Framework for Information Sharing in a Small-to-Medium Port System Supply Chain

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Abstract: Small-to-medium ports are characterised with inefficient, ineffective and resource intensive information sharing, which is not supporting their complex and dynamic environment. This creates challenges both for optimizing the internal planning of the activities at the port according to the demand, and for stronger supply chain integration with the external actors. This paper focuses on identifying the needs and criteria for an information sharing system, and proposes an approach for sharing operational data in port systems for improved supply chain integration, in the context of logistic engineering. The proposed approach has the potential to alleviate some of the problems when operating in a dynamic demand environment.

Keywords: Information sharing, supply chain integration, ICT, role based access, coordination, trust

1 Introduction

Port systems are an important part of many supply chains, as a place for transport transformation and cargo consolidation. Ports are often characterised by a complex supply chain environment, including not only many external customers, but also many different companies within the port, making the coordination and planning even more complex. In addition, the environment is unstable because of the high variety and lack of knowledge about the timing of the activities of the different actors at the port system. This creates a need for information sharing to ensure an efficient supply chain. Literature on supply chain management states that the companies should optimise external coordination and collaboration with suppliers and customers to improve its performance and reduce uncertainties [1] [2], and to do this effectively information sharing is required. It is known that integration and coordination via information sharing in supply chains are beneficial [3], [4]. Information sharing is the act of sharing information between separate organisational units. A previous study dealing with how to enable information sharing in a port, found that there is a need to develop a system to support the sharing of information [5]. The paper highlights the benefits of information sharing and finds that sharing more real-time data will ensure better planning, reduce waiting time and increase utilization of resources in port systems. The general level of integration and information sharing in small ports have not been developed

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much, even though it is possible [5]. Today, most information sharing in small ports is based on manual tools, such as phone calls and emails. This type of information sharing is not very flexible and is resource intensive, as all changes are propagated via manual communications methods. Therefore, an automatic IT system is required to ensure a higher level of information sharing in ports. Olesen et al. [5] finds that for such information sharing system to be usable in a small port, the system must address the issues of trust between actors of the supply chain, availability and quality of data and the complexity level of the system.

The paper is organized as follows: firs a literature presents the basic requirements and challenges for information sharing in supply chain. Further, a case study of small-to-medium port identifies the current information sharing and future needs of different actors at the port. Finally, an approach for sharing information in small-to-medium port system is proposed.

2 Theoretical Background and analysis

To develop an information-sharing approach it is necessary to understand the challenges related to the process of sharing information between organisational units. Therefore, this section will describe some of the benefits and challenges related to information sharing. According to Zhou [6] the dynamism of demand and supply are the reasons that information sharing has a high potential value. The main benefit of information sharing in the dynamic environment is the ability to adapt plans and schedules to external input, if there is new information or the external systems behaves in an unexpected manner [7]. Furthermore, information sharing would allow the different supply chain partners to align their operations [4], making it easier to align the production system with the input and output based on the supply chains' requirements.

Information sharing challenges also include the quality and availability of information within companies. This applies to intercompany coordination of processes, but also use of information to internal planning, such as ensuring correct capacity plans. However, literature on information mainly discusses how to improve the data quality instead of the reason for bad or non-existing data [8], [9]. Besides ensuring the data quality, it is important to have the necessary data, thus the system should only contain the information required in order to keep partners updated on the events that affect them.

According to a review by Perego [10] information and communication technology (ICT) solutions for transport companies and supply chain communication is an underdeveloped area in both literature and industry. Zhang [11] also underline the need for a new approach to how ICT systems should operate based on whether it is intra or inter company operations the system should support. Another problem regarding ICT solution is the sometimes extreme complexity that is caused by cross-functionality and huge amounts of data. Overall, information sharing systems should be developed to be as simple as possible. Furthermore, both user interface and technical aspects affect the complexity as both can prevent a successful implementation.

Currently, most ICT systems employs sharing technology to some degree, and what is missing is from both literature and praxis is a method that enables sharing of

data and acknowledges the special requirements of small and medium sized companies. Trust is one of the major hindrances for sharing information between companies [12], [13]. Trust between companies is one of the main challenges of information sharing. The trust level is often influenced by a lack of knowledge about the other companies' intentions and strategic direction [12]. A high level of trust is identified to enable: relational exchange of knowledge, facilitating parties to focus on long-term benefits of the relationship [1], supplier responsiveness [2], and collaboration [3].

It is stated by Olesen [5], that information sharing can be non-existent, manual or automatic, and that the true benefit is achieved with automatic sharing. There are some solutions that focus on the technical aspects of information sharing [14], [15], and some that discuss information sharing in a supply chain [6], [16]. However, it has not been adapted to fit systems like a port. Therefore, this paper focuses on how the information sharing systems should be adapted to support information sharing in port systems.

Based on the benefits, the requirements and the limitations of information sharing as is, the challenge moving forward is to realise why information sharing is not widely used in the industry. The main reasons are that most computer systems simply do not fit how the companies operate, and that there is no technical understanding of how companies are protective and secretive about even simple transaction data. The theoretical gap is not the technical solutions, but how they are applied in the organisation. To understand how an information sharing system can support a port system, the general setup of a port system is described.

3 Information sharing needs in a small-to medium port system

The case is done in a medium-sized port in Denmark with around 1800 ship berths a year. The port is a collection of many services and companies, often many of these need to work together in order to move cargo from land to sea or the other way around. Examples of actors in the port are:

- Port system
  - Port authority
  - Port Terminal
- Transporters
  - Shipping lines
  - Truck carriers
- Customer
  - Shipping brokers
  - Direct customers

The **Port Authority** has central role mediating information to all companies in the port system. The Port Authority controls the approach and docking procedures of the ships, and is in contact with the approaching ship. Further, the Port Authority is the link between the ships and land services, sending the orders to the local partner. Lastly, the Port Authority communicates with the shipping brokers to book future ship arrivals and services. The Port Authority receives information related to orders and experiences challenges when this information changes or arrives late. The only up-to-date information comes from the GPS system that tracks the ships within ca. 200 km of the port, and the port authority would like to receive more updated information, about movement and timing, and be able to propagate this information to the rest of the port system. The port authority uses a lot of time to gather and distribute information about delays and other events, and feels a need for more automated approach.

The **container terminal** handles the movement of containers between land and sea. The information currently present here includes the timing of when the ships arrive and the defined deadline for when trucks arrive based on ship departures. This means that the information flow is limited and directly related to the physical flow. Information on the containers is not known by the terminal prior to the arrival, however all activities that follow the arrival are dependent on the freight letter following the container. Information about destination and time of arrival or departure is not available before the actual arrival of a truck. The information is available about containers arriving via ship, but only the ship arrival date and the number of containers. The information on containers going to or from the hinterland is only known at the terminal the day before ship departure, as orders for the ship are only final here. The terminal deals with many containers leading to high risks of waiting time and low resource utilisation. Furthermore, trucks tend to arrive around the latest deadline, creating queues and heavy peak hours. The container terminal often experiences rework from the lack of coordination of information. Improving the information sharing will improve its planning of slot times, capacity and placement in the storage area. Currently there is no way of sharing this information.

Shipping brokers are the connection between the customers needing transport of goods from one place to another and the different services available through a port. Their task is to book transport on both land and see. Their main challenge is when ships or cargo is delayed and this has influence on the booking of equipment or transport, so they would benefit from having access to this information directly and fast, instead of having to source the information through external partners. Further, a shipping broker would also benefit from having access to information about available capacity in the port, as they can use this to plan their next shipments.

A Special Cargo supplier producing large products for the offshore industry, often charters specials ships to transport its products to the installation sites. Since the ships are specially fitted for the job they are expensive to operate, and the equipment needed on the landside to load the ship is expensive. The problem here is that the company producing the elements, sometimes does not inform others that their production is delayed, which means that the ship waits at the dock until the cargo is ready. If the delays in production could be communicated earlier, the ship could take other tasks before, saving the company money, as a ship in dock is very expensive. Further shared information would also make the ship's approach available as a planning constraint.

There is a need to develop an approach that solves the issue of no or slow information sharing in a port system. A possible solution to this is proposed in the next section.

4 Information Sharing System at Small-to-medium Ports

This section suggests an approach of how information sharing should be conducted in a small-to-medium port. However, it is the intention that the presented approach would allow the creation of an information sharing system. From the literature, it can be concluded that to overcome the issues of data quality, technical complexity and

trust, it is necessary to make a sharing system simple. Therefore the information sharing system must:

1. Be relatively easy to use and implement.
2. Share only transactional data, reducing complexity and increasing understanding of the consequences of sharing information.
3. Easy to configure the access to the data, based on organisational position.

The focus is on the ability to update information about changes inside the previously received order information, keeping these up to date. The solution should therefore focus on sharing only limited amounts of relevant data, reducing the need for complex software. This is supported by research studies, which indicate that high level of trust is not sufficient to reach the full collaboration potential, and requires the support of electronically mediated data exchange [5].

4.1 ICT approach

Fig. 1 illustrates the proposed system to share information in smaller ports. The important part of the system is its functionality in translating and sharing the *specific* and *correct information* needed by the supply chain partners. The system will function by having a set of standard information types that are relevant for the companies. The system will then map the chosen data types to the relevant data in a database, and be able to read changes when they happen. This allows customers and suppliers to exchange data between each other by implementing the same or similar systems. This proposed ICT solution can be a portal system that is either cloud based or installed on a local server; the specific solution is only relevant to the security setup of the ICT infrastructure in the companies.

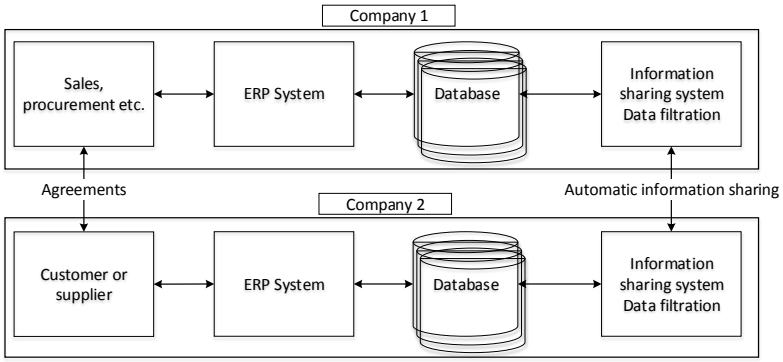

Fig. 1. Automatic information sharing through an add-on system or API that creates access control and information filtering.

The system will not use any new technology but will make use of a new approach to how technology and management work together. This is done by creating a new way of assigning access to specific data, and by creating an abstraction layer as seen in **Fig. 1**. The abstraction layer or information sharing system has several functions; 1)

to secure data from the outside, by only allowing indirect specified access to databases, 2) creating a uniform API for data exchange and data presentation, 3) to filter the information based on which partner and which data this partner has access to. These functions are then based on the pre-existing agreements made between two companies' frontend office functions.

As a means to secure and segment access, *Role-based user control* is introduced to allow for easy configuration of access to the information in a way that gives the owner of the data full control and knowledge about the level of sharing. Role-based user control, means assigning access privileges on a per-user and user-group basis [17]. This allows an easy way of configuring exactly what information is available for whom, and gives the benefit of defining a unique sharing scheme for each user and user group, making it more configurable and understandable what information is shared with who. This will also meet the trust barriers to define a very specific amount of information that needs to be shared.

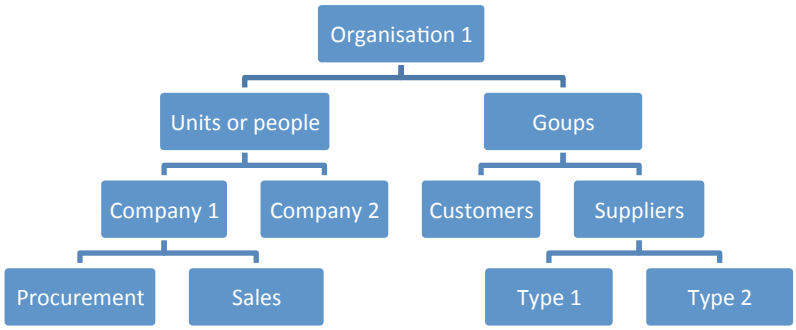

Fig. 2. Hierarchy of access and filtering

Fig. 2 shows the structure of groups and users. Each level can have a set of permissions that can be established for an entire group or for a specific user. This allows for segmentation of data, e.g. to customers giving access to capacity information and to suppliers access to inventory levels. It is therefore important that the access is controlled in a way that gives each company complete control and understanding of how the information is shared. Role-based access control also gives the benefit of defining a unique sharing scheme for each user or user group, making it more configurable and understandable what information is shared with whom. Stefansson[18] describes how to choose data that is relevant to the supply chain performance and how this transparency can increase the ability to track performance measurements. The solution described here does not consider any particular information as this is entirely configurable, and only requires a link to a database and a business decision about access restriction to this data.

This might seem simple, but the important realisation is that each company have full control over the information sharing on a level that should be understood by managers and not IT professionals. This enable the people with the organisational knowledge to

5 Discussion

The suggested setup, if implemented, will allow companies to share updated information without having to worry much about trust and about technological complexity, while keeping the critical information updated in close to real-time. The potential of the solution is to include some of the dynamic properties of any supply chain into the operations and planning of internal activities in companies. This includes already present and updated information in production planning, which makes it more likely that the committed production resources are used to produce according to the exact demand of customers, which is the ultimate mission for any operations. Also it is the primary principle behind the Lean philosophy, to only do what adds value to the customer [19]. By adhering to these concepts, it also helps reducing the impact of contingencies such as inventory etc. There are regular customers who deliver to the port several times a week and some who are one-off. The information system should therefore allow servicing these customers in different ways. Therefore, it is important that the system should have a web interface made available, where the customer has the possibility to book a time slot. There will be customers who will not make use of such a system. For more regular customers it would be more in terms of an application interface that can be connected to the companies' own planning systems and a central system in the port. Therefore, the IT solution should be able to translate the information from each actors IT system and make sure it will not influence other companies etc.

6 Conclusion and Further Research

This paper introduces an approach for creating an information sharing setup, usable for port supply chain integration. The information model takes the main barriers relating to information sharing into account and proposes a method to alleviate the impact of the barriers. The main contribution of this paper is to introduce a new abstraction layer between partner companies for sharing information based on identity and function. The proposed solution will help the trust issue by giving management insight and understanding about how and what they share and also making the benefits more clear, such as reducing the impact of dynamism. This allows an increased alignment of activities throughout the supply chain. The implication to theory is to bridge the gap between the literature showing the benefits of information sharing and the literature that shows how information can be shared over a public network, by considering the organisational issues. Further work will focus on operationalization of the approach, as in the current state only proposes the general aspect of the information approach. The implementation and evaluation of the performance effects of such a system are part of the future research. The ideas presented in this paper would also be relevant for other context such as manufacturing and it would be highly relevant to test a future information sharing system in this context as well.

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