Optimising Cargo Stowage Processes Increases Effective Use of Ships

Keep cargo moving and ships sailing

The primary role of ships is to transport cargo and, in some cases, passengers efficiently. Cargo loading and discharging times should be as short as possible and all waiting times in anchor and in ports should be avoided. This would benefit both the shipowners and the environment. Existing vessels can be operated more efficiently and fewer ships may transport the same amount of cargo. Speed of ships can be optimised, for example reduced, and thus the emissions can be minimised – no more purposeless waiting.

Key findings

Maritime transports are most effective when vessels are sailing as fully loaded as possible using optimised speed to reach the next port just in time. Entering the port without waiting and then unloading and loading the cargo immediately will minimise the time spend in port. Digital technologies are crucial in reaching this goal.

Effective cargo stowage processes will benefit shipowners who get better returns on their vessel investments; **clients** who get their goods faster and on accurate timetable; **port operators**, who can use their equipment more efficiently; and last but not least the **environment**, which benefits from less fuel consumption and emissions. These can potentially be decreased by at least 2–10% per route and ship.

In Ro-Ro shipping, improving the stability calculations based on accurate vessel and cargo unit data and reducing ballast water are important. **Knowing the real weight of each cargo unit has high priority** which the International Maritime Organization (IMO) should promote.

However, many impacts are also true for other ship types. **Shortening port stays and enabling optimal sailing schedules to minimise fuel consumption benefit all.**

Sharing of data between different actors of the logistics chain **is crucial in the cargo stowage optimisation process.** We need accurate real-time data from various locations and systems.

Integration of data is a technical issue, but **readiness to share** more data is a human one. Actors must be encouraged and sometimes obliged to share more data with each other.

Technical research and innovation on the digital solutions for the optimisation process is needed on all levels, but special emphasis should be placed on **continuously reliable satellite connections to and from ships.** Tracking and monitoring of cargo units via sensors, vision, drones and digital technologies is crucial as well.

Optimised cargo stowage increases eco-efficiency

Current inefficiencies in cargo handling and stowage processes can be diminished by using digital technologies. Cargo handling operations can become faster and smoother if, for example, a Ro-Ro vessel can be unloaded and loaded simultaneously. Doing so shortens the total time of the process remarkably. With the shorter time spent in port, the vessel can be used more efficiently in its main role of transporting cargo by sea. The speed of the vessel can also be reduced, lowering fuel consumption and emissions.

Optimal stowage based on digital data reduces the need to balance the stability and trim with ballast water, and consequently, fuel consumption reduces too. According to estimations, fuel consumption and emissions can potentially be decreased by at least 2–10% per route and ship in the medium term, depending on the baseline situation.

There are significant benefits for customers as well, as they will receive their cargo faster because the port time is shorter. Also, the accuracy of timetables will improve.

In this project, we focused on Ro-Ro ships, but many of the results are valid for other ship types as well. Voyages with full cargo loads and those avoiding ballast are always preferable from both the shipowner's and the environmental point of view. The same applies for the goal of minimising the time spent in ports. With more and accurate online data, the speed of a vessel can be optimised to minimise fuel consumption and emissions.

It should be added, that other factors also affect vessels' sailing schedules beyond the time port operations actually take, and sometimes it is reasonable for a vessel to lay in berth for a whole day even if the stowage process could be done in a much shorter time.

Implications and recommendations

The technological basis for taking steps towards more effective stowage process already exists, but making the technology more sophisticated, reliable, cost-efficient and user-friendly requires **innovations and investments**. Technology components should be integrated to perform in combination, and data capture, storage and performance monitoring needs more standardisation. Data should also be shared across the end-to-end cargo stowage process, which does not yet occur. Terminal operations and cargo stowage system integration are prerequisites for effective cargo stowage optimisation.

Training of crews, both onboard and in port terminals, and of clients is very important to get full use of the digital solutions. In principal, Ro-Ro ships are quite similar, but in practise, nearly all are unique when it comes to the detailed layout of cargo decks, ramps and other devices that impact the stowage process. Ports are also different, so the digital solutions have to be customised. Methods for simulation-based training and skill building would be useful.

One factor that was found to be very important for optimising stowage in the Ro-Ro business is that **the real weight and dimensions of each cargo unit** should be available before the loading plan is made, as it affects vessel utilisation, stability calculations and possible use of ballast water. An **international IMO-based regulatory framework** covering Ro-Ro cargo units – similar to Verified Gross Mass (VGM) requirements for container shipping – would benefit the industry from a safety and a fuel consumption and eco-efficiency perspective.

Research on and innovation in different digital solutions and automation related to cargo stowage and operations should be promoted on both EU and national levels. Introducing remote-controlled terminal tractors will be one step in optimising processes in some ports.

Transfer of information has to be promoted, and for this, we need various **standards**. For example, standards for sharing cargo unit and vessel positions as well as conditions across the logistics chain and standards for maritime cyber security are essential. International vessel voyage codes for Ro-Ro vessels would also be useful.

Shipping companies, port operators, and port authorities have to be ready to **share more information** with each other than they are used to in order to make optimisation of asset utilisation possible. They need to be encouraged to do this and, in some aspects, obliged to by policy-makers.

Better cargo unit tracking and connectivity as well as satellite connections for transmitting data from ships sailing on oceans are concrete requirements for reliable functioning of the optimised system.

Promoting the installation of **automated mooring systems** is recommended, as they make working on quays safer, smoother and more efficient by reducing time spent in port. They suit Ro-Ro and Ro-Pax traffic very well, where ships are sailing on fixed routes and using the same quays every time. Another highly recommended step is **cold ironing**: berthed ships plugging in to the shore's electrical network. This decreases emissions remarkably and has positive effects on the population's health in port cities.

Cargo stowage optimisation as part of the ECOPRODIGI project

In the case of loading, stowage and discharge processes of ships at ports the Danish shipping company DFDS was the industry end-user. DFDS operates freight and passenger/car transportation, and the focus in this case was on cargo in the ferry division. A team of researchers and industry experts from Aalborg University, University of Southern Denmark, University of South-Eastern Norway, Chalmers University of Technology, Kockum Sonics and Logimatic, together with DFDS staff, conducted visits to and studies of several ferry routes and terminals to investigate the current state of the end-to-end stowage process, systems and baseline eco-efficiency performance.

The research showed that several digital solutions have potential for solving eco-inefficiencies in cargo handling processes. These include smart gates with cargo unit validation, digital data capture of cargo unit positions and dimensions, and tracking devices on trailers and trucks. System integration and data sharing across applications in the end-to-end stowage process, 3D simulation models for optimal unloading and loading methods and optimisation models for stowage, dual cycling of cargo operations and predicting expected discharge time of cargo units/trailers upon vessel arrival are also useful solutions.

Further reading

Maritime industry processes in the Baltic Sea Region. Synthesis of eco-inefficiencies and the potential of digital technologies for solving them. ECOPRODIGI RESEARCH REPORT 2020.
Elisa Aro, Niels Gorm Malý Rytter, Teemu Itälinna.
https://ecoprodigi.eu/wp-content/uploads/2020/02/ECOPRODIGI-Research-Report-1-2020-final.pdf

A more specific policy agenda and the results on the pilotings conducted in the project will be released in December 2020.

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