ECOPRODIGI

PROVIDING TRAINING FOR SHIPPING AND PORTS ACTIVITIES IN THE BALTIC SEA REGION

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Interreg Baltic Sea Region

EUROPEAN REGIONAL DEVELOPMENT FUND

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First published on the 1st of September 2020, and
revised on the 21st of December 2020.

This training program has been produced as part of ECOPRODIGI project which has been funded by the EU Interreg Baltic Sea Programme. The objective of the project has been to increase eco-efficiency in the Baltic Sea region maritime sector by creating and piloting digital solutions in close cooperation between industry end-users and research organisations.

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Contents

Introduction: 3
WP 4 Objectives 3
Case 2 Objectives 3
WP 4.2 Providing training for shipping and ports Outcome 3
Company Scope 4
The development process of the pilot course: 4
Work progress and limitations 4
Development of the Excel Spreadsheet Model and the Discrete Event Simulation model: 5
Part 1 Spreadsheet model for "Instant" calculation of ship conditions: 5
Part 2 Discrete-event simulation model (DESM): 7
The testing of the pilot DFDS course: 8
The final DFDS course plan: 10
Course Part 1 (4 hours) 11
Exercise optimizing the loading of a RO-RO vessel. 11
Short exercise description 11
Part 1: Introduction of the spreadsheet model 12
Part 2: Tabletop Exercise 12
Course Part 2 (4 hours) 12
Exercise for optimizing the RO-RO cargo flow between terminal and vessel (DESM) 12
Exercise Part 1 Introduction of the Discrete Event Simulation Model (DESM) 13
Exercise Part 2 Tabletop game 14
Summary and reflections on training programme for shipping companies and ports 14

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Work Packet 4.2
Providing training for shipping and ports activities in the BSR
Led by University of Southeast Norway

Introduction:

WP 4 Objectives

- To create a training program directed to the shipping companies and ports as well as to the shipyard ecosystems in the Baltic Sea Region (BSR)

- To include the industry end-users outside of the project consortium to become aware of the importance of eco-efficiency and digitalization. In addition, to introduce the tools and gained knowhow the project provides them in this regard.

Case 2 Objectives

- Enable a RO-RO shipping company, its RO-RO terminals, and clients to achieve eco-efficiency benefits. This includes fuel savings, improved RO-RO vessel utilization, reduced waiting times for clients, less truck driving in the terminal etc. These are all vital parts in the end2end RO-RO cargo stowage process.

- To realize eco-efficiency benefits through use of digital technologies. Focus on enable integration of IT systems and develop and test advanced RO-RO cargo stowage or load planning tools.

- To facilitate the design of more efficient new work procedures on terminals / ships in collaboration with relevant staff and without compromising safety requirements.

WP 4.2 Providing training for shipping and ports Outcome

The training program for shipping companies and ports has the task of answering the following themes and spreading knowledge about how these can best be solved. The answers to the themes are obtained by working in the project's various work packets as listed below.

• What are the best practices and lessons learned in terms of co-creating, piloting and implementing digital performance systems and intelligent stowage systems?
DFDS case -outcome from WP 3.1 and 3.2, led by SDU/AAU.

• How the energy efficiency of a vessel can be improved using digitalisation and situation awareness?
Outcome from WP 3.1 and 3.2, led by SDU/AAU.

• How vessel stowage can be optimised based on digital information on exact weight and stowage positions and efficient cross-functional/organisational work practices at ports?
DFDS case -outcome from WP 3.1 and 3.2, led by SDU/AAU and USN developed simulation model and new course developed for ship operation management.

• How shipping companies can improve the sharing of knowledge with ports and terminal partners?
DFDS case -outcome from WP 3.1 and 3.2, led by SDU/AAU and USN developed simulation model.

• How shipping companies can maximise energy efficient stays in harbour?
DFDS case -outcome from WP 3.1 and 3.2, led by SDU/AAU and USN developed simulation model and new course developed for ship operation management

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• How can ships depart with the best operational settings?
Outcome from WP 3.1 and 3.2, led by SDU/AAU

Company Scope

- The company scope of the course is DFDS RO-RO vessels and terminals without passengers.
- The project aims to enable participation from DFDS Gothenburg RO-RO terminal employees in the development of the pilot course. To support a bottom-up improvement policy.

The development process of the pilot course:

Work progress and limitations

- Two on-site meetings (February and September 2020). The agenda was firstly a joint discussion on the roadmap for ECOPRODIGI, and the second meeting was the test of the pilot course.
- One field trip to Gothenburg DFDS RO-RO terminal, Petunia Seaways and Hollandia Seaways (November 2019)
- Workshops included on-site meetings of the working group during development of the simulation tools and the pilot course
- COVID-19 Limitations on work management hindering more field trips and workshops.

Comment on development of further software for load and unload RO-RO ship and terminal operations.

- During the development of the pilot course some important findings were discovered. A missing digital software for joint digital communication between the RO-RO terminal and the vessel, which supports efficient planning and control of the loading and unloading process, in order to minimize ships' turnaround time in port.
- There is no shared digital booking list between gate, terminal, and the vessel, which enables efficient planning and control of the loading and unloading process as well as minimum use of ballast water. As a consequence a great waste of time and resources use.
- There is no digital vessel load program that is shared with the cargo stowage planners at the terminal and the officer in charge of vessel stability. As a consequence a great waste of time and of too much oil / fuel consumption with associated emissions.

To meet these three challenges 1) Integration of systems, 2) sharing of booking data between the systems and 3) better support of the various functions and tasks, a management concept and model were developed in a spreadsheet to demonstrate the benefits of solving the 3 challenges and to support the process more effectively and to create eco-efficiency. In order to validate and verify the logistic concept, discrete event simulation models have been developed. The simulation model together with the spreadsheet model document and demonstrate the effect by optimizing the business process and the 3 mentioned problem. In the following the principles of the developed course are described.

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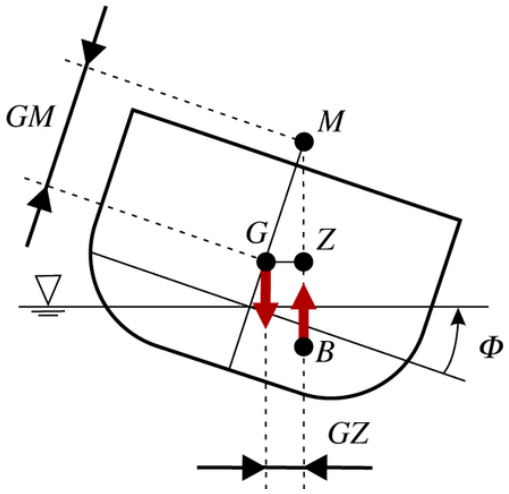
Development of the Excel Spreadsheet Model and the Discrete Event Simulation model:

Part 1 Spreadsheet model for "Instant" calculation of ship conditions:
One of the challenges RO-RO vessels have, is optimal planning of cargo stowage to get a vessel with safety stability, ECO-efficient trim and list, and using as little ballast water as possible. To be able to do this, the RO-RO vessel needs precise information about the cargos' weight, size and exact placement when loaded.

Since all weights on board will give moment to the ship in three direction (X, Y, Z). The position of the weight on the ship determines its moments. This simulation gives all loading positions a distance from APP (X) labelled Lcg, Centre line (Y) labelled tcg and keel (Z) labelled vcg. The aft perpendicular (APP) is near the stern of the ship and the forward perpendicular (FP), is near the bow of the ship. The longitudinal direction of the ship defines the trim of the ship. Trim is the difference between the draughts forward and aft. When the forward and aft draughts are the same the ship is said to be on an even keel. The angle of list is the degree to which a vessel heels (leans or tilts) to either port (left side) or starboard (right side) at equilibrium—with no external forces acting upon it. Listing is caused by the off-center line (Y) distribution of weight aboard due to uneven loading or to flooding. Last but not least, the stability of ships.

First we begin with a diagram.



The fundamental concept behind the understanding of intact stability of a floating body is that of Equilibrium. There are three types of equilibrium conditions that can occur, for a floating ship, depending on the relation between the positions of centre of gravity (G) and centre of buoyancy (B).

GM is referred to as the Metacentric Height. GM is the prime indicator of a ship's stability. As can be seen, the higher the point G is, GM is reduced and consequently GZ. GZ is the righting arm and represents the horizontal distance between the vertical action of buoyancy and that of gravity. The righting moment is the result of multiplying the ship's displacement (D) x GZ. Depending upon the purpose of the vessel, there are ranges of GM that are considered acceptable and/or desirable. GM plays a large role in structural stress and strain in a seaway, crew/passenger comfort and safety, and many other things of concern.

Summing up this simple example: The vertical center of gravity (vcg) is critical concerning ship stability. It is therefore of paramount importance in initial design and it is of major concern to the skipper when loading.

The following trailer positions on the ship are the starting point for a calculation example.

Cargo Name	Lcg (X)	Vcg(Z)	Tcg (Y)
U63	43	16,30	-7,25
U64	57	16,30	-7,25
U65	71	16,30	-7,25
M11	15	10,88	7,25
M12	29	10,88	7,25

Table 1 The position of the cargo weight determines its moments

Each position has a name and their centre of gravity in all three directions described in meters from reference point. When the cargo unit is placed on planned position, the moment for the cargo is calculated, as indicated in table below.

Label	Weigh	Name	Lcg (X)	Vcg (Y)	Tcg (Z)	Lmom	Vmom	Tmom
TN56	22	U63	43	16,30	-7,25	946	358,6	-159,5
TN57	22	U64	57	16,30	-7,25	1254	358,6	-159,5
TN58	22	U65	71	16,30	-7,25	1562	358,6	-159,5
Empty	0	M11	15	10,88	7,25	0	0	0
Empty	0	M12	29	10,88	7,25	0	0	0

Table 2 Moments of statical calculations, change in the Longitudinal Moment (Lmom)

The Excel Spreadsheet loading model is a simplified model of the loading computer, showing how the different plans for cargo placement will affect the ship's trim and list. The spreadsheet calculates this automatically, showing the end condition. The idea is to give the participants an understanding of how a good loading plan will reduce ballast water, which in turn reduces overall weight of the ship and by this will reduce fuel consumption. This is where eco-efficiency comes into play.

A ship behaves in a complex manner in the water when it comes to list, trim, and stability, this due to the hydrostatic forces acting on the vessel hull. The spreadsheet is not as accurate as the custom-made loading computers, but for the purpose of understanding how the forces works and how the ship's condition can be altered by smart loading, it serves its purpose. The model uses Moments of statical calculations as a tool to show how each cargo's placement onboard will affect the ship trim (cargo placement forward or aft) its list (cargo placement port and starboard) and stability (cargo placement on the different deck above or below waterline).

Part 2 Discrete-event simulation model (DESM):
Ro-Ro vessels operate according to schedules, i.e., line operations, where the turnaround time in port is a fixed period between the vessel's arrival and departure. As a result, the sailing time of the vessel is dependent on the time spent in port, and if the turnaround time sees deviation from the schedule and takes longer time, the sailing time is reduced accordingly. Furthermore, the sailing time of the vessel is a function of distance between ports and speed, and to reduce time between Port A and B the speed must be increased, that leads to increase in fuel consumption. Fuel consumption in its turn leads to higher operational costs and CO2, NOX impact etc. Moreover, the contribution of the terminal resources, such as terminal tractors, to the environmental footprint in shipping is understudied.

Fig. 1 DFDS in Rotterdam (Vlaardingen) as a case for DES

The development of the discrete-event simulation model was a result of cooperation between researchers from MARLOG at USN and with software provider – Integrate A/S with a head office in Aalborg, Denmark. One intensive workshop took place in February and another was planned in March. The focus of the DES is the turnaround time where vessel, terminal and cargo flows and their interdependencies are integrated and analysed.

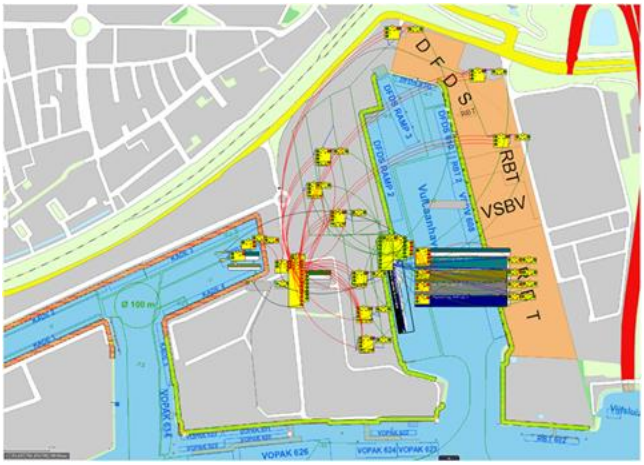


Fig. 2 Simulation design of Vlaardingen.

As a result, the use of simulation can make an insight and improve the eco-efficiency not only at sea, but also at port, which is the main purpose of using simulation. During the project, several different control concepts have been developed and these have been possible to test and consequence assessed via the simulation program.

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The simulation models are used throughout the course to demonstrate and demonstrate the various logistic concept that the course would like to guide the students towards in order to increase eco-efficiency. The course has several stages and each stage has a logistic concept which they are introduced to during the course. Each stage increases the eco-efficiency and the need for more integration and closer coordinated and integrated planning and control of ship and terminal.

For each stage and logistic concept, we can calculate eco-efficiency and performance as documentation for redesign of ship and terminal layout and management principles.

- Calculate utilization of vessel and terminal capacities, resources, and bottlenecks in cargo flows during the cargo handling operations.
- Calculate how the cargo should be stowed in terms of both terminal resources to optimize the loading time, and the stability of the vessel to minimize the use of ballast water.
- Test different principles for cargo handling reduce the total distance travelled by terminal tractors, with its corresponding fuel consumption and emission, as well as time spent in the operations.
- Minimize time in port allows slow steaming at sea which means reduction in fuel consumption and thus emission in addition to better utilization of the vessel.
- Minimize the overall expenses, in particular voyage costs port and operating costs.
- Trace a system and its performance in dynamics as well as to account for internal and external uncertainties, such as time deviations of cargo arrival.

Contribution to internal USN course development (Fleet Management and Cargo handling Course)

- Testing out and integrating loadmaster RO-RO vessel software into the course Cargo Handling at USN. Developing course exercises linking RO-RO vessels and IMDG cargo placement.
- Plan to further develop the DFDS course layout so that it fits USN Bachelor programme students. Furthermore, to implement the restructured DFDS course into the curriculum of the elective course Fleet Management at USN.

The testing of the pilot DFDS course:

Pilot course workshop settings included limitations:

- Held at USN in Vestfold Norway, September 8th, 2020.
- External reviewers distant from the course setting. They joined the meeting by Zoom.
- The course had to be reviewed as a paper course, caused by the small number of participants. The number was only two. It was hard to get participants with a real vessel experience caused by Covid 19.
- No representatives from DFDS were present during the pilot. Hence lacking direct DFDS personnel feedback insight. Had only the available input from Gothenburg RO-RO terminal employees that was gathered during the field trip. However, feedback was provided at the end of the project by DFDS during the presentation of a solution for all the participants in the project.

Important feedback from the pilot course workshop:

- The planned course length is too long. It should be reduced from a two days course to one day.
- Too complex course description and an expanded division of the course causing confusion among the participants.
- The pilot course content is too excessive and should remove the advanced undeveloped cargo handling part.
- Describe the basics of simulations better by developing introduction videos or other digital learning tools.
- Introduce key performance indicators at the start of the course. This allows a clear aim for the course in terms of simulation outputs.
- Make tabletop game instructions so the participants can prepare beforehand.
- Forced slow steaming concept into the simulation table top game. Hence to state clear environmental goals for the participants learning outcome.

Final DFDS case course improvements:

- Reduced the course content from four to two parts.
- Reduced the course duration from two to a one-day course
- Wrote instructions on the recommended length and video content for the introduction videos.
- Added instructions on how to run DESM scenarios for the participants
- Made tabletop game instructions enabling the participants to contribute with their own experience and terminal operation challenges.
- Added a section of the intention to use KPI's to make a best solution scenario. Such a scenario makes it possible to do benchmarking against the participants own game solutions.
- Added a clear slow steaming objective to Part 2 of the course.

Future course developments:

- Future DFDS course developments are dependent on feedback from DFDS and other relevant RO-RO terminal and vessel operators.
- Future DFDS course developments are dependent on new software solutions:
- The Excel Spreadsheet Simulation Model to be converted into a digital vessel loading computer model that gives the cargo stowing planner and the vessel officer the possibility to interact. This must be done by a company that develops software loading programs.
- Develop a software solution that allows the gate personnel, terminal workers, and the vessel officer to access an online digital booking list.

The final DFDS course plan:

This is a joint course programme for DFDS RO-RO terminal- and vessel employees. The course focus on digitalization and eco-efficiency improvements. The aim is to let the course participants incorporate innovative ideas to improve existing terminal and vessel operations.

The first target is to reduce the use of ballast water during loading/ discharging operations of RO-RO vessels by utilizing digital booking lists, combined with a digitalized load-planning tool. This facilitates a better joint understanding between the stowage planners and the officer in charge of the ship stability. Reducing weight on the vessel also reduces the fuel consumption.

The second target is to achieve a more effective turn-around time in port. This reduces the time in port and encourages a larger time available for the vessel at sea. Then the vessel can reduce speed and perform slow steaming. The aim is to facilitate more efficient work procedures at both the terminal and on the vessel by addressing known bottlenecks.

DFDS Course details

1. The length of the course: hours (One day).
2. Consist of two modules (Part 1 and Part 2)

The DFDS Course modules learning objectives

Course Part 1 Optimizing the loading plan of a RO-RO vessel:

- The participants must recognize when the ship is loaded suboptimal and are using more ballast than needed.
- To use digital loading tools to correct this unwanted condition.
- Know how to avoid that the vessel use excessive ballast water. This will reduce the overall displacement of the vessel, thus saving fuel consumption.
- Understand how an optimum trim/heel condition of the vessel will reduce the fuel consumption.

Course Part 2 Optimizing the RO-RO cargo flow between terminal and vessel (DESM):

- The participants understands the simulated logistic flow versus terminal and ship from watching prepared scenarios in a customized discrete event simulation model (DESM).
- The participants understands the DESM model unit's effect on optimization of the cargo flow between the terminal and the RO-RO vessel.
- The participants uses these resources and their effects to play out different scenarios in a tabletop game.
- The participants are able to test if there are any improvements that reduce turnaround time of ship in harbour. Any reduction in harbour time allows for further reduced speed between ports.

Course Part 1 (4 hours)

Exercise optimizing the loading of a RO-RO vessel.

Short exercise description

Course participants demonstrate optimized RO-RO vessel cargo placement, stability, and trim calculations by utilizing shared booking data between the terminal and the vessel.

Exercise introduction

Starting exercise that covers the course participants understanding of a RO-RO vessels stability (Static and dynamic) and the cargo distributions effect on the ship hull (Moments, heel, and trim). However, this cargo distribution also focus on the required loading report based on the RO-RO terminal cargo manifest. The cargo manifest is the RO-RO terminal document showing the booked cargo (Trailers, cassettes, cars, busses etc.). The loading plan determines the optimal stowage of the cargo on the different cargo decks.

The exercise RO-RO vessel loading plan

The loading plan emphasizes several safe loading objectives:

- Safe and secure stowage (Even distribution and easy access for lashing)
- Correct Hazardous Cargo (IMDG)placement
- Correct placement of refrigerated cargo.
- Correct placement of heavy cargo
- Effective loading and discharging of the cargo at the right destination
- Reduce the amount of ballast water used under and after loading operation.
- The vessel must always be in accordance with the required stability, shear forces and bending moments.
- The vessel must be in accordance to the required trim and heel requirements during the whole loading operation. This is important because of the aft loading ramp position (Ramp angle and list).

Exercise description

The exercise aims to let the course participants load the vessel to an upright condition (Even Keel) without using too much ballast water. The exercise recognizes the course participant's needs to gain a collective understanding of RO-RO vessel stability to be able to optimize the RO-RO vessels loaded condition. Therefore, be able to reduce the use of ballast water. The aim is to show the cargo manifest, a pre-planned loading plan and the effect of each cargo unit on the vessels hull (Change in center of gravity: longitudinal, transverse, and vertical). An optimal load distribution of the cargo will reduce the amount of required ballast water by estimated 10 to 20 percent (From DESM simulation runs).

Ballast Water

Ballast water is extra dock water or seawater that a RO-RO vessel pumps into internal tanks to lower the vessel draught, or to correct excessive trim and heel conditions. Ballast water is extra weight and the vessel must therefore use more fuel during transit between the terminals. However, if the vessel is only partially loaded there might be necessary to increase the draught of the vessel to ensure that the propellers are fully submerged. RO-RO vessels are normally equipped with an automatic trim and heel correction system.

This makes it more problematic when it comes to keeping control with the extra ballast water weight used during loading operations. Hence, the vessel risks to utilize too much ballast water and when the vessel departs it is carrying more weight than necessary.

Exercise learning objective

The learning objective of this exercise is to let the course participants gain the necessary tools to be able to do vessel cargo distribution optimization at their own RO-RO terminal operations.

Exercise tools

The main exercise tool is a Loading calculator Spreadsheet Model. This Excel spreadsheet model makes the calculation framework and the weight distribution visible. Moreover, it shows the cargo manifest in connection to the loading plan and the stability calculations. In a specific designed loading software program (Autoload program), these calculations and framework are not visible.

The exercise use a cargo manifest from a real RO-RO terminal. In addition, utilizing a standardized RO-RO vessel with aft loading ramp and four cargo decks for the stability calculations and the cargo distribution.

Part 1: Introduction of the spreadsheet model
The course participants start the exercise by watching a YouTube video describing the spreadsheet model functions before commencing the exercise.

Part 2: Tabletop Exercise

- Dividing the course participants into groups of three. Ship personnel evenly divided between the groups.
- Part 1: The groups distribute the cargo from the manifest to the vessel cargo decks in the spreadsheet model. Each cargo unit must be visually be checked by its individual contribution to the vessels change of its center of gravity. The group continue to do this until each member have learned the process.
- Part 2: Compare an optimum loading configuration with their group work from part 1.
- Part 3: Discuss the implications of the findings. What creates the reduction in watet ballast?

YouTube video content:

- Teaching content: The course lecturer first describes the present vessel and terminal loading/discharging routines. Next, gives a full presentation of the spreadsheet model by running a real case.

Course Part 2 (4 hours)

Exercise for optimizing the RO-RO cargo flow between terminal and vessel (DESM)

The aim for the final exercise is to look at the critical RO-RO terminal mechanism that are relevant in terms of optimizing the RO-RO cargo flow. Hence, to implement solutions to existing RO-RO terminals, by encouraging the course participants to use their own competence to improve existing RO-RO practice.

The exercise units

The exercise will play with the different resources and their effect on the loading process:

- Effect of the single cargo unit arrival at the terminal gate.
- Effect of cargo deviations (Delayed or "no show" cargo).
- Number of towing trucks involved in the cargo operation.
- How to do continuous operation (Lunch breaks, operation breakdowns, uneven cargo supply, and ideal terminal storage setup. In addition, optimized towing truck pickup and delivery of trailers).
- The amount of import- and export cargo units compared to the storing capacity of the terminal.
- Measuring of key performance indicators (KPI's), like comparing each cargo operation run against an ideal total loading/discharging time or an ideal final use of resources involved in the cargo operations.

The exercise layout

Running the exercise into two distinct parts:

- Part 1 is the preparation phase that prepares the course participants and that aims for building a joint platform for RO-RO terminal-vessel improvements to the cargo flow.
- After Part 1 is finished the course participants divides into smaller groups (3-5 people in each group).
- Part 2 is the tabletop game, where the course participants "compete" to make the best cargo flow solution against predefined KPI targets. The course participants should also estimate if their solutions are realistic compared to their own business.

Exercise Part 1 Introduction of the Discrete Event Simulation Model (DESM)
The preparation phase

1. The course participants watch a 15-20 minutes instructional video on the various Discrete Event Simulation Model (DESM) units and its structure.
2. The instructor gives the course participants several selected runs of the DESM to show the working model and its units working at various operational modes.
3. The model program simulates all the various resources.

Learning objective Part 1

The learning objective for part one of the exercise is to give the course participants a joint understanding of the operational flow of cargo between the terminal and the RO-RO vessel. This will give them the ability to use this common knowledge, skills, and general competence to apply, analyze or to justify changes in their present terminal-vessel cooperation.

Exercise Part 2 Tabletop game

The aim of the game is to solve the target KPI's with the least amount of available resources used.

The tabletop game

Tabletop game tools:

- A prepared booking list that suits the exercise
- Printed A1 overview of the terminal area and the gate area
- Printed A1 overview of the cargo decks
- Resource game cards with different time slots (Trailers, Cassettes, Import cars, Buses, Lorries, Towing trucks and vital personnel) Based on the DESM model parameters.
- Stop game cards (Breakdowns, Incidents, Timed lunch breaks, Delayed cargo units, No show cargo, etc.).

The Exercise setup:

- Groups of three participants work on one table each (A1 sheets are placed on the table)
- One copy of the booking list is given to each group
- Resource game cards are placed evenly on each table
- The instructors keeps the stop cards. When played they apply to all groups at the same time.
- The aim of the game is to solve the target KPI's with the least amount of available resources used.

Teaching video content for Part 1:

The course lecturer gives a concise description of each units used to build the model while running a demonstration of the Discrete Event Simulation Model in the background. The video should not exceed 15 to 20 minutes in length. The optimum video design is to run selected parts of the simulation while commenting both visually on the screen and orally. The instructor should be visible in the video stream.

Summary and reflections on training programme for shipping companies and ports

The purpose of the WP 4 in general, is to will provide concrete advice, knowledge and increased institutional capacity to shipping companies and ports in the Baltic Sea Region.

Through the project, we have investigated several different technologies and found that the technologies that create the most business value and eco-efficiency for shipping companies and ports are the technologies that create value for both organizations and not just one party.

The resources used in shipping companies and ports to run their business processes are so expensive and resource / energy intensive that all optimization of their use and timing and coordination of these create such a great basis for both eco-efficiency and competitive

advantage over other modes of transport. There is no doubt that maritime transport has come to stay and not least in the Baltic Sea region. The fact that the Baltic Sea region expands the use of integration between sea and land transport, where RO-RO ships become a larger part of door-to-door delivery to companies in the Baltic Sea region, will not only create better competitive advantage for companies in the Baltic Sea region, but also eco-efficiency for everyone's interest.

In the following, we have reflected the work and solutions made in relation to the four perspectives as the most important in the project.

(1) Technological perspective – possibilities and procedures related to creating and using new technologies.

Through the project's many cases, we have investigated several different technologies. Many of the technologies are not particularly advanced, but when put them together correctly and adapted to the situation under which the shipping companies and the port work, it has proven to be relatively easy and straightforward. We are especially in WP 4 work with integration of systems and develop procedure and models for the use of technology. It has been a great success to use e.g. discrete event simulation as it is a powerful visualization tool and good for documenting and consistently assessing different solution. Most users and decision makers are sceptical of the technological solutions they are presented with when they do not have the opportunity to validate technologies in their own business case and examine the value of the solutions in their own case before implementing the technologies today. We have clearly been able to convince the decision maker and not least the users of the value of using simulation tools.

With the use of digital technologies in the course and training program, we have clearly been able to demonstrate that even small initiatives of improvement can achieve greater environmental improvements. System integration and data exchange result in fewer resources being used to perform the task and faster. Time and productivity are a crucial factor when the goal is to reduce environmental impact and we have been able to demonstrate this through the use of technology.

(2) Business perspective - opportunities and procedures related to the creation of new business interactions and models.

The project has been strongly rooted in the shipping companies and their daily challenge to become eco-efficient. Therefore, the project has also had the right focus on what is important in the transition to sustainable / eco-efficient operations while maintaining competitiveness.

The possibilities and perspectives of integrating IT systems are undoubtedly an important area to work on if investments are to be made in IT systems. IT systems do not get the same value if they are not integrated with the systems that are to support the operation. The paradox is that when IT systems are integrated, greater value and more benefits are achieved in also investing in applications that must support the operation. Non-integrated IT systems do not achieve the same value as desired if they are not also integrated and often become just a reorganization of the business processes without the expected value.

In the developed course and training program, there are several business stages that the student goes through. Each stage has a given design of ship and terminal and sets an upper limit for where earning capacity. The first stage is as it is today, and the student will be able to clearly see the bottleneck in the design and the limitation in earning capacity. In the subsequent stages, the student will find that using digital technology to integrate systems opens up for closer and more efficient cooperation between the terminal and the ship.

The close collaboration by integrating systems and redesign of the terminal also enables new business models such as customer prioritization and price and service differentiation. Time and productivity are again a crucial factor when aiming for business benefits and reducing environmental impact which the developed course clearly demonstrates.

(3) Human perspective – aspects to take into account in redesigning work processes and tasks of individual workers (incl. how to encourage staff to take initiative in developing new concepts at grass-root level)

In the project, the technological barrier has not been as great as expected, as the employees like us to use the technology and create eco-efficiency improvements, for everyone's interest and benefit. In addition, demonstrations with integrated IT systems have shown that they support operations to employee satisfaction.

In the developed course and training program are the different stages with different work tasks for the employees. The purpose of the courses is also to support the employees' ability and competence to be active resources in development and new initiatives, as they are first hand to see how the activities can be redesigned and improved.

(4) BSR image perspective - opportunities and procedures for common Baltic Sea region identity and transnational networks to promote digitization and thereby environmental efficiency and competitiveness in industry.

Through the project's many analyzes and tests in case companies, it has been shown that there are more opportunities than limitations to promote eco-efficiency and the competitiveness of the Baltic Sea region. Right now that we are facing a fundamental change in the way the industry should run their business means there is more than ever before important to think out of the box. Together with companies and university partners, we have researched and mapped several new technologies that will in time become relevant and important for the transition to more eco-efficiency. This change has proved to be just as relevant and interesting for companies located on one side of the Baltic Sea as on the other side, as everyone has the benefits and advantages of the green and digital change. We have only just begun the transition, more will come and at a faster rate than today.

With the course program, we have put the green agenda from BSR in the spotlight. With the developed course program, BSR has shown the way for how environmental improvements can be achieved by using digital technology

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