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Information sharing platform in port of Rauma

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Abstract

The purpose of this thesis was to research the principles of the port-centric information sharing platform and its importance for the flow of cargo and information through ports, ports, supply chains and port stakeholders. The objective was to present a port-centric information sharing platform as one option for fast, accurate and reliable information flow in port of Rauma.

Supply chains are networks of organizations whose goal is to supply products and services on the market in a collaborative and coordinated manner. The activities of each actor in the supply chain affect all other operators, either directly or indirectly.

Ports are hubs of cargo and information flows of international trade. Number of private and public stakeholders operates in the port whose activities affect efficiency of supply chains channeling through the port.

Efficient supply chains require fast, accurate and reliable information flow, which in turn requires high-quality and reliable information sharing channels, which are accessible anytime, anywhere.

Port-centric information sharing platform could be a solution for centralized information sharing for port stakeholders and supply chain operators. The benefits of port-centric information sharing platform would be information transparency, improved data quality, reduced margins for errors in information flow, accessibility anywhere and anytime, predictability of processes within the supply chain, easier operational planning and scheduling, improved operational efficiency, optimized transportation channels, reduced lay-times of ships, land transports and cargoes, cargo tracking, data analyzing possibilities for various managerial purposes, improved security, and ultimately competitive advantage for ports and supply chains in general.

Since the port-centric information sharing platform would connect several stakeholders both within and outside the port, its effective deployment should be considered as a development project of its own as part of major stakeholders' own and joint development plan.

Key words
port-centric information sharing platform, supply chains, information flows

CONTENTS

1 INTRODUCTION

1.1 Background

I have been working in port of Rauma as a ships' agent since 2005 and one of the main tasks of ships' agent is to gather, receive, process, filter, and forward various grouped information of vessels' port call to various grouped stakeholders before, during and after the port call. It is obvious that the port stakeholders and supply chain operators require accurate information for planning and executing their resource allocation, but the demand of frequency and depth of accuracy of information, and demand for accessibility has increased considerably.

Roughly after a decade of experience as a ships' agent I started to develop in my mind a web-based platform, where grouped stakeholders could utilize grouped information anytime, anywhere.

In October 2018 Port of Rauma Ltd and collaborators held a in workshop with several port of Rauma stakeholders, where STM EfficientFlow -project was introduced. STM EfficientFlow -project aimed on efficient port calls in port of Rauma using real-time information sharing on a single platform. In that workshop I realized that in port of Rauma the ships' agents are in many ways the information sharing platform between the port stakeholders. That realization initiated this thesis.

1.2 Purpose

The purpose of this thesis was to research port-centric information sharing platform as an option for faster, more accurate and more reliable information flow of vessels' port calls in port of Rauma, but quite quickly it became clear, that port activities are just one section of wider range of activities within a network of supply chains and supply chain management. Hence, I familiarized myself on them too to have a deeper understanding on the underlying need and importance of fast, accurate and reliable information flow of port activities for supply chains and port stakeholders. I learned that supply chains are networks of organizations whose goal is to supply products and services on the market. The activities of each operator in the supply chain affect all other operators, either directly or indirectly. The purpose of supply chain management is to collaborate and coordinate within and between supply chain operators to benefit the whole supply chain. One important factor for efficient supply chain is fast, up-to-date and accurate flow of information, which in turn requires high-quality and reliable information sharing channels. Port-centric information sharing platform may be that channel.

Next step was familiarization on big data and cloud-based services as those provide an answer on how to build up and implement a port-centric information sharing platform. Amount of data related to port activities is very large and fragmented that gathering and processing it by conventional IT solutions is quite difficult, time-consuming and requires expertise, not to mention that processed data needs to be easy to find and utilize. That is where the cloud-based services steps in, as they can provide tools for gathering and processing the data for further utilization.

1.3 Objectives

Objectives of this thesis were to point out the factors that effects the quality, accuracy, and speed of information in port of Rauma, demonstrate the importance of fast, accurate and reliable information flow of port activities for supply chains and port stakeholders, define the benefits port-centric information sharing platform and identify factors for port operators refraining from utilization of port-centric information sharing platform.

1.4 Methodology

Methodology of this thesis was qualitative research. Working experience has provided me intuition of the underlying desire for information, but the theories of the subjects related to this thesis were not familiar for me, so I went through a lot of literature.

Also, I joined some STM EfficientFlow -project meetings, port-centric information sharing platform webinars and met service provider's representatives, which provided me a good general view in practise, how a port-centric information sharing platform works and what it needs from the port stakeholders to function as intended.

I interviewed some port of Rauma stakeholders to confirm and update my knowledge of current practises of information flow of port activities, such as cargo related information, cargo handling information and port traffic information.

2 PORT OF RAUMA

Port of Rauma is in west coast of Finland. Rauma has two fairways, southern Rihtniemi fairway with maximum draft of 12 meters, and northern fairway with maximum draft of 7,5 meters (see figure 1), the latter fairway is not kept open on wintertime by ice-breaking service.

Figure 1 Port of Rauma fairways (Port of Rauma handbook 2021, 2021).

Port of Rauma has 20 berths (see figure 2) for various types and sizes of ships, such as roros, lolos, bulkers, tankers, and container vessels, that can have maximum draft of 12 meters in roro 7, container terminal 3 and Petäjäs 2 and 3, and less in other berths (see figure 3).

Figure 2 Port of Rauma area map (Port of Rauma handbook 2021, 2021).

Laiturit / Berths	Konttialukset / Container vessels	Ro-Ro ja Sto-Ro alukset / Ro-Ro and Sto-Ro vessels	Lo-Lo alukset / Lo-Lo vessels	Irtolastialukset / Bulk carriers	Tankkialukset / Tankers
kpl / pcs	3	7	4	3	2
max syväys (m) / max draft (m)	12,00	12,00	8,20	12,00	8,50
laiturin pituus (m) / length of the berth (m)	520	205	347	445	223

Figure 3 Port of Rauma berths with maximum drafts and length of berths (Port of Rauma handbook 2021, 2021).

Port of Rauma has wide variety of warehouse capacity, cranes and cargo handling equipment to handle wide variety cargoes (see figure 4). Although, main commodities handled in port of Rauma are forest industry related (paper products, woodpulp, sawn woodgoods and plywood), container traffic, china clay and grain in bulk, and liquid chemicals, the warehouse facilities, cargo handling machinery, cranes with lifting capacity up to 200 tons, and good land transport connections enables project cargo shipments too. Because of good land transport connections, port of Rauma can be reached within 4,5 hours from southern, western, and central Finland and southern Bothnia (see figure 5).

Warehouse capacity

General cargo	284 000 m^2
Bulk cargo	230 000 m^3
Field areas	135 ha
Heated warehouses	35 000 m^2
Grain silos	175 000 t
Chemical and oil tanks	560 600 m^3
Container capacity	650 000 TEU
Miscellaneous	45 000 m^2

Machinery

Fixed knuckle boom cranes	1 x 45 tn 1 x 16 tn
Container Gantry Cranes	1 x 85 tn 2 x 48 tn
Mobile harbour cranes	3 x 100 tn 1 x 25 tn 1 x 14 tn 1 x 10 tn
Grain unloader/loader with conveyor (capacity with unloader 150 tn/h, with loader max. 500 tn/h)	
Enclosed conveyor system for discharging china clay (capacity 1000 tn/h, total length 500 m)	
Forklifts	115 pcs, capacity 3 - 32 tn 2 pcs counterbalance
Reach stackers	14 pcs, capacity 45 tn, 3 pcs, capacity 10 tn, 2 pcs for empty containers
Container movers	7 pcs
Container carriage	27 pcs
Undercarriage (casette)	18 pcs
Tug masters	35 pcs
Container stackers	10 pcs
TwinLift container spreaders	8 pcs
Load plates to stuff sawn wood	4 pcs
Automatic pulp grippers	6 pcs

Figure 4 Port of Rauma facilities (Port of Rauma handbook 2021, 2021)

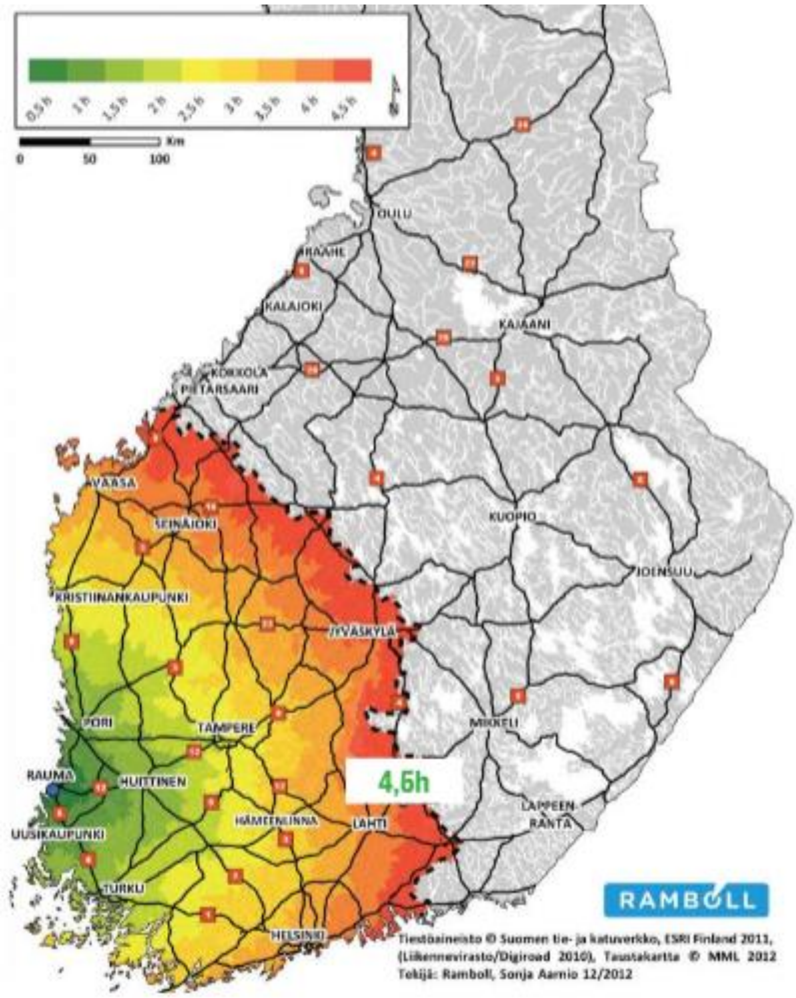


Figure 5 Road transport reachability (Port of Rauma handbook 2021, 2021)

Port of Rauma is Finland's fifth largest export port with 4,07 million tons in 2019, and 3,35 million tons in 2020 (see table 1) (Statistics Finland, 2021).

In imports, port of Rauma is 10th largest with its 1,7 million tons of imported commodities in 2019, and 1,5 million tons in 2020. It is 9th largest, if Sköldvik oil terminal in Porvoo is excluded (see table 2) (Statistics Finland, 2021).

Majority of exports from port of Rauma are forestry products, such as paper products, woodpulp, (chemical forestry products) sawn woodgoods and plywood (mechanical forestry products). In 2019 forestry products covered 3,07 million tons (75 %) of all exports, of which 2,19 million tons (54 %) were paper products. In 2020 forestry products covered 2,39 million tons (71 %) of which 1,62 million tons (48 %) were paper (see table 3) (Statistics Finland, 2021). Port of Rauma is Finland's the largest paper exporting port (Port of Rauma handbook 2021, 2021, p. 23).

Majority of imports in port of Rauma consists of commodities needed in forest industry production, such as timber, china clay, woodpulp and chemicals. In 2019 they covered 1,07 million tons (69 %) of all imports, and in 2020 they covered 61 % (0,83 million tons) of all imports (see table 4) (Statistics Finland, 2021).

Rauma is Finland's third largest container port (table 5). In 2019 261200 container units (TEUs) (129800 TEUs imported and 131300 exported), 2,1 million tons of containerized cargo, in total were shipped through port of Rauma. Corresponding numbers in 2020 were 217900 TEUs (106200 TEUs imported, 111700 TEUs exported), 1,9 million tons of containerized cargo (see table 6) (Statistics Finland, 2021).

CEO of Port of Rauma Ltd, Hannu Asumalahti, stated in port of Rauma's annual report of year 2019 (Port of Rauma, 2020), that traffic volumes and the results in port of Rauma in 2020 will be clearly lower due to industrial actions in the forest industry, such as closure of UPM Rauma's paper machine 2 in November 2019, of which annual production was 265000 tons (UPM, 2019), and coronavirus pandemic, that spread around the world in spring 2020. Furthermore, in August 2020 UPM announced, that it will close all three paper machines in Kaipola, Jämsä by mid-December 2020. Their annual production was 720000 tons of graphic paper.

Exports of forestry products in 2020 compared to 2019 declined almost 0,7 million tons (22 %) (Port of Rauma, 2021), of which paper products suffered decline of 0,57 million tons (26 %), whereas other forestry products suffered decline of 0,12 million tons (13 %).

In container traffic reduction in 2020 compared to year 2019 was 43300 TEUs (16,5 %), or 0,2 million tons (10 %) reduction of containerized cargo in total.

Although, years 2020 and current 2021 have been difficult for port of Rauma, there are also some good news. Metsä Fibre announced March 2020, that it will build a new sawmill to Rauma in the vicinity Metsä Fibres woodpulp factory. Production will begin in the third quarter of 2022. Sawn timber produced by the Rauma sawmill will be sold mainly to Europe and Asia. Metsä Fibre estimated that the annual usage of logs will be 1,5 million cubic metres (Metsä Fibre, 2020) and output will be 0,75 million cubic metres of sawn timber. Rauma sawmill will not have warehouses in its premises, nor plans to handle the shipping, so all produced sawn timber will be packed and loaded on transport equipment for delivery to the port of Rauma, where Euroports Rauma Ltd will handle the reception, storage, and shipping (Metsä Fibre, 2021).

Table 1 Finland's 10 largest export ports 2016-2020 (source: foreign shipping traffic, Statistics Finland. 2021)

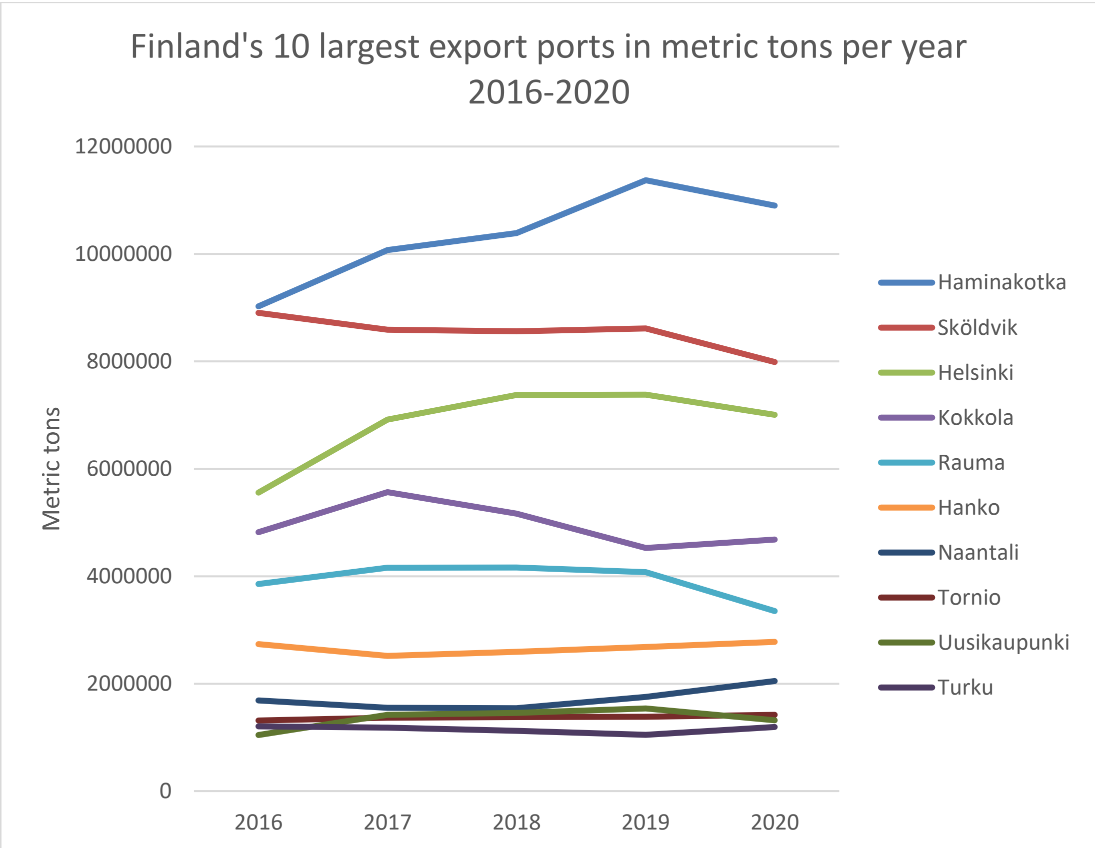


Table 2 Finland's 9 largest imports ports 2016-2020, Sköldvik oil terminal in Porvoo excluded (source: foreign shipping traffic, Statistics Finland, 2021).

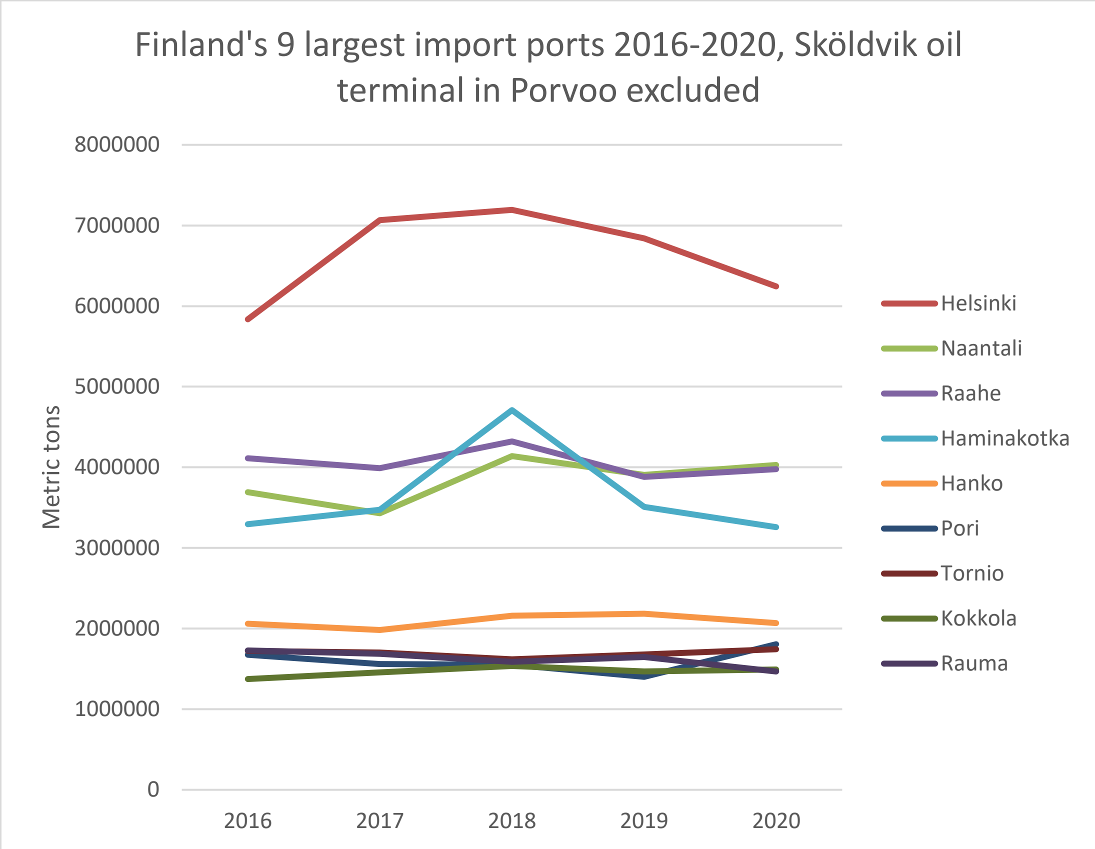
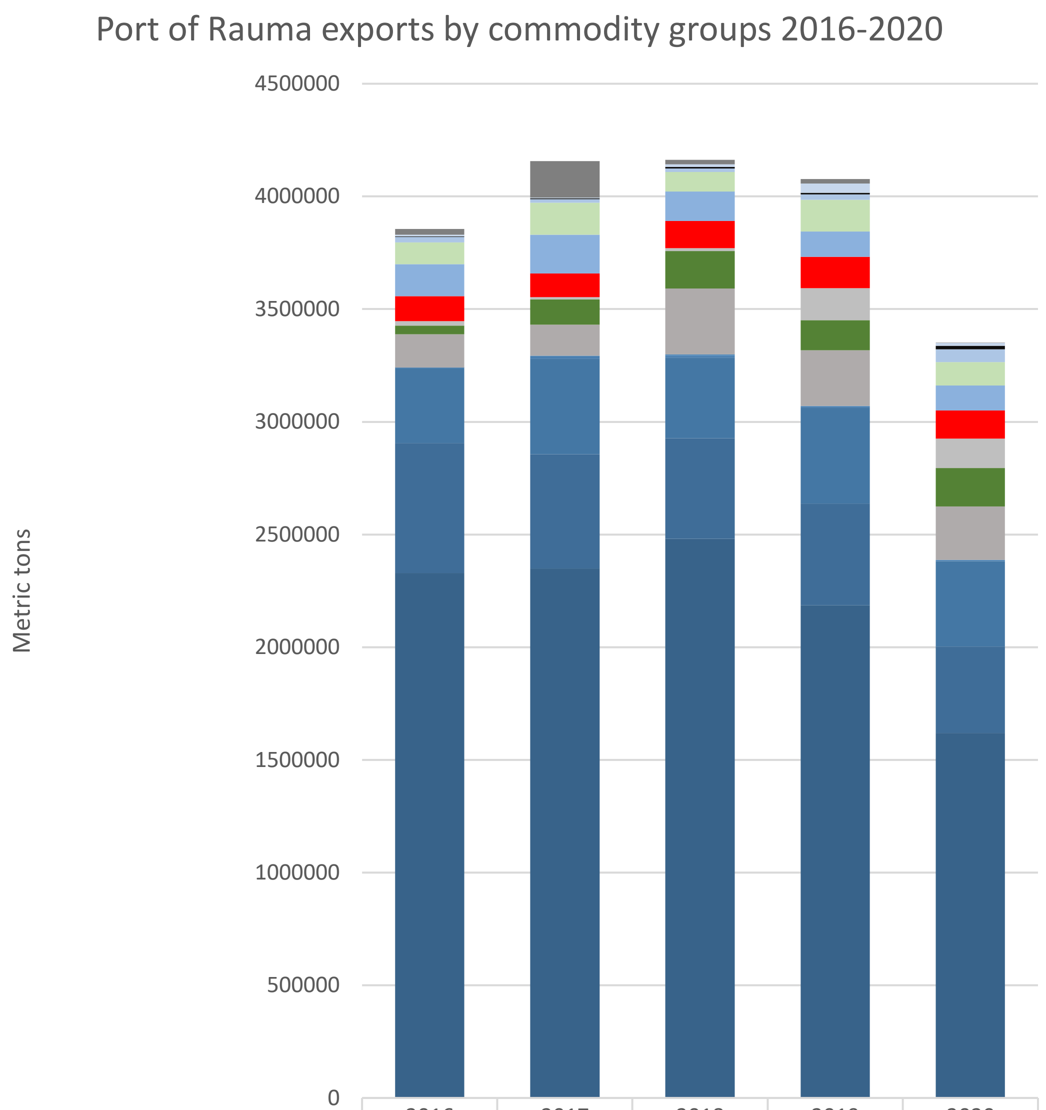
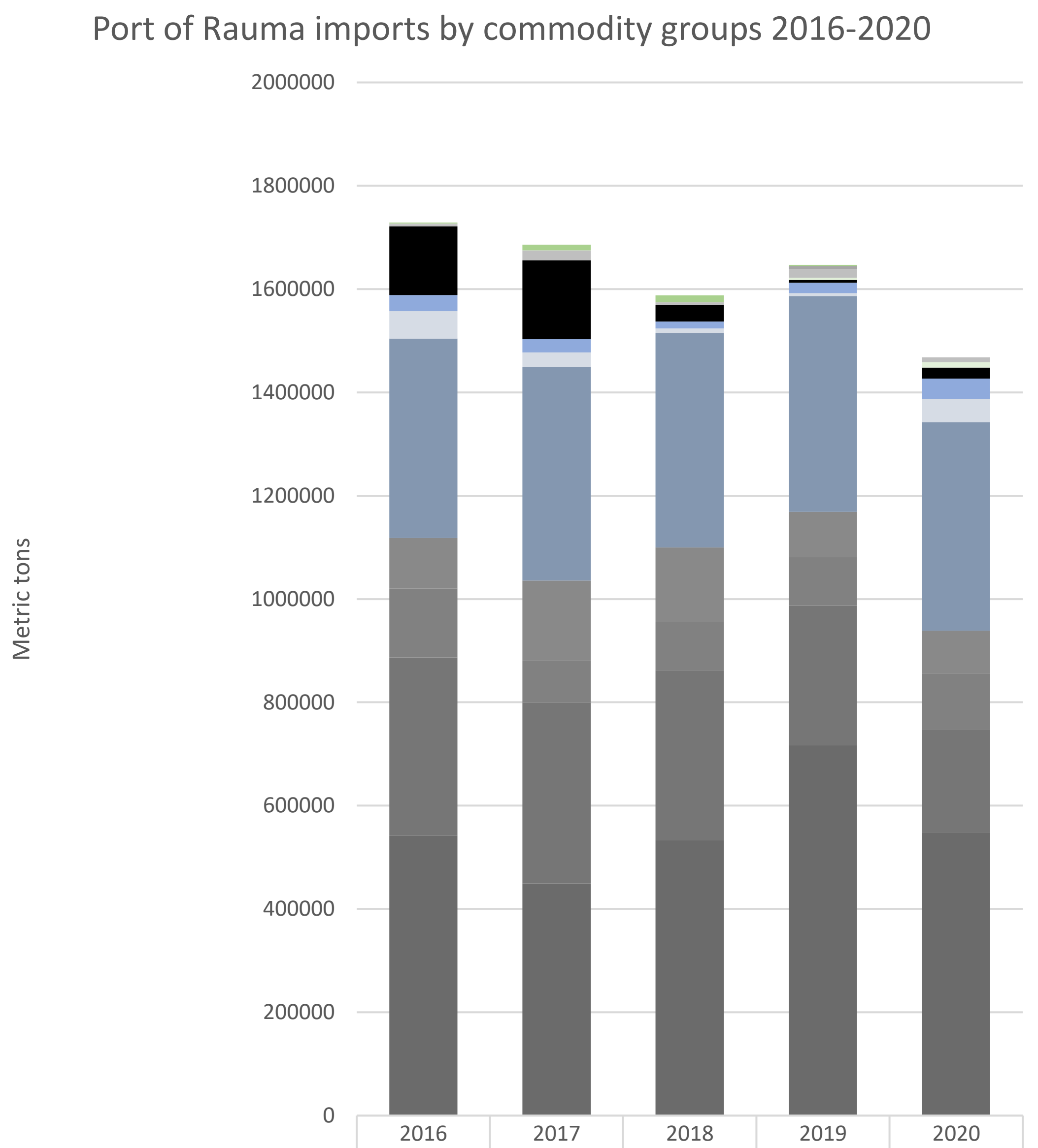


Table 3 Port of Rauma exports by commodity group 2016-2020 (source: foreign shipping traffic, Statistics Finland, 2021).



	2016	2017	2018	2019	2020
Oil products	25918	161821	19645	20095	1043
Crude minerals and cement	6771	3692	11495	40711	13454
Coal and coke	3564	4295	6727	6859	15160
Other merchandise	24199	15334	16816	24273	56597
Grain	95772	141593	85423	140674	104231
Metals and metal manufactures	141818	172591	131564	112167	110334
Chemicals	110814	104993	120598	138677	124775
Ores and concentrates	21217	10023	12344	142921	131562
Fertilizers	37110	111370	166028	132759	170086
General cargo	148094	138632	292314	247856	236683
Timber	812	433	6834	436	2790
Plywood and veneers	4201	12170	7935	6388	2842
Sawn woodgoods	330416	424319	358204	426583	379140
Wood pulp	576244	506908	445226	450245	383684
Paper	2329278	2349130	2481369	2186435	1619240

Table 4 Port of Rauma imports by commodity groups 2016-2020 (source: foreign shipping traffic, Statistics Finland, 2021).



	2016	2017	2018	2019	2020
Grain	1701	11193	13434	2610	
Ores and concentrates				4692	
Sawn wood	455			48	
Plywood and veneers	848	97	61		33
Paper	4196	19362	5742	17587	8807
Fertilizers				4136	10882
Oil products	133202	152171	31639	5324	21155
Metals and metal manufactures	30551	25947	13475	20391	39484
Other merchandise	53486	27836	8765	5735	44733
General cargo	386111	413662	415449	417771	403690
Wood pulp	97231	155580	144013	87024	83129
Chemicals	134037	80920	93390	94489	108422
Crude minerals and cement	344878	349872	329207	269455	198618
Timber	541826	449294	532888	717600	548613

Table 5 Finland's 10 largest container ports 2016-2020 total in TEUs per year (source: foreign shipping traffic, Statistics Finland, 2021).

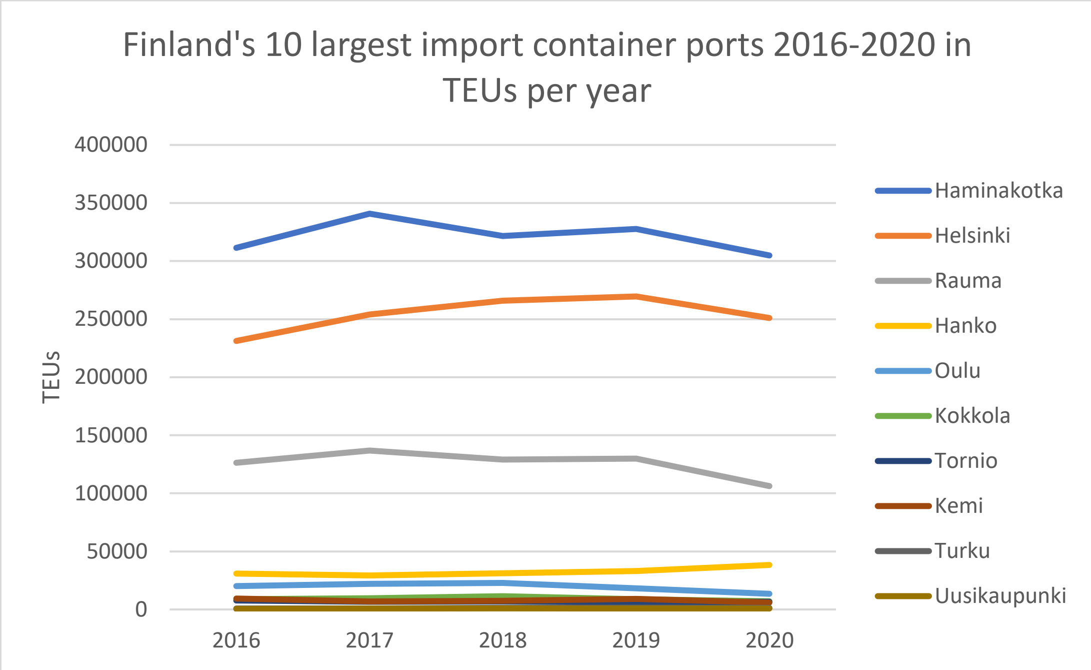
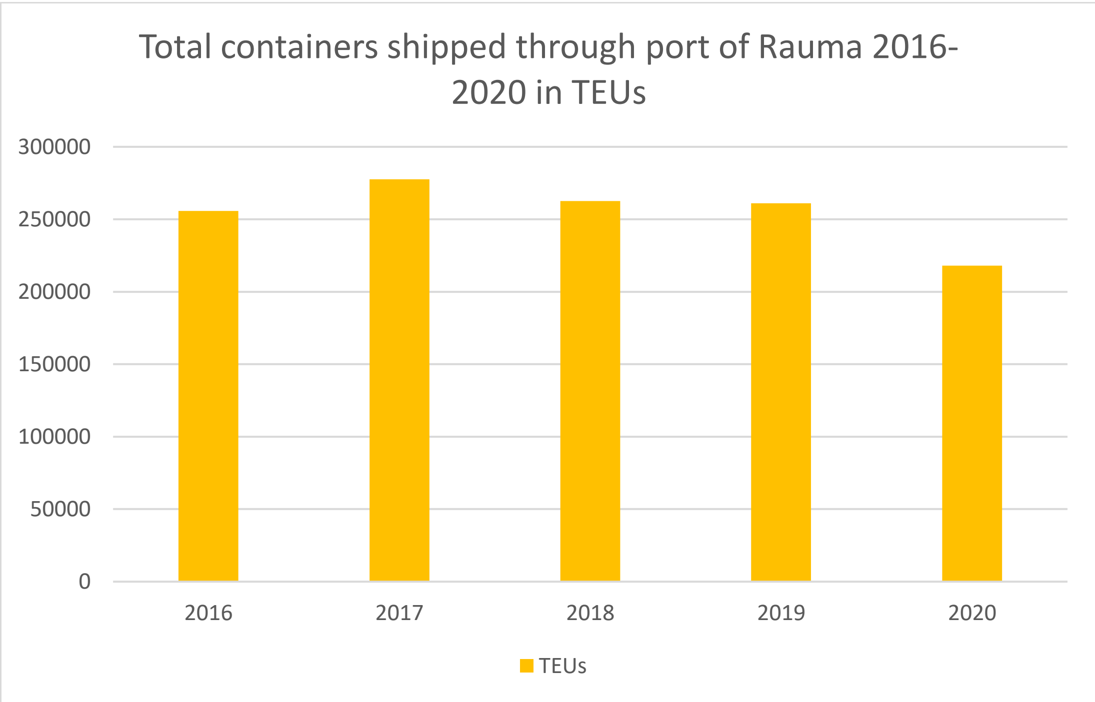


Table 6 Total containers shipped through port of Rauma 2016-2020 in TEUs (source: foreign shipping traffic, Statistics Finland, 2021).



3 SUPPLY CHAIN MANAGEMENT

Fast, reliable, and coordinated flow of high-quality goods is not only an advantage, but a requirement for survival in global markets. Term “supply chain management (SCM)” started to increase popularity in 1990s (Cooper et al., 1997, p. 67-89) as down- and upstream flow of goods, services, finance, and information from suppliers to customers, i.e., supply chain, evolved increasingly global.

Regardless the popularity of SCM, there is little consensus among industrial, commercial, and academic life how to accurately define supply chain management (SCM) (Mentzer et al., 2001, p. 4). However, the purpose of SCM is to improve the long-term performance of flow of goods, services, information, and finance within and between companies across the whole supply chain from raw materials into products until to end user on a systemic and strategic level (Mentzer et al., 2001, p. 2).

Each operator in the supply chain affects the performance of all other operators either directly or indirectly, and ultimately performance of the whole supply chain. SCM is aiming on becoming and to stay better than competitors by optimizing the efficiency, productivity, quality, and profitability of the whole supply chain, not just a single operator. (Cooper et al., 1997, p. 67-89).

According to Hugos, M., (2018, p. 5), there is a distinction between the concepts of logistics and supply chains:

- Logistics refers to various activities, such as procurement, distribution, maintenance, and inventory management within an organization

- Supply chain expands to cover a network of organizations that are co-operating and coordinating together to supply market

3.1 Logistic lead time

Purchase order initiates logistic process, but logistic lead time begins long before purchase order. As products bound in logistics (in transportation or warehouses) do not usually bring profits, purchase orders need to be done at the right time and right amounts, and economic order quantity (EOQ, see 7.2) is good tool for estimating order quantity and frequency. However, there are always time gaps between procurement, production, purchase order and delivery (Christopher, 2016, p. 95-96). Supply chain, which has smallest gaps and seamless logistical and informational stream, has an advantage.

Logistic lead time (see figure 6) illustrates the time gaps from procurement to manufacturing (lead-time gap in figure 6) and delivering the goods from supplier to customer (order fulfilment in figure 6) (Christopher, 2016, p. 95-96).

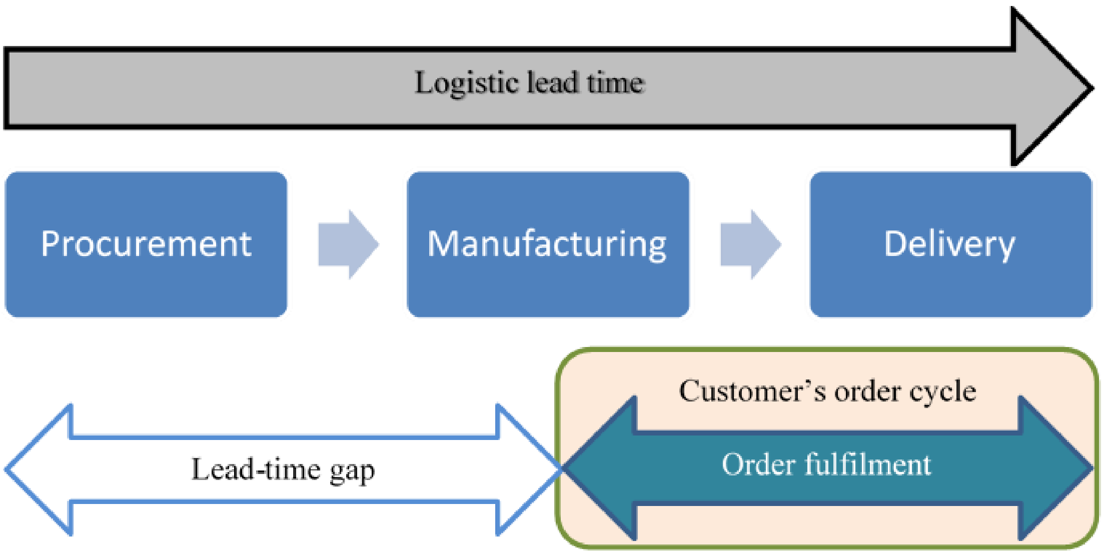


Figure 6 Logistic lead time.

Customer's order cycle, which is the time that customer is prepared to wait from the purchase order to delivery of goods. Usually fulfilling purchase order takes longer, than the receiver is willing to wait, because materials for the product needs to be procured and the product manufactured.

Traditionally shortening the logistic lead time is pursued by market forecasting and inventory management, but the uncertainty of forecasting grows along with the time span. Therefore, to increase the accuracy of economic order quantity to match with future demand, the logistic lead time needs to be shortened by shortening the customer's order cycle and lead time gap (Christopher, 2016, p. 95-96).

Customer's order cycle can be shortened by more frequent purchase orders, but economic order quantity (EOQ, see 3.2) sets limits for frequency and quantities of orders. Order fulfilments can be shortened by more efficient logistic chain. Shortening the lead-time gap requires high visibility of demand across the supply chain, as visibility improves forecasting and gives time for suppliers and other operators within supply chain to prepare and react on the changes on demand (Christopher, 2016, p. 96-99).

Sharing information across the supply chain and shortening the logistic lead time benefits all operators of the supply chain: customers can make timely and quantitatively more accurate purchase orders, suppliers can anticipate and adjust procurement and manufacturing process for producing right quantities of required products wholly or partly before the purchase order, logistic operators can reserve proper transportation, handling and warehouse capacity for transiting the goods from supplier to customer, and eventually overall result is better customer service and lower costs (Christopher, 2016, p. 99).

3.2 Economic Order Quantity (EOQ)

Logistics is management of flow of goods from the seller to the buyer in agreed place and agreed time in optimized cost-efficient manner without impacting the condition of the goods. Also, negative effects on for example environment, society, health, and safety are to be taken in consideration.

Usually in logistic chain transportation and storing do not add any extra value to the goods itself, unless they improve the availability, increase or preserve the quality of the goods or lower its price (Tapaninen, 2013, p. 34). Instead, transportation and storing are generally a necessary expenditure. Therefore, costs of transportation and storing needs to be minimalized.

Furthermore, capital is bound to the goods while it is transported or stored increasing the costs of interests, risk of damage and degradation of value. Also, storing will cause costs due to rental of warehouse and handling (Tapaninen, 2013, p. 36).

Logistics cost-relation factors are illustrated by so called Economic Order Quantity (EOQ):

$$EOQ = \sqrt{\frac{2UO}{\mathrm{hC}}}$$

where U = demand of units per a year, O = costs of order (including handling and transportation costs), h = cost of holding the goods (storing costs including rental of warehouse, handling and management, capital costs) per unit in percentage, C = value of the goods (Hugos, 2016, p. 55).

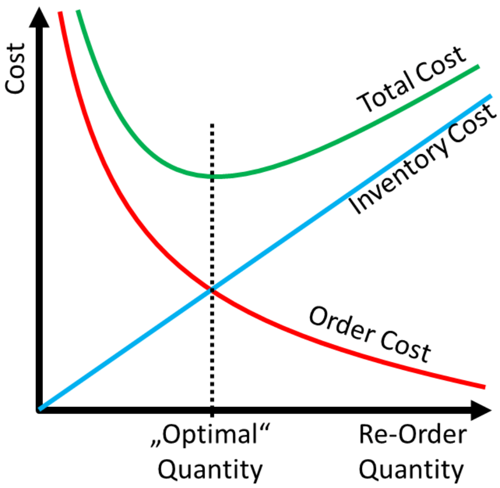


Figure 7 EOQ curve. (By Christoph Roser at AllAboutLean.com under the free CC-BY-SA 4.0 license, 2021).

Below are two examples of EOQ calculations:

Example 1:

Clothes shop in a Finnish town selling jeans:

- Demand, U, is 1000 jeans per year
- Costs of order, O, from wholesaler in Germany is 150 €
- Value of the pair of jeans, U, is 75 €
- Costs of holding of pair of jeans, h, is 15 %

$$EOQ = \sqrt{\frac{2x1000x150}{75x0{,}15}}$$

EOQ ~ 160 pairs of jeans (rounded to nearest tens). As 1000 pairs of jeans is sold per year, stock of 160 jeans is enough for 8 weeks.

Example 2:

Domestic appliance store selling televisions:

- All other factors are the same, except value of the television, U, is 850 €

$$EOQ = \sqrt{\frac{2x1000x150}{850x0{,}15}}$$

EOQ ~ 50 televisions (rounded to nearest tens). As 1000 television is sold per year, stock of 50 televisions is enough for 2,5 weeks.

EOQ (see figure 7) illustrates that as amount of capital bound to the goods increases, the smaller amount of goods should be bound in the logistic chain as being transported or stored, but more frequently.

EOQ is a basis for a simple single-facility inventory approach to define frequency and quantity of orders. However, as more factors come into play, such as product assembly line becomes more complicated, logistic chains grows, more operators getting involved, seasonal changes in sales, a systemwide approach, which may be very complex, may become more practical. However, optimal single-facility approach may still be used as indication for systemwide solutions (Mentzer et al., 2001, p. 244-245).

3.3 Competitive advantage

Competitive advantage can be achieved in two ways: cost advantage and value advantage, or mixture of them (Christopher, 2016, p. 4-7):

- Cost advantage:
  Operating at a lower cost provides greater profits. Cost reduction lies in greater sales volume and by improving market share (economies of scale). However, it may not always increase profitability, as part of the cost of the product is in the underlying supply chain. Therefore, better logistics and supply chain management can reduce unit costs by increasing the efficiency and productivity.

- Value advantage:
  Company can stand out from its competitors by offering better customer-tailored services or products that meets the requirements of the customers.

Competitive advantage can be reached by offering lower costs and better services (Christopher, 2016, p. 14).

According to Christopher M. (2016, p. 5), companies that have competitive advantage either have a cost advantage or value advantage, or combination of the two.

Traditional approach to cost advantage. Cost advantage refers to cheaper-than-competitor products. Mainly cost reduction can be achieved by economies of scale, which means greater sales volumes and larger market share. Therefore, greater market share is desired. This may work well at the early stage of the novel market, but as the market matures, more competitors will enter the market to share the same cake of customers. Maintaining higher share of the market relative to competitors requires the lower costs, but economies of scale does not necessarily improve profitability as significant part of the cost of the product are in underlying supply chain. Therefore, more efficient logistics and supply chain management reduces the unit costs (Christopher, 2016, p. 5-6) and increases the profit marginal.

However, cost advantage does not necessarily come from volumes and the economy of scale. Logistic costs may have a significant role on total costs of a product. Therefore, optimizing and streamlining the logistics processes across the supply chain enables considerable cost reductions (Christopher, 2016, p. 8), which can be achieved by planned and coordinated flow of goods and information between the stakeholders of supply chain. The opportunities for better usage of capacity, inventory reduction and closer integration at a planning level are considerable.

Value advantage refers to products that somehow distinguish from the rivals. Although, cost is a major criterion for a customer for selecting a product or service, significance of additional value that the product or service may offer, is considerable. Additional value may not be related to the product itself, but the benefits that the product offers and appeals the customer (Christopher, 2016, p. 6). Benefits of additional value depends on the preferences of the customer, for instance domestic content, ethically and environmentally sustainable production, quality of product service, reliability, reputation, status symbol etc. Each customer has their own requirements and preferences on the benefits. Segmentation of benefits may assist supply chain management to develop segment-specific services (Christopher, 2016, p. 7), group the customers into segments, and offer service packages for different groups. Customer-specific fine-tuning may still be needed. Also, segmentation may help to develop augmented services, that can distinguish services from the rivals. Value advantage can also be gained through faster response on demand, reliability of supply or just-in-time delivery or reduced the lead-times.

Logistics and supply chain management have a significant role on achieving competitive advantage. As all costs of a product across the supply chain will eventually be embedded in the price that the end-user will pay, transferring costs up- or downstream of the supply chain is not viable. Successful companies have realized that the real competition is not between companies, but between the supply chains. Therefore, all operators within the supply chain should be considered as collaborators, not adversaries (Christopher, 2016, p. 14).

3.3.1 4Rs

Competition between supply chains can summarized in four Rs, responsiveness, reliability, resilience, and relationships (Christopher, 2016, p. 23-25):

- Responsiveness:
  Shorter lead-time is not the only factor that customers are expecting. They also seek flexibility and customized solutions. Suppliers need to react quickly on fluctuations and meet the customers' requirements fast. This requires fast and reliable information flow across the supply chain.

- Reliability:
  Reason for a company to have safety stock is because of uncertainty of future demand, supplier's ability to fulfil the purchase order, or quality of materials and/or components. Reliability increases through re-engineering the processes that impact performance and reduce variabilities in the processes, both in manufacturing and logistics.

- Resilience:
  Resilience of supply chain is its ability to manage unexpected disturbances, which may risk the continuity of business. Managing the critical nodes and links of a supply chain, becomes a key priority. Resilient supply chains recognize strategically important inventory, delivery, and information channel. They also prioritize usage of spare capacity to cope with surge effects.

- Relationships:
  Collaboration between companies improves quality, enables mutual implementation of innovations, reduces costs, and integrates scheduling of production and deliveries. Customers can gain advantage by seeking mutually beneficial, long-term relationships with suppliers. Suppliers, on the other hand, benefits from partnerships as it protects the supplier from entry of competitors. When supplier's and customer's processes are tightly linked and they are mutually dependent, it is difficult for competitors to break in. Supply chain

management should take care of customer relationships across complex networks of companies that are interdependent in business collaboration, albeit legally independent. Successful supply chains are constantly seeking for win-win solutions based upon mutuality and trust.

3.4 Collaborative planning, forecasting and replenishment

Strategy for a partnership-based approach on managing the buyer/supplier interfaces across the supply chain is called collaborative planning, forecasting and replenishment (CPFR) (Martin, 2016, p. 106). According to Hugos, M. (2018, p. 211), supply chains, that have implemented CPFR are the most efficient, because they can best manage a "bullwhip effect". Bullwhip effect occurs, when small changes in product demand by the consumer at the front of the supply chain reverberates into wider and wider swings in demand experienced by companies further back in the supply chain. First there will be shortage of product and later swings to excess of supply (Hugos, 2018, 196).

CPFR process is divided into three activities, where each activity has several steps (Hugos, 2018, 211-212):

- Collaborative Planning:
    - Negotiate a front-end agreement that defines the responsibilities of the companies that will collaborate with each other
    - Build a joint business plan that shows how the companies will work together to meet demand

- Collaborative Forecasting:
    - Create sales forecasts for all the collaborating companies
    - Identify any exceptions or differences between companies
    - Resolve the exceptions to provide a common sales forecast

- Collaborative Replenishment:
    - Create order forecasts for all the collaborating companies

  - Identify exceptions between companies
  - Resolve the exceptions to provide an efficient production and delivery schedule
  - Generate actual orders to meet customer demand

Sharing information enables supply chain operators to adjust their own activities for better efficiency and increase profits for the operators and for the whole supply chain.

3.5 Complexity of supply chains

Usually supply chains, especially in international trade, are not linear chain of stakeholders, but rather a complex network of public and private organizations (Christopher, 2016, p. 173). This makes the organizations within the supply chain increasingly interdependent across the network. Also, the more complex the network gets, more volatile and unpredictable it becomes. Some relatively small, or even seemingly irrelevant, incident may send ripples that may grow into a Cascadian effect, that tremors throughout the supply chain with radical consequences. This chaotic nature of complex systems is famously known as a butterfly effect. As uncertainty of forecasting increases along with time factor, organizations are seeking ways to reduce their dependency on forecasting and become more demand and event driven (Christopher, 2016, p. 174).

Some reasons for complexity of supply chains are (Christopher, 2016, p. 174-179):

- Network complexity:
  Network complexities are formed by highly interdependent organizations that make independent decisions according to their own rules. Consequently, the actions of one organization may impact the whole network in ways that are difficult if not impossible to predict. Response to a disturbance in the past is not necessarily a guide to how to respond to a similar disturbance in the future.

- Process complexity:

Every supply chain has innumerable internal and external processes. Often these processes have been developed, added, and modified to meet the requirements of current situations. Lengthy processes containing many different activities, that may be unnecessary or parallel. They do not only create extended lead-times but are also more prone to variability in performance creating frequent discrepancies between planned and actual outcomes. Therefore, process structures need to be reviewed and re-engineered constantly. This constant reviewing of pervasive source of supply chain complexity needs to be minimized. Many business processes are 'legacy' processes and were designed for a particular purpose at a particular time and may no longer serve present changed conditions. Organizations that are planning to reduce process complexity must constantly consider the purpose of every process and consider whether to remove the process or reduce the number of steps in the process.

- Range complexity:

  Range of products and/or services that companies offer to the market tends to grow rather than reduce. The rate of introduction of new products and/or services seems to outpace the rate at which existing products and/or services are eliminated. As more variants are introduced to the market, the demand per variant will reduce. Furthermore, forecasting of individual variant becomes difficult, which results to larger inventory levels due to forecasting errors, and increased holding costs. Although, customers value range of options, limiting the variants to sufficient level is significant. Sufficient level of variants creates greater marginal revenues and lower marginal costs.

- Product complexity:

  Design of products can have a significant impact on supply chain complexity. Products should be designed so that the materials and components would not have lengthy lead-times, especially key components, which could disrupt the production line. By involving logistics and supply chain planners early in the design process, much of the subsequent complexity can be avoided.

- Customer complexity:

  Customer complexity is caused by exceedingly wide range of non-standard product options or customized solutions. Albeit, each customer has individual requirements, too wide range of individualized offerings complicates service provision. Complexity, that delivers real value for which customers are prepared to pay, can be justified.

- Supplier complexity:

  Wide range suppliers can increase the supply chain complexity as more relationships must be managed. Also, costs of total transactions increases. High level of integration with key suppliers increases agility, which requires active involvement of supply management and suppliers in the process integration. Too many suppliers may inhibit collaboration and integrations. On the other hand, too few critical suppliers can lead to too high dependency and can risk the supply chain. It would be better to categorize the products and have a leading supplier of each a category, that is in responsible the supply management of the designated category. Alternatively, the risk of inherent single sourcing might also be mitigated by adopting a strategy to single source, which is related to site, such as a factory, or to a product model. Pro-active management of supplier relationships for identifying opportunities to improve quality of products and processes, and cost-reduction initiatives is easier with smaller number of suppliers. Supplier complexity can be further reduced by standardizing, if possible, the connection and communication processes.

- Organizational complexity:

  Usually organization structures are hierarchical, and tasks are organized around functions and departments. Such structure is administratively convenient. Work force can be divided between functions, and budgetary control is efficient. However, hierarchical organization structure tends to inhibit agility, as they are focusing on efficiency, whereas customer focuses on effectiveness. Furthermore, functions tend to regress to serve their own agendas and lose their focus on the fundamental purpose of the business, which is to make profit and to keep lucrative customers. Functions should be seen as processes to create and deliver value to supply chain. Processes should be cross-functional and to work as a team to improve efficiency and reliability. Large organizations tend to be complicated and slow in responding in changes. Therefore, existing processes needs constant re-engineering and simplifying.

- Information complexity:
  Flow of information across the supply chain network is crucial for its functionality. The volume of data that flows to and from all directions is immense. Inaccurate information can cause misinterpretation and confusion. Bullwhip effect is an example of result of distorted and misinterpreted information. Information is directly or indirectly influenced by the above mentioned seven sources of complexity. Firstly, complexity of other seven sources need to be reduced and visibility enhanced. Greater visibility can be achieved by collaborative working across the supply chain. Information transparency necessary for more efficient and effective supply chain. To derive useful information from big data, introduction of advanced analytic tools is needed.

Managing the supply chain complexity reduction is essential as complexity is a major source of total end-to-end pipeline cost and a significant inhibitor of responsiveness. A good starting point in managing supply chain complexity is to identify source of complexity by analyzing the eight categories identified above (Christopher, 2016, p. 181).

However, all complexity is not bad. Companies can differentiate themselves from their competitors through certain level of complexity, as customers may seek product variety. Supply chain managers should map the value that customers seek and find ways to deliver that value with least complexity. Furthermore, certain level of complexity can make the supply chain resilient for disturbances as it would not be too dependent on too few key suppliers.

Complexity management is a delicate balance of over-simplification and cost-efficiency. Objective should be to reduce or eliminate any complexity that does not add value to the customer or that does not protect the supply chain from the risks (Christopher, 2016, p. 183).

4 PORT-CENTRIC ICT

Ports are interfaces of sea transport and land transport. They are fundamental elements of international trade and global supply chains. Using different kinds of modes of transportation in the logistic chain for delivering goods from seller to buyer means multimodal transport. International trade requires multimodal transport practically always, and several operators are involved. Seamless, fast, accurate and reliable flow of goods and information is crucial for functionality of the supply chains. They rely on information technology (Glass, Marlow & Nair, 2010, 347-363).

Development of information and communication technologies (ICT) has changed the role of ports from just a connection points of flow of goods between hinterlands and ships to nodes in the web of supply chains (see figure 8), where people, goods, transporters, information, finance, services, and authorities are interconnected.

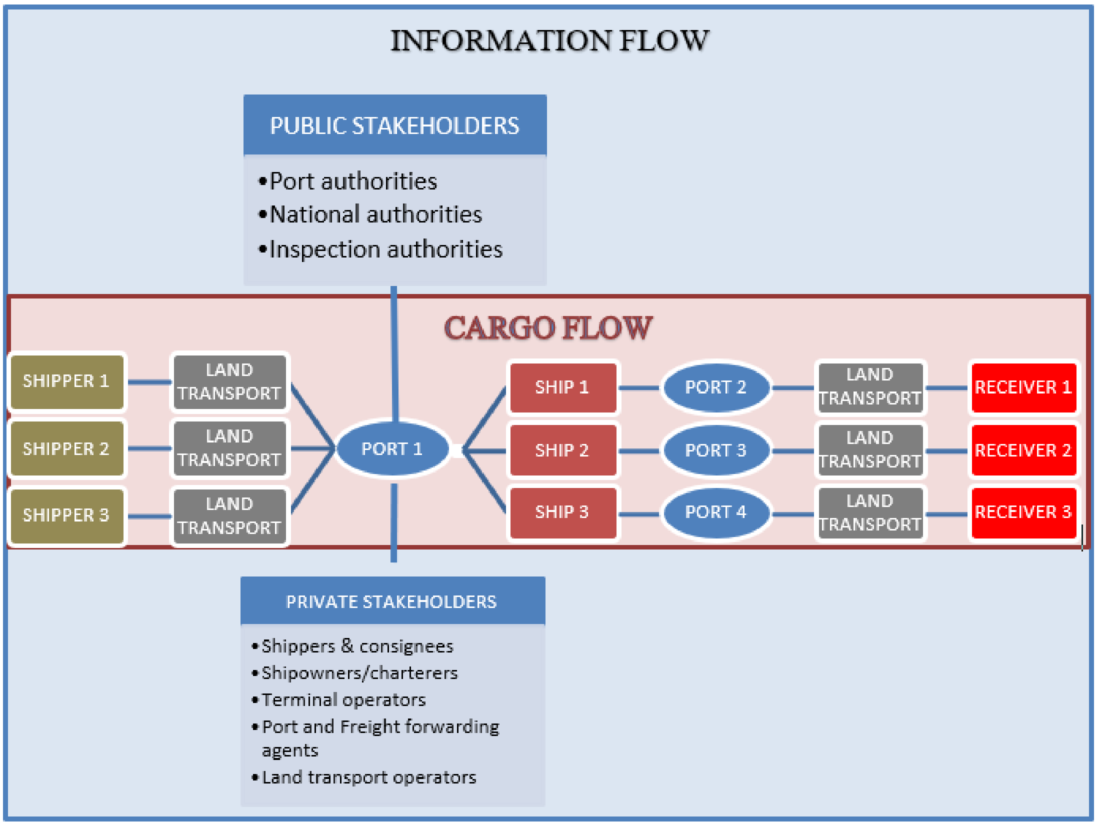


Figure 8 Port-centric information flow.

ICT has an essential role in adding value to modern supply chains through efficient information flow by increasing the speed, amount, accuracy, availability, and accessibility of information, which enables the supply chain partners to streamline the chain. The essentiality of ICT in supply chains is driving ports to compete against each other for customers, that are not only demanding satisfactory infrastructure, such as fairways, berths, terminals, land transport systems, services, and customer facilities, but customers are also demanding wider range of services that support additional value to the supply chains (Yip et al., 2016, p. 154-155).

Port-centric ICT can add value in three ways (Yip et al., 2016, p. 160-161):

- Reach:
  Customers can share customer-specific information, e.g., cargo details, progress of port operations or conditions in the port, anytime anywhere.

- Customization:
  Information can be segmented customer-specifically according to the needs of different types of users, such as shippers, shipowners, charterers, port operators, land transports, authorities and forwarding agents.

- Dialogue:
  Stakeholders of supply chains have an instant and direct standardized communication channel for seamless information flow, which increases transparency, reduces uncertainties in cargo flows and improves efficiency of trade.

If port-centric ICT platform is launched, it would be practical for supply chain operators to adopt introduction of port-centric ICT because of port’s role as a node of supply chains.

According to Yip et al. (2016, p. 162) port-centric ICT should collect at least five basic categories of information:

- Gate data:
  Cargo information for completing booking
  - Shipper's details
  - Cargo details
  - ETA and ETD

- Quay data:
  Ship's information for completing booking
  - Ship's details
  - Cargo details
  - ETA and ETD

- Yard data:
  Capacity of reception facilities

- Spontaneous data:
  - Complaints
  - Special requests and needs
  - Courier activities

- Value-added data:
  - Port facilities information
  - Value-added services, such as market analyzing, logistic objectives and strategic planning
  - Trade
  - Finance
  - Customs services
  - E-commerce

Organizations that are planning to adopt port-centric logistics and supply chains can use these categories as guidelines for developing appropriate parts of their ICT applications to match with port-centric ICT platform.

4.1 Port-centric ICT investment

Investment on port-centric ICT system may be expensive. According to Yip et al. (2016, p. 162-163), at least following issues should be considered when developing a port-centric ICT and reach its objectives as a tool for a port-centric logistic and supply chain:

- Comparing with competing ports:
  This may provide useful information for identifying the strengths and weaknesses, growth opportunities, and factors that can affect negatively on the future developments.

- Value-added services:
  Port-centric ICT can provide data for users for market analyzing, and enables port to set its logistic objectives and plan its strategies.

- Stakeholders:
  Stakeholders can be classified in two categories, public and private. Public stakeholders consist of inspection authorities, such as classification societies and port state control, national authorities, such as customs and immigration, and port authorities itself. Private stakeholders consist of shipowners/charterers and their ships, shippers and receivers, terminal operators, freight forwarding agents, port/clearance agents and land transport operators.

- Value for the customers:
  Ports are competing for the supply chains that channels between the hinterland and sea transports. Although shipowners/charterers are not willing to change their regular ports-of-call lightly because of established practices with the port service providers, such as terminal operators, agents, logistic operators and

authorities, and possibility of losing traffic to other ports and transporters, they will constantly evaluate port costs and the services they receive. Therefore, the needs and requirements of supply chains, especially the main ones, must be mapped, so that the port-centric ICT would provide benefits for them.

- Timing:
  Development of port-centric ICT becomes topical when change of port logistics becomes desirable or necessary.

- Influence on customer acquisition:
  Port-centric ICT effects on marketing the port services to current and new customers.

- Technology:
  Port-centric ICT's data processing capability and software's adaptability should meet the needs of major stakeholder.

- Implementation:
  Launching a port-centric ICT platform requires training of the users. They need to be ready to focus on providing data when platform is tested and executed. Reallocation of human resources may be needed, or work force increased momentarily. It may also require some port procedures to be reorganized.

4.2 Web-based port-centric ICT platform

Traditional B2B data transfer set-up is built by companies on-site. They invest on hardware, telecommunication channels, and software. Then users work on their workstations with their computers with compatible applications. This set-up also needs maintenance and updating. This can be expensive, rigid, and time consuming.

Transition from traditional B2B data transfer set-up to a web-based system, users' accessibility to information is no longer bound to place nor time if users have access to internet. Furthermore, on a web-based platform it is relatively easy (Yip et al., 2016,

p. 166) for system developers to define layers for different user groups through subscription and customize their information accessibility to meet their needs.

Currently increasing trend for distributing, processing, and using large amounts of B2B-data is to use cloud computing services. Computing resources are purchased from cloud service providers according to the need, and users pay subscription fee on-demand -basis. Consequently, costs of the data storage space and processing is distributed between all users reducing the costs per user. Usage of cloud services reduces the need of investments on site. Furthermore, cloud-based data-sharing platform can be established and kept up-to-date quickly (Laudon & Traver, 2017, p. 815-816).

Web-based port-centric ICT platform would be the data transfer channel between the users and cloud (see figure 9).

Although web-based services remain popular, the concurrent use of mobile devices, such as mobile phones, tablets and laptops, application-based services that are designed for mobile devices, are increasing popularity.

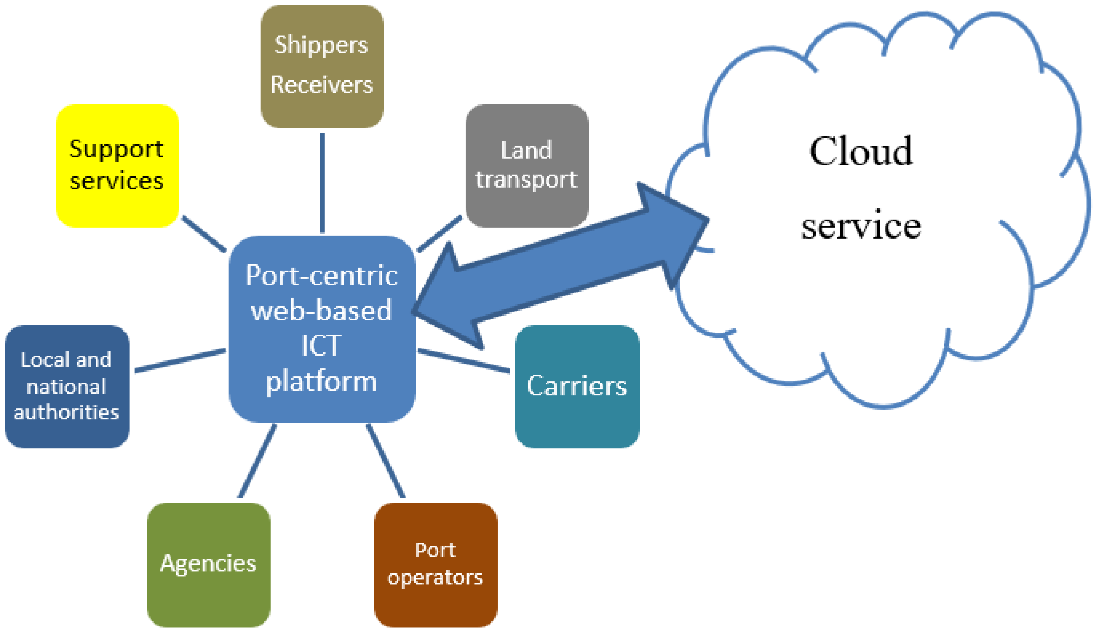


Figure 9 Port-centric web-based ICT platform as a data transfer channel between users and cloud.

4.3 Benefits of a port-centric ICT

Yip et al. (2016, p. 163-178) studied six case samples of port-centric ICT systems in Rotterdam in the Netherlands (Portbase), Felixstowe in United Kingdom (MCP Plc's Destin8), Le Havre in France (SOGET), Bremen in Germany (DBH), Hamburg in Germany (DAKOSY) and Barcelona in Spain (Portic). In this study four benefits were identified:

- Transactional benefits:
  Data that is submitted by users are accessible, reusable, and shareable by other users within and between organizations almost instantly and accurately, which improved visibility, quality, and reliability of data. Also, in some cases traceability was increased because of recorded digital footprints. Furthermore, web-based system enables accessibility anytime, anywhere, which is very useful feature in global logistics as shipments may concern multiple organizations across the globe.

- Operational benefits:
  Submission of data in single source in an automated and standardized form streamlines processes. Operational planning becomes better, simpler, and transparent. Also, increased information flow of cargo speeds up the flow of cargo through port and reduces lay time.

- Strategic benefits:
  Improved operational efficiency and possibility for seamless cargo transition may offer a competitive advantage to the port and attract new customers and trade.

- Security benefits:
  Port-centric ICT increases of secure port environment. Facilities and cargo operations can be secured better. Also unauthorized access is more difficult. Along with storing the data in database and tagged cargo, events are traceable.

> Secure port environment increases confidence and trust between port and stakeholders, which increases the port's competitive advantage.

Recent developments in ICT technologies, such as cloud computing and internet of things, has enabled easier and cheaper integration of information flow within and between organizations. Consequently, urge for interorganizational collaboration and coordination has increased (Yip et al., 2016, p. 163-178).

Ports as nodes of supply chains puts them in ideal position for connecting supply chain information flow by integrating and streamlining them on a single platform, a port-centric ICT. With proper planning and identifying objectives, port-centric ICT may reduce costs of the cargo transiting the port and add value to the supply chain by streamlining it. These factors may attract more customers, thus increasing the usage of port facilities and traffic. Therefore, port centric ICT platform should be included in general development plan of a port (Yip et al., 2016, p. 159-160). Port-centric ICT may also help the port to develop and achieve its own objectives, as it enables the port to collect data from port users' needs and react on them quickly.

4.4 Port of Rauma STM EfficientFlow -project

In 01.03.2018 started an STM EfficientFlow -project, which aimed on efficient port calls in port of Rauma using real-time information. Improved traffic flow could reduce waiting times, save bunkers for ships in the narrow Swedish and Finnish archipelagos, reduce emissions and possibly reduce erosion. Implementation of port collaboration solutions enables coordinated port call planning among the port stakeholders, optimizing their resource utilization, and synchronizing port call with the arriving ships and hinterland operations (Fintraffic, 2021).
Also, project objectives were to improve the flow of goods and deliver lasting results and best practices for application in other ports and corridors of the Central Baltic Sea.

The project could enable improved supply chain processes, business models and ICT tools for enhanced information exchange between port stakeholders, ports, hinterland operators and ships. By improved information exchange between the port stakeholders, they could achieve higher efficiency, reduced transport time, higher transport predictability, better transport quality and improved sustainability. The project expected to produce a time saving of 7% (Port of Rauma Ltd, 2021).

The project was collaborated with Swedish Maritime administration, Satakunta University of Applied Sciences (SAMK), Vessel Traffic Service Finland Ltd (VTS), port of Gävle and Port of Rauma Ltd. Financier was European Union Interreg Central Baltic Program that finances high quality projects in Finland (including Åland), Estonia, Latvia, and Sweden, that aim on solving common challenges together and across borders (Interreg Central Baltic, 2021). Total budget was 4,5 million euros of which Port of Rauma Ltd contributed 630000 € and European Regional Development Fund (ERDF) contributed 480000 € (Port of Rauma, 2021).

In 18.10.2018 Port of Rauma Ltd held a workshop, where STM EfficientFlow -project was introduced. Several representatives of stakeholders were present, including port operators, ship’s agents, pilots, tug company, hauler, national railway company, YIL port Gävle, Satakunta University of Applied Sciences (SAMK), Port of Rauma Ltd and Swedish Maritime Administration (Angelova, 2018, p. 1).

In the workshop it was recognized that flow of information had several challenges (Angelova, 2018, p. 2):

- lack of standardization
- manual paper-based system
- poor communication practices
- high dependency on the ship’s agents
- legal restrictions

In the workshop it was stated that flow of information was fragmented into many independent parts and the link between the parts were the ships' agent. It was also stated that it was extremely important to have all parties interconnected. For that purpose, an information sharing platform was desired.

In 28.08.2020 was held an Efficient Flow -port app launching event to port of Rauma stakeholders, where Port Activity App was introduced (Kujala, 2020). In 12.11.2020 was held a public launch event of Efficient Flow -project and Port Activity App (SAMK, 2020).

Port Activity App is a cloud-based application based on a software-as-a-service (SaaS) model. Port Activity App is a platform aiming on sharing fast, accurate and reliable information related to port activities between port stakeholders, such as port, ships, shipowners/charterers, shippers, receivers, port operators, pilots, tugs, public authorities, VTS, haulers, freight forwarders and ships agents. Information may contain notifications of ships' position, condition and ETA, ETD, ATA and ATD, pilot boarding times, tugs availability, haulers' vehicles position, port's gate information, progress of cargo operations and environmental conditions, such as weather, water level, traffic notifications and berth conditions. It can also serve as a real-time communication channel between stakeholders.

According to Unikie Ltd (Unikie. 2021), a smart port or terminal means improving the flow of all types of cargo, resources, staffing, equipment, and information along with reducing fuel costs due to waiting time or insufficient planning. Improvements to the quality of information and implementing automated processes can benefit the wider supply chain and port community.

The full potential of Port Activity App as an efficient information sharing platform would require wide range of collaboration between major stakeholders of the ports and their willingness and readiness to provide their relevant port activity data.

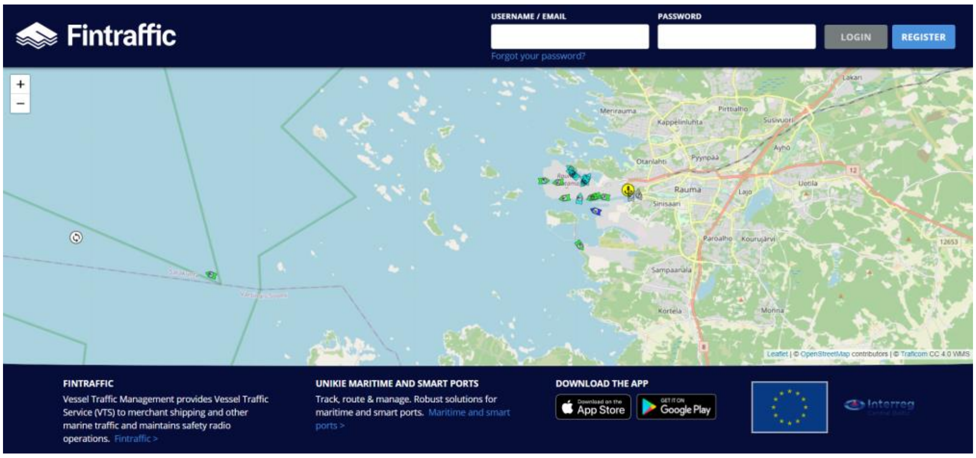


Figure 10 Desktop front page view of Port Activity App (source: Port Activity App, 2021)

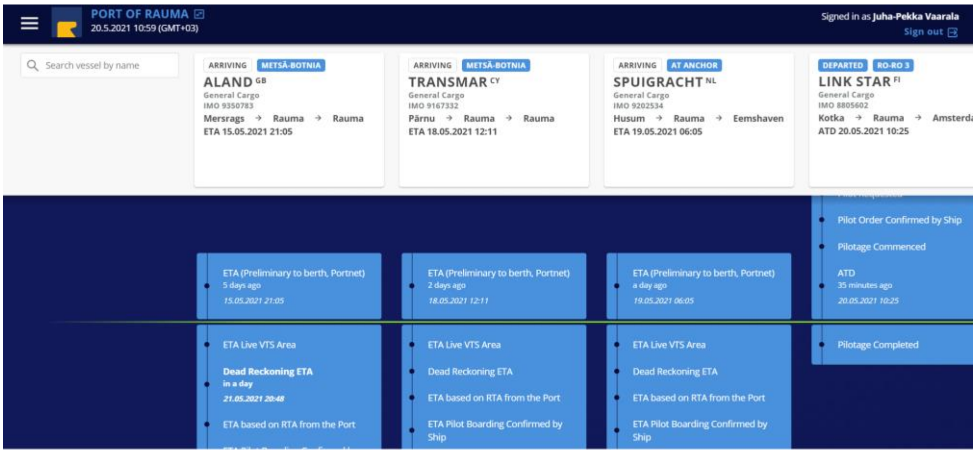


Figure 11 Desktop front page view of user of Port Activity App (source: Port Activity App, 2021)

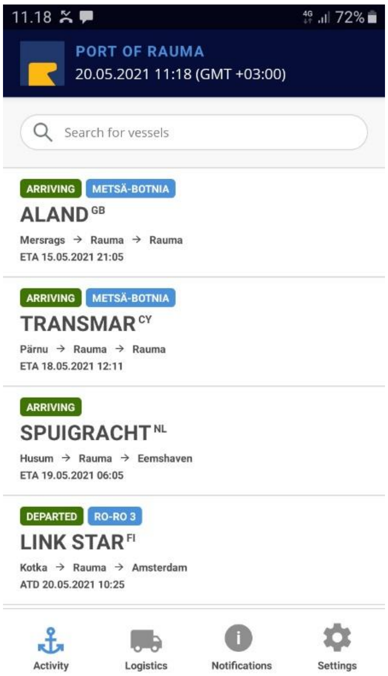


Figure 12 Mobile phone view of Port Activity App (source: Port Activity App, 2021)

5 BIG DATA

Big Data refers to vast amounts of data in various sources, formats and structures, including traces that are left in the web and other digital repositories for later analysing. Along with the growth of people's accessibility of World Wide Web (WWW) around the world, development of variety of devices, web-based services, social media, online applications, cloud services and semantic web (i.e., web of data processed by computers) (Hyvönen 2018, p. 21) and Internet of Things (IoT, see 5.2), amount of data has grown immensely. WWW has enabled information to become a global resource available virtually to everybody anytime, anywhere. Vast amount of available data enables huge opportunities for using the data for one's benefit.

Big data can be in unstructured, quasi-structured, semi-structured and structured forms (EMC Education Services & Services, E. 2015, p. 2-6 & 296):

- Unstructured data:
  Inconsistent format, data without inherent structure (e.g., PDFs, images, videos). Unstructured data is extremely difficult to collect, transfer, process and structure with conventional IT-solutions, i.e., one or few computers with one or few software, not to mention IT-expertise required for doing it. However, whether the size of data is deemed large, is relative to capacity of available resources to process the available data sets (Hyvönen 2018, p. 24).

- Quasi-structured data:
  Relatively inconsistent format (e.g., hyperlink between websites)

- Semi-structured data:
  Self-describing format (e.g., XML-files)

- Structured data:
  Specific and consistent format and structure (e.g., transaction data (e.g., EDI-files), online analytical processing data cubes (e.g., databases), simple spreadsheets (e.g., Excel-files)

Challenges related for using automatically collected and stored data from various sources in multiple formats is generally represented by three “V”s, Volume, Velocity & Variety (Sedkaoui, p. 42-45):

1. Volume: enormous amount of available data
2. Velocity: the speed the data is created, analysed and stored
3. Variety: wide variety of data in different forms from various sources

Lately challenges have been extended by seven more “V”s, Variability, Veracity, Validity, Vulnerability, Volatility, Visualization & Value (Sedkaoui, p. 53):

4. Variability: multitude of data dimensions resulting from variety of different forms and sources
5. Veracity: quality of data can be imprecise, imperfect, unreliable, erroneous or irrelevant
6. Validity: data may be inaccurate or incorrect
7. Vulnerability: people’s personal and behavioural data is used various purposes without their will (e.g., advertising, identity thefts)
8. Volatility: duration of availability and storing of data in the original source
9. Visualization: clear presentation of results of data processing
10. Value: benefits gained from processing and analysing the data

According to Waller and Fawcett (2013, p. 77-84) big data has potential in logistics and supply chains applications such as forecasting, inventory management, transportation management and resource planning. Atzori, Iera and Morabito (2010, p. 2787-805) gave examples of potential usage of big data and internet of things (IoT) in following:

- Tracking products by radio-frequency identification (RFID)

- Integrating on-board vehicle systems with intelligent traffic systems, which will assist the drivers for better navigation and improve safety

- Mobile ticketing by using near field communication (NFC) tags

- Monitoring environmental parameters (temperature, humidity, shocks) of perishable goods like food products

- Augmented maps on mobile devices, which will show objects of interest for users such as hotels, restaurants, monuments, events etc. on map application

Despite the potential of utilizing big data, amount of data is simply way too large and scattered for supply chain operators to process, not to mention specialized IT-personnel to do that. Using big data effectively along with existing conventional data requires predictive analytic tools (Wang & Pettit, 2016, p. 15). However, it has been argued that big data has already been a part of logistics for a long time in emails and spreadsheets, we just have not realized it (Field, 2014 p. 46-51).

The purpose of utilizing big data in supply chain is to connect threads of information into a single coherent, unambiguous, and transparent entirety in a platform, where stakeholders of supply chains can search, input and share information.

5.1 Cloud services

Traditionally companies have invested in establishing their own computer systems and software to support their business activities. Investments on planning, building up IT infrastructure (telecommunication network, servers, computers) and software (programming, license fees), and maintaining them, can be expensive.

Cloud services can provide computing power and software solutions for multiple users simultaneously, where service users will pay according to the usage of the cloud services (computing power and software), hence establishing physical computer system on-site is not needed. Scalability of cloud services provides great flexibility in service providers' pricing model to meet the needs of users, so cloud services are a viable option for entrepreneurs for large-, medium- and small-sized companies (Wang & Pettit, 2016, p. 9). As cloud services are web-based, the data and applications can be stored, shared, analyzed and collaborated with users anytime and anywhere. Also, multiple interconnected data centers around the world makes the cloud services very robust and fail-safe (Murugesan & Bojanova, 2016, p. 5-6).

Cloud services have also its limitations. Their web-based nature requires that users must have a reliable and fast internet access to connect the cloud. Furthermore, the network between users and cloud service may have uncertainties. Capacity of cloud service may slow down due to high usage levels causing higher workload on the servers. Cloud services may also have temporary break of service e.g., due to maintenance work. Although data is replicated in multiple computers there may occur loss of data due to cloud failure. Also, cloud services may be vulnerable unauthorized access to data, users' information, and service attacks (Murugesan & Bojanova, 2016, p. 10-12).

Cloud computing has six distinguishable features (Murugesan & Bojanova, 2016, p. 5):

- On-demand self-service:
  Computing resources for server time and network storage are automatically and individually allocated according to the user's needs.

- Broad network access:
  Users have access to cloud services by various devices such as mobile phones, tablets, laptops, and desktops.

- Resource pooling:
  Computing resources for storing, processing, memory, and bandwidth usage, are pooled to serve multiple users. Resources are allocated, released, and re-allocated between the users automatically according to the users' demand.

Users have no control over the exact location of the server, but may choose the location, region, or datacenter.

- Rapid elasticity:
  Allocation, release, and re-allocation of resources between the users is almost instantaneous, at least from the user's perspective.

- Measured service:
  Usage of resources is automatically controlled and optimized through metering capabilities, according to the type of service.

- Multitenancy:
  Cloud computing is a shared pool of resources used by multiple users.

Cloud service models can be classified in three categories according to the needs of the user (Murugesan & Bojanova, 2016, p. 6):

- Software as a service (SaaS):
  Users use an application, which is in the cloud. Users has limited control over configuring the settings of the application, but not in the underlying infrastructure (network, servers, operating systems, storage or individual application capabilities).

- Platform as a service (PaaS):
  Users deploy the service on the cloud infrastructure and use supported programming language, libraries, and tools, and control the settings of the platform service. User has no control over the configurations of the underlying cloud infrastructure (network, servers, operating systems, or storage).

- Infrastructure as a service (IaaS):
  Users can deploy, run, and control operating systems, applications, and provide processing, storage and network resources appointed by cloud service provider, and control them. User has no control over the underlying cloud infrastructure.

Cloud service providers are also offering wider variety of services, e.g., data storing, analytics, virtual desktops, security applications, identity and access management services, and monitoring services. Variety of services is expanding.

Cloud deployment models can be classified in five categories depending on the ownership and management, and primary user base of applications (Murugesan & Bojanova, 2016, p. 9-10):

- Public cloud:
  Everyone can use it, but the infrastructure is owned and managed by the cloud service provider. Users pay for the usage of the service, although some services may be free.

- Private cloud:
  Private cloud is deployed, provided, and controlled by its operator, such as company or organization. Operator has full control over its users, content, resource allocation and infrastructure.

- Virtual private cloud:
  Virtual private cloud is like private cloud, except operator is "renting" computing sources from the cloud service provider with additional provisions and features for specific security and compliance required by the operator.

- Community cloud:
  Community cloud is optimized and deployed for industrial sector or organizations with specific requirements that are crucial for them. Community clouds are also known as industrial or vertical clouds.

- Hybrid cloud:
  Hybrid cloud is a mixture of two or more above-mentioned models. Company or organization, or cluster of them, can define layers of usage of clouds depending on the profiles of the users.

Adoption of cloud service may be intriguing and temping for a company or organization. However, to gain optimal usage of the service one must prepare itself strategically, culturally, and organizationally, and understand the concept cloud computing. Transitioning to cloud services needs a strategic plan, which defines the type of cloud service model (SaaS, PaaS, or IaaS) and cloud deployment model (public, private or mixture of them) according to the purpose and operational environment of application, and step-by-step -transition phase plan. The migration process should also include the role of people, organizational processes and services, management of transfer and novel IT management and framework of governance (Murugesan, & Bojanova, 2016, p. 12).

For selecting the proper cloud service model, following factors should be considered (Murugesan & Bojanova, 2016, p. 12):

- Performance requirements, security requirements and cloud service availability and continuity

- Amount of data transfer between the user and the clouds and/or between the clouds

- Sensitive nature of the applications

- Control of their application and data

- Total costs involved

- Whether the external cloud providers are trusted

- Terms and conditions imposed by the external cloud providers

- In-house technical capabilities (Claybrook, 2010)

In multimodal logistics, cloud services could be used as web-based platform, electronic logistics marketplace (ELM). In open ELM shippers, carriers and customers can do spot-trading of transport services. In closed ELM they could share information and long-term collaboration (Wang, Potter & Naim, 2007, p. 1170-187).

In closed ELM the whole consignment process would be in one platform, from where supply chain could utilize data of the consignment. Customer generates a purchase order, which would be transferred to shipper. Then shipper and carrier would do the transport planning and execution. During transportation, all related parties could follow the progress of the consignment. Transparent and interconnected supply chain would enable pro-active planning, increase the performance, and streamline the whole supply chain, thus eventually reduce the costs, and improve customer service (Wang, Potter & Naim, 2007, p. 1170-1187).

5.2 Internet of Things (IoT)

Internet of Things (IoT) is a concept of items around us that are linked, by wire or wirelessly, and can interact with each other, often using same internet protocol as internet (Atzori, Iera & Morabito, 2010, p. 2787-805), without human interference (Buyya & Dastjerdi, 2016, p. 2). Furthermore, IoT has unique characteristics and requirements, such as scalability, heterogeneity support, total integration, and real-time query processing (Buyya & Dastjerdi, 2016, p. 4).

Industrial IoT (IIoT) is form of IoT applications used by big high-tech companies, where machines can perform specific tasks such as data acquisition and communication accurately. Concept of IIoT consist of communication between machines, big data analysis, and machine learning. IIoT enables companies to track their goods, manage the supply chains, perform quality control and assurance, and detect and resolve problems faster resulting in savings in time, money, and energy consumption (Buyya & Dastjerdi, 2016, p. 5).

The structure of IoT consists of sensory devices, readers, communication network, and computer database for utilizing the data. Sensory devices can be passive, where no power source needed as they are activated and powered by a reader, or active, where power source is embedded.

IoT creates and ubiquitous interconnected network of identifiable objects, that can interact with each other autonomously such as radio frequency identification (RFID) systems, mobile devices, and domestic appliances. They can provide vast amounts of data for users to use in various purposes.

Alas, IoT devices have become targets of maleficent actions, as their protection is much easier to penetrate than servers. Also, the sheer number of IoT items compared to the servers is unparallel. Furthermore, as IoT is heterogenic and widely distributed, the patching process and updating their security is time consuming (Buyya & Dastjerdi, 2016, p. 19).

5.2.1 Radio frequency identification (RFID)

In supply chains RFIDs are an example of IoT. Radio frequency identification (RFID) works by a tag that contains a microchip for data storage and managing the receipt and transmission of data, and an antenna for transmitting and receiving information via radio waves. RFID reader receives information transmitted by RFID tag and forwards it to computer database from where the information can be utilized either manually or automatically. Reader interacts with numerous RFID tags. There are passive and active RFID systems with own distinctive features (Zelbst & Sower, 2016, p. 13-22):

- Passive:
  Reader sends a signal to the tag, which activates the microchip in the tag to send a signal to the reader in return. Passive RFID microchip does not need a power source, which makes them long-lived. Reader's signal provides enough power to activate the chip. Their data storage capacity is low. Passive systems operate in low (LF), high (HF) and ultra-high (UHF) frequency. LF and HF frequencies are used for security purposes and UHF is used for inventory and logistics purposes. Globally, UHF RFID reader frequencies are divided in three regions, region 1 for Europe and Africa (865,6-867,6 MHz), region 2 for North

and South America (902-928 MHz) and region 3 for Asia Pacific, which does not have a standardized frequency span. Because of regionalization, usage of passive RFID tags in global supply chain is difficult, unless using multiregional tags. Passive tags interact with the readers at close range. LF and HF are used for security purposes, so their operational range is limited to restrict unauthorized access and cloning. LF is few centimeters and HF dozen centimeters. UHF tags are used for inventory and logistic purposes. Their operational range is dozen meters.

- Active:
  Active RFID microchips have their own power source. They can transmit signal autonomously without activation signal from receiver. However, their power source will eventually deplete, thus they are much short-lived, but their life span be extended by remotely shut down and activated. Active RFIDs can store more information than passive ones. Also, additional sensors, that can monitor and control functions autonomously, can be integrated to them, so they can be used in more variety of ways. Their operational range is limited by the connectivity to transceiver, such as RFID reader, Wi-Fi network, cellular link tower or even satellites, depending on which they are designed to be connected.

In supply chain management RFIDs are used for inventory management, tracking the cargo, transportation unit or vehicle, monitoring their status, such as temperature, humidity, shocks, functioning of mechanics, process controls and payment systems. Furthermore, every stage of the RFID tag can be recorded and tracked. All can be done with high speed and accurately. Consequently, supply shortages, inventory levels, risk of stockouts, product loss, counterfeit, and thefts, are reduced (Zelbst & Sower, 2016, p. 36-41). Development of smart and active IoT technologies can provide wide range of applications to support the supply chain.

RFIDs have some limitations (Zelbst & Sower, 2016, p. 22-23, 29-30):

- Physical obstacles:
  Some liquids, like water can absorb the signal, and some solid materials, like metal, stone or concrete, can reflect or bounce the signal away.

- Shadowing:
  If RFID tags are stocked, only top tag is activated, and tags underneath are shadowed and remain passive.

- Polarization:
  Antennas on RFID are polarized either linearly or circularly. Linearly polarized antennas must be aligned with the tag to work, whereas circularly polarized antennas can be almost in any position and still be read, but some of the power of the signal is lost.

- Unauthorized access:
  As RFIDs are numerous and operate with radio signals, they may be vulnerable to unauthorized access.

RFIDs are more expensive than bar codes, although the gap is narrowing rapidly, but they have significant advantages (Zelbst & Sower, 2016, p. 52-53):

- RFID readers do not need to be in line of sight with the tag or at close range

- Reading of RFID tags is much faster as tags can be read simultaneously instead of sequentially

- RFID tags have read/write capability

- RFID tags can be inserted within the products to protect the tag, which makes them more durable

- Active RFIDs can be integrated with various sensor technologies

Bar codes and RFID tags can also be used simultaneously, even on the same tag.

According to studies of Zelbst & Sower (2016, p. 62-64), utilization of RFID technologies improves information sharing of supply chain and therefore improves its performance and saves its costs. However, without a good overall view of performance of supply chain, RFID technologies can be felt as an additional expenditure.

Until recently RFID readers used middleware to send their data to databases, but now trend is towards intelligent RFID readers that will send data directly to databases.

Another trend is using cloud computing services instead of establishing and maintaining their own computer infrastructure. Then companies would only pay for the usage of the cloud services (Zelbst & Sower, 2016, p. 15) (see 3.1).

5.2.2 Usage of RFID in port of Rauma

Port of Rauma Ltd uses passive RFID system for automated gate access control of hauler and personnel traffic. RFID reader is at the gate and the tags can be purchased from the Port of Rauma Ltd. Furthermore, gate has an automatic car license plate reader. Database, where information of port users is saved, is owned by Port of Rauma Ltd. However, gate access information is not yet distributed to the relevant stakeholders of port of Rauma.

Some woodpulp suppliers produce woodpulp units that have RFID tags embedded on the wrapping and port operator’s forklifts and stevedores handling the units have readers, that sends the data in the operator’s database for further use.

5.3 Electronic Data Interchange (EDI)

Electronic Data Interchange (EDI) is a standardized format for transmitting and receiving, without human interference, standardized documents and messages between computers and applications of industrial trading partners (Walton & Maruchek, 1997, p. 30-35) in a structured and computer processable form. EDI is one of the most important developments in logistics (La Londe & Cooper, 1989). Role of EDI and other information technology systems have increased significantly by enhancing greatly the purchasing compared to traditional information flow (Pagell et al., 1996, p. 27-34), such as mail, fax, and telex. EDI has increased the speed, accessibility, and reliability of data transfer (Sheombar, 1992, p. 4-14) and enables business partners to response fast (Rogers et al, 1992, p. 15-20).

Standardized data formats enable supply chain partners to share and transfer accurate information quickly. It makes easier for companies to plan and schedule purchase orders, follow in real time their inventory levels, and react fast on changes in demand (Emmelhainz, 1988, p. 55-70).

EDI, by its nature, is an interorganizational information transfer channel. Therefore, if an organization in supply chain channel adopts EDI, it may force others adopt it too, especially if the adopter plays a major role in the supply chain channel (Williams, 1994, p. 173-203), binding organizations tighter together (Gosain et al, 2004, p. 7-45). Even if EDI may provide a cost-effective data transmission channel, many organizations need to invest on interface software between internal systems and EDI format, which may be relatively expensive for small and medium-sized companies (Wang & Pettit, 2016, p. 7).

Although EDI is a considerable option for supply chain members, it has an issue, that has not been solved in worldwide shipping and it is Bill of Lading (BL). BL has three key functions:

- Cargo receipt, i.e., confirmation of the receipt of the goods to carriage

- Contract of carriage, i.e., terms of the contract of the carriage

- Document of title, i.e., ownership of the goods

The first two functions are not an issue as they can be transferred in digital form, but the last one, document of title, brings up severe legal issues especially in endorsing and transferring the BL to a third-party buyer, as, authenticating of digital signatures worldwide may be problematic, which may hinder the use of BsL in EDI format. During recent decades, a lot of international efforts have been put to solving the legal issues, but the work is still unfinished (Wang & Pettit, 2016, p. 141-151).

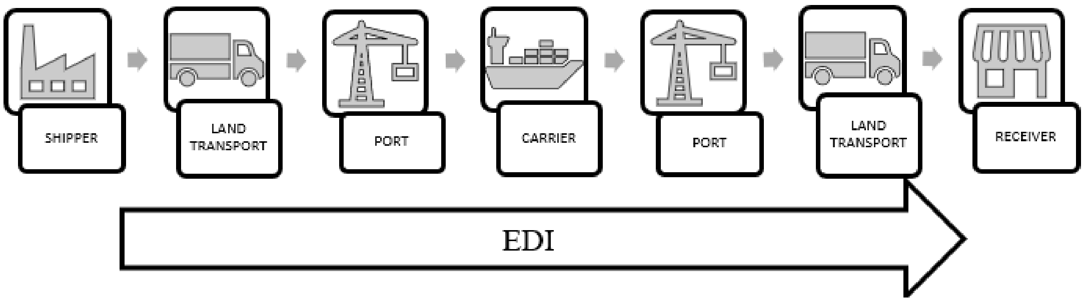


Figure 13 Progress of shipment information in EDI format throughout the supply chain

6 PORT OF RAUMA TRAFFIC INFORMATION

6.1 Port of Rauma Ltd gate information

At the gate of port of Rauma, Port of Rauma Ltd has installed following automated readers:

- Automatic licence plate reader passenger and freight transport vehicles. Users, their representatives, gate security or traffic information service inputs port user's or visitor's personal and vehicle details manually in the web-based gate database

- RFID reader for passenger and freight transport vehicles and pedestrians and bicycle users who have applied the RFID tag from the gate

- Photographic container reader for container identification

Port of Rauma Ltd offers access to its database for port users for further utilization, but the port users have not utilized the service (Isberg, 2021) appealing on the costs and lack of utility (Luoma, 2021).

All other land transport vehicles, except local forest industry transport vehicles, must visit at the traffic information service before entry to port for further driving instructions for delivering cargo they are carrying or receiving cargo for carriage. Also, cargo related paperwork is done at the traffic information service. Local forest industry transport vehicles contact port of Rauma terminal workers directly by VHF prior arrival to the gate of port of Rauma and drive directly to the warehouse without visiting at the traffic information service (Yliniemi & Jalava, 2021).

6.2 Port of Rauma Ltd vessels' port call information

Port of Rauma Ltd has a website which displays list of known vessels arriving to port of Rauma within next seven days, vessels that are in berth, and vessels that have departed within last seven days (see figure 14) (Port of Rauma Ltd, 2021). Website displays vessels' name, nationality, previous and next port of call, either estimated or actual times of arrival and departure, berth, ship's agent, and owner/charterer (see figure 14). Vessels' pre-arrival information (ETA and ETD) Port of Rauma Ltd's database receives from national web-based port traffic declaration service, Portnet (see 6.3), where in turn representatives of the ships, such as ships' agents, provide notifications on arrival and departure of the ship to the authorities.

After arrival vessels' times are manually input in the port database by employees of Botnia Port Service Ltd, which is an affiliate of Port of Rauma Ltd and oversees port of Rauma operational services and port security.

Arrivals At Berth Departed

The 15 vessels arriving in Port of Rauma Ltd

Vessel	Nat.	From / To	ETA	Berth	ETS	Agent of Arrival / Departure	Vessel Owner
Ultramar	CY	EEPRN FIRAU	31.05.21 12:00	Metsä-Botnia / MB1	01.06.21 06:11	C&C Port Agency Finland Oy Ltd	AtoB@C Shipping Ab
Kraftca	NL	FIHKO FIHKO	01.06.21 07:00	Iso-Hakuni / Ro-Ro 5	01.06.21 22:00	Oy Transfennica Ab	Oy Transfennica Ab
Prima Queen	NL	FITKU DELBC	01.06.21 09:00	Petäjäs / P3	02.06.21 12:00	Prima Logistics Oy Ab Ltd	Prima Shipping Oy
Scheldegracht	NL	SEHUS NLEEM	01.06.21 11:05	? / ?	04.06.21 23:05	Euroports Rauma Oy	Spliethoff Oy
Norrbotten	GB	SETUN FIRAU	01.06.21 15:05	? / ?	02.06.21 15:05	Euroports Rauma Oy	Navalis Shipping gmbh & co. kg
Emotion	NL	EEMUG DEHAM	02.06.21 06:05	? / ?	02.06.21 23:05	Euroports Rauma Oy	Hapag-Lloyd Kreuzfahren GmbH
Meri	FI	LTKLJ NOHAL	02.06.21 10:00	Iso-Hakuni / Ro-Ro 3	02.06.21 21:00	Meriaura Oy	Meriaura
Sonderborg	PT	EETLL DEBRV	03.06.21 05:00	Konttilaituri / ?	04.06.21 08:00	Unifeeder A/S C/O Unifeeder Poland /SSC	Unifeeder A/S
Link Star	FI	ESSDR DERSK	03.06.21 06:05	? / ?	04.06.21 23:05	Euroports Rauma Oy	Upm-Kymmene Oyj, Seaways
Violetta	MH	GBTIL FIHEL	03.06.21 20:00	Konttilaituri / KL 3	05.06.21 05:00	C&C Port Agency Finland Oy Ltd	MSC Finland Oy
Ambassadeur	NL	PLSZZ FIRAU	04.06.21 00:00	Laitsaari / 15	05.06.21 00:00	Euroports Rauma Oy	Wagenborg Shipping B/V
Macao	PT	FIHEL DEWVN	04.06.21 06:05	? / ?	04.06.21 23:05	Euroports Rauma Oy	Maersk Finland Oy
Pulpca	NL	FIKTK FIHKO	04.06.21 07:00	? / ?	04.06.21 23:59	Oy Transfennica Ab	Oy Transfennica Ab
Rocamar	AG	EEPRN FIKAS	04.06.21 08:11	Metsä-Botnia / MB1	04.06.21 22:11	C&C Port Agency Finland Oy Ltd	AtoB@C Shipping Ab
Elbsailor	AG	EETLL DEBRV	05.06.21 22:50	Konttilaituri / ?	07.06.21 22:50	Unifeeder A/S C/O Unifeeder Poland /SSC	Unifeeder A/S

Arrivals At Berth Departed

The 2 vessels at Berth in Port of Rauma Ltd

Vessel	Nat.	From / To	ATA	Berth	ETS	Agent of Arrival / Departure	Vessel Owner
Stadiongracht	NL	RULED PLGDY	30.05.21 19:25	Iso-Hakuni / Ro-Ro 6	01.06.21 00:00	Euroports Rauma Oy	Spliethoffs Bevrachtingskantoor B.V.
Super Caroline	MH	MACAS TRIZM	27.05.21 16:45	Iso-Hakuni / Ro-Ro 7	05.06.21 00:00	Euroports Rauma Oy	T.K.B.Shipping A/S

Arrivals At Berth Departed

The 16 vessels has departed from Port of Rauma Ltd

Vessel	Nat.	From / To	ATA	Berth	ATS	Agent of Arrival / Departure	Vessel Owner
Delphis Riga	HK	FIHEL DEBRV	28.05.21 06:40	Konttilaituri / KL 3	29.05.21 15:10	Euroports Rauma Oy	Sealand Europe A/S
Baltic Bright	SE	NLAMS DERSK	28.05.21 07:05	Iso-Hakuni / Ro-Ro 3	29.05.21 14:40	Euroports Rauma Oy	Upm-Kymmene Oyj, Seaways
Baltic Merchant	GI	FIKAS NLRTM	28.05.21 20:40	Petäjäs / P3	29.05.21 12:05	C&C Port Agency Finland Oy Ltd	AtoB@C Shipping Ab
Trica	NL	FIHKO GBTIL	28.05.21 07:15	Iso-Hakuni / Ro-Ro 5	28.05.21 22:35	Oy Transfennica Ab	Oy Transfennica Ab
Baltic Merchant	GI	FIKAS NLRTM	28.05.21 16:00	Petäjäs / P2	28.05.21 18:25	C&C Port Agency Finland Oy Ltd	AtoB@C Shipping Ab
Silvamar	NL	PLSZZ DEHAM	26.05.21 17:05	Petäjäs / P3	28.05.21 18:20	GAC Finland Oy	AtoB@C Shipping Ab
Transfighter	SE	FIOUL BEZEE	27.05.21 05:50	Iso-Hakuni / Ro-Ro 4	27.05.21 22:15	Euroports Rauma Oy	Swedish Orient Line
Valdivia	PT	FIHEL BEANR	27.05.21 06:50	Konttilaituri / KL 3	27.05.21 22:10	C&C Port Agency Finland Oy Ltd	MSC Finland Oy
Rystraum	NO	NLRTM SEOER	27.05.21 13:50	Öljysatama / Öljylaituri	27.05.21 20:05	GAC Finland Oy	Utkilen AS
Empire	NL	EEMUG DEHAM	25.05.21 17:40	Konttilaituri / KL 1	27.05.21 17:20	Euroports Rauma Oy	Hapag-Lloyd Kreuzfahren GmbH
Lady Clarissa	NL	FIPRS GBHUL	26.05.21 02:10	Keskuslaituri / Ro-Ro 1	27.05.21 14:15	Euroports Rauma Oy	Upm-Kymmene Oyj, Seaways
Polaris VG	FI	FIKTK ESFRO	25.05.21 23:20	Iso-Hakuni / Ro-Ro 3	26.05.21 23:00	Euroports Rauma Oy	Upm-Kymmene Oyj, Seaways
Spuigracht	NL	SEHUS NLEEM	22.05.21 09:00	Iso-Hakuni / Ro-Ro 6	25.05.21 21:00	Euroports Rauma Oy	Spliethoffs Bevrachtingskantoor B.V.
Pulpca	NL	FIHKO FIHKO	25.05.21 06:45	Iso-Hakuni / Ro-Ro 5	25.05.21 19:55	Oy Transfennica Ab	Oy Transfennica Ab
Warber	NL	DERSK FIKTK	21.05.21 19:25	Laitsaari / 15	24.05.21 16:15	Euroports Rauma Oy	Upm-Kymmene Oyj, Seaways

Figure 14 Port of Rauma list of vessels arriving at berth and departed (source: Port of Rauma Ltd, 2021)

6.3 Port traffic declaration service (Portnet)

Portnet a web-based port traffic declaration service platform provided by Finnish Transport and Communications Agency, Traficom, where representatives of the ships, such as ships' agents, provide notifications on arrival and departure of the ship to the authorities (Customs Finland, 2021). Notifications includes vessel's details, estimated and actual arrival and departure times, name of port and berth, previous and next port of call, cargo information, number crew and their personal details, ship's stores, crew's personal effects, ten previous ports and their security level, waste declaration, shipowner/charterer and vessel's representative/agent.

Notifications are mandatory for all seagoing vessels used for commercial purposes, excluding coastal fishing vessels which return daily or within 36 hours to their port of registry or to another port in the territory of the Member States without calling at a port located in a third country, seagoing leisure craft, if they are 45 meters or longer or if they can carry more than 12 passengers, or traditional ships, if they can carry more than 12 passengers (Customs Finland, 2021).

Statutory basis for mandatory Portnet notifications is as following (Customs Finland, 2021):

- Vessel Traffic Service Act (623/2005), section 20 a (225/2012), section 22 a (576/2018), section 22 b (225/2012), section 22 c (791/2013) and section 22 g (791/2013)
- Act on Fairway Dues (1122/2005), section 13, subsection 2
- Finnish Customs Act (304/2016), section 52
- Act on Excise Duty (182/2010), sections 19 and 98
- Act (254/2007) on implementing the regulations under the scope of the legislation of the WHO International Health Regulations (2005)
- Act on Environmental Protection in Maritime Transport (1672/2009), section 3
- Regulation (EU) No 952/2013 establishing the Union Customs Code, Articles 134, 135, 140 and 267
- Commission Delegated Regulation (EU) 2015/2446, articles 120, 121 and 129 d, which has been added to article 55 paragraph 13 of the regulation mentioned below in the delegated regulation
- Delegated Regulation (EU) 2016/341 as regards transitional rules for certain provisions of the Union Customs Code and for amending article 53 of the delegated regulation (delegating regulation concerning transitional rules)

6.4 Arrival and exit declaration service (AREX)

Web-based arrival and exit declaration service (AREX) is provided by Customs Finland. It is used for submitting declarations for third country goods and European Union goods arriving in Finland. Also, the AREX service is used for submitting declarations for European Union goods that will exit Finland and for third country goods that have been in temporary storage and are to be reloaded for transshipment. Only identified users can submit all the various entry and exit declarations (Customs Finland, 2021).

Declarations can also be done electronically, which is very useful feature for companies that have large number of goods to be declared. Requirements for electronic declarations are (Customs Finland, 2021):

- Data communication links for transmitting messages
- Software for creating and sending declarations to the various systems of customs
- Testing the applications and data communication links with customs
- Authorization for message exchange granted by customs
- Server certificate from the Digital and Population Data Services Agency
- Competence in the procedures to ensure that the submission of declarations runs smoothly

Usually, AREX notifications in port of Rauma are done by port operator’s freight forwarding department, but also ships’ agents are making them. However, some shippers or liners are doing it electronically.

6.5 Port vessel traffic information to other stakeholders

6.5.1 Pilots

Pilots are local advisor for masters of the vessels to navigate the vessels safely in and out of the ports. Finland's waters are very challenging due to rocky and fragmented archipelago with thousands of islands and islets, changing weather conditions and icy winter, and environmentally sensitive Baltic Sea. The purpose of pilotage is to enhance the safety of vessel traffic and prevent environmental damage generated by vessel traffic.

Ships arriving to and departing from Finnish ports must use pilots if the vessel's cargo is considered dangerous or hazardous, or if such services are required due to the size of the vessel itself. It is statute in Finland's Pilotage Act (Luotsauslaki 940/2003) and the Government Decree on Pilotage (Pilotage Decree 1385/2016). However, vessels are exempted from usage a pilot if master of the vessel has a valid pilot's license or if the Finnish Transport and Communications Agency Traficom has granted the vessel the right to sail without a pilot (Finnpilot Ltd, 2021).

The vessel agent or crew must send with advance notice 12 hours prior to the vessel's arrival at the pilot boarding area to Pilot Dispatch Centre. Final binding order must be done three hours before arrival at the pilot boarding area. On departure same rules apply, except binding order must be done two hours before departure.

Pilot Dispatch Center and ships' agents communicate by phone and emails several times a day. Also, Euroports Rauma Ltd ships' agency sends a ship list (see Figure 15) three times a day to keep the Pilot Dispatch Centre among many other receivers, such as west coast vessel traffic service, Botnia Port Service Ltd and Alfons Håkans tug company, aware of the port traffic in port of Rauma. Constant communication and ship list are important for their resource planning. The importance of ship list is high-lighted if it is not sent, as they will call and ask for it.

Saapumispäivä: 27.05.2021 - 05.06.2021
Matkasarja: - 54999

Matka	PL	LL	Laivanimi	Lt	Pv	Saapumisaika	A/T	Lähtöaika	A/T	Pos.tark	Määräsatamat	Ts	Ms	Ed	Huomautus
51883	K1,5	K1,5	EMPIRE		TI	25.05.2021 17:36	T	27.05.2021 17:20	T		DEHAM	EEMUG	DEHAM		ei luotsia, HAPAG
52203		R1	LADY CLARISSA	P	KE	26.05.2021 02:00	T	27.05.2021 14:15	T	26.05.2021 08:35	GBHUL	FIPRS	GBHUL		
52179		R4	TRANSFIGHTER	P	TO	27.05.2021 05:50	T	27.05.2021 22:15	T		BEZEE, BEANR	FIOUL	BEZEE		
51930	K3	K3	VALDIVIA		TO	27.05.2021 06:50	T	27.05.2021 22:10	T		BEANR, BEGNE				MSC, C&C
52200		R7	SUPER CAROLINE	P	TO	27.05.2021 16:45	T	05.06.2021 00:00	A		TRIDS	MACAS	TRIZM		ROMULAIVA
52156	K3	K3	DELPHIS RIGA	P	PE	28.05.2021 06:40	T	29.05.2021 15:05	A		DEWVN, DEBRV	FIHEL	DEBRV		MAERSK, STYYRPUURI KAI
51908	R3	R3	BALTIC BRIGHT	P	PE	28.05.2021 07:05	T	29.05.2021 11:05	A		DERSK	NLAMS	DERSK		
51961	R5	R5	TRICA		PE	28.05.2021 07:15	T	28.05.2021 22:05	A		BEANR, GBTIL	FIHKO	GBTIL		ei luotsia
51988		R6	STADIONGRACHT	P	SU	30.05.2021 15:05	A	01.06.2021 00:00	A	28.05.2021 11:26	USBAL	RULED	PLGDY		
51846	R5	R5	KRAFTCA		TI	01.06.2021 06:05	A	01.06.2021 23:05	A	24.05.2021 15:46	BEANR, GBTIL, FIHKO	FIHKO	FIHKO		
52234			NORRBOTTEN		TI	01.06.2021 15:05	A	02.06.2021 15:05	A	26.05.2021 10:39		SETUN	FIRAU		P. SELLUA
52245			MERI		KE	02.06.2021 00:00	A	03.06.2021 00:00	A	24.05.2021 14:59			NOMQN	M	MERIAURA, Mantsinen lastau
51964		R6	SCHELDEGRACHT		KE	02.06.2021 06:05	A	04.06.2021 23:05	A	28.05.2021 10:14	USJAX, USBAL	SEHUS	NLEEM		
52181	K3	K3	EMOTION		KE	02.06.2021 06:05	A	02.06.2021 23:05	A	26.05.2021 10:40	DEHAM	EEMUG	DEHAM		HAPAG
52034	K1,5	K1,5	SONDERBORG		KE	02.06.2021 19:05	A	03.06.2021 00:00	A	27.05.2021 17:23	DEHAM, DEBRV				UNIFEEDER
51636	R3	R3	LINK STAR		TO	03.06.2021 06:05	A	04.06.2021 23:05	A	28.05.2021 08:38	DERSK	ESSDR	DERSK		
52169	K3	K3	VIOLETTA		TO	03.06.2021 15:05	A	04.06.2021 00:00	A	27.05.2021 22:45	BEANR, BEGNE				MSC, C&C
52258	15		AMBASSADEUR		PE	04.06.2021 00:00	A	05.06.2021 00:00	A	27.05.2021 14:09		PLSZZ	FIRAU		P rautalankaa
52157			MACAO		PE	04.06.2021 06:05	A	04.06.2021 23:05	A	26.05.2021 10:42	DEWVN, DEBRV	FIHEL	DEWVN		

Figure 15 Euroports Rauma Ltd ship list (source: Euroports Rauma Ltd)

6.5.2 Tugs

Sometimes vessel needs tugs assistance for berthing and departure due to limited or insufficient manoeuvrability, adverse weather conditions, such as strong winds or ice conditions, safety, or pilot’s recommendation. In port of Rauma the main tug service provider in Alfons Håkans Ltd which has a station in the port of Rauma. Their main service areas are Uusikaupunki, Rauma and Pori, but not excluded to assist further if needed. Normally they require two hours notification for assistance. Recent years they have also provided ice breaking service within the port. To allocate their resources, communication between pilots and ships’ agents is important. Hence, Euroports Rauma Ltd ships’ agency ship list and Port Activity App are very useful tools for them.

6.5.3 Vessel traffic service (VTS)

Finnish transport agency, Finntraffic, provides vessel traffic service (VTS) to merchant shipping and other marine traffic, which aims improving the safety of marine traffic, efficient flow of vessel traffic, prevention of accidents and mitigating the potential environmental hazards of accidents.

Also, VTS monitors international waters in the Gulf of Finland in cooperation with Russia and Estonia. The jointly organized ship reporting system GOFREP encompasses the entire Gulf of Finland, except for territorial VTS areas.

Also, VTS cooperates with authorities, ports and other port stakeholders and partners. When necessary, VTS provides assistance to authorities and supervises compliance with the Pilotage Act (Finntraffic, 2021).

West coast VTS have requested Euroports Rauma Ltd ships' agency to send the ship list to aid them to achieve their aims for safe marine traffic and efficient flow of vessel traffic. Especially notes of vessels sailing without a pilot has been found very useful (West coast VTS, 2021).

7 PORT OPERATOR INFORMATION FLOW

7.1 Terminal Operating System (TOS)

Main port operator in port of Rauma uses terminal operating system (TOS) for all its operative purposes:

- Terminals uses it for planning and managing cargo handling operations (loading and discharging vessels and land transports) and warehousing

- Resource management uses it for planning and distributing work force and machinery

- Freight forwarding department uses it for booking and releasing cargo, connecting vessels or land transports with the cargo, and receiving and generating various land and sea transport documents, such as mate's receipts, waybills, manifests, bills of lading, custom documents, and cargo lists

- All departments use it for utilizing information of cargo operations in terminals and in vessels

- Ships' agency uses it for updating vessels' ETA, ATA, ETD and ATD. It is also used as a source of information when reporting the progress of vessels' cargo operations for stakeholders. Also, it is used for keeping national port traffic declaration service, Portnet, up to date

- It is used as a database of operations, cargo movements, warehouses' inventory, operational history, equipment inventory, customers' information, list of global ports, vessels' information etc.

- Management uses it for operative analyzes and reporting in IBM business analytics suite, Cognos

7.2 Port operator's utilization of Electronic data interface (EDI)

Electronic data interface (EDI) is port of Rauma's port operator's main cargo-related data transfer channel between shippers, carriers, and port operator. EDI-interface is embedded in port operator's terminal Operating System (TOS), so EDI-messaging is done in TOS. Although there are several EDI-formats, port operator has been actively invested in adding blocks to TOS for making it compatible with various EDI-formats used by port operator's main clients. Various shipping documents from shippers or carriers are received as EDI-files, such as bookings, manifests, waybills, bills of lading, seaway bills etc. The messages may contain some, but not necessarily all the following information:

- Booking number
- Order numbers
- Shipper
- Consignee
- Type and amount of cargo
- Identification codes of cargo units
- Name of the vessel
- Carrier's voyage number
- Details of land transportation unit(s) from the shipper to the port
- Estimated time of delivery
- Estimated date of loading

Freight forwarders use TOS to connect EDI-messages with carriers' voyage numbers generated in TOS, hence connects the actual cargo with the actual carriers.

However, all shippers or carriers are not using EDI, or their EDI-formats are not compatible with port operator's TOS's EDI interface. Then cargo information is received by email and manually fed in TOS.

7.3 Ship's agent

Ships' agent is a representative and interface between ships and shipowners/charterers and land organizations in port. Ship's agency's objective is to supervise that the requirements and needs of the shipowner/charterer and the vessel are fulfilled, serve them as a local advisor and contact person, comply with the rules imposed by local and national authorities, and keep all relevant parties informed on vessel's progress before arrival, during port stay and after departure.

In figure 16 is a workflow chart of Euroports Rauma Ltd agency department. Owners/charterers sends inquiry of a vessel intended to call to port of Rauma for discharging and/or loading cargo, or some other reason. The inquiry contains information sheet of the vessel, estimated time of arrival (ETA) the reason of the port call, cargo information intended to be discharged or loaded, inquiry of estimated port call costs (cargo operations costs, port costs, agency fee), estimated duration of port call, and additional services, if needed e.g., possibility for crew changes, arranging services or spare parts, delivery of cash to Master etc. and costs of the additional services.

Agency will inform shippers/receivers' representatives (usually Euroports Rauma Ltd's freight forwarding department), port operator's resource management (Euroports Bulk Terminal Oy, Euroports Containers Oy and Euroports Breakbulk Oy) and Port of Rauma Ltd of the incoming vessel call for berthing plan during port stay, taking in consideration type of cargo they are discharging or loading, type of the vessel (roro/storo, lolo, sideloader, container, bulk) and the location of terminals where their cargo is to be discharged or loaded. Other factors must be considered, such as berth conditions, ships' drafts on arrival and on departure, ships' overall length, duration of cargo operations and available berths. Also, availability of work force, working hours and estimated duration of cargo operations is inquired normally by phone calls.

Once all information of the inquiry acquired, agency will send the reply to owners/charterers for their approval or rejection. If approved, shipowner/charterer nominate them as their agent and sends them instruction letter, which contains

important information to the agency how all documentation, services and invoices related to port call are to be settled. However, Euroports Rauma Ltd ship's agency has established long-term relationships with various liners and owners/charterers whose vessels call regularly in Port of Rauma, so agency agreement is common practice even without official nomination.
After agency has received the agency nomination, they input the vessel in Terminal Operating System (TOS), which gives a unique internal voyage number. Some liner vessels are generated in the TOS automatically by receiving electronic data interchange (EDI) -messages from shippers' systems.

Agents will submit vessels into national online port traffic declaration service, Portnet (see 6.3), which is "*an information system for port traffic and it is maintained by Finnish Transport and Communications Agency and Finnish Customs*." (Portnet, 2021), giving the vessel's port call a unique Portnet -voyage number. Through Portnet, vessels' representatives (such as ship's agent) can submit notifications of vessels' arrivals, departures, and relevant documents (crew lists, passenger lists, bonded stores, crews' personal effects, cargo information, including dangerous goods (i.e., IMO cargo), vessels' certificates etc.) electronically to Finnish customs, which are required by national authorities. Some information, e.g., submitting the vessel and its gradually sharpening ETA can be done via TOS software, which agents keep updated, but most of required information must input manually in the Portnet.

Agency receives updates of vessel's approach by emails and phone calls from the vessel and/or owner/charterer. They also use other sources, for tracking the vessel's progress towards Rauma, such as Marinetraffic (Marinetraffic, 2021) for long (over 100 nm), medium (100-50 nm) and close range (less than 50 nm), vessel traffic service (VTS) by calling them for medium and close range, also acquiring important information related to vessel traffic and safety issues from VTS, Finnpilot's pilot order center for medium and close range, also acquiring information of availability of pilots and if pilots have requirements or restrictions, and in case of congestion of pilot orders, and port of Rauma for close range, and also acquiring information of possible berthing conditions in the port of Rauma (ice conditions, other vessels arriving or departing).

The closer vessel’s arrival gets the better overall view and prospects of the port stay agents have. They keep relevant parties (shipowner/charterer, vessel, freight forwarders, stevedores, shippers, consignees, agents of next ports, port authority, pilots, tug companies, Finnish national authorities (immigration/border guard, customs, vessel traffic service, crewing agencies, service companies etc.) updated on vessel’s ETA, berthing conditions (berth, weather, ice conditions, additional conditions, such as usage of tugs recommended by pilots) and port stay prospects, including estimated time of completion (ETC) and departure (ETD).

Once vessel has arrived, agents send notification to customs and border guard via Portnet, and inform all relevant parties, such as owners/charterers, vessel, stevedores, freight forwarders, shippers and consignees or their representatives, etc. by email. The email contains following information:

- Name of vessel
- Cargo to be loaded/discharged.
- Time of End of sea passage (EOSP), which is vessel’s arrival to pilot boarding area.
- Notice of Readiness tendered (NOR), which is vessel’s notification of her readiness to commence cargo operations. This is a relevant document when counting the duration of port stay and possible demurrages due to delays in port stay.
- Pilot boarding time (POB).
- Time of berthing (ATA) and place/number of berth.
- Time of commencing cargo operations and number of gangs working.
- Other relevant information related to port stay and cargo operations (planned working hours, weather, water level, ice conditions, vessel’s conditions etc.).
- Estimated time of completion (ETC).
- Estimated time of sailing/departure (ETS/ETD).

Agents sends reports of progress of cargo operations and other factors affecting the port stay several times a day. Also, they arrange and supervise that other requirements and services vessel may have (e.g., crew changes, immigration formalities, hotel arrangements, taxi transportations, spare parts deliveries, provisions, mails, shipments, doctor’s appointments, service engineers, laundry services, etc.) go as planned and react if something goes wrong and assist owners/charterers and the vessel.

After completion of cargo operations, agents order pilot and tugs, if needed, and deliver Statement of Facts (SOF) for Master of the vessel to sign. If vessel has loaded cargo, the agents also deliver Mate’s Receipt and Bills of Lading (BsL) (or similar, e.g., Seaway Bill (SWB)) for Master to sign, and manifests, and if dangerous goods loaded, then IMO manifest and dangerous goods declarations. However, it is a common practice in Rauma that BsL and SWBs are issued retroactively, and the agents sign them “as Agents on behalf of the Master”, but they need an authorization letter from the Master. Furthermore, they will send drafts of BsL for owners/charterers approval before signing the final BsL and releasing them. The reason for this practice is that on completion of the cargo operations, information on the cargo documents may still be incomplete, thus delaying the departure of the vessel is not practically or financially viable as finalizing the cargo documents can take days, or even weeks, and usually vessels are in hurry to sail to next port.

Once vessel has sailed, the agents send departure report by email usually to the same parties as vessel’s arrival and update messages, inputs the departure time to Portnet and TOS, and in due time finalizes the cargo documents and sends them to proper receivers, and send invoices of the port call to proper receivers, usually to owners/charterers. It is noteworthy, that liners use electronic EDI-messages for cargo documentation and transmission, so no BsL, SWBs nor manifests need to be sent by the agents.

Agency contract is discharged once all relevant documents (statement of facts, bills of ladings, manifests, and other relevant cargo documents) have been sent, remuneration for their services received, and all invoices related to port stay settled.

When dealing with people, main tools of flow of information are emails and phone calls.

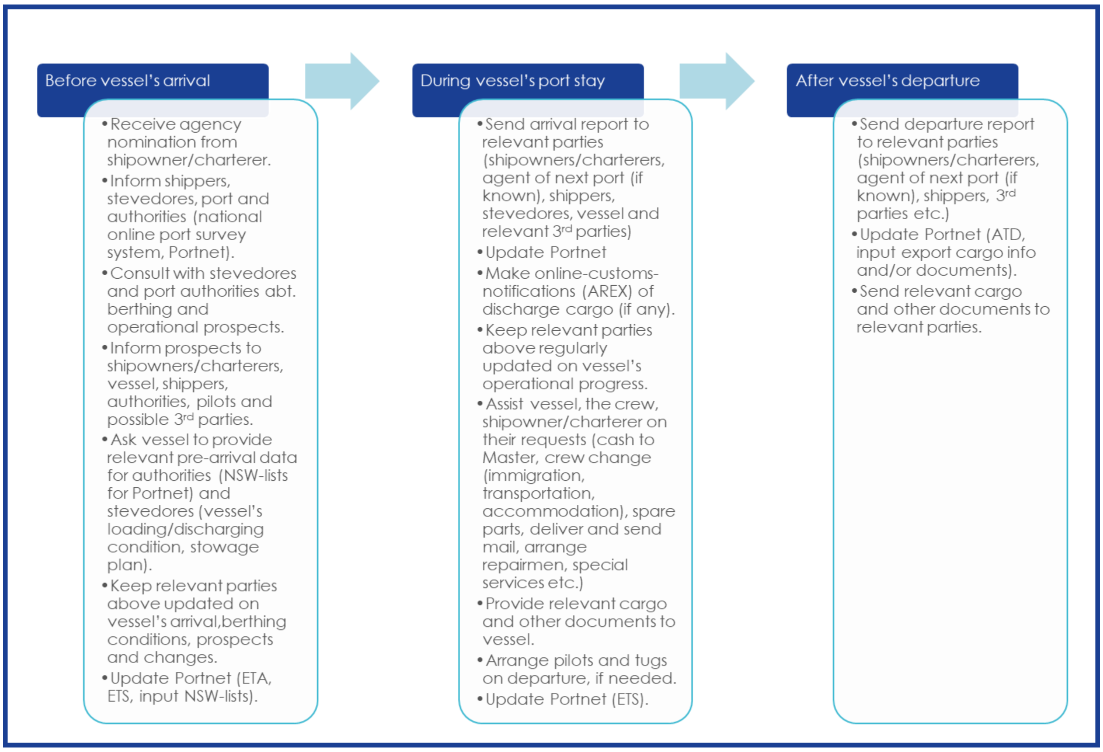


Figure 16 Euroports Rauma Ltd ship's agency workflow chart

7.4 Import cargo information flow

7.4.1 Freight forwarding

Freight forwarders receive manifests of goods to be discharged from carrier or ship's agent either electronically in EDI-messages or by email and generates import file in TOS and transfers it under vessel's voyage number generated in TOS and appoints, in collaboration with terminal, a terminal warehouse, where cargo is to be stored and informs terminal, and traffic information service, so they can guide land transport operator to retrieve the cargo from right terminal warehouse.

Procedure of containers differs a bit. Container terminal operator receives container vessel's discharging plane and appoints the container storage positions in TOS (see 7.1). Cargo manifests of containers are still sent to freight forwarders.

Goods that require customs declaration (goods that arrive outside EU) are done in customs electronic service, AREX.

Also, EU cargo are reported in AREX.

Goods are released to receiver once they are customs cleared and carrier has sent a release note, which is also reported to TOS.

After ship's arrival ships' agent verifies arrival to Portnet. Cargo is discharged in the appointed warehouse and if terminal operators notice any deviations, they are reported in TOS and forwarded to receivers.

Freight forwarders send a request for receivers or their subcontractors to arrange transportation (Euroports Rauma Ltd, 2010).

7.4.2 Terminal

Resource management receives discharging plans from the vessel, vessel's agent, or shipowners, usually about two days before vessel's arrival. Resource management plans distribution of resources several days before vessel's arrival.

Terminal operator sees from TOS, what cargo is to be discharged and what is appointed terminal warehouse where discharged goods are to be stored for waiting to be picked up by receiver. If receiver has instructed freight forwarder to do something for the cargo, such as storing or packing, it is done in the terminal. Terminal hands the goods to receiver if goods are cleared and release note received and reports the hand-over to TOS (Euroports Rauma Ltd, 2010).

As mentioned earlier in 6.6.1, procedure of imported containers is a bit different. Container shipping line sends discharging plan, which contains containers details (identification number, type, filling rate and weight) and positions (bay and tier) and discharging port, usually in BAPLIE -format. Container terminal operator plans the discharging and appoints storage positions in the storage field in TOS. Storage of discharged containers is planned so that stacking is being avoided, if possible, so that their utilization would be as fast as possible.

7.5 Export information flow of land transports

At this point cargo has arrived and stored in terminal warehouse (see 7.4.2) and it is customs cleared and release note received, and receiver has dispatched a hauler to retrieve the goods from port. All truck drivers retrieving cargo must visit at the traffic information service before entry to port for gate access, paperwork (such as contract of carriage, which is prepared by freight forwarders in TOS), and further instructions for retrieving cargo. Traffic information service gets the required information from TOS. Traffic information service informs terminal of incoming vehicle.

Vehicle arrives terminal warehouse and terminal operator loads cargo in the vehicle and reports hand-over in TOS.

National railway operator train control system receives terminal information from traffic information service which in turn gets the required information from TOS. Traffic information service informs terminal of incoming train.

Train arrives terminal warehouse and terminal operator loads cargo in the wagons and reports hand-over in TOS.

7.6 Export cargo information flow of sea carriage

All land transports delivering cargo to port of Rauma to be exported are directed to the appointed terminals, which are defined by the type and destination of the cargo.

7.6.1 Freight forwarding

Freight forwarders receives export booking order from shippers either by EDI-messages or email. Orders are generated and transferred under ship's voyage number in TOS. Freight forwarders passes the information resource management, terminal operators, and traffic information service. Also, freight forwarders request a loading permit from customs, and if cargo is going outside EU, export customs clearance is done.

Once cargo is loaded on the ship, cargo documents, such as mate’s receipt, cargo lists, manifests, bills of lading or seaway bills, are done. If any deviations on the cargo noticed in terminals, terminal operator informs freight forwarders and/or ship’s agent inserts information to TOS. Freight forwarder reports deviations to shipper and ship’s agent reports to ship and shipowner/charterer.

7.6.2 Terminal

Resource management receives loading plans from the vessel, vessel’s agent, or shipowners, usually about two days before vessel’s arrival. Resource management plans distribution of resources several days before vessel’s arrival.

Terminal receives information of incoming cargo and transport vehicle from freight forwarders and/or traffic information service. Cargo is discharged from the vehicle and stored in the terminal warehouse. Also, condition of cargo is checked during discharging the vehicle and if any deviations noticed, it is reported to freight forwarders and to TOS.

Paper and woodpulp deliveries are different. As cargo information is already in EDI-messages, goods in transportation units are already tallied at the manufacturing site, and processes have very little variation, usually lorry drivers already know where to drive and terminal operators can expect the lorry. Therefore, communication between lorry drivers and terminal by VHF before arrival to the gate of port Rauma has been found to be cost-effective and lorry driver can drive directly to the terminal without visiting at the traffic information service. Also, tallying at the terminal is deemed unnecessary. Only if defects are found in the units at some point of the cargo handling, the terminal worker inputs the information to the terminal operating system manually on the touch screen display integrated on cargo handling machinery, or handheld device. Paper reels have bar codes and woodpulp units have RFID tags for fast unit identification. Bar code readers need visual access, whereas RFIDs can be read at close range, but no visual access required.

All cargo to be containerized is tallied in terminal during stuffing.

All other land transport vehicles must visit at the traffic information service before entry to port for paperwork and further instructions for delivering cargo they are carrying or receiving cargo for carriage and informs terminal operator of incoming vehicle. Traffic information service gets the required information from TOS.

National railway operator train control system receives terminal information from traffic information service which gets the required information from terminal operating system, which in turn has received the information from the shippers in EDI-message.

Resource management allocates resources to terminals and ship's operations and gives estimates of duration of ship's cargo operations.

Flow of cargo during ship's loading operations can be followed in real time from TOS. Project cargo is an exception.

Once cargo is loaded onboard, port operator's foreman reports amount of cargo loaded to ship's agent, freight forwarders and resource management.

7.7 Containerization

If shipper wants their cargo to be containerized, they send a booking note of cargo to be containerized and identification numbers of containers appointed and released by container owner to freight forwarders who generates an order to TOS and informs container terminal operator. Container terminal operator informs container stacker driver the types, numbers and sizes of the containers needed for containerization, loads the empty containers on container movers to be delivered in the right terminals for stuffing. Once stuffing the container is completed, terminal worker inputs information to TOS. Driver of the container mover sees from their cabin-integrated display the completed containers and delivers it to container terminal storage field waiting for shipment (Huuhka, 2007, p. 37-39). Stevedores are submitting handlings to TOS by using cabin-integrated displays or hand-held devices.

7.8 Port operator’s automated cargo reading systems

All paper reels and woodpulp units and UPM Plc’s timber packages that arrives to port of Rauma terminals to be stored for further shipments have been tallied and weighed in the factory during loading in the trucks or trains, thus exact quantity of reels, units, pallets or packages are known on delivery to terminals. Also, cargo details have been received in EDI-messages. Therefore, tally at terminals is not considered necessary nor effective. Exception is cargo that have defects, or they are stuffed in containers, then they are tallied manually and submitted in TOS.

Woodpulp units of Metsä Fibre Plc are provided with radio frequency identification (RFID) tags. Forklifts handling the woodpulp units have readers, which can read the tags at close range, so their handling is automatically submitted to TOS.

Paper reels have barcodes but reading them requires visual contact, so reading them when handling large amounts is unreliable and therefore not utilized, except if they are defected, or stuffed in containers. Then handheld readers are used and submitted to TOS.

Container handling machinery has no automatic container number readers. All handled containers are manually inserted to TOS by using cabin-integrated display, or hand-held device.

Bulk terminal’s conveyors have scale, which feeds cargo quantity data to TOS.

8 CONCLUSIONS

Process of this thesis has taught me a lot of supply chains and how performance of a seemingly independent operators within the supply chain affects the performance of all other operators either directly or indirectly, and ultimately performance of the whole supply chain. It has become clear, that collaboration with supply chain stakeholders, both public and private, makes the operators and the whole supply chain competitive.

One factor of the main factors of competitive supply chain came up in almost every subject: fast, accurate and reliable information flow, which is accessible anytime and anywhere. The benefits of efficient information flow to supply chains can be summarized as:

- Responsiveness to react quickly on fluctuations and meet the customers' requirements fast through fast and reliable information flow across the supply chain

- Reliability of material quality and delivery of goods by re-engineering the processes that impact performance and reduce variabilities in the processes

- Resilience to manage unexpected disturbances by identifying and managing strategically important inventory, delivery, and information channels

- Relationships to collaborate with operators as it helps to build mutually beneficial, long-term relationships, and trust and protects from competitors to break in. Long-term relationships improve quality, enables mutual implementation of new innovation, reduces costs, and integrates scheduling of production and deliveries as operators tends to constantly seek for win-win solutions

- Cost advantage as the efficiency and productivity of logistics and supply chain can be increased by planned and coordinated flow of goods and information between the stakeholders of supply chain

- Value advantage as supply chain operators can offer faster response on demand, reliability of supply, just-in-time delivery and reduced the lead-times through increased the efficiency of supply chain

- Shortened logistic lead-time and better forecasting through high visibility of demand increasing visibility of demand

ICT solutions are an answer to supply chains' demand of efficient information flow. However, information related to supply chains is very large and fragmented and amount of data is increasing along with the applications to support the supply chains, especially internet of things (IoT) with RFIDs and augmented mobile solutions. Utilizing the data requires predictive analytics tools, lot of computation power and expertise. An option for operators establishing their own expensive computer systems is a single cloud-based platform for all to use could be a cost-effective solution, where service users will pay according to the usage of the cloud services.

That is where port-centric information sharing platform steps in. The essentiality of ICT solutions in supply chains has driven ports to compete against each other for customers. Satisfactory infrastructure, such as fairways, berths, terminals, land transport systems, services, and customer facilities are not enough. Customers are also demanding wider range of services that support additional value to the supply chains.

Port of Rauma Ltd met the challenge by introducing STM EfficientFlow -project in 2018. In a workshop in October 2018 it was identified, that in port of Rauma information was fragmented, which may reduce the quality, efficiency, and reliability of performance of port stakeholders. It was also identified that information flow was highly dependent on ships' agents, because they were collecting the information, processing, filtering, segmenting the stakeholders into groups, grouping information according to the needs of grouped stakeholders and sending the grouped information to grouped stakeholders. It was also stated that it was extremely important to have all parties interconnected. Therefore, a single information sharing platform was desired. In many ways ships' agents operates as a port-centric information flow platform.

Result of STM EfficientFlow -project was Port Activity App, that was introduced in August 2020. It is a cloud-based application based on Software-as-a-service (SaaS) – model developed by Unikie Ltd, which aims on sharing fast, accurate and reliable information of port activities between port stakeholders. From my point of view, its usage is limited as we, the ships' agents, are providing information it uses for stakeholders' utilization.

One might ask if port-centric information platform would replace ships' agents in Rauma? It could reduce stakeholders' high dependency on information flow provided by the agent, but they would still be needed for surveying the quality, quantity, segregation and grouping of information flow. Probably it would change their role towards data controller and surveyor. Also, vessels and shipowners/charterers need wide variety of additional services, which requires local knowledge and connections, especially in Rauma, because it is either end or start point of several shipping lines. Therefore, many captains consider Rauma as a "home port", where services and crew changes are made and covid-19 -pandemic even highlighted it, because Rauma, or Finland in general, was one of the few places, where they were even possible to arrange.

Extended usage of the application requires wide collaboration and mutual approval from major stakeholders for information sharing. In port of Rauma the main port operator is in essential role for the application's extended usage.

Rauma port stakeholders have their own ICT systems utilizing data, so why to invest on port-centric information platform? Service provider must convince the port of Rauma stakeholders and probably wider range of supply chain operators, that the benefits of the platform are worth of the efforts and investments. Port-centric information platform should provide at least some of the following benefits for port stakeholders: information transparency, improved data quality, reduced margins for errors in information flow, accessibility anywhere and anytime, predictability of processes within the supply chain, easier operational planning and scheduling, improved operational efficiency, optimized transportation channels, reduced lay times of ships, land transports and cargoes, cargo tracking, data analyzing possibilities for various managerial purposes, improved security, user-friendly user interface, and ultimately competitive advantage for supply chains in general. Also, as costs per user on cloud services tends to decrease as number of users increase, can same be expected on Port Activity App, or similar?

As port of Rauma stakeholders have their own ICT systems, timing for planning and later utilization a platform becomes topical when major stakeholders are planning to renew their IT systems or change of port logistics becomes desirable or necessary. When that time comes, development and implementation of port-centric information sharing platform should be considered as a project of its own as part of stakeholder's and/or whole supply chain's overall development plan.

I also found minor issues that may affect on the quality and reliability of information flow in port of Rauma, regardless implementation of port-centric information sharing platform. First, port of Rauma automated gate reading is not utilized by stakeholders due to cost factor and therefore truck drivers must visit at traffic information service for cargo documentation and traffic guidance, although usually all information is already in the systems. It is likely that by implementing utilization of gate information cargo and traffic flow would increase, but is it enough to cover the costs of the service and who should be paying for it? They are issues that supply chain managers should consider. Second issue is manual feeding of container handling information. Manually inserted information is relatively slow compared to automated reading and risk of incorrect information feed is increased. Automatic container readers in container stackers, container movers and container cranes and reference stations for better GPS-positioning of containers needs investments and costs would fall on the port operators. Worthiness of investments versus added value is subject for another study.

REFERENCES

Allaboutlean.com. (2021). https://www.allaboutlean.com/different-ways-to-pull-system-2/economic-order-quantity-theory/, visited 14.04.2021.

Angelova, T. (2018). Efficient Flow stakeholders workshop memo 19.10.2018.

Apache Hadoop. (2021). visited 09.04.2021. https://www.tutorialspoint.com/hadoop/hadoop_mapreduce.htm

Atzori, L., Iera, A. & Morabito, G. (2010). The internet of things: a survey, Computer networks, 54 (15).

Buyya, R. & Dastjerdi, A. V. (2016). Internet of things: Principles and paradigms. 1st edition. Amsterdam, The Netherlands: Morgan Kaufmann.

Christopher, M. (2016). Logistics & supply chain management. Fifth edition. Harlow, England: Pearson.

Claybrook, B. (2010). Cloud vs. in-house: Where to run that app? Computer World. http://www.computerworld. com/article/2520140/networking/cloud-vs--in-house--where-to-run-that-app-.html, visited 08.06.2021.

Cooper, M. et al. (1997). Meshing multiple alliances. Journal of business logistics, 18 (1).

Customs Finland, https://tulli.fi/-/tullin-maarays-suomeen-saapuvia-ja-suomesta-lahtevia-aluksia-koskevasta-ilmoitusmenettelysta?languageId=en_US, visited 31.05.2021.

Customs Finland, https://tulli.fi/en/e-services/services/message-exchange, visited 31.05.2021.

Customs Finland, https://tulli.fi/en/e-services/services/port-traffic-declaration-service-portnet-, visited 31.05.2021.

Customs Finland, https://tulli.fi/en/e-services/services/safety-and-security-declaration-service-arex-, visited 31.05.2021.

EMC Education Services & Services, E. (2015). Data science & big data analytics: Discovering, analyzing, visualizing and presenting data. 1st edition. Indianapolis, Indiana: John Wiley & Sons.

Emmelhainz, M. (1990). Electronic data interchange: A total management guide. New York: Van Nostrand Reinhold.

Emmelhainz, M. (1988). Strategic issues of EDI implementation. Journal of Business Logistics, 9(2).

Euroports Rauma Ltd, https://www.euroports.fi/company.php?udpview=toimintamme-raumalla, visited 15.05.2021.

Field, A. (2014). Too big to fail?. Journal of Commerce, 15 (12).

Finnpilot, https://finnpilot.fi/en/pilotage/what-is-pilotage/, visited 01.06.2021.

Finntraffic, https://www.fintraffic.fi/en/fintraffic/stm-efficientflow, visited 11.05.2021.

Finntraffic, https://www.fintraffic.fi/en/vts, visited 02.06.2021

Finntraffic, West Coast VTS, (02.06.2021) phone conversation with operator Pulli.

Glass, D., Marlow, P. & Nair, R. (2010). The use and legal effects of carriage documents in international multimodal transport. International Journal of Shipping and Transport Logistics, 2 (4).

Gosai, S. et al. (2004). Coordinating for flexibility in e-business supply chains. Journal of Management Information Systems, 21(3).

Hugos, M. H. (2018). Essentials of supply chain management. Fourth edition. Hoboken, NJ: Wiley.

Huuhka, S. & ammattikorkeakoulu, S. (2007). GPS-pohjainen optimointijärjestelmä Rauman sataman konttiliikenteessä. Satakunnan ammattikorkeakoulu.

Hyvönen, E. (2018). Semanttinen web: Linkitetyn avoimen datan käsikirja. Tallinna: Gaudeamus Oy.

Interreg Central Baltic, https://interreg.eu/programme/interreg-finland-estonia-latvia-sweden/#:~:text=The%20Central%20Baltic%20Programme%202014,be%20applied%20for%20in%20calls, visited 19.05.2021.

Isberg, L. (19.05.2021) phone conversation with Botnia Port Service Ltd Lauri Isberg.

Jones, T. & Riley D. (1985). Using inventory for competitive advantage through supply chain management. International Journal of Physical Distribution and Materials Management, 15(5).

Keskinen, S., (10.10.2019). Euroports Rauma Ltd cargo/information flow chart, received by email from Sanna Keskinen Euroports Rauma Ltd.

Kujala, K. (2020). Invitation to Efficient Flow -port application launching event.

Luoma, K., (25.05.2021) phone conversation with Euroports Breakbulk Ltd Kristian Luoma.

La Londe, B. & Cooper, M. (1989). Partnerships in providing customer service: A third party perspective. Oak Brook, IL: Council of Logistics management.

Laudon, K. C. & Traver, C. G. (2017). E-commerce: business. technology. society. Twelfth edition, global edition. Harlow, Essex: Pearson.

Mentzer, J. et al. (2001). Supply chain management. Thousand Oakes: Sage Publications, Inc.

Metsä Fibre Plc, https://www.metsafibre.com/en/media/all-news/Pages/news.aspx?EncryptedId=A98958AC6C04739F&Title=MetsaGroupsinvestmentprojectsinFinlandprogresstheworldsmostmodernsawmillwillbebuiltinRauma, visited 15.05.2021.

Metsä Fibre Plc, https://www.metsafibre.com/en/media/all-news/Pages/news.aspx?EncryptedId=AB60563126097FF6&Title=MetsaFibreandEuroportsFinlandconcludeanagreementonportoperationsforRaumasawmillssawntimber, visited 15.05.2021.

Murugesan, S. & Bojanova, I. (2016). Encyclopedia of cloud computing. Chichester, West Sussex, England: IEEE Press.

Pagell, M. et al. (1996). Motivating the purchasing professional. International Journal of Purchasing and Materials Management, 32(3).

Port Activity App, https://portactivity.fi/, visited 20.05.2021.

Portnet, https://app.portnet.fi/com.atbusiness.asm.ASMLogin, visited 02.06.2021

Port of Rauma Ltd, https://portofrauma.com/en/port-of-rauma-ltd/publications-and-media/, visited 15.05.2021.

Port of Rauma Ltd, https://issuu.com/mediakumppanit/docs/rauman_satama_vuosikertomus_en_2019, visited 13.05.2021.

Port of Rauma Ltd, https://portofrauma.com/en/koronavuoden-satamaliikenne-ja-tulos-alavireinen/, visited 15.05.2021.

Port of Rauma Ltd, https://portofrauma.com/en/projects/efficient-flow/, visited 19.05.2021.

Port of Rauma Ltd, https://portofrauma.com/en/vessel-traffic-and-transport/list-of-vessels/ships/, visited 31.05.2021.

Rogers, D. et al. (1992). Enhancing service responsiveness: The strategic potential of EDI. International Journal of Physical Distribution and Logistics Management, 22(8).

SAMK. (2020) Invitation to Efficient Flow -port application launching event.

Sedkaoui, S. (2018). Data analytics and big data. Hoboken, New Jersey: ISTE Ltd/John Wiley and Sons Inc.

Sheombar, H. (1992). EDI-induced redesign of co-ordination in logistics. International Journal of Physical Distribution and Logistics Management, 22(8)

Statistics Finland, https://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__lii__uvliik__vv/statfin_uvliik_pxt_12it.px/chart/chartViewLine/, visited 12.05.2021.

Statistics Finland, https://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__lii__uvliik__vv/statfin_uvliik_pxt_12it.px/chart/chartViewLine/, visited 12.05.2021.

Statistics Finland, https://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__lii__uvliik__vv/statfin_uvliik_pxt_12iz.px/chart/chartViewLine/, visited 14.05.2021.

Tapaninen, U. (2013). Merenkulun logistiikka. [Helsinki]: Otatieto.

Unikie Ltd, https://www.unikie.com/en/expertise/maritime-smart-ports/, visited 20.05.2021.

UPM Plc, https://www.upm.com/about-us/for-media/releases/2019/11/upm-closes-paper-machine-2-in-rauma--employee-consultation-processes-concluded/#:~:text=Paper%20machine%202%20in%20Rauma%20will%20be%20permanently%20closed%20on,reduced%20by%20265.000%20tonnes%20annually, visited 15.05.2021.

UPM Plchttps://www.upm.com/about-us/for-media/releases/2020/10/upm-kaipola-paper-mill-to-be-permanently-closed-during-the-last-quarter-of-2020-operations-continue-at-jamsankoski-paper-mill/, visited 15.05.2021.

Waller, M. & Fawsett, S. (2013). Data science, predictive analytics, and big data: a revolution that will transform supply chain design and management. Journal of Business Logistics, 34 (2).

Walton, S. & Maruchek, A. (1997). The relationship between EDI and supplier reliability, International Journal of Purchasing and Materials Management, 33 Summer.

Wang, Y. et al. (2007). Electronic marketplaces for tailored logistics, Industrial Management and Data Systems, 107 (8).

Wang, Y. & Pettit, S. (2016). Introduction. E-logistics: Managing your digital supply chains for competitive advantage. London; Philadelphia: Kogan Page Ltd.

Williams, L. (1994). Understanding distribution channels: An interorganizational study of EDI adoption. Journal of Business Logistics, 15(2).

Yip, T. et al. (2016). Port-centric ICT system, building value in supply chains. E-logistics: Managing your digital supply chains for competitive advantage. London; Philadelphia: Kogan Page Ltd.

Yliniemi, L. & Jalava, S. (19.05.2021), phone conversation with Euroports Rauma Ltd Yliniemi Laura and Jalava Sanna.

Zelbst, P. & Sower, V. E. (2016). RFID for the supply chain and operations professional. Second edition. New York, New York (222 East 46th Street, New York, NY 10017): Business Expert Press.

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