The RoRo Shipping Game

Eco-efficient Shipping via Simulation Based Training

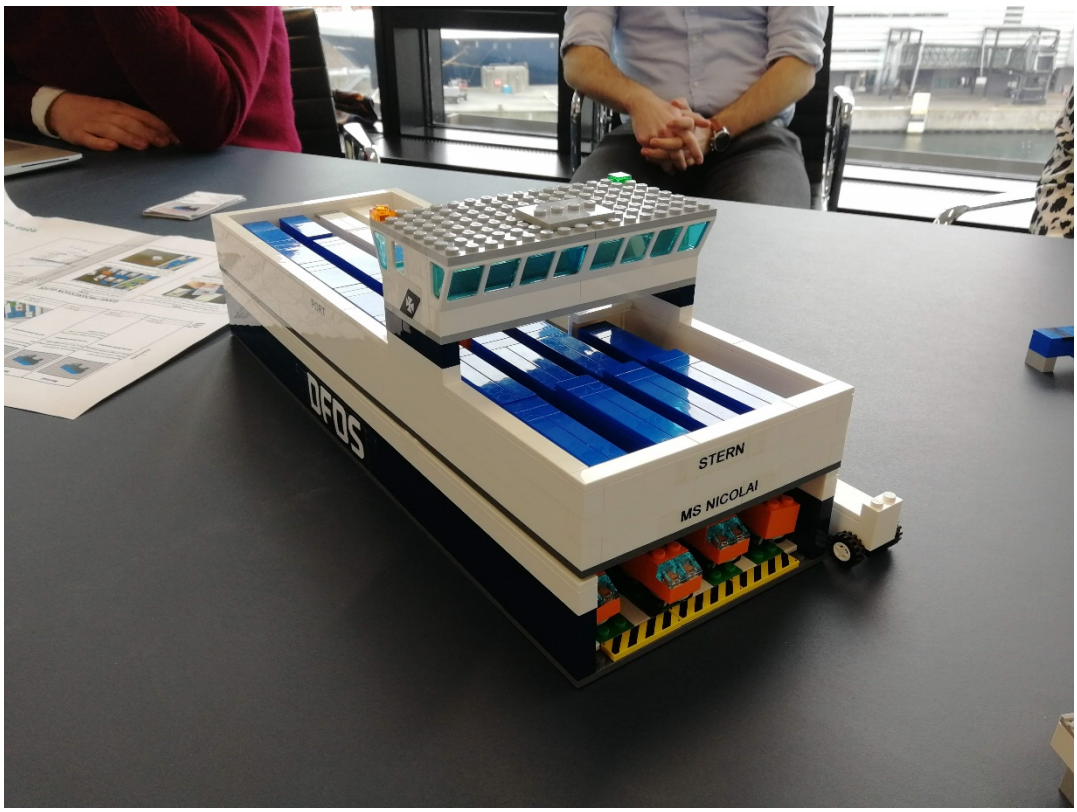

Figure 1: Photo from DFDS Game Workshop, March 2022

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Background & Introduction

Simulation Based Training (SBT) is recognized as an efficient and powerful instruction method compared to more traditional classroom teaching. Classroom teaching offers a controllable and cost-efficient (scalable) dissemination of curriculum taught to students and industry professionals, but typically fails in creating an engaging learning experience and building skills and capabilities for practical / real life problem solving among participants. Within the maritime industry there is a long tradition for doing SBT, which typically is applied to train students and professionals in areas of vessel navigation, engine and crane operations, maintenance and repair of machinery, firefighting and rescue operations etc. Though most of the training has emphasized technical or safety aspects, there are also recent examples on how energy efficiency aspects have been integrated into the training see for example Jensen et al. (2018). However, within maritime logistics and economics, SBT is much less applied, though there in recent years have been growing invention and use of such methods in the area, see for example: Rytter (2015), (Rytter et al., 2016), Kurapati et al. (2018), Jensen et al. (2018), Cariou and Guillotreau (2021), Pruyn and Hassel (2021).

The purpose of this report is to present a SBT tool named "The RoRo Shipping Game" which has been developed via funding from several EU and DK funded research and innovation projects executed from 2018-2022 at Aalborg University Copenhagen (AAU) and University of Southern Denmark (SDU). The effort was initially supported by the Baltic Sea Interreg EU projects ECOPRODIGI and EXOPRODIGI[1] as well as the Clean Shipping Project Platform[2], and eventually the DK RoRoGreen project[3] and Innovation Fund DK contributed with support for the last deliverables. Delivery of a first version of the game was delayed significantly, partly due to transfer of staff from AAU to SDU, and partly due to COVID19 restrictions imposed by DK authorities on university and company work conditions in recent years. However, despite obstacles faced, the team was finally spring 2022 able to deliver a first prototype version of the business simulation, also test and validate it's potential in collaboration with industry professionals.

The purpose of the game is to bring a team of students or industry professionals together for a day and via the game and an engaging learning experience, convey them an understanding of first how to conduct key logistical work processes within RoRo Shipping[4] and secondly how daily commercial and operational decisions can impact the eco-efficiency / sustainability of RoRo shipping with respect to efficiency, profitability, fuel consumption and CO^2 / GHG emissions of vessels and mobile equipment in ports. This report will provide further introduction to how the game has been designed and the learning objectives are met. The business simulation has been tested in collaboration with the shipping company DFDS (see figure 1), but it is not limited to specific business and operational challenges of their company, and the game has been designed to be relevant for most European RoRo and optionally also RoPax[5] shipping companies. The game is available in a first prototype version, and it will likely be upgraded further as it will be disseminated to and applied in the industry. It is the ambition of the inventors / authors that the game will play an important role for future training and skill building efforts for RoRo shipping and the maritime industry in general, and for further information about the game and how to acquire game materials, make a trial session etc., please reach out to the authors of this report using the contact information provided at the end.

[1] https://ecoprodigi.eu/
[2] https://cshipp.eu/
[3] https://rorogreen.dtu.dk/
[4] RoRo Ships transport vehicle cargo units (trucks, trailers, busses, cars etc.) which are rolled on and off to the ships, see for example: https://www.marineinsight.com/types-of-ships/what-are-ro-ro-ships/.
[5] RoPax Ships typically transport both passengers and vehicle cargo units.

Simulation Based Training Methods

Classical large lecture or classroom teaching is traditionally considered as the most attractive instruction method allowing for a controllable and cost-efficient (scalable) dissemination of subject information to students and professionals. A competent and enthusiastic lecturer, a good structuring of curriculum taught across several lectures, exercises for students or professionals to solve after classes and a final exam – is likely to succeed in closing the knowledge gaps between the lecturer and the audience with relatively little time and resources spent compared to other instruction methods. However the large lecturing format also has a number of shortages (Brandon-Jones et al., 2012): It often fails to provide lecturers with feedback regarding student understanding of matters; emphasis is mainly on auditory learning as opposed to other learning styles, including visual, reading/writing, or kinesthetic learning; it bases itself on the assumption that all students learn at the same pace and have similar levels of understanding; and finally there is a significant risk of information loss due to lack of student engagement during activities. Participant engagement is critical given the evidence that involvement in the learning process significantly improves knowledge retention and the ability to apply that knowledge in practice (Kolb, 1984). Furthermore, research has demonstrated that teaching should not be restricted to become simple dissemination of knowledge but perceived more as "the passing on of knowledge, this also including a preparation for working life and the internalization of value systems and culture" (Baruch, 2006) which indicates that, traditional lectures may not at all be suited to teach higher order learning skills covering application, analysis, synthesis, or evaluation of knowledge.

To complement the large lecturing format, are often adding a range of other pedagogical instruments to their courses, as the use of film clips, real-world based case assignments and problem-based learning methods into their courses means. The international publishers of textbooks (Pearson, McGraw-Hill, Wiley etc.) early on also recognized this tendency, and over the last decade they have offered "value added services" in the form of complete course packages, including a standardized lecturing setup, curriculum, teaching and presentation materials, multimedia, exam assignments etc. to lecturers and / or students. Materials are available online with the textbooks with a potential positive impact on lecturing quality and student learnings.

More than a decade ago, a plethora of internet based digital course offerings began entering the global market for student and professional training. E-learning courses typically allow the student flexibility to study and complete a course at a time and with a pace that is desired as well with an individual learning path via adaptive learning[6] methods. E-learning is cost-efficient to run for the educational institution or training provider when the initial investment in course design has been made using either open source or commercially available learning management systems (LMS) / platforms. Some digital learning programs are supported by a lecturer or coach offering guidance, being part of evaluations etc. When first developed, e-learning programs are scalable for low cost and can potentially target a global audience. There today exist several online course portals, as for example Coursera (Coursera, 2022) and Edx (Edx, 2022) where students and professionals either for free or against a fee (if an official exam and diploma is desired) can access multiple online (undergraduate or graduate) courses from a range of universities and business schools across the world. Though such portals and digital learning offerings will play a vital role in future educations or skill building thus posing a fundamental challenge to previous monopolies and business models of universities, engineering schools, business schools etc., it is evident that they also in their current setup and form has a number of shortcomings compared to teaching methods where participants and lecturers are physically present at the same location.

[6] For definition of adaptive learning, see https://en.wikipedia.org/wiki/Adaptive_learning

Lecturing via digital meeting platforms as Zoom and Microsoft Teams accelerated due to COVD19, and their use will likely remain an integrated part of future educations and course offerings going forward. Meeting platforms bring forward the opportunity of running a course or lecture without lecturers and students being physically present on same location with added benefits to both training providers and participants with respect to flexibility, costs and time. Online lectures can be used to run a whole or part of a training program online, and they convey some of the social space and 2-way interaction which were key elements of traditional classroom teaching which is a benefit compared to e-learning methods. But recent research also indicates that online lectures as stand-alone instrument, reduces attention, motivation and engagement of both lecturers, students and professionals – again impacting the learning experience negatively compared to when participants are physically present at the same location.

In the search for cost-efficient and high impact teaching and training methods, there are however also alternative trails to follow which might lead us in promising directions, and one of these leads us towards a category of experiential learning methods labeled as SBT or educational game methods (Fish, 2007) which are widely applied across engineering and management disciplines. SBT is according to Salas et al. (2009) defined as a training and learning methodology which has the purpose of imparting to students and professionals, a set of competencies (i.e., knowledge, skills, and attitudes) that ultimately improve their performance and the overall performance of the organizations that employ them. This is achieved offering a simplified and simulated, yet real-life inspired, entertaining and motivating way of learning to the participants. SBT typically includes for example physical / tabletop simulations, computerized games (lately in virtual reality), role-plays and live cases where individuals or groups have to complete a set of tasks in depth (often in real-time), in collaboration and / or competition with each other over an extended period of time. SBT is considered to provide several benefits compared to other training methods (Salas et. al, 2009):

- SBT is superior to other training strategies for imparting complex applied competencies.
- SBT can lead to learning in a reduced time frame
- SBT provides a more complex and realistic learning environment than other training strategies
- SBT more readily allows for reality to be simplified and manageable
- SBT provides a (relatively) risk-free environment for learning and experimentation
- SBT is an ideal method for training Infrequently engaged but critical skills
- SBT can be quite affordable
- SBT is (usually) simple to learn and operate
- SBT is a form of learner-controlled training
- SBT is inherently more engaging than other training methods

Experts thus predict that SBT, whether implemented in one form or another, will play a significant role in recruiting, training and skill building across all fields and industries in the future (Forbes, 2013), also in the area of maritime education and training (Pryun and Hassel, 2021). Almost a decade ago, AAU / SDU made the first steps to explore how SBT can be applied to the area of maritime economics and logistics, which lead to development and delivery of “The Liner Shipping Game” (Effektivitet, 2015), (Rytter et al., 2016), LinerGame (2022), so far applied on more than 4 continents and 20 countries for training. When a team of researchers late 2017 began collaboration with DFDS, investigating options for making logistical processes of the RoRo / RoPax shipping industry digital and sustainable, an obvious opportunity occurred for exploring SBT as an instrument for disseminating several of the research and innovation project results and for future training and skill building for the industry.

Eco-efficient RoRo Shipping in the EU and Baltic Sea Region

Short sea shipping (SSS) is a vital element in Europe's (EUs) logistical infrastructure and considered one of the most economic and environmental friendly modes of transport for both vehicles, cargo and passengers in the region compared to other modes of transport as for example airlines, road, rail transport etc. RoRo and RoPax ferries make up a large share of SSS, and EU and particularly the Baltic Sea Region, is considered a front rummer in this segment, where innovations contribute to making the global maritime industry more digital, efficient and sustainable. The RoRo Shipping Game was originally developed as part of the ECOPRODIGI, EXOPRODIGI and Clean Shipping Platform projects which share a common aim of contributing to making the Baltic Sea Region and EU maritime industry more eco-efficient via digitalization, green technologies, societal inventions and regulatory as well as policy recommendations. For a more formal explanation of the term Eco-Efficiency, the authors rely of a definition of Eco-Efficiency proposed by Ehrenfeld (2005) several decades back:

"Eco-efficiency has been proposed as one of the main tools to promote a transformation from unsustainable development to one of sustainable development. It is based on the concept of creating more goods and services while using fewer resources and creating less waste and pollution. It is measured as the ratio between the (added) value of what has been produced (e.g. GDP) and the (added) environment impacts of the product or service (e.g. C02 emissions)…Ergo the term has become synonymous with a management philosophy geared towards sustainability, combining ecological and economic efficiency"

The game has been developed with dissemination in mind and as a training tool to provide a team of participants with a thorough understanding of how daily work practices of a RoRo shipping line as well as how commercial and operational decisions impact logistics, economic and environmental performance of a modern shipping company. For sake of simplicity, regarding environmental aspects, the game mainly considers air emissions (CO^2, GHG and particle emissions), and other polluting elements of maritime operations as for example water quality, animal life etc. are not in scope for the game. A key element of the game is to emphasize the importance of standardized, integrated and digitalized work processes for simplicity and efficiency of ship and port operations, as well as data driven decision making to improve eco-efficiency of maritime and RoRo supply chains in the future.

Aim and Learning objectives for the Game

The main aim of The RoRo Shipping Game is to convey a team of students and / or industry professionals an understanding of key terms and work processes coupled to logistics and cargo operations of RoRo vessels and to create awareness for how commercial and operational decision processes and their data foundation, can impact the eco-efficiency of RoRo vessels and mobile equipment in terminals. A game event is typically run in a single day and provides an engaging and alluring team building experience for the participants participating in the business simulation / game. The game is designed as a tabletop business simulation, where a digital decision support tool, has been built to support participants executing key work processes and monitoring Eco-efficiency performance during game playing. The game is suitable to be played by both students and industry professionals with an interest in maritime operations and logistics. It is potentially relevant as a training tool for managers and staff from shipping companies, ports, forwarders, haulage companies etc. whom daily work with RoRo shipping of trailers and vehicles, but also other businesses working with this segment of the industry as ship brokers, ship agents, bankers, consultants, equipment vendors, yards etc. For RoRo and RoPax shipping companies the game can particularly be relevant for professionals working in HQ functions distant from daily business and operations and local sites. The game can for this category of participants, play and important role providing participants with a good understanding of key business terms and core business and challenges in in a very cost-efficient manner.

Finally, the game can potentially also be used as a recruiting instrument and onboarding tool for new staff hired in a shipping company and for team building in general. To summarize the business simulation / game conveys the following insights and skills to participants:

- Introduction to the terms and fundamentals of RoRo Shipping
- Understanding of activities and work processes of core functions in a modern RoRo shipping line
- Importance of cross functional collaboration and commercial and operational decision making when to maximize profitability and eco-efficiency of ships and mobile equipment in ports
- Importance of process standardization, integration and digitalization and data quality for efficiency and decision-making quality for RoRo Shipping
- Relevance of methods for demand forecasting and optimization when to optimize Revenue, Stowage and Cargo Operations of RoRo Ships
- Competitive and Sustainable challenges of RoRo Shipping in the market for Short Sea Shipping in Europe and the Blatic Sea Region
- Team spirit and an efficient as well as engaging learning experience via game playing, also using the Lego® models developed for the game, the set of game materials and digital tool developed to support participants in their tasks and learning experience

Figure 2: Achieving set learning objectives is critical for the business simulation

The list above can be considered key earning objectives, which the game has been designed to meet for sessions conducted (figure 2).

The Game Setup

The specific game design / setup will be explained in this section.

Route

The Game has been designed with a typical Short Sea RoRo Shipping Route in scope, and at the outset a Gothenburg (SWE) - Immingham (UK) route was chosen similar to the route operated by the RoRo Shipping company DFDS. Inspired by available timetables and schedules for their route, the transit sailing time was set to 35 hours which represents a longer route for a typical RoRo ship in Europe not being a car carrier. Car carriers typically sail longer routes and across the oceans (this mode of transport is thus not SSS), as in the case of for example car carriers transporting European and American cars across the Atlantic Ocean. For RoRo

Ships, planned vessel schedule or departure decisions has a significant impact on not only transit time, but also speed and fuel consumption, and if another route is included for the game in, game developers and instructors should make required adjustments to several of the game modules, materials etc.

RoRo Vessels

There is no game board available, but the game setup however includes a tabletop setup which includes 2 Lego® vessels per route. The Lego are own design and are built to be simplified replicas of a real RoRo ferry, see figure 3. Design features have been chosen to reflect a variety of ferries observed across routes and ports in the DFDS network. The ferry design can be upgraded also made more visually appealing in the future, as the initial design mainly was drafted to enable the desired game script to be played, and not with the visual or beauty aspects in focus.

The vessels are designed as 704 lane meter capacity vessels with two decks: Main deck and Upper deck. Similar to a real vessel, the lane system is visible on the ferry, and special lanes and sections of the vessel have equivalently been enabled with electrical plugs for refrigerated or heated trailers. The size of the vessel is downscaled compared to a typical RoRo vessel typically in the range of 2000-4000 Lane Meters. Some of the newest Mega-RoRo vessels of the DFDS fleet are significantly larger and has 5 decks and a capacity of app. 7000 lane meters, thus carrying up to 400-450 standard trailers onboard[7]. Most RoRo vessels typically have multiple decks such as basement / lower hold, main deck, upper deck(s) & weather deck. Basement deck is usually an area below the main deck which is accessed through a ramp that will close for the voyage as the main deck is loaded with cargo units. The main deck is where the cargo usually enters the vessel via the ramp to the quay side. The upper decks are similar to the main deck, but only accessible via a ramp in the ship and/or from the side of the vessel. The weather deck is the top deck on vessels and is often not fully covered with a roof. For simplicity, size and number of decks on the vessel for the game, has been reduced to two ensure that participants would not consume more time than required planning stowage and executing cargo operations for the vessel. The complexity of the vessel designed for the game, should be sufficient for the participant to grasp several of the stowage and cargo operations challenges of the industry.

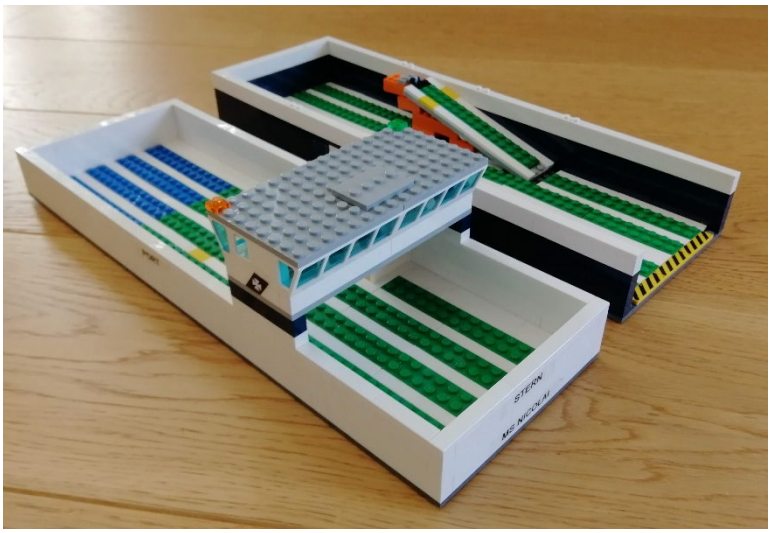

Figure 3: The Lego® vessel designed for the Game vessel, split into two decks

Cargo units

The RoRo shipping Game include a set of cargo units which should be booked for, loaded and discharged on the vessels which also have been built in Lego®. Focus of this game are unaccompanied cargo units and vans which are pulled / driven on and off the vessel with terminal tractors / tugs or drivers (the drivers are assumed present but being invisible in the game). In real RoRo Shipping a variety of both accompanied and unaccompanied RoRo cargo units are stowed on the vessels. The most common unaccompanied cargo types

[7] DFDS have recently received 6 Mega RoRo Vessels from the Jinling Shipyard in Chine, see for example: https://www.dfds.com/en/about/media/news/dfds-takes-delivery-of-its-largest-freight-ferry-ever

are the typical truck box / curtain / container trailers which generally exist in more standardized sizes, with the most typical size and dimensions illustrated in figure 4.[8]

Figure 4: Standard trailer dimensions

While the sizes are relatively standardized, also for longer trailers, content and category of the trailers can vary a lot. Some trailers are refrigerated and needs constant power to keep cargo below a certain temperature. These trailers must thus be linked to a power plug on the ship. Other trailers include cargo classified as dangerous among which there are multiple subcategories. Each subcategory of dangerous cargo will follow specific rules for stowage onboard the vessel to comply with safety requirements. An example can be hazardous gas being which is to be placed on the weather deck. If a leakage occurs, such trailers will not fill up any decks with potentially explosive or toxic gas. Another example is dangerous cargo not being allowed to be placed adjacently to each other, to prevent an incident (leakage, fire etc.) of one unit to spread onto other units potentially and thus escalating the danger. Other types of cargo that you could encounter on a RoRo ship includes shipping of vehicles of various kinds. For example, DFDS transports a lot of cars in and out of their terminals in Gothenburg and Ghent. RoRo-vessels also handle out of gauge and special cargo requests on a regular basis, as for example transportation of military equipment that needs transferring or blades for a new windmill in an oversized load.

The RoRo Shipping Game, has been designed to include the following cargo types:

1. Normal trailer: The typical box/curtain/container truck trailer
2. Heavy trailer: A heavier box/curtain/container truck trailer
3. Long trailer: A longer standard box/curtain truck trailer
4. Refrigerated trailer: The trailers that require a power plug
5. Hazardous trailer: The collection of different hazardous cargo types
6. Van: The typical smaller cargo such as cars or vans.
7. Special cargo: Large out of gauge unusual transports

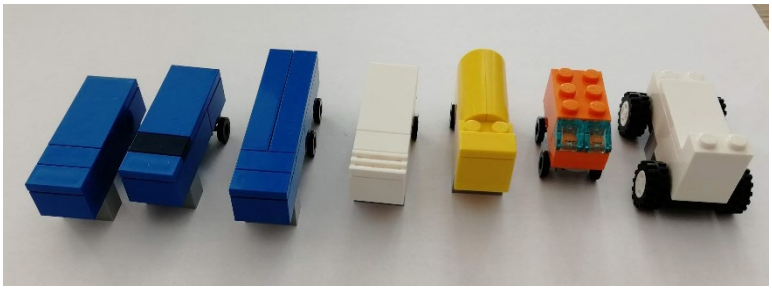

Figure 5: All cargo units in the game

[8] A standard box / curtain trailer can carry 33 pallets compared to a standard 40" ISO container carrying 23-34 of EUR pallets in size (800 x 120 cm).

Client segments

Most RoRo Shipping companies offer long term agreements (for example 1-year contracts) to their clients often being logistics or haulage companies and industrial clients, which make frequent use of their services. The contracts provide clients favorable terms with respect to rates, flexibility, priority, booking, services offered etc. considered critical for client businesses. Larger clients with special contracts are typically named key clients, compared to clients with few shipments generally booking more on standard terms. Shipping companies often issue a space commitment to key clients which guarantees that the client will be prioritized and get on board if the vessel is full for a fixed number of cargo units per day / week / departure. Also shipping companies can offer priority arrangements to clients willing to pay for it, which implies that they can receive their cargo units discharged first at destination port. The game has been set up with the assumption that there are 2 client segments which book on different terms: Key clients and normal clients. A specific share of the daily incoming booking cards are thus designated "committed" and are for key client cargo customers. Key client or "committed" bookings must be accepted for a specific departure in contrast to "non-committed" cargo customers, where participants can choose to accept / reject the booking based on the rate level and capacity situation of the vessel attempting to maximize their revenue and vessel utilization per departure.

Game Processes

The game mainly consists of the three key processes and belonging work tasks: Booking Uptake, Stowage & Cargo Operations.

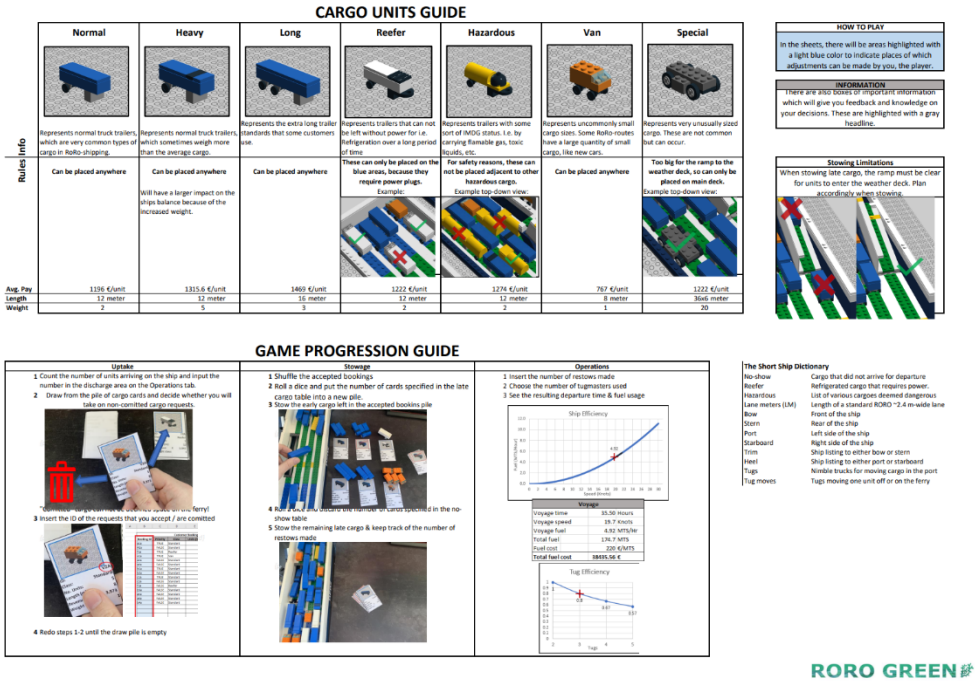

Figure 6: Game information sheet given to players

A printed A3 sheet providing participants with an overview of key work processes, decisions to be made and tools applied are available at the table during game playing, see Figure 6 for an example.

For booking uptake, the task of the team is to accept / reject booking requests and steer booking intake several days ahead for the next voyage on the route with the purpose of maximizing revenue and utilization for the vessel. During booking uptake players turn a deck of printed booking cards one at a time until the booking cut off (deadline before vessel departure) is in action and there are no further cards for that game

day, see figure 7 for a picture of the booking cards. Players have to prioritize their intake of bookings based on rates and available vessel capacity in lane meters or metric tons - and should thus consider the optimal cargo mix considering incoming committed vs non-committed bookings, cargo category, size and weight. During uptake management, players should plan for potential late cargo arrivals and no-shows, where the latter represents client bookings which do not materialize at all for a departure. As an input to their decision making, they receive market statistics on previous customer orders and rates as a data foundation to complement their own gut feeling of what is optimal to do.

For stowage, the task of the players is to stow, i.e. determine cargo unit positions on the ship, with the purpose of maximizing space utilization, respect set stowage restrictions, minimize stress on the vessel and reduce the need for extra ballast water to ensure stability of the vessel at sea. Several stowage restrictions have been set for the game and examples are: The ramp at main deck should stay clear so late cargo to be stowed on the weather deck can get access to it and special cargo must be stowed on main deck as it cannot fit the ramp. Also Hazardous cargo must be separated, and Refrigerated units are to be placed in a special zone with electrical plugs available.

Figure 7: Booking Cards

With cargo operations, the task of the team is to review the voyage schedule and decide number of terminal tractors to allocate to load and discharge of cargo units on the vessel. Their decision will impact duration of cargo operations, and how early / on-time / late the vessel can leave the port. Allocating more tugs cost higher daily costs but enable the vessel to depart earlier and slow steam while keeping the ETD of the destination port, eventually leading to fuel savings and emission reductions compared to if the vessel sails on time or late. Allocating less tugs to the tasks, will of course have the opposite impact.

After completing all three processes, the final task is to register, calculate and review team performance for the recent departure / day in the game, for a pre-defined set of performance metrics on which the players can improve during game playing.

All game processes are digitally supported via an own constructed MS Excel application, so decisions are made and registered in a spread sheet built to manage the information flow of the game and register game decisions, see Figure 8 for a screenshot of the user interface for the stowage tasks. To be able to play the game participants or facilitators should use laptops on which MS Excel 2021 version 2023 can run (two PCs are sufficient for a game setup with 1 route and 2 vessels). Other versions of MS Excel being compatible with .xlsm macro-files can also function at a playable level.

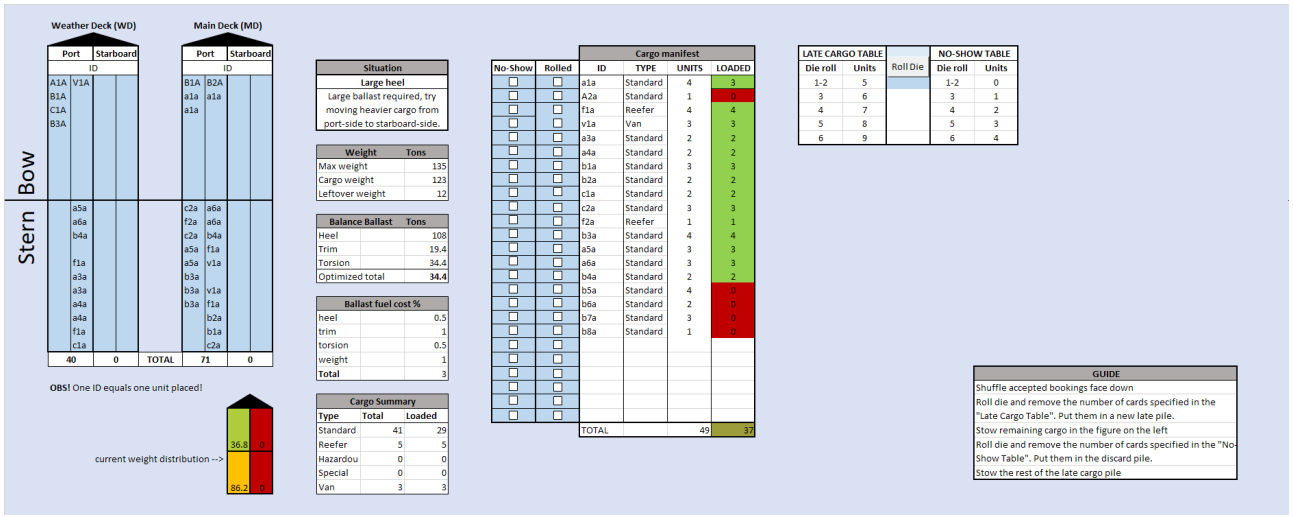

Figure 8: Spreadsheet for stowage operations

Organization and Team Roles

The game is played by making a team of participants responsible for one route with 2 RoRo terminals on the chosen Gothenburg-Immingham route operated by a shipping company. The game is thus designed to include 2-4 participants per port / vessel and ideally 4-8 persons per game set. If multiple teams are set up in parallel, competition between teams and shipping lines can be enabled, but it also requires more game materials, laptops etc.

Participant roles

The participants will either in collaboration or via rotation execute all functional roles and tasks of the game during a game day / round to make sure they receive a thorough cross functional understanding of the RoRo shipping business processes. After a game day / session they will therefore be familiar with how it is to work as decision makers in functions being responsible for booking and revenue management, onshore / onboard stowage planning and cargo operations.

The Facilitator role

The instructor or facilitator is a vital part of the RoRo Shipping Game. He or she is to set up, prepare and instruct the game during the day, as well as observe game behavior and results and wrap up key learnings in dialogue with the participants at the end of a game session. The facilitator is responsible for explaining purpose, content, logic and rules of the game to participants in a concise manner and provide ongoing support during game playing for any questions / mistakes / errors / frustrations which occur in a session. It is also his / her task to ensure that participants experience an exciting day with relevant learnings and engagement and fun at the same time. The facilitator can preferably be familiar with RoRo Shipping from beforehand – this to be able to explain and interpret game incidents and results in context of real world business reality, which increases the learning outcomes for the participants in the game.

Measuring Team Performance

For scoring team performance, the game has been designed with 3 categories of measurements / key performance indicators considered relevant when to meet an Eco-efficiency strategy and objectives:

1. Asset Utilization: How well are ships and other assets utilized?
2. Economy: What are costs, revenue and profitability of the voyage?
3. Sustainability: What is the total amount of fuel consumption and CO^2 emitted from port operations and the vessel?

For all three categories there are sub metrics and numbers to show for "each day" of game playing as basis for team and facilitator analysis and discussion on impact of observed game playing and identifying improvement actions for upcoming rounds. The selected KPIs are considered strategically relevant for Ro-Ro shipping companies in general, and they also somehow relate to KPIs typically set for the different departments / units of a shipping company. The pricing / sales / customer service departments are often responsible for revenue and booking intake. The terminal and vessel operations departments are in combination responsible for asset utilization, schedule adherence and expenses for and across voyages. The area of sustainability and emissions have also been included, since it is considered a strategically important metric across functions for shipping companies and sustainability departments already today, and even more in the future as mentioned above.

Agenda of a typical game day

A typical game session will last 4-7 hours and will include introduction, game playing and wrap up of the day. The introduction part should be relatively short, and details should be conveyed during game playing. The game has been designed with up to 6 "days" / vessel voyages (per ship) of game playing. A game round represents one day, and typically includes that a vessel arrives at terminal to discharge cargo units and load new bookings for the upcoming voyage, which is scheduled to take place 7 hours after arrival. The team then has to execute all the tasks, typically staring with the operational tasks, i.e. stowage and cargo operations, for the vessel at berth first, and finishing with the commercial, i.e. booking uptake at the end (bookings are taken for next vessel coming in). The ship then leaves port, and team performance is reviewed, discussed and actions are planned for subsequent departures / rounds.

Game testing and lessons learned so far

The current version of the game has been tested with DFDS on a few industry professionals with business experience and some externals 2 times to validate the quality of the design. The tests provided positive feedback on the game design and several suggestions for further adjustments to be made, which since have been implemented in the game. The overall feedback from participants was positive, and the features or desired virtues of the game came through easily for the players, though the testing highlighted the critical role of facilitators in delivering a successful game experience (the game is not easily playable without an experienced facilitator). A larger scale validation of the game benefits and drawbacks is planned for the future in parallel with future testing of the game.

Next Steps

In the upcoming year, the inventors of the game, will emphasize further trials of the business simulation, testing various game setups and elements for a mix of participants, students, professionals etc. Based on tests, further adjustments of the game design and materials might take place. Long term, a next step could be to make a fully digitalized and virtual version of the game which can be accessed and played online, which will enable us to train many teams and participants from multiple locations simultaneously. A fully digital and virtual game, for example implemented in the Omniverse or Metaverse[9] in the future, would be able to

[9] https://cmte.ieee.org/futuredirections/2021/11/16/metaverse-vs-omniverse/

include many more features and represent reality of RoRo Shipping better than the tabletop version. It would potentially allow for multiple play options with respect to levels, complexity and duration of sessions. The current tabletop version has clear limitations as it is bound to a physical reality. However, a fully digital and virtual version of the game, might run the risk of neglecting important physical (embodied) learning dimensions as well as miss out on team building or social as well as engagement / motivational benefits delivered by the current tabletop version of the game.

Conclusion

Approximately 4 years ago, our team of researchers and game inventors, started out generating first ideas for how to create a dissemination instrument and training tool to the RoRo Shipping industry supporting it in building skills for for designing and operating Eco-efficient maritime logistics and cargo operations. This report has presented the final results of a 4-year part time effort, and it should provide the reader with a brief overview of key aspects and elements of the game delivered. There are multiple options for improving and expanding the current version of the game in the future, but we are still convinced that the current version of The RoRo Shipping already today can be deployed as a powerful instrument for training students, managers, staff, crew etc. of the maritime and logistics industry in how RoRo Shipping can contribute to accomplishment of strategically important Eco-efficiency objectives in the future. EU and the IMO have recently announced ambitious targets and regulatory actions for further decarbonization of the maritime industry which shipping companies will face in the coming decade. The Shipping industry is accountable for an estimated 3% of the global GHG emissions, equivalent to app. 1 billion tons of CO^2 according to the 4th GHG study for Shipping[10], not even including for example emissions from mobile equipment etc. in ports. EU's FIT for 55 plan presented by the EU commission in 2021 has also raised EU's ambition for reducing total greenhouse gas emissions to at least 55% by 2030 compared to 1990 level, and includes the ambition for EU to be the world's first climate neutral continent by 2050. Decarbonization of the European maritime industry without hampering competitiveness, is considered a vital element in reaching those continental objectives. IMO has thus set targets for reducing the carbon intensity of ships (CII) with 40% by 2030 compared to 2008 levels and with 70% by 2050, and eventually total emissions from the whole sector should be reduced with 50% by 2050. Our team of researchers hope that the RoRo Shipping Game will be become one out of several training instruments or methods applied in the EU and Baltic Sea Region in the future. We believe that the business simulation can contribute to further awareness and understanding among decision makers and work force of how to realize an Eco-efficient maritime industry; an industry which eventually can bring both economic growth, health and attractive living conditions to the citizens of Europe.

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[10] A summary of results from the 4th Greenhouse Gas Study is available at: https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Fourth%20IMO%20GHG%20Study%202020%20Executive-Summary.pdf

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