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STM EFFICIENT FLOW

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Table of Content

1 General Information

1.1 Scope and Purpose

Sea Traffic Management connects and updates the maritime world in real time, with efficient information exchange. STM´s goals are to create a safer, more efficient and environmentally friendly maritime sector. In relation of the year 2015, STM aims to reduce accidents by 50%, reduce voyage costs by 10% and reduce waiting time for berthing by 30%, and lower the fuel consumptions and greenhouse gas emissions by 7% by the year 2030.

STM services allow on-board and on shore to make decisions based on real-time information. These services enable more just-in-time arrivals, right steaming, reduced administrative burden and decreased risk related to human factors. Examples of STM's services are:

- Route optimization services
- Ship to ship route exchange
- Enhanced monitoring
- Port call synchronization
- Winter navigation

STM reduces the risks and makes the maritime transport chain more efficient. The beneficiaries are various shipping actors such as cargo owners, port actors, bridge officers, service providers, ship owners and authorities.[1]

The scope of the final D.T1.12 is to collect information from main Deliverables what have been created and reported during EfficientFlow project duration from 2018 to 2020.

Deliverable T.1.1 defines the 'Current Situation' and the 'Desired Target Mode' as described in activity T1.1 of Work Package T1 'Port Flow Optimization'. The report aims to serve as a reliable foundation for establishment of business model and business logic as well as development of governance structure for enhanced collaboration between the multiple actors and to sustain the Sea Traffic Management Concept in the ports of Rauma and Gävle.

The scope of D.T1.2 "Business model and business logic" is to introduce optimized and more efficient business model by conducting a thorough analysis of the business model and the business logic currently in use in the ports, between the port call actors and including the logistics chain. For this purpose, the ports of Rauma and Gävle will be used as a pilot port. The suggested business model offers better utilization of the fixed assets through real-time information sharing that leads to an improved time and resource management. The business logic described in this report is valid not only for the pilot ports, but for any other port. This report also is to provide reliable basis for establishment of a local governance structure for enhanced collaboration between the multiple actors as stated in Activity A.T1.3 'Establishment of local governance structure'.

The D.T1.3 "Establishment of local governance structure" aims at creating a platform for collaboration between port call actors involved in the port call process. Local governance structure describes a framework for exchanging information. It plays vital role in supporting the collaboration

[1] https://www.seatrafficmanagement.info/about-stm/

between the different actors by assigning them suitable roles. By accepting the role, each actor accepts certain duties and responsibilities. It has to be considered that the different partners may have different priorities. Therefore, the Local Governance's vision, mission and strategic objectives have to be adequately communicated, well understood and accepted by all partners in order to avoid any partnership disturbances and governance issues.

The purpose of D.T1.4.1 "Software Architecture Document" to provide an architectural overview of the new ICT solution supporting the collaborative decision making and the information exchange between the port call actors, between the ports and their hinterland operators (rail and road) and between the ports and the ships. By implementing the ICT tool in practice, the participants in the whole logistics chain will benefit from the following value-adds:

- Improved information exchange
- Increased situation awareness
- Better planning and coordination
- Optimized processes
- Time and costs savings
- Flexibility in case of non-expected events

The new ICT tool has the potential to reduce the lead times by eliminating the waiting times through digitalization of the data handling processes and interconnecting all players into an integrated and synchronized real-time information sharing platform called Port Activity App.

The scope of D.T1.6 "Study on information flows for Intermodal sharing of information" is to make study on intermodal information sharing between key stakeholders of port and hinterland logistics operators. The purpose of the study is to verify how the information sharing is working and identify areas for improvement.

The D.T1.9 "Testbed" document presents the testing of Port of Gävle (Port Activity Gävle) and Port of Rauma (Port Activity Rauma) Efficient Flow applications. For the first time ever this type of port applications are published, so extensive testing was expected to be needed. Port of Rauma, Port of Gävle and SAMK personnel were the first testing groups and after corrections other port stakeholders joined the testing groups. Due to the feedback from stakeholder of the ports new features was ordered as additional orders as following. Various tests have been initiated for both applications by several actors (students, SAMK personnel, port actors) to do a complete and thorough examination, reflecting real-life situations.

The results of the tests have been utilized to make both applications perform better and to be more user-friendly, for fixing critical bugs and to validate data from different sources and making sure the data is up to date. The purpose of this document is to present the test methods for different test groups, what kind of tasks and goals each test group have had, results that have gotten and finally analysing and evaluating the results.

The purpose of D.T1.10 "Identification of indicators" is to identify indicators for analysis and evaluation. The selected indicators will be used as a basis for decision making in the local governance structures in the ports of Rauma and port of Gävle as well as for marketing and dissemination purposes. The indicators were determined by carrying out the following activities:

- multiple workshops between the partners
- multiple workshops between the partners and port call actors
- interviewing of port call actors

- reviewing literature

The D.T1.11" Collection of data for analysis and evaluation" presents collection and analyses of port call data aim to reveal the impact of the Rauma & Gävle Port Activity Application. Port Activity Application is not the goal of Efficient Flow-project. Efficient Flow T1 aims to make port calls 7% more efficient in comparison to the past without the use of various tools and functions established through the development of Efficient Flow T1 and T2. However ambitious the 7% is, it is noteworthy, that the Port Activity Application is a tool to achieve the 7%, not the goal itself. Therefore, as the aim of this document is to collect the data that illustrates the increased efficiency and reflection to named port call activities. Port Activity Application, at best, is only as good as the people who use it. All the measures taken in the port and on-board vessels to increase the efficiency of the port calls are known long ago. The real impact of the port activity application is not to invent new measures, but to attract users to share information for the effective timing of the formerly known activities. Finally, all evaluations based on the performance of the Rauma & Gävle Port Activity Application should be monitored through the user of the application.

All improvements to the efficiency of the operations aim eventually to save money. Rauma & Gävle Port Activity Application increases shared situation awareness of the operations, but with limited to none effects to safety. Value added is behind the improved business cases of the stakeholders. Rauma & Gävle Port Activity Application has to be attractive to the point of saving money and reducing environmental impact. Only by doing so, it can reach user quantities that are on the level of creating a meaningful impact on the overall pool of individual port activities.

This document collects data with various methods including interviews, logbook entries, enterprise resource planning systems, and Rauma & Gävle Port Activity Application.

1.2 Structure of the document

This document is organised as follows:

Part 1	general information about the scope and the purpose, list of the abbreviations and definitions used
Part 2	introduce the needs for analysis and evaluation in both ports
Part 3	describes the analysis and evaluation methodology in detail
Part 4	introduction of the Port of Rauma
Part 5	introduction of the Port of Gävle
Part 6	presents the analysis results from Deliverable T1.6.1 "Report on intermodal sharing of information"
Part 7	presents the analysis results from Deliverable T1.9.1 "Tested report" as an input to the analysis and evaluation

Part 8	analysis (presents KPIs results) Deliverable T1.11.1 “Collected package of data”
Part 9	presents the project’s results evaluation conclusion of everything

Abbreviations

AAPD	Average Arrival Pilot Duration
AC	Activity Completed
ACG	Arrival clearance Granted
AIS	Automatic Identification System
ALD	All Lines on Deck
ANWT	Actual Net Working Time
APAWAY	Arrival Pilot AWAY
APCA	Actual number of Port Call Actors
APD	Arrival Pilotage Duration
API	Application Programming Interface
APOB	Arrival Pilot On Board
AT	Actual Time
AT	Actual Time
ATA	Actual Time of Arrival
ATD	Actual Time of Departure
ATMF	Arrival Tug Made Fast
B	Berth
BBS	Best Behavioural Safety
BD	Berthing Duration
CMNP	number of Correct/Total ICT tool Messages in the Next Period
CMPP	number of Correct/Total ICT tool Messages in the Previous Period
COC	Cargo Operations Completed
COF	Cargo Operations Finished
DCG	Departure Clearance Granted
DI	Document Issued
DPAWAY	Departure Pilot AWAY
DPD	Departure Pilotage Duration
DPOB	Departure Pilot On Board
DTMF	Departure Tug Made fast
DWT	Deadweight Tonnage
ECDIS	Electronic Chart Display and Information System
EDI	Electronic Data Interchange
EF	Efficient Flow
EMEA	Europe, the Middle East and Africa
ERP	Enterprise Resource Planning

ET	Estimated Time
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
ETR	Estimated Time of Readiness
ETS	Estimated Time of Sailing
FLA	First Line Ashore
GHG	Greenhouse gas
ICT	Information and Communication Technology
IMO	International Maritime Organization
IT	Information Technology
JIT	Just-In-Time
KFA	Key Focus Area
KPA	Key Performance Area
KPI	Key Performance Indicator
KPO	Key Performance Objective
KPT	Key Performance Target
LGS	Local Governance Structure
LoLo	Lift on/Lift off
M2M	Machine to Machine
MCP	Maritime Connectivity Platform
MNP	number of Messages in the Next Period
MNWT	Maximum Net Working Time
MPP	number of Messages in the Previous Period
MSW -	Maritime Single Windows.
MWT	Maximum Working Time
PAA	Port Activity App
PBP	Pilot Boarding Place
PCS	Port Community System
POB	Pilot On Board
PortCDM	Port Collaborative Decision Making
PS	Pilot Station
PTA	Planned Time of Arrival
RCA	Root Cause Analysis
RoRo	Roll on/Roll off
RTA	Requested Time of Arrival
SAD	Software Architecture Document
SCRS	Ship is Clear and Ready to Sail
SD	Shifting Duration
SFC	Specific Fuel Consumption
SMA	Swedish Maritime Administration
SMFNB	Ship Made Fast on the New Berth
SPCOD	Ship is Ready for Cargo Operations

SPDD	Ship ‘s Preparations for Departure Duration
SRCO	Ship Ready for Cargo Operations
SRS	Ship Ready to Sail
SSB	Ship Service Begin
SSF	Ship Service Finish
STM	Sea traffic Management
StoRo	Stowable RoRo
SU	Single Up
SUOB	Ship Single Up on the Old Berth
T%	Target percentage
TA	Tug Area
TCP	Terminal Commence Preparations
TEU	Twenty – foot Equivalent Unit
TOS	Terminal Operator System
TPCA	Total number of Port Call Actors
TPD	Terminal’s Preparations Duration
TRCO	Terminal is Ready for Cargo Operations
TTD	Target Time Difference
UBD	Un-Berthing Duration
WC	Work Commenced
WF	Work Finished
WP	Work Package

2 Introduction

The overall objective of the EfficientFlow project is to improve the flow of goods and passengers through the two corridors of Gävle-Rauma and Stockholm-Turku by implementation of Sea Traffic Management.

Sea Traffic Management (STM) is an answer to the need for improved efficiency in maritime transport; within port areas as well as between ports. The STM concept takes a holistic view on services within maritime transport, from quay to quay. STM is a concept for optimizing the processes, interaction between stakeholders and exchange of information. Improved exchange of information is an important facilitator for increased situational awareness, shortened lead times in the port call process and thereby improved efficiency, safety of navigation and environmental performance. STM has been defined in the MONALISA 2.0 project and is validated in the STM Validation Project. EfficientFlow is built on the outcomes from these two projects.

The EfficientFlow project applies new ICT tool in the ports of Gävle and Rauma. The aim was to improve the efficiency in the corridor and facilitate increased information exchange between ship and ports, between the ports and between ports and hinterland operators in order to ensure increased and efficient transport flows. STM concept consists of business models, processes, message standards, and ICT tools. Experiences and best practices from the STM Validation Project were utilized in the implementation of the Work Package.

The WPT1 main objective is to enhance the collaboration between the multiple port call actors and to sustain the Sea Traffic Management Concept in the ports of Rauma and Gävle. In the long run this also includes the connection to approaching vessels and synchronizing of their port visits and the connection to Hinterland operators.

In the application we state that we will implement a “new ICT-tool” for this purpose and the desired target mode will be what this tool will accomplish. If we go through the workshop’s outcome in the D.T1.1 we quickly can identify that both ports, see a need for improved information sharing and that there is a challenge to determine Estimated Times. With STM and Port Call Optimization, that the port call actors share timestamps between each other, a better predictability and improved situational awareness will be the result, based on what we have experienced in earlier projects (STM Validation Project). With the content of this report in mind, next steps have been identified and to be able to perform this information sharing a new ICT-tool that integrates/connects port call actors systems is something that there is a demand for from the ports.

Vessel crew could download the Port Activity Application and, in the future, enter the timestamps into the service with PPA in the unlikely event of the STM tool malfunction. Additionally, smart phone application allows vessel key personnel to have access to PAA without the necessity to intervene with ECDIS in the unlikely event of ECDIS malfunctioning. This would increase redundancy of information sharing. A timestamp is representing activity in the sequel of actions

when the vessel is closing to a port or departing from it. From the vessel crew perspective, the decision making, and related reporting activities are mostly related to the schedule of the vessel, as in, when is the vessel expected to arrive to port. ETA and ETD information is included in the active (monitored) route's schedule and shared through STM ECDIS. This again reflects the adjustment of the vessel speed and maintaining awareness of effects to the schedule, and finally forwarding that information to whom it may concern. The crew has an import role to play to apply for a vessel specific slot time. The crew will use the STM-module on-board as embed to vessel ECDIS, or alternatively the JIT (Just In Time) web application for non STM-compliant vessels.

The value-added for the vessel staff is related to the evaluation of whom should be informed of the vessel activities and when. In practice, pre-determined group of authorised recipients are informed about adjustment of the vessel's speed directly from the STM-compliant ECDIS through change of the schedule. When a timestamp is entered into the Rauma & Gävle Port Activity Application using STM compliant ECDIS system, a data entry is automatically generated to all necessary stakeholders. Previously, a portion of Rauma & Gävle Port Activity Application tasks was appointed to the vessel agent utilizing PAA. Following paragraphs concentrate on the role of the vessel agent.

Formerly, the crew has forwarded ETA information to the vessel agent, who has been solely responsible for the practical actions towards the arrangement of the correctly timed services in the port. This usually includes but has not been limited to:

- pilot booking
- Portnet reporting
- tugboat services
- quay side reservation
- linesmen
- stevedoring reservations
- cranes and lifting services
- bunkering services
- cargo forwarding services
- customs clearance
- immigration clearance
- crew declaration
- stores declaration
- freshwater deliveries
- ships chandler contacting
- crew change arrangements
- spare parts needs
- medical assistance

It can be generally understood that the character of vessel agent is centric to successful port call of a vessel, both in operational and regulatory context. Closer inspection to the pragmatic actions of the vessel actions reveal the true nature of the work scope, connecting people. Information sharing is a necessity that someone must take care of, and to date this task has been primarily with the vessel agent. However well Rauma & Gävle Port Activity Application

performs, it will never release the shipping agent from his/her duties as there still exists multiple actions that are not just data and information sharing, but practical formalities related to for example crew change arrangements Finally, PAA could potentially have a role in removing reporting obligations to governmental bodies and ports.

Maritime pilots are local experts guiding the vessel through the congested fairways safely and efficiently to the port for loading and unloading of the cargo and passengers. Pilots are crucial for the safe and efficient conduction of maritime safety-critical operations. In accordance with the applicable legislation and national regulatory framework, piloting providers determine the unit price, the reduced unit price and other possible commission fees related to pilotage. The pilotage fee is based on the tonnage of the vessel in question and the distance to be piloted. The pilotage fee is charged for each beginning nautical mile.

If the pilot has arrived at the vessel or pilot station as requested, but the pilotage does not get underway within an hour of the pilot's arrival, the vessel shall be charged a standby fee until the pilotage begins or the pilot departs from the vessel or pilot station. The standby fee in Finnish territorial waters is EUR 500 for each new hour beyond the initial hour. In Swedish territorial waters equivalent fee is bound to the particular vessel's normal pilotage fee. As stated in the Swedish Maritime Administration regulations on the provision of pilots, ordering of pilots, allocation of pilots and pilotage fees: established on 19 September 2019: *"If a vessel has not arrived at the agreed boarding place or is not ready to leave harbour or other place at the agreed time, charging for pilotage will still start at the agreed time."*

If the pilot is notified on the route to the vessel, when he arrives at the vessel, or during the standby period that the ship will not employ a pilot, the vessel shall be charged a minimum standby fee of two hours. A minimum cancellation fee of EUR 1,000 will be charged within Finnish territorial waters and a fee of three pilotage hours according to the vessel gross tonnage in Swedish territorial waters. [2]

The result of this Deliverable must however be easy to understand and to use and the challenge ahead is to limit ourselves and do the complicated as easy as we can. Therefore this Deliverable will be highly valuable continuing the process of implementing and sustaining Sea Traffic Management in the ports of Rauma and Gävle.

[2] https://finnpilot.fi/wp-content/uploads/2019/12/Pilotage-Fees-2020.pdf Swedish Maritime Administration regulations on the provision of pilots, ordering of pilots, allocation of pilots and pilotage fees: established on 19 September 2019.

3 Analysis and Evaluation methodology

In general evaluating a project means performing a rigorous analysis of completed goals, objectives and activities to determine whether the project has produced planned results, delivered expected benefits, and made desired change. As a process, project evaluation takes a series of steps to identify and measure the outcomes and impacts resulted from project completion.

The evaluation in this deliverable covered all activities of the EF WPT1 that had concluded or were in their closure period by the 30 NOV 2020. This amounted to 11 concluded project activities, which were sufficiently far along in implementation terms to be evaluated, plus an additional project activity related to WPC.

WP T1 Port flow optimization

Activity T1.1 Definition of current situation and desired target mode (The aim of the Activity is to development of business model, business logic, governance, processes etc. for enhanced collaboration between the multiple actors and to sustain STM in the ports.)

Deliverable T1.1.1 Documented Zero mode and desired mode

Activity T1.2 Business model and business logic (The work will be carried out through workshops (joint between actors in the two ports as well as individual workshops in the respective ports). The workshops will be prepared and the result of the workshops documented.)

Deliverable T1.2.1 Documented Business Model and business logic

Deliverable T1.2.2 Workshops

Activity T1.3 Establishment of local governance structure (Create an arena for collaboration between the multiple actors involved in the port call process, a framework of exchange of information and knowledge building, port call process dev, rules for sharing info.)

Deliverable T1.3.1 Document on agreed local governance structure

Activity T1.4 Preparation of use case and Software Architecture (This activity aims at prepare for the procurement of a technical solution for PortCDM in the ports of Gävle and Rauma by identifying and describing use cases and preparation of a software architecture doc.)

Deliverable T1.4.1 Software Architecture Document (SAD)

Activity T1.5 Procurement of a PortCDM solution (This activity encompasses the preparation of procurement package, tender, evaluation, contracting and testing (in factory and on site) for the respective port.)

Deliverable T1.5.1 Procurement Documentation for Gävle respective Rauma

Deliverable T1.5.2 Contract

Deliverable T1.5.3 Port CDM IT solution (Gävle and Rauma, Delivered by Feb 2019)

Activity T1.6 Study on information flows for Intermodal sharing of information (The activity encompasses the identification of use cases and common information flows as well as mapping of selected key stakeholders with regular rail/road traffic flow to/from the ports.

Deliverable T1.6.1 Report on intermodal sharing of information

Deliverable T1.6.2 Meeting with external stakeholders

Activity T1.7 Planning for automated ordering and planning of pilotage services (The activity encompasses tasks like analysis of processes preparation of use cases and operating procedures, identification and analysis of business model and preparation of the SAD.)

Deliverable T1.7.1 Documented pilotage planning and ordering process

Deliverable T1.7.2 Software Architecture Document (SAD)

Activity T1.8 Procurement of a system for automated ordering and planning of pilotage services (A public procurement will be made in order to develop and implement a prototype of a new innovative ICT tool to support the pilot order and planning.)

Deliverable T1.8.1 Tender documentation

Deliverable T1.8.2 Contract with supplier

Deliverable T1.8.3 Thematic meetings.

Activity T1.9 Testbed (The STM solution in the ports and onboard selected ships calling the ports will be made operational and the testing will be carried out in the normal operations of the actors involved in the port calls, including the selected ships.

Deliverable T1.9.1 Tested report as an input to the analysis and evaluation

Activity T1.10 Identification of indicators for analysis and evaluation (The results will be used as a basis for decision making in the local governance structures in the two ports as well as for marketing and dissemination purposes.)

Deliverable T1.10.1 Report with identified follow-up indicators

Activity T1.11 Collection of data for analysis and evaluation (The data will be collected from identified sources, both quantitative and qualitative.)

Deliverable T1.11.1 Collected package of data

Activity T1.12 Analysis and Evaluation for dissemination (The results of the analysis will be used for improvements of processes and in promotion and marketing of the developed and improved corridor.)

Deliverable T1.12.1 Report with analysis of achieved value compared with the value proposition

Activity T1.13 Work Package Coordination (In the lifetime of the Work Package, a number of coordination meetings (online and face-to-face) will be organised to discuss and if necessary, take actions on the progress of the WP.)

Deliverable T1.13.1 Meeting documentation

Deliverable T1.13.2 Coordinating meetings (Held biweekly)

Deliverable T1.13.4 Meeting with external stakeholders.

Deliverable T1.13.5 Thematic meetings

Activity T1.14 Joint workshops on technical realization

In order to analyse the EfficientFlow objectives and the extent to which they have been reached however, it was covered those project activities that had results of the using and implementing new Port Activity App. Hence, a lighter assessment of activities D.T.1.6, 1.9 and 1.11 have been included in the specific objective -level analysis. The main stakeholders were included in the group of workshops, interviews and have been participated testing and launching event.

Extensive analyses and evaluations have been carried out within the above activities and an extensive exchange of gained experiences was done, including training and improved operational procedures. Outcome of the WPT1 and Efficient Flow project (ICT tools, guidebooks, steps on how to work) was done as open source, freely available and will be spread widely to all interested stakeholders.

4 Introduction of port of Rauma

Port of Rauma is the fourth largest general harbour in Finland and the largest container port on the west coast of Finland. In addition to containers, also Ro-Ro, Lo-Lo, bulk and liquid bulk cargoes are handled. Rauma is also well known for their expertise in handling of project cargo. Port of Rauma has more than 20 weekly departures – mostly to the main ports in Europe, United States and Far East.

The Port of Rauma situates on the West coast of Finland and is the one of the country´s largest ports handling approximately 6 million tons of cargo during year 2019. The prestigious so-called old city – Rauma centre– got, in year 1991, designated as one of UNESCO's World Heritage Sites. Rauma grew its importance as a Center of shipbuilding, pulp and paper mills and metal industry after the Second World War, which was catalyst for fast growth within Finnish industry. Presently Port of Rauma still exports timber and other wood products.

Facts and figures:

- 5,83 million metric tons in total
- of which 4,06 million tons exported
- 1,7 million tons imported and
- 0,08 million tons national transportations
- Including 2610000 TEU containers translating in to 2,1 million metric tons in containers
- 115 hectares of land space
- 260 thousand square meters of covered space for general cargos
- 30 thousand square meters of heated warehouses
- 230 thousand square meters of bulk cargo warehouses
- total of 20 berths
- silo capacity for 175 thousand tons
- capacity to store 560 thousand cubic meters of chemicals and oil
- the Container Terminal in the Port of Rauma covers about 14 hectares
- the Chemical Harbour and the Oil Harbour support liquid bulk cargoes

During year 2019 there was growth in number of sea vessels and also in their size which was made possible by the increased depth of the sea lane to 12 meters. Port of Rauma had in total 1087 ship visits during the year.

Route 8 connects the cities in the Gulf of Bothnia from Turku to Rauma and Pori all the way up to Oulu and Tornio. Route 12 connects Rauma to the hinterlands via Tampere. The ports along this important cargo and passenger traffic route cover approx. 40 % of Finland's import and export cargo shipments. The rail line between Rauma and Kokemäki is part of the Finish trunk railway and carries freight approx. 2.5 million tonnes per year.

As port authority, the Port of Rauma are in charge of maintaining and developing the port infrastructure, vessel water and waste management and area safety and security.

5 Introduction of port of Gävle

The Port of Gävle is located at the coast of Gulf of Bothnia and approximately 150 km north of Sweden´s capital Stockholm. In comparison with other ports in the country, Port of Gävle ranks in the top ten within combined cargo and in container cargo third biggest within Sweden.

Strategically located, two hours north of Stockholm and right next to the industrial Central Sweden region, Port of Gävle is a natural Swedish east coast hub for import and export of goods. Large vessels can call at the port efficiently for quick loading and discharging at the container terminal, bulk terminal and energy port/terminal. Port of Gävle have first-class road and rail connections, with comparably little traffic and queues, which makes it easy for goods owners in Stockholm and Mid Sweden to export and import via the port.

All global container shipping companies use Port of Gävle and the around the clock open hours expanding container port is very reliable and flexible. The container terminal is operated by a dedicated rail shuttle ("ContainerExpressen") between Port of Gävle and the intermodal terminal Yilport Stockholm Nord, in Rosersberg, just north of Stockholm.

The bulk terminal handles materials and supplies to the primary industries (for example china clay, alloys, scrap, concentrates and biofuels) as well as project cargoes where requirements on the lifting capacity and intermediary store area are high (for example wind turbines).

The energy port/terminal is one of Sweden's largest with all the biggest petroleum and chemical companies represented. The energy port handles for example gasoline, diesel, fuel oil, vegetable oils, ethanol and chemicals for the primary industries. Gävle energy port/terminal also have a very important function by supplying Stockholm Arlanda Airport with its jet fuel needs through two daily rail shuttles.

Facts and figures:

Owner: The municipality of Gävle

- TEN-T (Comprehensive)
- Terminal operator (container and dry bulk cargo): Yilport
- 900 ship port calls annually
- 300 trucks daily
- 38 000 railway wagons annually
- Fairway/channel (Holmuddsrännan) water depth 13,4 meters (maximum draft allowed 12,2 meters at normal water level)
- 2 800 meters of quay
- 170 000 square meters of warehousing
- 1 000 000 square meters of storage space

- Energy terminal storage volume: 850 000 cubic meters, divided between some 150 shore tanks as well as six underground caverns with a total storage volume of 750 000 cubic meters
- 20 ha available land in connection to the port
- 6 terminals (the container terminal, the bulk terminal, the combi terminal, the Granudden terminal and the energy port/terminal with the oil terminal and the chemical terminal)
- 6 million tonnes of goods handled every year
- The largest container terminal on the east coast and the third largest in the Sweden
- Container terminal total throughput 230 000 TEU annually
- ISO certified 9001 and 14001

The terminals serve mainly the wood and steel industries and handle also liquids for i.e. the needs of Arlanda international airport. Train transportation plays a remarkable role in the land logistics and in average approximately 20 trains leave the port each day. Sea lanes to the port have been improved in the past years allowing sea vessels with beam of 42 m and draught of 12,2 m to enter the port. This allow bigger payloads to be transported and also leaves bigger tolerances for challenging weather conditions.

6 Analysys of the D.T1.6.1 'Study on information flows for Intermodal sharing of information'

A study on intermodal information sharing was conducted as a part of the EfficientFlow project. The focus of the study is on intermodal information sharing between key stakeholders of port and hinterland logistics operators. As the Port Activity application developed by the project is a big step in digitalization of the port operations the report is also looking ahead presenting port digitalization concept.

The study was conducted starting with desktop work and literature review. Several live and recorded webinar presentations and white papers on related topics were visited to grasp the latest developments in the area.

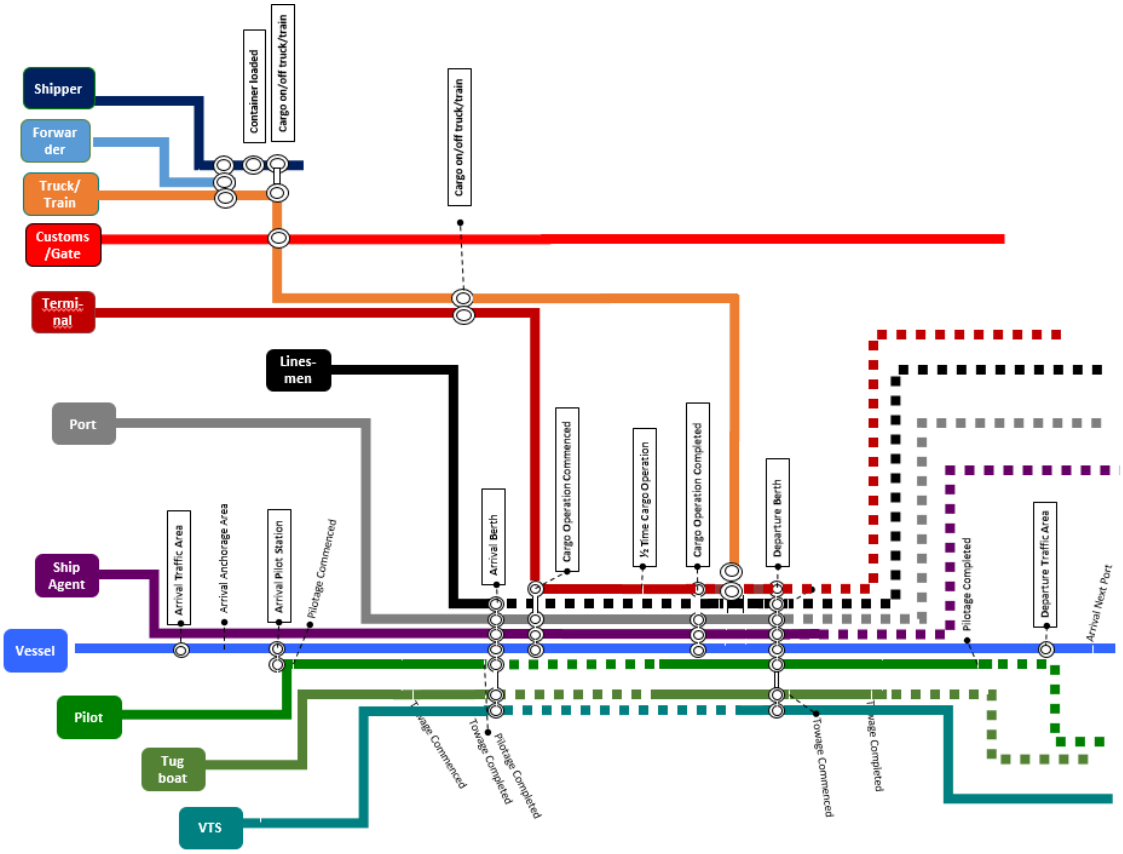


Figure 1. Port call & hinterland Metromap

The main approach of this study focused on the information flows between the port operators and relevant hinterland logistics operators (trucks and trains). To illustrate this, a stakeholder Metromap including hinterland logistics operators was developed. The Metromap proved to be useful when explaining the interconnection between the port and hinterland in the auditions where EF APP presentation was used.

Initially the timely target was to conduct the key stakeholder qualitative interviews during springtime 2020 as face-to-face meetings and discussions. Due to the CoVid-19-epidemic

outbreak, this plan was however put on hold and the semi-structured interviews were eventually held online. Finally, it was decided to make the presentations and have discussions with relevant and interested hinterland stakeholders during May and June 2020 before the summer break. Report based on findings and auditions was finalized during autumn 2020.

6.1 Key stakeholder auditions in Finland

A series of interviews with Hinterland-logistics operators was conducted to gain understanding on what information and how this information is dealt with. These interviews followed the same basic structure to maintain comparability and simultaneously allowing flexibility in the discussion to let brainstorming-like ideas to emerge.

The basic structure of the presentation and audition was as follows:

1. Presentation of the main project
2. Presentation of the Hinterlands Work Package
3. Metromap presentation
4. Port Activity application
5. Timestamps
6. Discussion agenda
    - Q&A
    - Interested?
    - What timestamps do you find useful?
    - Any further timestamp information which could be useful?
    - Any Hinterland timestamps available which could be provided to the port app timestamps?
    - What kind of information/location data/timestamps would you believe should be added to aid your day to day operations and streamline your logistic operations

Slideshow presentation used during the auditions can be found in D.T1.6.1.1. reporting document.

A clear finding of the auditions was that the hinterland logistics operators had some interest in the Port Activity Application as it is now but were hoping for development of it to better support information need. In relation to arriving shipments the stakeholders had some interest in ETA and ATA information of ships provided. This information is however also generally available in the web pages of the ports and thus using the application only for this would not create much additional value.

When considering outbound shipments, the Information on estimated time of departure (ETD) or actual time of departure (ATD) of vessel provided by the application do not either have much relevance for operational nor planning purposes of hinterland operators as cut-off time for delivering a container to the port is generally several days before departure of the vessel. The most critical factor in shipping containers outbound at Rauma port is also related to the availability and booking of the container as the booking process currently is manual and need to be done by e-mail or phone.

As most of the operators served many ports one challenge identified was also that each port has their own application.

There is as previously mentioned however a genuine interest in developing the digitalization and automatization supporting the connectivity of hinterland and port operations further. To add further value for the hinterland operators relevant Estimation to complete (ETC) information related to the arriving container or cargo status should be added to the application. Also information related to availability of empty containers should be digitalized and in accessible format. This information is available in digital form in operational systems of parties operating in the port but not yet directly visible or accessible for external parties.

The Port operator in Rauma has not yet data on unloading or availability of container for pick-up by trucking company. They are however developing e-service solutions.

For the railway company information related to the capacity situation of the terminal operations is crucial for planning and operational purposes. Development of digital and automated information sharing on this subject would be highly appreciated.

Feedback from PoR stakeholders https://youtu.be/odpqz676smE

6.2 Key stakeholder auditions in Sweden

A series of interviews with Hinterland-logistics operators was conducted to gain understanding on what information and how this information is dealt with. These interviews followed the same basic structure to maintain comparability and simultaneously allowing flexibility in the discussion to let brainstorming-like ideas to emerge.

The basic structure of the presentation and audition was as follows:

1. Presentation of the main project
2. Presentation of the Hinterlands Work Package
3. Metromap
4. Port Activity application
5. Timestamps
6. Discussion agenda
    - Q&A
    - Interest for the Port Activity Application?
    - What timestamps do you find useful?
    - Any further timestamp information which could be useful?
    - Any Hinterland timestamps available which could be provided to the port app timestamps?
    - What kind of information/location data/timestamps would you believe should be added to aid your day to day operations and streamline your logistic operations?

Slideshow presentation used during the interviews can be found in D.T1.6.1.1. reporting document.

The result of the auditions in Sweden was supporting the findings of Finland. That is hinterland logistics operators had little interest in the Port Activity App as it is now. The stakeholders in Sweden had some interest in estimated time of arrival (ETA) and actual time of arrival (ATA) information of ships provided but this information is also generally available in the web pages of the ports and thus using the application for this would not create real value.

As in Finland the Information on estimated time of departure (ETD) or actual time of departure (ATD) of vessel is not very relevant for operational nor planning purposes of hinterland operators as cut-off time for delivering a container to the port is generally several days before departure of the vessel. The most critical factor in shipping containers outbound at Gävle port is also related to the availability and booking of the container as the booking process currently is manual and need to be done by e-mail or phone.

As the information sharing process currently also in Sweden is quite manual there is, based on interviews conducted, a genuine interest from the hinterland operators to develop the digitalization and automatization supporting the connectivity of hinterland and port operations further. As in Finland to add further value for the hinterland operators relevant Estimation to complete (ETC) information related to the container status should be added to the application.

The railway operator in Sweden was very interested in developing the data sharing further. This would greatly help the planning of logistics operations both inbound and outbound. As the volumes with railway transportation are generally bigger the need for information supporting planning well beforehand would be welcome. When collecting containers from the port further information on transportation capacity required (weight/ volume) and unloading sequence to plan the setup of trains and wagons would greatly support smoother operations.

The Port operator in Gävle has data on unloading or availability of container for pick-up by trucking company available in their terminal operating system and is working on extending the data to include estimated time of completion ETC information.

6.3 Conclusions

Intermodal sharing of information is crucial when managing intermodal logistics. Digitalization can typically be initiated at the port managing and automating information flows within the port and between the port and the vessels.

The development of the Port Activity application is definitely a prominent step forward on the Port digitalization roadmap. From the view of managing the whole intermodal flow efficiently this is a good start and need to be extended to managing information flows with the hinterland and between ports connecting all the logistics operators handling the goods and other stakeholder including both shipping parties.

6.4 Observations and findings

It is vital to ensure efficient information sharing between operators within the intermodal logistic chain, to achieve the potential benefits of this transportation method.

Intermodality provides the possibility to choose the most effective method of transportation in respect of economics, lead time, reliability, and time management. All these factors' effectiveness is affected by correct and timely information being available to all operators within the delivery chain.

During the study it was observed that centralized and automated information exchange methods in the scope of the study had been minor before implementing the Port Activity Application developed by the project. Methods of gaining crude or precise information varied from operator to operator. The potential to develop information sharing to support operations has however been identified and activities to digitalize and automate operations are ongoing and being planned further.

Within the frame of logistics in this study, information was still fragmented to several locations, methods gaining information are numerous and information sharing occurred mainly between neighbouring operators in the supply chain. Predictability would be increased if information, especially change information, would be available from two or three nodes for allowing more time for the operators to adopt in changed timetables or other affective occurrences.

Studies show that to gain optimal benefit from intermodal transportation, end to end information of current state of the container should be readily available as well as information of circumstantial deviation leading to changes in the activities further in the supply chain. These were also items raised by the interviewed actors as needing development.

Situational information of the transportation includes geographical locational data of the container, which forwarder, which transportation method, which vehicle, location of the container on the ship, neighbouring containers, unload sequence.

At the moment data regarding the container or other cargo for transportation is not easily available, it is not always precise and methods of gaining this data varies. Intermediate information sharing between nodes needs to be further developed. For instance, a container is shipped from Gävle to Rauma by a sea vessel and at Rauma port the following trucking forwarder takes over the transportation from Rauma port onwards. The trucking forwarder has semi-reliable information of which sea vessel the container will be loaded on and what the estimated ETD and ETA are.

Final confirmation of the loading is not updated as well as not deviations in ETA due to weather, technical breakdowns or other variables affecting the transportation schedule.

At present, forwarders gather information on cargo status with differing methods, which are often manual, inefficient and not very accurate. Due shipment status not being automatically updated in a centralized fashion, forwarder rely on very traditional methods, including person to person telecommunication combined with manual searches in databases. This is time and resource consuming, which is also identified by these forwarders.

Forwarders also rely on information based on causal experience and third-party information. For instance, a trucking company might interpret weather forecasts to judge if the ship is able to dock in schedule or not. Decisions regardingly are made by the Captain on the vessel, but information is not distributed to the supply chain to parties impacted by such decisions.

Approximative un-loading schedules of containers from ship to harbour are not available, estimates are made based on the weight of the container to be forwarded.

Port operators in both Gävle and Rauma have proved that the developed Port Activity application has had tremendous effects in improving efficiency in the ports. Some hinterland operators also stated that some of the information currently available with the application supports their operations and most of them would be very interested in future development possibilities of the application and other PCS solutions supporting port and hinterland digitalization and automatization.

There is need for interoperability and data harmonisation between various ICT tools/systems, with the aim to provide appropriate actors, involved in port call and hinterland operations with timely and reliable data and communication.

The PAA in port of Rauma has also a Logistic module providing gate timestamp information on the trucks entering and exiting the port. This module could possibly be developed further to provide data also related to the containers/cargo status.

Based on the study findings and results of the project major development and steps in digitalization has been achieved with development of the Port Activity Application (PAA). VTS Finland taking ownership of the developed applications future in Finland also proves credibility of the application and secures to the future evolvement of the application and port digitalization.

In Sweden the considerations related to the ownership on PAA, future promotion and distribution to Swedish port is still ongoing.

7 Analysys of the D.T1.9.1 'Testbed' results

7.1 Test methodology

First the Unikie company provided the preliminary test for the PAA Rauma and Gävle. After this several tests have been initiated for applications in both ports, Rauma and Gävle. Information exchanging have been kept during all testing process between project partners and Unikie. Test methods have been practical and involved students, personnel from SAMK and port actors. During and after the tests, feedback has been gathered and reported forward to Unikies' development unit. Collaboration between PoR and PoG were very fruitful and certainly will continue after EF project.

Before each test group, there were certain goals and tasks for the testing, such as;

- Usability testing for the user interface of the applications
- Integration testing for validating the data from different sources
- System testing to identify server capabilities for multiple users at the same time
- Security testing to see applications' GDPR compliance
- Bug-hunting for finding the most critical bugs and misfunctions

Depending what the goals were, different tasks for the test group was decided. Different tests were made within the same groups. Some test groups received how to -instructions for the applications, others did not. That was on purpose to see if the users can actually perform tasks without having any information about the applications beforehand. This, for example, was part of the usability testing.

For some test users were given real-life situations to perform in the application to see how it will meet the purposes of the real port infrastructure. Obviously, we´ve had actual port actors to test the application in their everyday work, too.

7.2 Test report of the PAA Rauma and Gävle by UNIKIE

Unikie worked in the SCRUM framework, in 2 weeks sprints. Sprint content was defined in sprint planning sessions. After each sprint Unikie had a sprint review for all stakeholders. At the end of each sprint implemented features and bug fixes were deployed to the testing environment. Unikie followed Agile methodology and key elements were continuous integration (CI), continuous testing (CT) and continuous deployment (CD). This ensured that progress was visible to all stakeholders as soon as possible. This also kept the project on the correct track throughout the project.

7.3 SAMK personnel test results

Dozens of bugs were found and recorded during the SAMKs use case testing. These were helpful in developing more reliable and robust application. However, one key finding was that not all the information received by the app via integrated interfaces were up to date. The Port activity application and its testing revealed that the data from different stakeholders is not always reliable and has not been updated by the ones responsible.

7.4 Port of Rauma PAA test

The basic principle of Port Activity App will be that port actors share their estimated and actual times regarding certain states in the port call process as a minimum set of data. Port Activity App has several interfaces to other systems in order to exchange data. Application is able to send and receive timestamps between external sources, whom will be able to extract timestamps from Port Activity App system through an API (Application Programming Interface).

Unikie is a software company with +300 technical experts, who was selected to built a mobile and web-based application, called Port Activity App, for ports of Rauma and Gävle. Purpose of the application is to share information and timestamps (estimates and actual) during port calls, and put the information into a clean and simple user interface. Data is collected from various sources, port actors and systems, such as AIS Live, Opera, Port Info System, Pilot System and manual input.

Different challenges that has been recognized during the developing of the applications are related to:

- Various IT systems used, multiple points of unaligned information with no or limited data transfer
- Vast amount of information and communications back and forth between different actors
- No centralized place or accessibility to reliable information
- There is no working warning system or ability to react to unexpected events, which makes the planning horizon limited (Unikie Polo 2020 07.pdf)

Integrated systems for PoR app are:

- Portnet by Traficom (Digitraffic, Open Marine traffic data)
- Pilot order, pilotaging timestamps
- Port Data System (PDS) by Satamatieto
- Opera, cargo operations, Actuals cargo operation timestamps,
- Visy, Logistics, truck traffic timestamps
- STM Sea Traffic Management module (VIS)
  (Unikie Polo 2020 07.pdf)

Information from the application will improve the flow of goods and passengers through the two corridors of Gävle-Rauma and Stockholm-Turku and the overall information exchange between the port actors.

Port Activity App is freely available for everyone, not only for all port actors and ships. Further development will take place with VTS Finland and Unikie, as they agreed to offer the open-source platform as a Software-as-a-service (Saas).

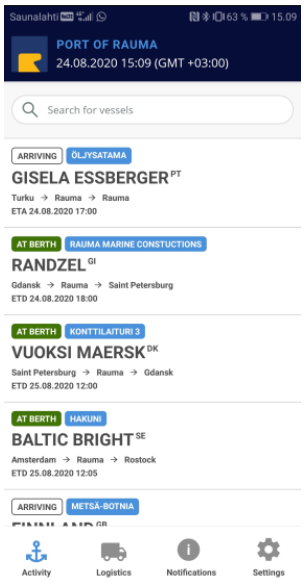


Figure 2. Screenshot from the Port Activity App Rauma mobile application.

Figure 3. Screenshot of the Port Activity App Rauma web-application.

In April of 2020, port of Rauma stakeholders joined the testing group.

PoR personnel test group, which included actual port actors, started using the application in their everyday work. During the testing period, weekly meetings were held and the test group has been continuously reporting to WP T1 testing group.

SAMK personnel test started testing already during development phase. Results of the testing can be found under chapter 4. These two testing groups did weekly co-operation and all WP T1 testing results were communicated together at biweekly meetings and in Unikie Port Activity App sprint review -meetings online at 9.3.2020, 23.3.2020, 6.4.2020, 20.4.2020, 7.5.2020, 11.5.2020, 20.5.2020, 27.5.2020, 3.6.2020 (there was added new features), 5.6.2020, 8.6.2020, 15.6.2020 and 31.8.2020

Plans for the PoR test was to include port actors and have them use the Port Activity Application in their work, performing port calls, checking timestamps and to compare data streams from different port operation systems.

Logistics module test was done with the trucking company AH Trans. All of their 1200 trucks go daily to Port of Rauma from Monday to Friday. Only AH Trans trucks were followed and showed on the logistics -page of the application.

M/S Baltic Bright is the main testing vessel for STM functionality for sharing the route with the port and testing the new timestamps.

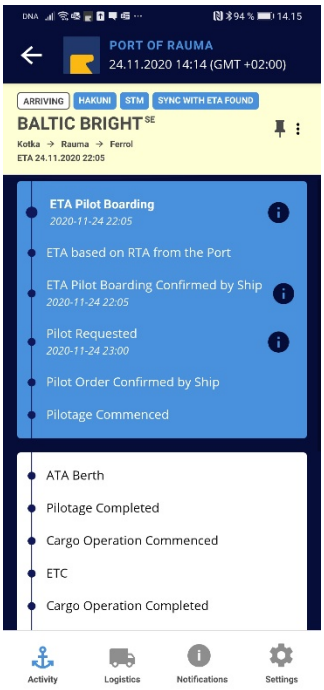


Figure 4. Screen shot

Port actors who were part of the testing group were already familiar with the application and its purpose. No further information was given, the main thing was to check the timestamps and their accuracy.

The main thing that the Port Activity App is supposed to do, is to decrease the amount of phone calls that there needs to be during the port calls at the moment. This was also the main point of the testing – to see if the use of the application will decrease the need for phone calls significantly.

Port actors were asked to check the timestamps frequently and to report them if errors will occur. In addition to this and in co-operation with the port actors, on task was to think; How to make people to use this as a main information channel?

Errors were collected in a separate Excel sheet and they were forwarded to Unikie's developing team for fixing. Timestamps need to be followed since there are still errors in minor part of the data streams. This will make the application more reliable.

There was also noticed misinformation in timestamps that were reported.

7.5 Port of Rauma test results

Test group thinks that at least the mobile version of the application is simple and easy to use and the indicators of colours (blue, which means that the operations are happening at the sea, and white, when operations are happening in the port), are easy to read and to remember. All of the connections to different operation systems, such as Digitraffic, Pilot Order, PortNet and Opera are working well and the data streams are stable and updated within timeframe that is optimal for the port actors.

Different ideas from different stakeholders came up while testing period. Truckers would like to see when their container is ready to be picked up, tugboat company would like to send invoices to shipping company and agents would prefer to see arriving trucks 100 kilometres before the port. These are great suggestions for further development of the application.

Logistic chain module was tested only by the timestamps, that were received from the gate automation company VISY.

Captains with pilot exemption certificates, meaning that they arrive and depart without a local pilot. In the application, they could follow the situation in port especially when departing. They are able the see other timestamps of the application, ETD for example and so forth enhance their situational awareness. That, in turn, would enhance their situational awareness about traffic situation outside and planned schedule in port.

New features will be published, and the testing will continue with especially the new and updated application.

7.6 Port of Gävle PAA test

The basic principles of Port Activity App in both ports (Port of Rauma and Port of Gävle) are the same, but the user interface is different from each other. Port Activity App Gävle does not have the Logistics page integrated, as it only has Activity and Notification pages on the first page. Port Activity App Gävle's is that the port actors automatically get information during vessel port calls. It is also possible for the port actors to share their estimated times regarding certain states in the port call process. Port Activity App has several interfaces to other systems to exchange data. An additional feature of the Port Activity App is that external systems may extract data from the system through an API interface.

Data is automatically collected from various sources, such as Swedish Maritime Administration, Pilot system, AIS (i.e. ship information position, speed) and Yilport container terminal. Live ETA is an important new timestamp together with AT of passing Holmuddschannel and AT anchorage.

Different challenges that has been recognized during the developing of the applications are related to:

- Fine tuning of API (data interface to external data sources)

Integrated systems for Port of Gävle PAA are:

- Maritime Single Windows, Swedish Maritime Organization

- Fenix, Pilot system, Swedish Maritime organization
- AIS data (Vessel information from Grieg connect (Shiplog)
- Yilport, container terminal
- STM Sea Traffic Management module (VIS)

Testing was done between August and September of 2020 with 20 (ten in August + ten more in September) port actors, who were testing the Port Activity Gävle application in real-life situations. They had received a test template, where they would add comments and report errors.

Port of Gävle founded a CAB-group early in the EF-project, CAB- Customer Advisory Board.

The intention of the CAB-group was to gather dedicated port actors and encourage them to be engaged in the EF-project in general and in the Port Activity App in particular.

Several port actors participate in the CAB-group and Port of Gävle has set up CAB-meeting on a regular basis. The CAB-group has been very successful, and the EF-project has gained a lot from the CAB-group. The main input from the CAB-group has been regarding port actors' process and day to day business.

During the PAA test session the CAB-group has used the PAA in their daily operation. The benefit of this idea has been that the project has received input and comments from the real life in a port, i.e. the port actors. The test has not, when executed by the CAB-group, been executed behind a desk without any chance for reality checks.

Plan was to check timestamps from the application and see if they are accurate or not with the port operations and the data from port operation systems. Also, the port actors were asked to add timestamps manually and see how quickly they update, are the notifications going to the right persons and is everything working properly as they should in real-life operations. Addition to these plans, the port actors were asked to think about the value what the application would bring to their everyday work.

Each port actor within the test group has been met in person or online several times, and they have been told about the application and its purpose. Therefore, they were familiar with the application before the testing. The port actors were informed to add screenshots about the errors and issues they would potentially find during the testing and use this application as a communication channel instead of several phone calls during each port call.

Goals for the test was to perform real-life situations during their own port calls and check the timestamps, if they are accurate or not. Goal was also to find critical bugs and issues in the communication flow within the application. Another goal was to get comments from the port actors to things such as, what value they can see the application is bringing to their everyday work.

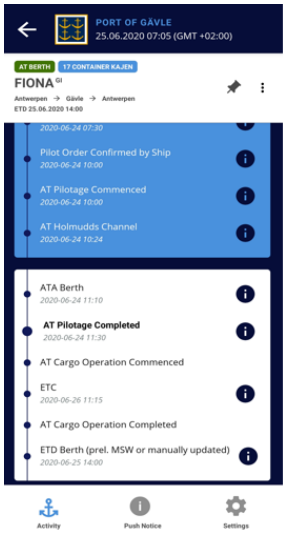
Tasks were planned to reflect the real-life use of the application, such as login in to the application frequently, checking the data and comparing it to other port operation systems and to check and manually add timestamps into the application. They were asked to use the application within the port calls that the port actors are involved, so it's connected to an actual port call.

All of the found errors were collected in a separate Excel sheet with screenshots, so it is easier for Unikie, the developing company, to locate and fix the error. There were some major issues related to timestamps, where some of the timestamps were incorrect, or the original data source of the

timestamp was incorrect. These issues cannot happen when the application is in production-mode, so it was very important to locate these issues now, during the test-phase.

Some of the timestamps were missing from the application only, but they were visible in the port operation system. That indicates an internal error in the application.

One specific timestamp, the live ETA, was not available in the app until 24 hours prior to the port call. Unikie was informed about the errors and now they are all fixed.



SHIP	TIMESTAMPS	TIMESTAMPS NOTED (June)	Other comments
FIONA			
	ETA Prel. To Berth from MSW	25/14:00	
	ETA Live Outer Port Area		
	(Dead Reckoning Calc		
	ETA Based on RTA		
	ATA Outer Port Area		
	ATA Anchorage		
	Pilot Prel. Requested		
	Pilot Order Confirmed by ship	24/10:00	Excellent timestamps
	AT Pilotage Commenced	24/10:00	Excellent timestamps
	AT Holmudds Channel	24/10:24	Excellent timestamps
	ATA Berth	24/11:10	Excellent timestamps
	AT Pilotage Completed	24/11:30	Excellent timestamps
	AT Cargo Op. Commenced	????	Missing
	ETC	26/11:15	
	AT Cargo Op Completed		
	ETD Berth Prel from MSW	25/14:00	Same as ETA ??
	Pilot Prel. Requested		
	Pilot Order Confirmed by ship		
	ATD Berth		
	AT Pilotage Completed		
	ATD Outer Port Area		

Figure 5. Screenshot of missing timestamps that were noticed during the test.

7.6.1 Port of Gävle's Just-in-time arrival (JIT) test

In the final stage of the project, the results are evaluated and analysed. One important subject is how the information exchange between port actors and vessels are improved by the new information tool, Port Activity App (PAA), as well as improved sustainability.

One feature in the Port Activity App is the Just-in-time arrival module, which makes it possible for ships to apply for a queue ticket by slot request prior the arrival to Port of Gävle and Port of Rauma. Port of Rauma has enough piers at the moment, so they do not need any slot, but when the new sawmill starts operating in 2020 and new piers are not ready due to the permissions, there is a need also in Port of Rauma for this kind of slot request. And the new feature in PAA can be used for the slot request.

Testing of the JIT arrival module was done in the end of October, when two vessels, Tarnbris and Doris, participated in the test during current port calls. Each step of the testing flow is described in the pictures below.

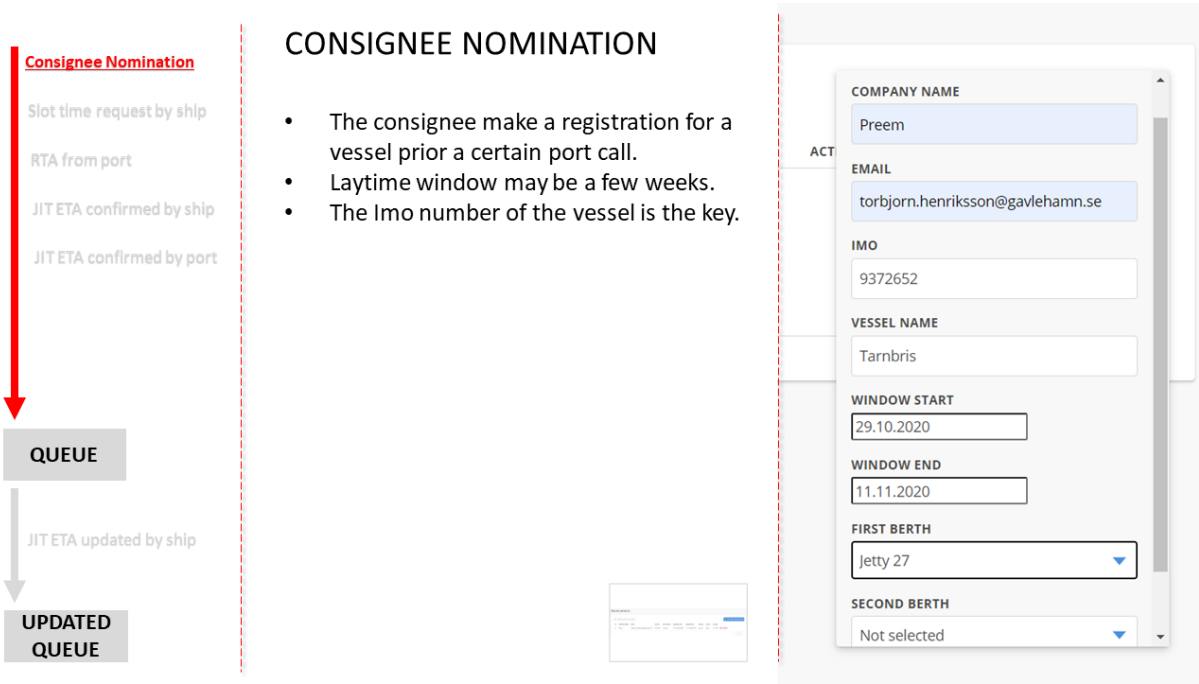


Figure 6. Screenshot Vessel needs to register prior to a port call.

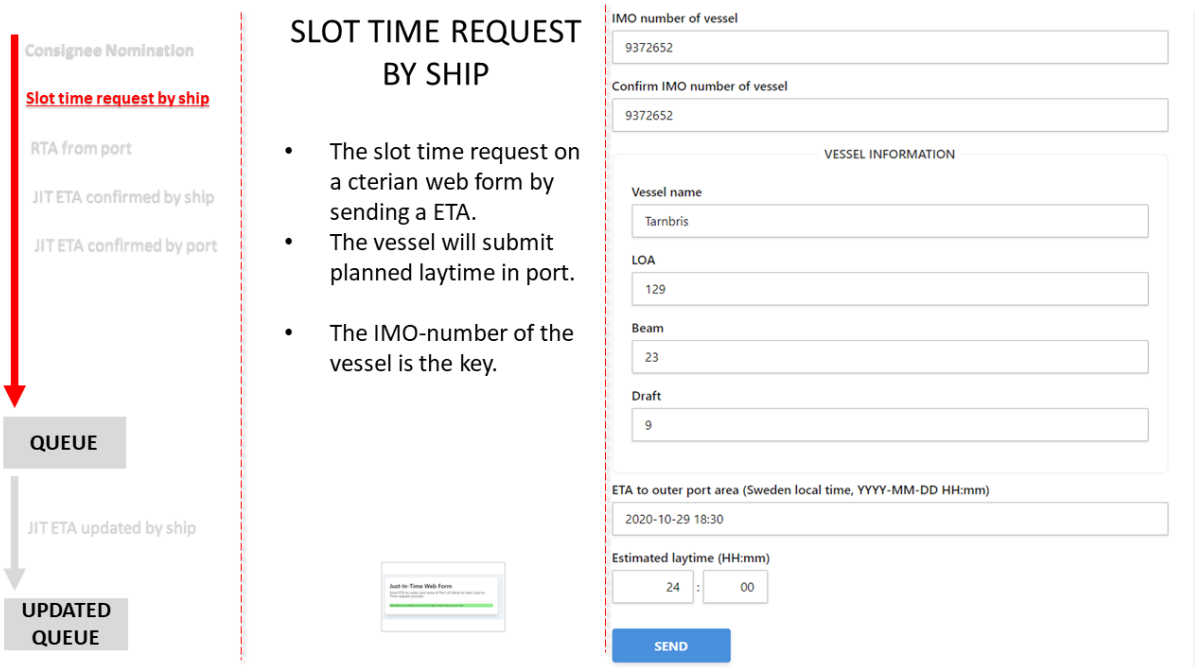


Figure 7. Screenshot The ship will then make a slot time request for the port.

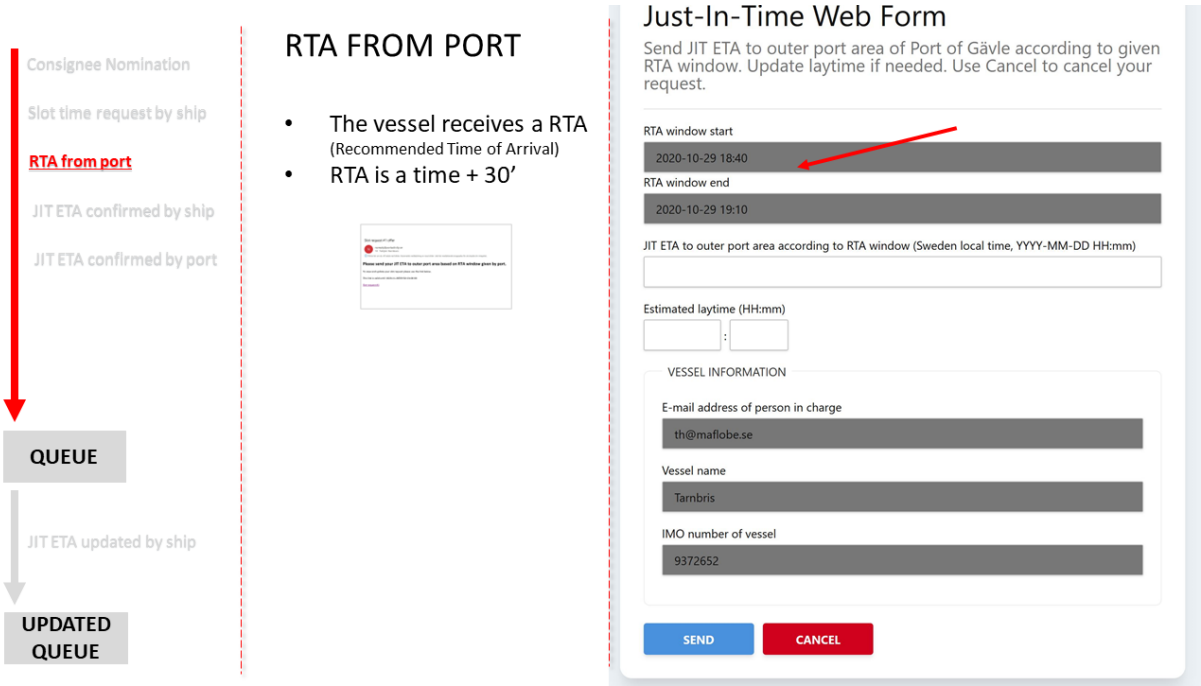


Figure 8. Screenshot The vessel receives a recommended time of arrival (RTA) according to the availability of the pier or other similar service.

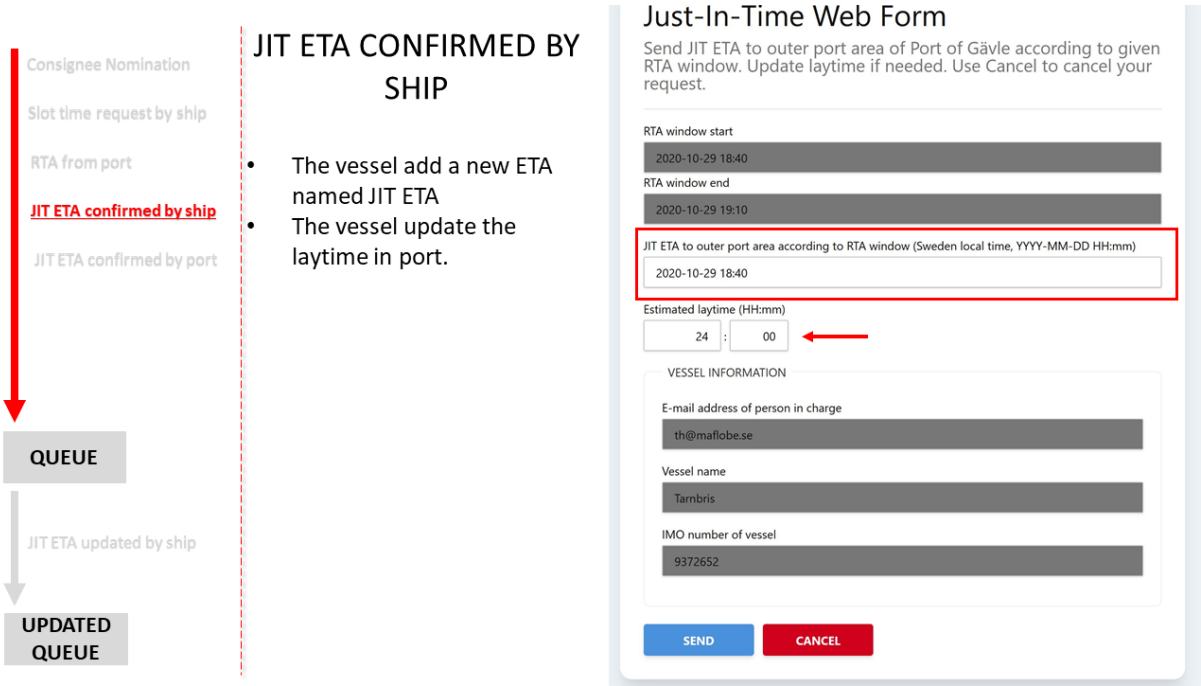


Figure 9. Screenshot The vessel updates the laytime in port.

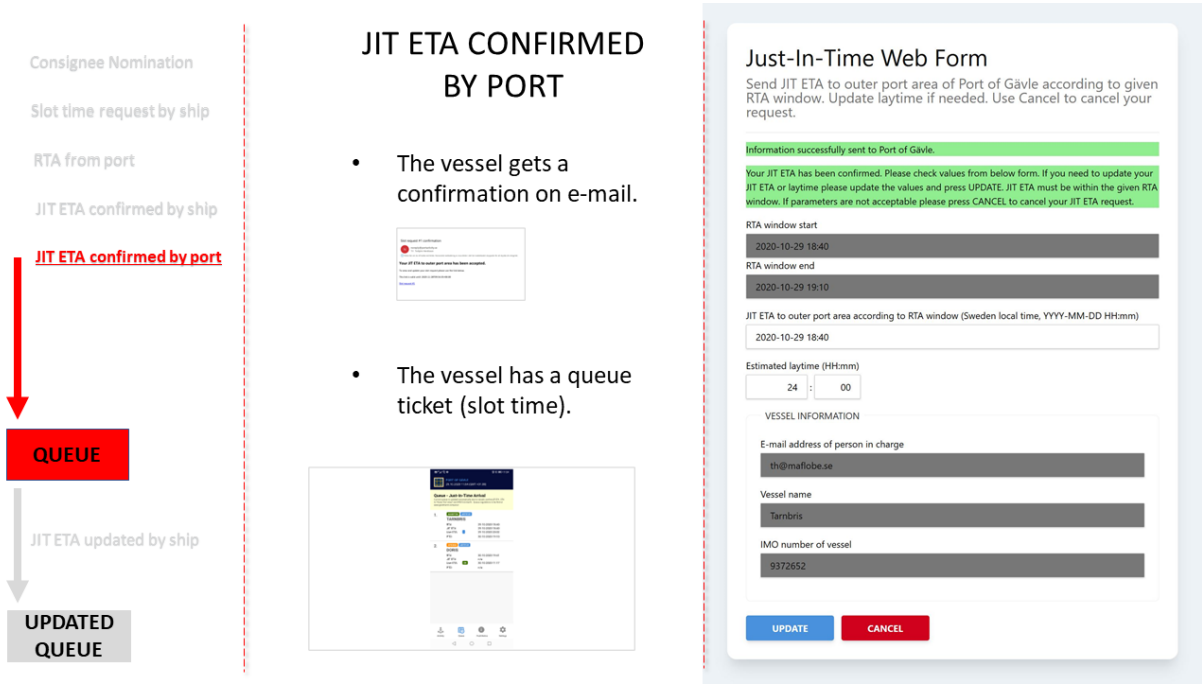


Figure 10. Screenshot The port can confirm the request and it will be show in the Port Activity App.

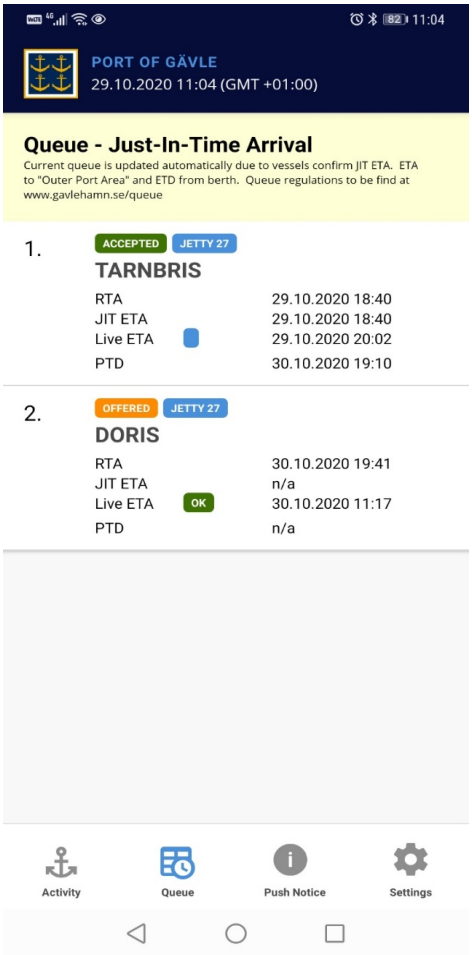


Figure 11. Screenshot Both vessels requested the berth 27 at Port of Gävle and the queue for the specific berth was shown in Port Activity App.

The results of the testing confirm that the JIT Arrival feature was working according specification and the vessels received a queue ticket after the slot time request process was finished. The vessel Tarnbris received an RTA due to the current berth queue as a results, Tarnbris was able to adjust speed in order to arrive just in time, which made the sea transport more energy efficient, decreased harmful emissions by saving fuel and provided positive impact on the climate.

The organisation BIMCO[3] released in December 2018 Charter Party templates that allows a charter and a carrier to agree on slow-speed during a sea voyage, the new clause is named STM-clause. The only chance for a charterer and carrier to activate the STM-clause is that the port has a queue system based on JIT arrival concept.

The JIT Arrival feature is more or less necessary when a port use a queue system due to the importance of accurate information flow as well as transparency of information for all port actors and ship owners.

BIMCO adopted STM-Clause for Voyage Charter parties in December 2018. The clause, developed to facilitate just-in-time port calls in commercial contracts, allows a charterer and a carrier to agree on adjustments of a ship's speed during sea voyage, to meet a requirement of a specific arrival time.

One of the concerns, identified at an early stage of EF project, was the issue of competing vessels, that claim for the same berth/pier.

The most suitable solution, found by the project, is that the port has a queue system, based on JIT arrival concept. The queue system would enable application and activation (triggering) of the STM clause, that would fit in port's daily practice.

The JIT Arrival feature is more or less necessary when a port use a queue system due to the importance of accurate information flow as well as transparency of information for all port actors and ship owners

7.7 Port of Gävle test results

Most valuable takeaways from the testing was to notice that the application is stable – without a continuous and seamless data stream between the app and port operation systems the port actors are not able to do their work and the application is not valuable for them. The latest findings of the critical bugs concerning incorrect data are now fixed, and another test will follow later on with a more complete Port Activity Gävle app.

The results of JIT Arrival feature test showed the features works together with the Port Activity app for all vessels, STM-vessels as well as for vessels not yet with a STM-feature installed.

It means, when the JIT Arrival concept is launched in a port a vessel can receive a queue ticket and the vessel can slow down the speed to arrive on time, Just-In-Time for the port operation.

[3] BIMCO is the world's largest direct-membership organisation for ship owners, charterers, shipbrokers and agents. In total, around 60% of the world's merchant fleet is a BIMCO member, measured by tonnage (weight of the unloaded ships). The organisation has NGO status and is based in Copenhagen, Denmark, with offices in Athens, Singapore and Shanghai. https://www.bimco.org/about-us-and-our-members

The JIT Arrival test was the first one and more tests are necessary to fine tune the concept.

7.8 Analysis of the testbed results

At the time of test-process starting the software for both ports have been in a “minimum viable product” (MVP) -phase. It had all the necessary components, such as integrations between the application and different port operation systems, Activity-page and a possibility to send and receive ship-specific notifications to all related parties. Port Activity Rauma had also functions for following the logistic flows in the port.

Purpose of the tests was to locate the most critical bugs, improve the applications user-friendliness and to optimize the servers, so they would not had any misfunctions, even if there was tens or hundreds of simultaneous users. Purpose was also to receive feedback from the end users and provide them further to team responsible for development.

During SAMK personnel test, the main purpose was to follow the timestamps and data streams from different port operation system and see, how up to date the data is. During the testing, which was ongoing for several days (started at 12.5.2020, 15.05., 18.05., 21.-22.05., continued in August after holiday season and ended 17.08.), SAMK personnel logged in to the application to cros-checked the data that is shown in the Activity-page. At the same time, the test users had to check many other port operation systems where the data is coming from to the application and see, how accurate the data is.

Tests in both ports, Gävle and Rauma, were more practical and involved port actors and tasks in a real environment, where the application is supposed to be used in the future. Valuable information, feedback and new ideas, such as truckers would like to see when their container is ready to be picked up, a tug company would like a possibility to send invoices from the app or a map-view could be integrated within the apps Activity- or ship-specific view, were received for future development of the applications.

Most of the port actors were delighted about the simplicity of the app, which was the goal from the very beginning, and found it very helpful comparing to a situation, where everything is communicated through a normal phone call. Phone calls can be replaced by messages in the application. Our detailed information could be found under chapter 6.3 and 6.4.

Overall, the comprehensive testing with various parties and partners have given great insights and great advantage to, not only Unikie, but for port actors, too. Everyone involved in these tests were pleased to be part of building something that will potentially make a huge impact in the whole industry. After the massive testing phase training videos for apps developed.

Training videos could be found by the links PoR App and PoG App.

WPT2 received prolongation from the Central Baltic for a 6 month up to May 2021 and continue the STM/VIS testing. Also, the data about routes from STM vessels and sending RTA (Recommended Time of Arrival) messages is planned to be collected for Port Activity App, according the pandemic restrictions.

8 KPIs results and analysis

Data collection is a process where information is collected from relevant sources for the elaboration of the acknowledged research problem, to challenge assumptions and evaluate results.

KPIs results data have been collected from interviews (PoR) and questioners (PoG) with the main stakeholders. The case study has been provided for calculate potential savings by ships with using PAA.

8.1 Soft indicators follow up in EfficientFlow project, Port of Rauma

The interviews consisted of the following respondents:

MV Empire Captain David Janse

MV Empire Captain Sjouke Weima

MV Polaris VG Captain Thord Vaenenberg

MV Baltic Bright Captain Robert Skogsberg

MV Baltic Bright Captain Knut Nilsson

Interview situations were separate from each other, and respondents were not aware of the responses provided by others. As an over-arching finding from the interviews was the contribution, the application can provide for the port calls not only during the period of navigation but while moored and planning the departure. Port Activity Application includes detailed information on how the traffic is arranged and what the future looks in navigable water near the port. This assists appropriate port call actors in planning and scheduling the departure for a safe outbound voyage. Moreover, when the schedule is clear and foreseeable, stevedores, linesmen, pilot and so on can be arranged in good time without the risk of charging for the hours standing by.

Baltic Bright has no facility to use the port app currently except own private mobile phones. Although STM module is primary means for the vessel to enter timestamps, Port Activity Application would be a feasible option in the event of STM module not functioning. SAMK has promised to deliver credentials for joining the Port Activity Application community. All timestamps from Baltic Bright are inserted through the STM module which is now working after updates in Adveto-ECDIS.

Timestamps of Baltic Bright are entered by the agent mostly. Baltic Bright captains, other have pilotage exemptions and other will soon examine Rauma 12M fairway pilotage exemption certificate (PEC), so soon no timestamps originate to pilots. As it seems the crew only enters timestamps when they are using ECDIS, as in only during the sailing. This reflects the role of the Port Activity Application; it keeps the logistic chain aware of the status of the vessel while the vessel is merely focusing to the functions of the STM module route sharing, “Recommended Time of Arrival” to a certain location, and advices received from the agent. Vessel shares her schedule through STM-compliant ECDIS with among others, PAA, thus with authorised port call actors. Resulting from the situation in port/terminal and berthing availability/prospects, the RTA is worked out and send back to vessel from PAA directly to ECDIS. If applicable, vessel adjusts

the speed to arrive as requested/recommended. All ETAs is updated accordingly from/by STM ECDIS. It includes also appropriate timestamps to PAA.

RTA means “requested” from the port, but is considered “recommended” on ship’s bridge, due to masters “overriding authority” and “ultimate responsibility” for the safety of vessel.Having said that, it is noteworthy, that agent bases his/her decision at least partially to the information received through the Port Activity Application.

8.2 Port Activity App Effects on GHG Emissions - Use Case Study

All the energy used by a ship at the sea originates from the combustion of the ship fuel being typically heavy fuel oil (HFO). According to energy analysis done for a cruise ship sailing in the Baltic Sea in winter conditions the biggest energy user is the propulsion (46%) and the rest goes to heating (27%) and electric power generation (27%) (Baldi et all 2018). So more than half of the energy can be consumed in other operations than making the ship move.

For cargo ships, having the highest share of the annual fuel consumption and emissions (container ships, bulk carriers and oil tankers) the propulsion takes much bigger proportion of the energy use. E.g. for a container ship, the division of its energy use is more like 86% for propulsion (Main Engine), 12% for electric power generation (Auxiliary Engine) and only 2% for heating (Boiler) (Faber, J. et al. 2020, Figure 5). Naturally the cargo does not require heat as the passengers do. In case of oil tankers, the demand for heating (boiler) is already much higher (22%) which is already rather close to the one of mentioned cruise ship.

In this chapter is represented couple of use case calculations on how a port activity application developed in the CB Efficient Flow project can reduce the consumption of fuel used for propulsion and cut down CO_2 and other GHG emissions while ship is optimal steaming part of the voyage for Just-in-time arrival.

Background

International Maritime Organization (IMO) is an agency of the United Nations which has been formed to promote maritime safety. IMO currently groups 167 Member States and 3 Associate Members.

In “International Convention on the Prevention of Pollution from Ships” better known as MARPOL Convention, IMO has set international rules and regulations concerning pollution and emissions from marine traffic. MARPOL has altogether six annexes of which the latest Annex VI “Prevention of Air Pollution from Ships” entered into force in May 2005. Annex VI sets limits for sulphur oxides and nitrogen oxides from ships and prohibits deliberate emissions of ozone depleting substances. Additionally, chapter added in 2011 covers issues and measures related to energy efficiency of the ships with goal to cut down greenhouse gas (GHG) emissions from ships. (IMO 2020)

According to recently published “Fourth IMO GHG Study” the greenhouse gas emissions of total shipping worldwide were 1076 million tonnes (CO_2e) in 2018. Almost all (98%) of this amount was carbon dioxide (CO_2) and the rest consisted of other GHG gases like methane (CH_4) and nitrous oxide (N_2O). The share of shipping emissions of all anthropogenic emissions was 2.89% and it has increased since 2012 with 0.12%. (Fourth IMO GHG Study 2020, 10.)

While the total GHG emissions of shipping are increasing moderately, the share of methane emissions from all GHG is increasing more rapidly along with wider use of LNG-fuelled ships. During the period of 2012-2018 estimated methane emission increase has been 151-155%. (Fourth IMO GHG Study 2020, 134.) This is alarming since methane is much more efficient GHG than carbon dioxide with 86 times higher warming potential. Many of the engines using methane are inefficient in combusting the methane and thus unburned methane escapes to atmosphere. Currently there are no regulations in place for limiting methane emissions.

In Central Baltic Efficient Flow project, a port activity application was developed with aim to enhance the information exchange between the ship arrival and departure related stakeholders like ships, pilots, tugs and linesmen and other port actors. In this open source-based application the data from different interfaces and systems is gathered into one place offering the same situational awareness for all stakeholders interested of the movement of certain ship. Application can also be used for passing notifications between the users e.g. about unexpected occurrences affecting to the ships normal traffic schedules.

Efficient Flow project partners included ports of Rauma and Gävle who each had their tailor-made version of the application for their use. As example, port can use port activity application for informing arriving ships of changes affecting their arrival schedule. If e.g. there will be no berthing place for the arriving ship at the time of ETA port can request ship to delay its arrival with RTA and thus ship can adjust the speed under remaining part of the voyage and save energy and cut down GHG and other emissions.

CASE 1: Ship lower speed due RTA received during the voyage

This case illustrates the fuel and CO_2 savings achieved when ship can apply optimal steaming for three quarter of the voyage from Germany to Finland. ETA is sent to destination port after sailing quarter of the voyage and in the reply RTA destination port postpones berthing slot time with four hours. Goal for the ship is to have Just-in-time arrival in order to avoid waiting and unnecessary anchorage.

Calculations

Used example ship/route information:

- Ship type: Container, 2000 TEU, GWT 32 482 t
- Speed: 19 knots
- Route: Rauma (Finland)-Rostock(Germany),
- Total voyage distance (VDist): 578 NM, 1070 km
- Distance left to destination after speed is adjusted: 440 NM, 815 km

Table 1. Savings in case 1. Ship is optimal steaming three quarters of the voyage.

	Speed[kn]	VoyDur [h]	SFC [g/km]	SFC [t/d]	SFC [t/voy]	CO2 [g/km]	CO2 [kg/voy]
Before	19	30	80396	68	86	250580	268235
After/part1	19	7	80398	68	21	250580	64042
After/part2	16.2	27	58446	42	48	182167	148444
Savings/diff	-2.8	4			-18		-55749
Savings(%)		13.2 %			-20.8 %		-20.8 %
Savings (€)					8675		

Original ETA: 22.04.2020 07:00
RTA from port: 22.04.2020 11:00
→New adjusted ETA 22.04.2020 11:00 (ship speed lowered accordingly)

From the table 1 it can be seen that when optimal steaming three quarters of the voyage nearly 56 tons of CO_2 emissions can be saved. This means naturally also almost 18 tons and 21% cut down in fuel consumption and costs. With the 411 $ average bunker price (Figure 1) and used currency change rate (1€ = 1.18$) it would be about 8 700 €.

Figure 12. Average bunker prices and trend for EMEA.

CASE 2: Ship postpones ETA due new RTA update from destination port before voyage beginning

This case illustrates the fuel and CO2 savings achieved when ship can apply optimal steaming practically for the whole voyage from Germany to Finland. Ship sends ETA to next destination port before departure and in the reply RTA the destination port postpones berthing slot time with four hours. Goal for ship is to have Just-in-time arrival.

Calculations

Used example ship/route information:

- Ship type: Container, 2000 TEU, GWT 32 482 t
- Average speed 19 knots
- Route: Rauma (Finland)-Rostock(Germany),
- Voyage distance (VDist): 578 NM, 1070 km

Original ETA: 22.04.2020 07:00

RTA from port: 22.04.2020 11:00
→New adjusted ETA 22.04.2020 11:00 (ship voyage speed adjusted)

Table 2. Savings in case 2. Ship optimal steaming the whole voyage.

	Speed[kn]	VoyDur[h]	SFC[g/km]	SFC [t/d]	SFC [t/voy]	CO_2 [g/km]	CO_2 [kg/voy]
Before	19	30	80396	68	86	250580	268235
After	16.8	34	62856	47	67	195911	209714
Savings	-2.2	+4.0	-17540	-21	-19	-54669	-58521
Savings (%)	-12 %	+13 %	-22 %	-31 %	-22 %	-22 %	-22 %
Savings (€)					9106		

From table 2 it can be seen that when ship lower the average speed from 19 to 16.8 knots savings are significant both in terms of fuel consumption (SFC) and in terms of CO2 emissions. During the voyage, 19 tons of fuel is saved and over 58.5 tons less CO2 is released when ship adjusts its speed according to RTA and arrives just in time. In fuel cost savings this would be about 9 100 €.

8.3 Soft indicators follow up in EfficientFlow project, Port of Gävle

This chapter explains the impact on the Port Information Flow Optimization due to a new information flow because of the launch of Port Activity App, PAA. The soft indicators are based on the current situation when the project started 2018 compared to the information flow situation for the port actors after the PAA was launched.

In the report delivery D.T1.1. in the beginning of the EF-project a desired target mode was stated.

The basic principle and idea with port call optimization (port operations) were defined. Port call actors need to share their estimated and actual times regarding certain states in the port call process. Port call actors need to communicate in a more efficient way in the future.

In order to define the current situation more in detail a Questionnaire was submitted 2018 to port actors in Port of Gävle. The focus of the Questionnaire was to find out how much the port actors used phone, e-mail, etc. as communication tools during a port call. The questionnaire of 2018 was followed up with a new questionnaire 2020 after the PAA was launched and the port actors were able to receive online information through the PAA. The questionnaires 2018 and 2020 were submitted to about 30 port actors. The reply was a little bit less than 50% both 2018 and 2020.

The results of the questionnaire 2018 unambiguously showed that most of the issues and bottle necks are caused due to lack of information, lack of clarity, use of unreliable and outdated data, manual communication practices, misunderstandings, non-automated processes of data handling, poor or no data sharing, use of obsolete technologies and human factor. Following was stated in the report D.T1.1 year 2018. “There is an urgent need to implement a common real-time data sharing software interconnecting all participants in the logistic chain regardless of their role.”

STM EFFICIENT FLOW

THE RESULT OF QUESTIONNAIRE 2018 VS 2020

Seven questions were submitted 2020 and the answers were compared to the current situation in 2018. Please see questions 2020 and result as well as result 2018 below.

Answers to the questions includes:

- Yes, for sure
- Yes, to certain degree
- Maybe but not so much
- No

Comparing answers of 2018 and 2020:

- 50% of respondents answered after testing results that when in PAA information is displayed such as ETA, Live ETA, 4 pilot times, nautical chart picture, current times when ships are at the quay, ETD etc. it will for sure decrease phone calls. 29% of respondents keep their opinion on the same level "Yes, to certain degree", and 14% respondents changed their opinion that from "yes, for sure" to "maybe, but not so much".
- After testing 50% of respondents agree that it will be advantaging in their daily planning and providing opportunities for efficiencies when in PAA there is now information about a ship call to the Port of Gävle gathered in one place and available in real time, around the clock. 29% of respondents didn't change their opinion after testing and agree that "Yes, to certain degree", 7% of respondents change their opinion from categorical "No" to "Maybe, but not so much" and 14% of respondents changed their opinion from "yes, for sure" to "maybe, but not so much". According to answers in 2018 and comparing them to results of 2020 we can see positive dynamic in respondents' opinion related to new Port Activity App.
- 50% of the respondents in 2018 had opinion that communication misses and sharing of old information will decrease when PAA exists for everyone for sure, in 2020 this number significantly increased to 78%. The percentage of the answers "Yes, to certain degree" decreased in 2 times, and answers "Maybe, but not so much" decreased in 3 times.
- Number of respondents who absolutely agree that it will be an advantage that the information in PAA is automatic and largely not dependent on a person entering it when they have the time and opportunity increased almost in 2 times from 42% to 71%. The number of respondents who think that "Yes, it will, to certain degree" increased almost in 3 times from 21% to 57%. And there is no anyone of respondents who thinks that "Maybe it will, but not so much".
- 79% respondents sure, that PAA availability 24/7 and data entering automatically will make possible to trust the information better compared to the previous answers, which showed 50%. Also 7% of respondents changed their answers to "no, it will not".
- Although in 2018 opinion that a special function where you can send out push notices to all port actors will improve the ability to convey information to everyone if there is a sudden event or delay was more sceptical, in 2020 after testing the APP it have been changed. Yes for sure answered 71% compere to 50% in 2018, "yes, to certain degree" answered 35% compare to 21% in 2018, and no one respondent answered "no" in 2020 compare to 14% in 2018.

General comments what have been mentioned regarding the Port Activity App and its functions as well as upcoming features such as sea chart and queuing systems (Just-In-Time) from the behalf of Port actors were positive:

- Nice feature with sea chart but may take some time to acclimatize to new procedure.
- Vessel planned berth number is good information that is very useful.
- AIS vessel position on a sea chart is very useful feature.
- Queue system is a very interesting feature that will improve terminal efficiency as well as reduce negative impact on the climate.

The comments of the questioner participants showed positive feedback and the growing popularity of PAA among main users and stakeholders. The result proved that expectations of the respondents have been reached.

Sum up of the soft indicators PoG.

The results of the questionnaire 2020 defined that the PAA with automated and online information flow has a significant impact on the information flow efficiency. The PAA is also a springboard to improve the work procedure for port actors which will have a positive impact on the port flow process.

Conclusions PoR

From the use case results it can be clearly seen that Just-in-time approach can result in significant GHG emission savings while optimal steaming cuts down the fuel consumption and costs. An application that enables Just-in-time approach can be one part of the solutions where emissions of the whole maritime transportation sector are decreased on our way to carbon neutral transportation.

8.4 Analysis of the KPIs results

There were data inputs we were not able to collect within the scope of the project due to operational restrictions during pandemic situation. The vast amount of KPI's sets restrictions to the practical meaningfulness to collect all available data from the port calls. The amount of data has expanded to the level of thousands of port calls in Rauma and Gävle. Each port call includes dozens of individual time stamps. Therefore, it appears to be a practical solution to establish a pool of use case vessels that are monitored throughout the continuity of the project. These use case vessels are frequent visitors and will continue providing metrics for the evaluation of the functionality of the PAA. Additionally, data collection in longer time span supports development of the PAA and its future extensions.

Data collection for the KPI's 4.30 - 4.31 is arranged with an online questionnaire providing metrics as the answers are in a slide bar following Likert-scale. Frequent surveys will continue providing measurable data that can be compared to a past-track to see the course of development of the PAA.

In the following chapter each KPI is described in an table with the data input and result. In the comments section it is established, whether the KPI meets the associated KPO. There are 11 KPI's that are reported not meeting target. This does not mean in any way, that the PAA has failed, as there are many variables that effect to for example "Metrics related to KPI 'Arrival

Clearance waiting time" (KPI 4.4.). PAA contributes to the exchange of information in a timely manner. Even with the totally shared situational awareness of all relevant stakeholders effecting to the arrival clearance the process can fail. In all KPI's there are numerous contributors affecting the outcome, which have got nothing to do with timely sharing of information.

Target have been met for the following KPIs

'Pilot on arrival waiting time' (PoR PAA, PoG PAA)
'Berthing waiting time' (PoR PAA)
'Pilot on departure waiting time' (PoR PAA, PoG PAA)
'ETA average accuracy' (PoR PAA, PoG PAA)
'Optimization of pilotage on arrival' (PoR PAA, PoG PAA)
'Optimization of the berthing' (PoR PAA)
'Optimization of pilotage on departure' (PoR PAA, PoG PAA)
'PortCDM implementation' (PoR PAA, PoG PAA)
'PortCDM messages quantity' (PoR PAA, PoG PAA)

Target have not been met for the following KPIs

'Berthing waiting time' (PoG PAA)
'Arrival Clearance waiting time' (PoR PAA)
'Commencing Cargo Ops waiting time' (PoR PAA)
'Departure Clearance waiting time' (PoR PAA)
'Unberthing waiting time' (PoR PAA, PoG PAA)
'ETD average accuracy' (PoR PAA, PoG PAA)
'Optimization of the berthing' (PoG PAA)
'Optimization of arrival clearance' (PoR PAA)
'Optimization of ship's preparation for cargo ops' (PoR PAA)
'Optimization of the terminal's preparation for cargo ops' (PoR PAA)
'Optimization cargo ops' (PoR PAA)
'Optimization of ship's preparation for departure' (PoR PAA)
'Optimization of departure clearance' (PoR PAA)
'Optimization of the port infrastructure utilization' (PoR PAA)

The data was unavailable to collect for the following KPIs for the date of the reporting

'Tug on arrival waiting time' (PoR PAA, PoG PAA)
'Ship service waiting time' (PoR PAA, PoG PAA)
'Tug on departure waiting time' (PoR PAA, PoG PAA)
'Optimization of ship's preparation for cargo ops' (PoG PAA)
'Optimization of the terminal's preparation for cargo ops' (PoG PAA)
'Optimization of ship's services' (PoR PAA, PoG PAA)
'Optimization cargo ops' (PoG PAA)
'Optimization of ship's preparation for departure' (PoG PAA)
'Optimization of departure clearance' (PoG PAA)
'Optimization of the unberthing' (PoR PAA, PoG PAA)

‘Optimization of the shifting’ (PoR PAA, PoG PAA)
‘Optimization of administrative ops’ (PoR PAA, PoG PAA)
‘Optimization of the port infrastructure utilization’ (PoG PAA)

The project team focused on testing the most significant KPIs. Positive test results can be observed for almost all the most relevant indicators in both ports. Some of the results were not achieved due to changes in testing process because of the pandemic and related restrictions in both countries and within shipping and piloting companies. Some of the data are currently not available due to difficulties associated with collecting process because of limitations of the pandemic.

For provide metrics related to KPI:

- 4.30 ‘PortCDM messages quality’
- 4.31 ‘Overall increment of stakeholders’ confidence’,
- 4.32 ‘Increment of stakeholders’ confidence towards decision-making support’,
- 4.33 Increment of stakeholders’ confidence towards making the business environment more efficient’

A series of online surveys should be established to chart the development of the views of the various stakeholders within the logistic chain. In D.T.1.11 could be found detailed information about a questionnaire developed for the purpose. Same questionnaire should be repeated to see the alteration of the opinions of the respondents.

8.5 Conclusion

Project aims list as one target a time saving of seven percent in the logistic operation. It can be said that the application enables the achievement of this goal. However, the application itself achieves nothing. The overall responsibility remains with the users of the application. Therefore, the saving of time should be determined through the actions taken by the users.

Port Activity Application provides new data in the form of queuing system and recommended Time of Arrival. It gathers readily existing data and presents it in collated format under a single application. It can be said that the value that the Port Activity Application adds to the logistic chain lies with the enhanced communication. While saying so, it is noticeable, that even though the communication would be flawless, there will be events in the logistics chain that lead to unwanted outcomes. In this study, various targets were not met, however, the rationale behind these delays are not behind the failure to communicate, but in operational factors such last minute changes as e.g. accidents and incidents.

Online questionnaire will support provision of information of the status of Rauma and Gävle Port Activity Application. The increased added value to the operations can only be measured through the value the application provides to its users. Immediate time savings, or losses for that matter, have exceptionally complex birth mechanisms in logistic chain. Therefore, they can, at best, be only partially explained with the failure to communicate. After the duration of this project, data collection will be kept alive to have long term understanding of the overall effects the information sharing tool provides.

9 Evaluation of the project results

The EfficientFlow project contributes to more efficient traffic flow in the two corridors Gävle-Rauma and Stockholm-Turku by implementation of Sea Traffic Management and its integration into the full logistic chain. The results consist of less manual information exchange, improved processes and practical application of new ICT tools, what have been proved by testing and questionnaires results.

The value proposition identified by the project partners and users, encompasses:

- increased situational awareness among the actors in the ports and at sea in the corridors;
- connected port and more flexible route planning;
- improved port-hinterland information exchange;
- well-coordinated, faster and more optimized port operations;
- improved just-in-time processes, saved fuel, less waiting times, improved planning horizon, improved berth productivity; and
- increased flexibility in case of non-expected events.

As a result, ships could adjust speed in order to arrive just-in-time, which could means making maritime transport more energy efficient, decreases harmful emissions (CO2), provides positive impact on erosion as well as provides safety and socio-economic benefits to the corridors.

Increased accuracy of information by digitization, waiting times and lead times could be reduced in all parts of the logistic chain and a large number of telephone calls between actors could be reduced to a minimum by the introduction of new ICT tools adding to time savings in the movement of goods. The risk of misunderstanding and misinterpretation of information could also be reduced, which could contribute to reduced movement time of goods in the corridors.

The results achieved will last beyond the lifetime of the project and could be transferrable to other ports and countries in the Central Baltic area.

Project specific objectives

The port actors in Gävle and Rauma are applying STM to facilitate more accurate timing of port operations. The increased information exchange at the ports of Gävle and Rauma facilitate an increased flexibility in the port call planning.

A Port Activity App is implemented in the two ports and connectors with port actors are made. The port actors could establish a closer collaboration and information sharing for the improvement of the ports. Information between the ports and hinterland operators could also be addressed. The pilotage ordering and planning of the Swedish Maritime Administration now could be made more automatic and less time consuming.

The objective has been reached by close collaboration between the partners and with support from important stakeholders. One of the key stakeholders in the ports is the terminal operator. The terminal operators in both the port of Gävle and the port of Rauma have shown great interest in the Project and have contributed to achieve the objective.

Business model for enhanced information exchange between port actors, between ports, between port and hinterland operators and between ports and ships

Each stakeholder participating in the logistics chain can benefit in its own way by using new Port App. For Port/Terminal operators the labour scheduling and the employee's shifts planning aim to reduce the time and productivity waste as much as possible. However, currently in almost all ports during the off-peak periods the overmanning is very common issue. This could be handled easier by applying the enhanced business model in practice. Being aware of the cargo flow in advance, the actors can be able to predict and plan the expected workload. As a result, the terminal operators will save time and costs due to better long- and short-term planning, improved labour management and less cargo handling operations. Some other areas where a Ship and Port ICT Application can improve the port operator's performance are the capacity planning, the cargo flow scheduling, dwell time and the cargo transportation due to more accurate estimated times. This undisputedly leads to significant time savings as well.

Shipping lines can be able to monitor the cargo handling operations in real-time. So far, the shipping lines receive the actual cargo data, stowage and loading plan after the ship's departure. Another advantage is the real-time updates of the berth's schedules. This results in possibility for adjusting the ship's steaming speed according to the latest berth status. As an important step forward is the recently adopted STM contractual clause by BIMCO, that will permit further improvement in the efficiency of the ship and port operations. On other hand the late departures due to administrative issues caused by lack of information sharing or miscommunication can be minimized. The ships can be filled closer to their maximum capacity as the information regarding last-minute arrivals will be already available. Ship's stay at port can be easier to predict and any deviations in the pre-agreed schedules can be communicated in due time.

By using the Ship and Port ICT Application the port authority and port services have an excellent overview of the ship's, haulier's and cargo traffic in the port area. The carrier's and the port's operational plan can be aligned. Port service providers such as mooring services, tugboats, icebreakers, pilots, etc. can to be arranged adequately in due time. Pilots can be automatically notified early enough in case of change in the ship's schedules. The land transportation companies can be able to plan their resources and optimize their operations efficiently. The hauliers can schedule optimal trips according to the cargo type and the cargo volume avoiding idle runs between two consecutive shipments. The automated port access can save an extra time if the port gate is integrated with a Ship and Port ICT Application.

Benefit for the industry in general lies in fact that the delivery time depends on many factors, but one of the most variable and thus important factors is the time of the cargo stay in the port area. The ports offering shortest transit times are more competitive than the others. The transit time, however, includes the time needed for obtaining customs clearance. Therefore, the enhanced business model promotes excellent collaboration and information sharing between customs, port authorities and terminal operators in order to improve the information flow and to reduce the total lead time. The Ship and Port ICT Application can significantly reduce the workload from the ship's agents. Instead of being the middleman, the enhanced business model can assign them supervisory duties. The new role as a second control level responsible person can allow them to coordinate the information and cargo flow better.

Test-bed results

Interest in the beginning to this project was huge by different ports and by VTS Finland. Finally, in November 2020, VTS Finland and Unikie agreed to offer the open-source platform as a Software-as-a-service (Saas). VTS Finland sees that there can be built a natural ecosystem around the application and a community of developers due to the possibilities of open source -

solution. Each port can use the timestamps that are freely available or use the application by themselves and develop the application to their specific needs with a chosen partner.

Time schedule in the project application was too optimistic and project partners estimated that tender process needs well defined criteria, D.1.5.1 Procurement Documentation. When internal development was at the final stages and stakeholders from PoR were called for a meeting, corona changed these plans.

The idea for the applications was very appealing to port actors, as they do not currently have a system that provides all the necessary information in one interface. According to test-bed results, the Activity-page and a possibility to send notifications, that are instantly visible for all related parties, are some of the most useful features in the applications.

Before the Testbed, we had to think carefully about the expected results and outcomes from the tests. Obviously, we wanted the use of the applications to be as easy and simple as it can be, so giving the application to someone to use for the first time without any instructions was the theme for some of the tests. In the future, the applications should be so simple to use, that the users do not need any instructions.

With various tests we have done with different target groups, we have been able to locate the most critical bugs, issues and malfunctions that had been causing troubles while using the applications. Most of the issues were related to getting real-time data from the port systems. Without real-time data, the application does not bring enough value for the port actors. Also, during the tests was found out many things considering the user interface (UI) and user experience (UX).

The applications should be easy to use for anybody, and based on the user feedback, Unikie made changes to the applications. The server-side problems, where the application could not handle many users simultaneously, is now optimized for larger number of users. Improvements for getting the data immediately from port systems were made, too.

After many tests, iterations and feedback sent to Unikie for further development, the applications are now fully adoptable by the port actors. Detailed report can be found from the 6.1. document ‘Study on information flows for Intermodal sharing of information’. Collaboration between both ports, Port of Rauma and Gävle, was the key to make the Testbed successful. Without the great work organizing and implementing different tests in both ports, the results would not have been as good as they were, and we would not have the possibility to make testing of the applications so complete. And without the overall testing we could have missed some critical bugs in the applications. Communication between ports, test users and port actors were very important during the Testbed period.

Port Activity Applications were presented to related target groups on 22-23.1.2020 at Navigate 2020 in Turku, Finland, 3.-4.3.2020 at the Ports 4.0 event in Riga, Latvia; 25-26.8.2020 online at the BUP Research Forum at the BUP Symposium 2020 in Visby, Sweden.

Main Launch event for Port Activity App Rauma took place in 28.8.2020 at Port of Rauma, Rauma, Finland, including port actors and main stakeholders by companies like GAC, Unikie, RMC Finland, SAMK, Image Soft Oy, Euroports, Alfons Håkans, Port of Rauma and VR.

10 Conclusions

The project aim was creating processes, operating procedures, collaboration schemes and ICT tool that are lasting and that will continue to be in operation after the lifetime of the project.

The partners, together with the user groups are the end-users in the corridor through Gävle-Rauma. This could increase the sustainability and ensure lasting results. The Port Authorities in Gävle and Rauma had a key role in the implementation of Port Activity App in the two ports. The implementation has been done in close cooperation with the key stakeholders in the ports and in close cooperation with the operators at sea and in the hinterland.

In the ScanMed corridor, traffic is monitored by the two national authorities, Swedish Maritime Administration and Vessel Traffic Service in Finland. The ship operators in the corridor confirm the need of the action and are interested in implementing STM onboard their ships presently operating the corridor.

As seen during the project time the collaboration has been good between two countries Sweden and Finland and their project partners SMA, PoG from Sweden and PoR and SAMK from Finland. Without this collaboration this project would not have gained the success. Port stakeholders will take apps in use but there is a challenge how to have experienced port stakeholder to change from old routines like emails and phone calls to new, much easier communication tool? SAMK has decided to continue the research and as this is especially teaching process it will fit well in the core activities. SAMK will also establish a digitalization group in Rauma which will informally talk about new digitalisation possibilities and challenges in ports but also wider in maritime cluster. In future big challenge will be updates of different systems which will have influence on whole system both sides of the bay.

The EfficientFlow project improves the flow of goods and people in the Central Baltic region. Other ports and corridors in the region have possibilities to gain development opportunities by applying the experiences learnt from EfficientFlow. The transport eco-system is complex and the introduction of new concepts of digitalization, such as STM, requires willingness, time and resources. The invested resources contribute to long-lasting real hands-on changes in the functioning of the transport corridor Gävle-Rauma and improve its digital maturity. And, it also contributes to achieve the transport policy goals of both the EU, the involved countries and the Central Baltic region at large.

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