based part of the ‘Belt-Road-Initiative’ (BRI), [22] ‘digitalization’.

Since the empirical data obtained from the interviews was comprehensive regarding information, the authors applied qualitative data analysis [23]. It consists of data collection, data organization, preliminary listening to recordings and notes reading, data classification and analysis.

The authors contacted the country managers of two leading ocean carriers - globally (by Twenty-foot Equivalent, TEU fleet capacity), and locally (by loaded TEU shipped). Besides, the authors engaged three globally present freight forwarders (by TEU arranged volume and regions of doing business). One of them is a leader in digitization at the same time [24].

The authors arranged an interview with one of the Ministry of Transport of the Czech Republic high profile policymakers working in the division of rail transport encompassing the field of intermodal transport, one with a global fast-moving consumer goods (FMCG) producers and one with a worldwide FMCG trading company, too.

For interviewees' distribution, see Table 2. All interviewees are experts in the researched field both from the perspective of experience in business or public-sector policymaking (over 15 years).

Table 2. Interviewees' distribution

Position title by organization	Organization
Country top manager	Ocean carrier (O1)
Country top manager	Ocean carrier (O2)
Ocean-freight head	Freight forwarder (F1)
Country FCL manager	Freight forwarder (F2)
Air & Sea branch manager	Freight forwarder (F3)
Procurement manager	Cargo beneficiary (C1)
EMEA SCM director	Cargo beneficiary (C2)
Rail transport department head	Ministry of Transport of the Czech Republic (M1)

3.2. Case study analysis outcomes

Table 3 illustrates the qualitative data analysis outcome applying MAXQDA software tool [25] after transcribing the interviews.

Table 3. Interviewees' perceptions of RQs regarding the importance of a question by recordings time and number of characters in transcripts

Interviewee	O1	O2	F1	F2	F3	C1	C2	M1
RQ 1	1	1	1	1	1	1	1	2
RQ 2	2	2	2	2	2	2	2	1

It shows the importance of addressed RQs according to the interviewees by the time spent responding to each RQ and their sub-questions. The RQs were ranked one (higher) and two (lower) based on these measurements

for each interviewee, demonstrating the importance of RQs. This ranking affects the 'weight' of responses regarding qualitative analysis interpretation.

Regarding the top 10 keywords in the interviewees' responses, Figure 1 illustrates their relative importance. It combines the total occurrence of in the transcribed answers for RQ 1 and RQ 2 with including the words in the RQs or used by the interviewees not involved in the questions (circled).

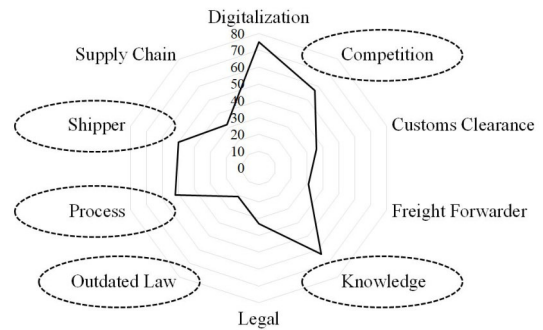


Figure 1. Top 10 keywords in response by the occurrence

For the RQ 1, the managers of F1, F2 and F3 pointed out the facilitation of e-customs procedures in most TAR corridor countries and the possibility to use an electronic equivalent of the common CIM-SMGS CN as the latest rail market development. It makes Asia – Europe rail links more competitive in comparison to maritime shipping. The common CIM-SMGS CN is recognized as a customs document with the letter of credit (L/C) as a payment instrument in most countries along the TAR corridors. F1 and F3 stressed the increasing importance of online monitoring of shipments with an active transponder as already requested by cargo beneficiaries in the Czech Republic. At the same time, O1 considers the introduction of new e-system in cooperation with authorities (pilot version in Europe) monitoring the location of empty containers to optimize better their re-positioning. The MT interviewee was unable to differentiate digitization from digitalization.

Regarding RQ 2, both O1 and O2 as well as F1 and F3 as service providers confirmed that the approaches within digital transformation of the intermodal transport in the market are still in pilot versions without implementation or massification at a local scale. They expressed concern of their ability to change their business models, timely data management and to address customer requirements in time not to be leapfrogged by the very customers or e-commerce companies. They admitted in different wording an ongoing extreme level of price competition among logistics service providers in the Czech Republic, in general, leaving not much space for a reasonable profit margin from the perspective of

service providers. In other words, their profitability is not able to generate sufficient funding for innovations at least at a local level unless they are adopted from a regional level. O1 stated that 'law of nature' will make for instance the e-B/L with its unique functions obsolete and replaced by other sorts of consignment notes such as sea-waybill (SWB) as it is happening in the rail market where paper-based WBs are e-replaced.

Furthermore, F1 and F2 stated that the pace of digitization of documents linked to customs procedures and shipments between Far East Asia and the Czech Republic via NSR corridor is higher compared to the shipments' documentation via maritime shipping.

Moreover, C2 confirmed the company was pushed to get electronic and digital means of communication more by their customers while booking with Fs and rail operators offering routings within NSR lanes. From the perspective of M1, the organization reflects the needs to accelerate legal regulations related to e-documents in intermodal transport facilitation. On the other hand, M1 transposed the primary responsibility on EU institutions for the e-legislation process quality and pace via directives and orders while limiting accountability by local government and its policymakers.

Supported by the study, it shows there are many issues to address the readiness of the companies (from service provider viewpoint) to implement digital solutions and innovations with their supply chains including the rail freight market.

One of the digitization challenges and its precondition is the ability of company management at the local market level to push the standardized (electronic) information requirement with their customer. In other words, companies have to communicate the need for standardized (electronic) data with the policymakers who frame binding legal regulations. Different companies with different market position (carriers, freight forwarders or even shippers) seek diverse strategies while using various tools when it comes to supply chains digital transformation. Moreover, their focus is fragmented.

Another issue is the antitrust law regulation making the digital industry transformation for sure lengthy. The companies cannot or are not willing to share tacit knowledge, lesson learned or best practice when it comes to the implementation of digitalization under real business conditions. At the same time, the service providers do not perceive the transport infrastructure physical constraint as the digital transformation holdout. Mostly, there are concerns regarding the efficiency of communication and process management related to the digital transformation projects where the managers sometimes question their business justification. In the rail freight market, Os and Fs expect their customers (exporters, im-

porters) to use and exploit the digital transformation opportunities better since they make a profit to invest in digital innovations.

When it comes to the importance of law regulation in the field of electronic documentation perceived by the private sector in rail (and intermodal) freight market, the companies prefer to circumvent the so far not fully accomplished legal framework by tailor-made contractual agreements with their suppliers or customers.

4. Conclusion

Regarding the perception of policymakers in the field of digitalization, F1, F2, and F3, as well as C1 and C2, stated the inability of national, European or global level policymakers framing the legal aspects of the market changes and 'catch up' with the industry changes and innovations. Furthermore, F1 and F2 stated that the pace of digitization of documents linked to customs procedures and shipments between Far East Asia and the EU markets via TAR corridor is higher compared to the shipments' documentation via maritime shipping. From the perspective of M1, the organization reflects the needs to accelerate legal regulations related to e-documents in intermodal transport facilitation.

To e-enable legal instruments in international transport of cargo to a full extent, amendments or recasts of existing multinational conventions were necessary. It always comes along with a cumbersome and time-consuming process of drafting, revising, signing before it hopefully gets ratified and adopted by signatory states [11]. In railway transport (CIM and SMGS), it is almost completed. The research study focused on the perception of the driving forces, challenges and opportunities in logistics 4.0 or digitalization and rail transport potential in future trade dynamics between PRC and the EU with the Czech Republic as its showcase market. In the qualitative stage, the authors analyzed the viewpoint of freight forwarders as a key intermodal transport intermediary, ocean carriers as the key overseas intermodal transport providers, cargo beneficiaries and a policymaker representative affecting the institutional and legal framework for innovations. Besides the mentioned private sector players, scope and pace of digital transformation will be affected by the state sector and policymakers' approach. Many public authorities and their representatives still demand paper-based documentary paperwork [26].

Moreover, there is a lack of immediate urgency to change it as paper-based documents function. Besides, there is ongoing reluctance to change the paper-based documents by banks with their traditional wait-and-see attitude when it comes to trade technological innovations [27].

The digital transformation analysis supplemented by the geographically scoped case study identifies the key challenges in the field of paperless trade environments when it comes to data sharing within the market horizontal and vertical cooperation.

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