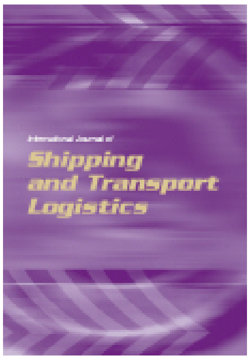

International Journal of Shipping and Transport Logistics

ISSN online: 1756-6525 - ISSN print: 1756-6517
https://www.inderscience.com/ijstl

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DOI: 10.1504/IJSTL.2024.10067464

Article History:

Received:	14 February 2024
Last revised:	30 May 2024
Accepted:	01 June 2024
Published online:	05 June 2025

A business model perspective to enhance efficiency of port hinterland connection with truck appointment system – a multiple case study of ports in northern Europe

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Abstract: Inefficient port and hinterland connections negatively impact both the financial bottom line and environmental performance of the logistics system. To improve hinterland connections truck appointment system (TAS) has been implemented with varying performance, indicating a need to better understand TAS from a business model perspective. Therefore, the purpose of this study is to investigate TAS from a business model perspective. Semi-structured interviews and observations were conducted with port operators, port authorities and hauliers in five European container ports. The study reveals how various approaches to TAS impact business model components. The efficiency improvements from TAS need to match the costs of the TAS to make a valid business case to motivate additional administration of the service and to provide value to customers, i.e., shippers. This paper's conceptualisation of TAS from a business model perspective can help guide efficiency improvements in port terminals.

Keywords: business models; intermodal transport; truck appointment system; TAS; seaports; hinterland connections.

Reference to this paper should be made as follows: Wide, P., Rogerson, S. and Williamsson, J. (2025) 'A business model perspective to enhance efficiency of port hinterland connection with truck appointment system – a multiple case study of ports in northern Europe', *Int. J. Shipping and Transport Logistics*, Vol. 20, No. 2, pp.271–289.

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1 Introduction

Connecting port and hinterland operations is an essential part of intermodal freight transport (de Langen et al., 2013). Challenges associated with efficient hinterland connections derive from large vessels arriving in ports with containers to be managed within a short time frame while ports have limited space and resources. Additionally, inland transport modes have a lower density of containers, necessitating a high number of transports to be performed (Jeevan and Roso, 2019). Two main approaches to relieve port operations and increase a port's competitiveness are

a to perform the port operations outside the port area, such as dry ports (Roso et al., 2009) or extended gate (de Langen et al., 2013)

b make the operations in the port more efficient to manage higher throughput with the same or lower number of resources.

For both these approaches, a port's hinterland connections are vital for container flows. Previous empirical findings show that hinterland connections for containers suffer from not having access to the right containers at the right time in ports, resulting in wasted time (Jacobsson et al., 2020). Also, hinterland connections involve multiple and interdependent actors, leading to process alignment challenges (Gumuskaya et al., 2020; Wide, 2020).

Aligning processes for hinterland connections involves coordination between several actors (Stoop et al., 2023; Wide et al., 2021). This alignment can be supported by information exchange through enhancing relationships further (Di Vaio and Varriale, 2020), where hauliers sharing arrival information is beneficial (Zhao and Goodchild, 2010). For such information exchange truck appointment system (TAS) constitutes a key technological system (Giuliano and O'Brien, 2007; Huynh et al., 2016; Morais and Lord, 2006). While TAS shows potential to generate value for ports through increased operational efficiency (Covic, 2017; Huynh and Walton, 2008; Shao et al., 2022), there has also been implementation challenges (Giuliano and O'Brien, 2007; Islam and Olsen, 2014). Meanwhile, hinterland efficiency improvements through information technology lack business cases (Behdani et al., 2020), which can help explain such implementation challenges. Taking a business model perspective on technologies is valuable to highlight changes from the technology on operations and understanding how a technology can innovate operations (Del Giudice et al., 2021; Henríquez et al., 2022). However, the business model perspective in port literature has mainly focused on the port authorities to develop the port area (c.f., Notteboom and Haralambides (2020) or van der Lugt (2017)) and not on specific offerings generated from a technology, such as TAS offers support to hinterland connections. Therefore, the purpose of this paper is to investigate TAS from a business model perspective to support the alignment processes between a port and its hinterland. To cover the purpose, two research questions were derived. By taking a business model perspective, it is possible to identify how TAS impacts different business model components, as costs and creates value for the port and other involved actors. Therefore, the first research question (RQ) is formulated as:

RQ1 How can TAS potentially effect business model components?

To further illustrate the different approaches to TAS the second RQ is formulated as:

RQ2 How do different approaches to TAS impact the value components?

By connecting information related to TAS with the concept of value proposition from business models, this paper answers the call from Behdani et al. (2020) to understand the value of information for port hinterland connections. Additionally, maritime transport research has paid limited attention to business models for operations and services targeting hinterland connections but rather studied extended gate or hinterland bundling (de Langen et al., 2013; Hintjens et al., 2020).

This paper consists of six sections. After this introduction section, a frame of reference section discusses different business model perspectives in maritime transport and connected to the study scope of TAS. Section 3 highlights the methodology of the paper and Section 4 provides the results from the case studies. Thereafter, Section 5 provides a discussion of the study before Section 6 concludes the paper.

2 Frame of reference

A business model is 'a system of interdependent activities that transcends the focal firm and spans its boundaries' (Zott and Amit, 2010, p. 216). In the maritime port context, business model research mainly followed the development of the role of a port from a transaction node to a logistics hub (De Martino et al., 2015; Kringelum, 2019). A common approach to study business models in a port context is to explore the role of port authorities for port business model based on the view of port authorities as port development companies (de Langen and van der Lugt, 2017). For example, port authorities developing a port by setting up rail shuttles for port hinterland transport (van den Berg et al., 2012) or keeping and attracting users and investors to a port by utilising information for efficient port and inland operations (van der Lugt, 2017). Moreover, Notteboom and Haralambides (2020) discussed the cost structures of port fees from a port authority perspective and found need to further explore business models for port authorities.

Others have viewed changes to business model implications in a port context in general. Hintjens et al. (2020) investigated how bundling in hinterland transport could result in insights for a general port business model. Henríquez et al. (2020) took a technical perspective, examining the role of 5G in port business models. Similarly, Henríquez et al. (2022) investigated Industry 4.0 technology as a form of business model innovation, discussing the business model for the port in general, but collecting data only from the port authority. Ma et al. (2020) illustrated the principles of a sharing economy within the context of a changed business model in the port environment. A recent literature review from Del Giudice et al. (2021) found scarce maritime and port research on innovations in business models via technology, such as TAS in this paper. Additionally, studies have discussed the business model perspective for port sustainability. De Martino (2021) developed a business model framework for sustainable port co-created value. In connection, Fobbe and Hilletofth (2021) found actor interactions a key element for sustainable value creation, but found limited implementation of such interactions.

Table 1 Summary of business model approaches found in maritime port literature

Reference	*Business model focus*	*Location case/empirical case*
Hintjens et al. (2020)	Business model focus for bundling in hinterland transport	Zeebrugge (Netherlands) and Dunkirk (France)
van der Lugt (2017)	Port authority in maritime logistics	Not applicable
Notteboom and Haralambides (2020)	Port authority business model with focus on cost structures of port fees	Not applicable
Henríquez et al. (2020)	5G focus for innovating port business models in general	Barcelona
Ma et al. (2020)	Sharing economy approach to changed business model in port environment	Hong Kong
Henríquez et al. (2022)	Industry 4.0 technology connected to port business models. Port is discussed in general, but data were collected from port authority	Barcelona
van den berg (2015)	Basic and inland network value proposition for terminal operator business model	Rotterdam port
Kringelum (2019)	Challenges for port authorities in adopting business model to new functions	Not applicable
De Martino (2021)	Port sustainable business models and value co-creation	Not applicable
Fobbe and Hilletofth (2021)	Port sustainability in connection to business model	Not applicable

Studies on business models in ports have mainly taken a port authority or port ecosystem perspective, as seen in Table 1. Even though the port operator has an important role in the daily operations performed in a port, their business models have received scarce attention in the port business model literature. Nevertheless, van den berg (2015) took a port operator perspective and found two different business models for a port operator: the traditional business model, which includes value propositions to shipping companies of (un)loading vessels, storage and (un)loading to hinterland transport and the new business model, which revolves around offering transport to an inland terminal. The author highlighted that the business models differed in terms of terminal value proposition (traditional business model) versus port network value proposition (new business model).

2.1 TAS from a business model canvas perspective

By using the business model canvas (Osterwalder and Pigneur, 2010) it is possible to map how the network business model of a port operator (van den berg, 2015) is potentially influenced by offering TAS. The business model canvas (BMC) outlines four areas containing nine components (Osterwalder and Pigneur, 2010). The BMC's central area is the value offering, which is explained by three supporting areas, infrastructure, customers, and finances. Infrastructure consists of the components, resources, activities, and partners connected to the value proposition. The customer area entails customer segments, customer relationships and customer channels. The area of finances outlines revenue streams and cost structure. A TAS influences how the value proposition from the port operator is created and delivered to their customers, in this case the hauliers. The value delivered to hauliers is expected to be derived from an improved use of resources by using improved digital channels and generating closer and better customer relationships. For example, Di Vaio and Varriale (2020) found digital platforms to increase performance of business process in ports and the inter-organisational relationships in the sea-land supply chain. By improving hinterland connections the traditional transshipment offer in terms of value proposition for a port operator and the network value proposition as per van den berg (2015) can be altered via improved processes inside the port and at the gate (delivering/receiving a container). Consequently, the value can be captured by the port operator and generated for the actors in the network, in this case the hauliers and the shipper.

2.2 TAS as a hinterland connection service and its value implications

The literature on TAS points to three main value implications for actors involved in hinterland connections. First, by utilising information on truck arrival, yard operations can be organised to minimise re-stacking of containers and thus improve port yard operations (Covic, 2017; Zhao and Goodchild, 2013). Second, with improved yard preparations and a limited number of trucks per time slot, especially during peak hours, terminal gate operations performed by the terminal operator can be better planned and executed. This leads to shorter turn-around times for trucks (Huynh and Walton, 2008; Shao et al., 2022), as well as lower emissions from idle trucks (Morais and Lord, 2006). Third, a TAS can improve haulier hinterland operations. Decreasing fluctuations in queuing time supports improvements of the conditions for scheduling trucks and complying with schedules (Ioannou et al., 2006). Moreover, shorter turn-around times for trucks leads to improved resource utilisation by minimising operations costs for hauliers and increasing the number of met customer demands per truck (Namboothiri and Erera, 2008; Torkjazi et al., 2018). A TAS can also benefit hauliers to decrease empty truck runs, by better plan for combining pick-up and delivery of containers to ports (Caballini et al., 2020; Schulte et al., 2017).

3 Method

The study is based on five container ports that employ two different hinterland connection approaches to process trucks that arrive at a port to deliver and/or pick up a container. The cases were selected based on two criteria. Firstly, the status of the implementation process, i.e., the port plans to or already has a TAS established. This allowed for variation with regards to the maturity of the business model development for TAS. Secondly, to study the different functions of the TAS the cases were selected based on differences in terms of technological design and manner of stakeholder engagement in TAS. Case A was chosen to represent a case that uses a manual approach to serve arriving trucks, where all hauliers notify the port to receive an access code, but without adding a truck appointment time. Consequently, the trucks show up at the hauliers' convenience and the port operator provides the containers on an ad-hoc basis depending on when the trucks arrive. The four other ports adopt an information-based approach to serve arriving trucks, where it is mandatory for trucks to book a slot time before arrival using a TAS. This approach aims to manage the number of trucks in each time slot and raise the port operator's awareness of truck arrivals so the port can plan the order of containers collection accordingly (Covic, 2017).

The cases represent different parts of Europe and have implemented various levels of TAS. Table 2 provides an overview of the cases and their status regarding implementing a TAS. The cases were chosen to represent different TAS implementations that illustrate various perspectives. Additionally, all cases are container ports with hinterland connections that require port operator to prepare and perform operations before and during the arrival of the trucks.

The lack of extent theory around hinterland connections and the various actors involved in the operations calls for an explorative case study research strategy (Yin, 2014). To obtain in-depth empirical data the data collection method of semi-structured interviews and observations were chosen (Flick, 2014) and performed from spring 2022 to spring 2023. The semi-structured interviews followed an interview guide based on the concepts found in the literature around TAS and BMC. The interview guide is attached in Appendix A. The data collection was initiated with a purposive selection of experts from the ports. Thereafter, a snowballing approach (Naderifar et al., 2017) was chosen to capture knowledgeable individuals by asking the respondents to recommend other relevant individuals to interview. Additionally, to cover the haulier perspective, it was possible in Case A to include two hauliers. The observations included guided on-site visits of port terminals. The data collection is summarised in Table 3. Case B included interviews with the port authority as they were the actor in charge of the changes made to the hinterland connection processes. The interviews with Cases A, B and C were performed digitally via Microsoft Teams, recorded and transcribed. For Cases D and E face-to-face interviews were performed. After these interviews, unclear points were clarified by follow up questions via emails to ensure credibility (Halldórsson and Aastrup, 2003).

In the data analysis, the content in the empirical data were matched by thematic coding (Braun and Clarke, 2006), supported by tools in Microsoft Excel and PowerPoint. The themes analysed followed the business model canvas components, both in terms of differences and connections between the themes (Maxwell, 2013). First a within-case analysis was performed to capture the various business model aspects in each case, and thereafter, a cross-case analysis to compare how the business model components for the cases with a TAS matched and differed from the case without a TAS.

Table 2 Overview of the cases and their TAS status

Case	*Location*	*Driving actor for development of TAS*	*TAS status*	*Slot time duration and priority*	*Restrictions/penalties*
A	Sweden	n/a	No TAS with slot times implemented but pre-booking in place	n/a	n/a
B	Spain	Port authority	TAS implementation initiated	A one-hour slot, with an additional grace period of one hour before or after the time window, effectively allowing a three-hour arrival window	Limiting the number of slots hauliers can book if they misuse the TAS
C	Germany	Port operator	TAS implemented	A one-hour slot, with a safety span of 30 minutes on either side of the slot, resulting in a two-hour window where priority 1 is given at the gate. Priority 2, which is only issued if terminal capacity utilisation allows it, applies if the truck arrives within one hour before or after the allotted window for priority 1	Limiting the number of slots hauliers can book for upcoming week if they misuse the TAS. All cancelled appointments are summarised by the terminal to evaluate misuse
D	Germany	Port operator	TAS implementation initiated	If the arrival is within 30 minutes before or after the booked one-hour time slot, priority 1 is given. Priority 2 is given to trucks that arrive one hour before or after the priority 1 time slot if capacity at the gate is available	n/a
E	UK	Port operator	TAS implemented	A one-hour slot, with a grace period of 10 minutes before or after	A penalty fee is applied when a slot is cancelled due to re-book for a new slot or a no-show. In case of adverse weather or road traffic or if a cancelled slot is booked by another haulier, the terminal operator can remove the penalty fee. There are plans to offer a premium ticket, where a few hauliers can pay to arrive whenever they want

Table 3 Summary of the performed data collection

Actor	*Data collection method*	*Position of interviewee/responsible*	*Duration*	*Case*
Port operator	Semi-structured interview	Yard planner	45 min	A
Port operator	Semi-structured interview	Customer partner	60 min	A
Haulier A	Semi-structured interview	Truck planner	60 min	A
Haulier A	Semi-structured interview	Manager truck planning	45 min	A
Haulier B	Semi-structured interview	Manager truck planning	60 min	A
Port authority	Semi-structured interview	Operations manager	60 min	B
Port authority	Semi-structured interview	IT manager	60 min	B
Port operator	Semi-structured interview	Project manager	45 min	C
Port operator	Semi-structured interview	Gate manager	90 min	D
Port authority	Semi-structured interview	Project manager	90 min	D
Port operator	On-site visit	Gate manager	60 min	D
Port operator	Semi-structured interview	Port manager	30 min	E
Port operator	On-site visit	Port manager	45 min	E

4 Results

4.1 Two approaches to TAS

The results indicate that there are two distinct approaches, here termed relaxed and strict, to a TAS. The relaxed approach, illustrated by Cases B, C and D, uses the TAS to provide support and indicate predicted arrivals (not actual arrivals) for aligning terminal and haulier operations. Under this approach, there is no strict policy for missed appointments, missed slots can be re-booked without further implications and trucks get served when capacity is available. In such systems, misuse of the TAS can lead to warnings. Cases B, C and D's focus on improving coordination, limiting the number of trucks per appointment window and controlling export container drop-off can explain the relaxed approach, as such aims can still be achieved with the TAS, even with low quality of booking from hauliers. However, the relaxed approach suffers from utilisation issues when planned demand for an hour differs from actual demand due to re-booking. Case E illustrated a stricter approach, using penalty fees to deter unwanted cancellation and re-booking and even considering expanding to some sort of premium cost structure.

4.2 Business model perspective

The business model canvas is used in this paper as an analytical framework to depict the empirical results around TAS within the context of business models. The potential effects on business model components found in the different cases are compiled in Table 4.

Table 4 Potential effects on business model components found in the different cases

Business model components	*Effects*	*Supportive quotes*
	• Increase efficiency in transshipments (gate and yard operations)	• 'I can see many benefits, as of now we struggle to plan inflow of freight and cannot put a container on the right place…more resources needed to move the containers' – Yard planner Case A
	• Increase visibility of port capacity	• 'The appointment system is very important…and with this tool it [is] transparent. Everyone in the port knows what's happening now in the port.' – operation manager Case B
	• Planning possibilities for gate and yard operations	• 'When you have to pick up some that is in the first floor or the second [stacked], then you have to move a lot of them [the containers], now if you have information that what will happen. Could be that you put up [that container on top] now.' – operation manager Case B
		• 'We designed the system to implement it in three steps. … It is not a unique solution, you have to think of your needs to decide how to develop it [the system].' – IT manager Case B
		• 'So many parties involved in the design of the system' – project manager Case C
	• Make booking (hauliers)	• '…[TAS is] mandatory to use for all trucks no matter import or export containers … and a slot is booked based on this time.' – gate manager Case D
	• Allocate slot structure for each day	• '… and from our side [terminal operator] we say how many trucks can come per hour to keep our promises because this is defined by our capacities.' – project manager Case C
	• Track haulier on-time performance	• '…cancel it [the slot] and book a new one, and […] how many slots are booked and how many you have cancelled we supervise now automatically. … the rules need to be respected.' – project manager Case C
	• IT update/maintenance	• 'We have said no, it is no longer possible to re-book and re-book and re-book your slot, but you have to cancel it and book a new one […] therefore we changed this [in the system].' – project manager Case C
	• IT application (via provider or developer)	• 'We have a company who's developing the port community communication system' – project manager Case C
	• IT solution development skills	• '…when they think that they have to introduce more developers, more developing systems, usually they [the hauliers] are not comfortable because they have no knowledge about it, and only big companies think that they can' – operations manager Case B
		• '...so XX [name of system] is our backbone [system] and XX is an interface for the customer to use…and these are [would need to be] integrated.' – customer partner Case A
		• '…use the gate operating system as an interface between terminal operating system and TAS' – gate manager Case D
	• Analytical skills	• 'We now see the need for staff with analytic skills to analyse the data from the TAS' – port manager Case E

Table 4 Potential effects on business model components found in the different cases (continued)

Business model components	*Effects*	*Supportive quotes*
Key partners	• IT service provider	• 'We have developed the preannouncement together with the IT service provider' – gate manager Case D
Customer relations	• Direct link with hauliers by receiving a booking	• 'If all parameters are complete the booking is completed and confirmed [in the system]' – gate manager Case D
	• Operator determines availability for hauliers	• 'We predominantly base the booking slots around the capabilities of the resource at a given point of time using trend analysis to assist with this from a planning perspective. This can be flexed up or down based on forecast volumes' – port manager Case E
	• Establish closer relations	• 'The data from TAS has been used to discuss with hauliers about inefficiencies in their own operations.' – port manager Case E
		• '…but what we have designed is a dashboard for the trucking companies where they will receive [information for] every week. [so that they can know] how their behaviour is' – operation manager Case B
Customer channels	• Electronic data interchange (EDI)	• 'All data can be entered via EDI or web interface' – gate manager Case D
	• Web interface	• '… web interface although we also have an App [application]' – port manager Case E
	• Applications	
Customer segments	• Long-distance or short-distance hauliers	• '…we will offer different slot class for regional traffic' – gate manager Case D
Cost structure	• Reducing transshipment costs	• 'We have seen improvements in …better labour utilisation and planning of downtime such as tea breaks.' – port manager Case E
	• Investment costs in IT system	• '…the biggest investment was in IT systems because we also had to adapt our IT systems so that we communicate the right information' – project manager Case C
	• Operating costs of IT system	• 'Trading [of slots] between hauliers happens. [We are] considering changing charging structure … to solve this issue.' – port manager Case E
Revenue streams	• Integrated in port community system fee	• 'Using the booking system is not a charge. It is included in the fee that they [the hauliers] pay in their port communities system' – IT manager Case B
	• Booking fee	• 'We apply a fee for each booking' – Port manager Case E
	• Cancellation of slot penalty fee	• 'If slot is missed [the] haulier will not get in unless a new slot is booked. This will generally drive a no-show or Cancellation charge.' – Port manager Case E

4.2.1 Value proposition

The TAS affects the efficiency of performed transshipments in terms of yard and gate operations. The main efficiency improvements are gained by matching gate capacity and arriving trucks. Nevertheless, the case study revealed different approaches, as the port in Case C focused on limiting truck arrivals during peak hours while the port in Case E focused on restoring control to the terminal rather than responding to when hauliers want to call. In Case D, the port added the value focus from the TAS regarding yard density, using the TAS to control the days before the shipped export containers are dropped in the port. Additionally, respondents from Cases B and C highlighted the value possibility of offering visibility into port capacity by sharing information from the TAS with hauliers. The planning of yard capacity, such as labour and equipment, was viewed as possible via forecasts to improve resource utilisation. Nevertheless, none of the five ports had achieved integration with information from the TAS for this value. Terminals that had reached furthest in the implementation (Cases B, C and E) struggled to utilise the information from the TAS for yard planning purposes. For Case C, the port struggled with uncertain data due to a lack of precise arrival predictions from hauliers and many cancellations and no-shows. The port in Case B still lacked routines to use information from the TAS to improve terminal operations. Even though the port in Case E had penalty fees to encourage fewer cancellations and no-shows, their focus so far had been hinterland connections, with integration with yard planning reserved for future developments.

4.2.2 Key activities

Implementing a TAS includes the activities of developing and designing the system. In the use phase, the TAS system needs updates and maintenance. The information from a TAS allows adaptations for planning of gate and yard operations. Moreover, hauliers need to book appointments for truck arrivals, while terminal operators need to allocate slot structures for each day and track haulier on-time performance.

4.2.3 Key resources and key partners

The resources for implementing a TAS concern the information solution, which is either obtained from a service provider or developed in-house. An in-house solution requires information technology development and integration skills. Furthermore, Case E respondents highlighted the need for analytical skills to deploy the information from the TAS within port terminal operations. If the system is purchased from a service provider, the port must establish contact with a new partner.

4.2.4 Customer relations

A TAS creates a direct link with hauliers where the booking is received. Nevertheless, the terminal operator determines availability for hauliers by selecting the number of slots per appointment window. The cases showed that customer relations were developed over time after implementation. The port in Case D was too early in adopting a TAS to have focused on developing customer relations, while the other ports with TAS had established closer relations. Respondents in Cases B and C indicated having established customer relations by visualising port capacity versus bookings to provide hauliers with knowledge about occupancy at terminal gates. Furthermore, the port in Case E established closer relations by utilising information from the TAS to interact with hauliers to evaluate haulier operations, such as finding single trips that could be combined into round trips. Interestingly, none of the studied ports indicated a business relationship between the terminal operator and hauliers. The lack of agreements between the port operator and hauliers complicates the formalisation and implementation of TAS. Nevertheless, the Case E port managed to implement a TAS with penalty and usage fees.

4.2.5 Customer channels

The channels used for the TAS revolved around direct electronic data interchange (EDI) connections between the terminal operator system and the haulier system or application or web interface. Additionally, both hauliers and the terminal operator in Case A raised the low level of willingness to use systems to share information about arrivals. Small hauliers were perceived to have greater difficulties to integrate systems with their operations, while large hauliers had in-house developers available for support. This pattern was also observed from terminal operators in Cases B, C and D.

4.2.6 Customer segments

The hauliers were not divided according to segments, except for Case D, where hauliers with short and long distance were given different rules for booking. That hauliers with short distance transport needed booking slots with short notice, was taken into consideration when developing the TAS. The other cases had no specific rules for certain hauliers and little indication of such a need.

4.2.7 Cost structure and revenue streams

The costs for a terminal operator are impacted by the implementation and operating costs (such as maintenance) for the information system deployed. In Case B, these costs were assigned to the port authority, while in the other cases with TAS, the port operator carried these costs. For transshipments, however, the value provided from the TAS for planning purposes intend to lower impacts on costs. The revenue streams varied between the cases, as the ports in Cases C and D did not apply any fees, while that of Case B charged a fee for using the PCS, including a small fee related to the TAS. The port in Case E was the only one with clear fees connected to the TAS, applying both a booking fee and a penalty fee for cancellation of a booked slot.

5 Discussion

By mapping and understanding the BMC components for TAS the first research question of this paper is answered. This understanding adds to maritime literature with a business model focus from a port authority perspective (e.g., de Langen and van der Lugt, 2017 or van den Berg et al., 2012). With a port operator perspective for hinterland connections, this paper adds insights to previous maritime port business model literature with a similar perspective (c.f. van den berg, 2015). In contrast to previous studies applying a network perspective to the hinterland context, such as hinterland setups (van den berg, 2015), the current study broadens the port operator's role around hinterland connections and interaction with other actors in creating value. The port operator has a large role in how hinterland connections are performed through the port's service. This includes the power to decide what is expected of hauliers (to book appointments or not) and to determine various options, such as specific TAS rules for regional transports. In this sense, the port operator controls the level of value provided from the TAS. Nevertheless, the benefits for the port operator come at the cost of the haulier's flexibility, a finding similar to the results from Islam and Olsen (2014). Constraining hauliers' flexibility indicates a need for efficiency improvements at the port. In contrast, Case E shows the possibility to leverage improvements from TAS for hauliers as well, by improved truck utilisation as previous research also has shown (Caballini et al., 2020; Schulte et al., 2017). Complementing these previous findings, the current paper indicates the need for collaboration between port operator and hauliers in combination with acceptance from hauliers (and shippers) of strict rules of TAS, including fees, to achieve such benefits.

The business model conceptualisation around TAS presented in this paper complements previous work on technological solutions for ports to innovate their business model (Henríquez et al., 2022; Henríquez et al., 2020) with a detailed description of the TAS solution. Previous research has highlighted interactions as key for sustainable co-creation (Fobbe and Hilletofth, 2021), and the current study indicates that TAS can offer such interactions for operational values, by facilitating exchange of information about different actors' operations and resources. This is similar to findings from Di Vaio and Varriale (2020) but for the specific technological application of TAS. The details around hinterland connections services contribute to the discussion of the role of port operators in relation to hinterland transport and how they can differentiate their operations from that of competitors. The presented case details not only provide benefits but also highlight issues connected to the TAS, issues that need to be considered for increased value in hinterland connections. Even though the TAS in the cases are similar in their offering, the various options are important for a value proposition that considers all involved actors.

In their aim to align port and hinterland processes, the two identified approaches for TAS of strict and soft answer the second research question in this paper. Nevertheless, the approaches raise questions about which actor should carry which costs for the value propositions. TAS can provide value for terminal operations, as they can handle more containers with the same resources, but costs for terminal operators include TAS implementation and operating costs. Should hauliers pay a fee for accessing a port, the costs of transport between port and shipper increase. On the other hand, if there is no organised coordination of hinterland connections, it is reasonable to assume that both the port operator's handling costs and the hauliers' waiting times at terminal will increase. Nevertheless, the port in Case A, which manages the hinterland connection without a TAS, seems to maintain container handling at valid (local) market prices, showing no indications of higher handling costs compared to competitors. From a value chain perspective, the value provided to operations by the TAS needs to match, or hopefully surpass, the increased costs at port for implementing and operating the TAS and the costs paid by hauliers via fees and additional administration. The values can therefore not be limited to the port operations but should provide a distinct improvement on the turn-around times for the trucks, to facilitate value across multiple actors. If the value is not showing efficiency improvements on turn-around times, it may limit the willingness for collaboration and the competitiveness of the port.

Even though all cases indicated that TAS generates value, it seems to be difficult to create efficiency improvements in yard, gate and haulier operations by introducing a TAS, as also indicated by previous research (Covic, 2017; Huynh and Walton, 2008; Ioannou et al., 2006). One reason is the lack of quality in the haulier's prediction of arrivals. With control via fees, the port in Case E seems to better utilise information for capacity and demand planning but still has not fully extended the potential of its TAS to yard operations. Additionally, the cases show that not all benefits can be obtained immediately as TAS is implemented, rather the actors need to get the TAS up and running before it can support further optimisation of operations. Interestingly, no case had provided hauliers any support for predicting truck arrivals, but they relied nonetheless on the hauliers to manage these predictions. If the aim of a TAS for future port operations is to achieve coordination to efficiently match capacity and demand at the gate and integrate yard planning in short-term planning, the system needs high reliability concerning truck arrivals. It would therefore be beneficial to discuss how to integrate the TAS with systems supporting the prediction of truck arrivals. Finally, the development of charging certain hauliers for a premium ticket could be viewed as a shift back towards not having a TAS. The only difference is that before the TAS, the hauliers could come as they wished, whereas with premium tickets they must pay for this flexibility.

6 Conclusions

The purpose of this paper was to investigate TAS from a port business model perspective. TAS support a port to align processes with its hinterland and by taking a business model perspective this paper highlights the support via different business model components across the studied cases. The main difference between the cases with a TAS revolved around how they ensured that hauliers kept their booked time slots. A relaxed approach, featuring the possibility of making changes free of charge, favour achieving the TAS aims without penalty fees. Nevertheless, this approach suffered from difficulties in utilising the information on truck arrivals for planning purposes. A stricter approach, with a penalty for hauliers who cancel their booked time slot, yields improved truck arrival information for planning purposes, but at an added cost in the transport chain. All added costs from the TAS need to be matched with efficiency improvements for hinterland connections to make a viable business case for the TAS. Difficulties in understanding and providing estimates for these improvements can hinder the implementation of a TAS. Moreover, while ports control the processes for hinterland connections by guiding the TAS design, they need to enhance the value from the TAS to stay competitive.

This paper provides theoretical contributions by conceptualising TAS from a business model perspective. Combining TAS with viewpoints on digital business model research contributes a new lens applied to the hinterland connection literature. The benefits of TAS have been recognised from practice with container ports in Europe adding TAS to their operations and desired value needs to be generated. The detailed descriptions of the business model components for TAS generate practical contributions to port decision makers to understand new aspects of TAS. Additionally, the strict and relax approaches highlighted help the involved actors to understand the value provided to hinterland connections and how it can support interactions and lead to solutions that provide value for the whole maritime chain connected to the port. Moreover, the paper provides insights on options needed to be considered to implement a TAS. No one-size-fits-all is found but rather the purpose of the TAS seems to be steering the design of the system. This paper highlights these differences from a business model canvas perspective.

The business model canvas approach highlights topics that may be developed further. For example, it may be worth considering the finances area of the business model to investigate possible fee structures, such as premium tickets, and their impacts on operations. Here, a regulatory perspective opens other research directions into which policies cause challenges or improvements for hinterland connections. Additionally, the hinterland connections can be further developed by combining the TAS with information systems for predictive truck arrivals, thus supporting hauliers in arrival predictions and providing terminal operators with improved data for their planning. Future research could also address the extension and connection towards PCS to broaden the concept of TAS further to the yard operations and include goal conflicts between collaboration and competition. The business model conceptualisation can be broadened with concepts around sustainable business models or business model innovations, to further develop the business model perspective on TAS. Moreover, future research could investigate relational aspects of a port authority and hauliers for TAS to find preferences of policies for cost structures.

Acknowledgements

The authors would like to thank Vinnova FFI program and EU Interreg NSR program for financial support for this work.

The open access fee of this work is supported by China Merchants Energy Shipping.

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Appendix A

Interview guide

Introductory questions

- Explain your current role
  - How are the current hinterland connections setup?
- What was your role in the implementation phases of TAS?
  - How does your gate- and yard operations work today in connection to the hinterland access point?

Business model connections

Differences depending on current TAS implementation

- How does the processes around TAS work? (E.g., appointment lead-time, grace period, appointment window, number of trucks per window) [value propositions/customer relations]

  Is it mandatory for hauliers to use TAS? Why? [value propositions]

  If not mandatory, what are the alternatives?
- How do you use the truck arrival information in your organisation? [value proposition]
- What information is exchanged via TAS from the hauliers/drivers or forwarding agents? [value propositions]
- What drivers or benefits with the TAS do see for other actors, such as hauliers/drivers, port authority/port terminal, forwarding agents? [value propositions]
- What resources or activities have had to be included or expanded to the terminal operations (or other operations) in order to facilitate TAS? [key resources, key activities]

  What resources (assets required to realise the service) did you find were essential to TAS? [key resources]

  What new activities or capabilities did the TAS require? E.g., re-stacking [key activities]
- How were other actors (hauliers, forwarding agents and port authority/port terminal) included in the TAS design? [key partners]
- Who planned and/or decided on implementing TAS? [key partners]
- Who invested in the implementation and operating of the TAS? [key partners]
- How is the arrival information communicated? E.g., media, actor [key activities/Customer channels]
- When and by what actor does the arrival information take place? [value propositions/customer segments]

- How is the TAS promoted to the other actors (hauliers and forwarding agents)? [Customer channels]
- Does the TAS differentiate between the actors (hauliers /forwarding agents)? [Customer segments, Customer relationships]

  If different customer segments, what service quality is each segment offered?

  What support services do you provide related to TAS?
- Do you charge extra for the service and if so, how? [revenue streams]

  Do you charge the hauliers or forwarding agents for using the TAS?

  Subscription/usage fee/volume/TAS-usage discount/peak (time)-dependent?

  Do you charge the hauliers or forwarding agents for not using the TAS?

  a Service penalty fee?

  b Peak period appointment fee?
- What were the main costs related the TAS (implementing and operating)? [Cost structure]