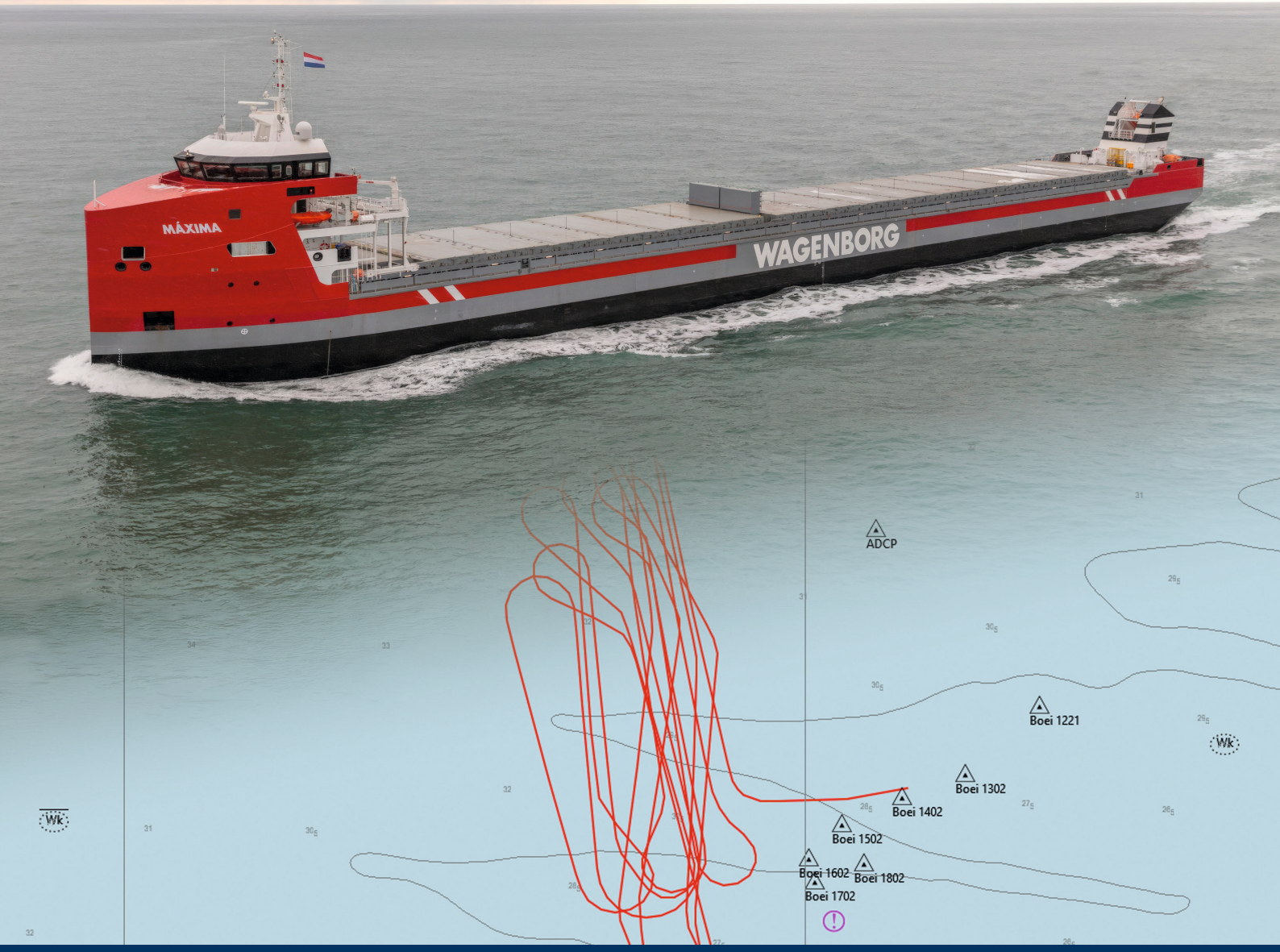


Data driven operational advice for reducing ship emissions

Green Deal Validation

NETHERLANDS MARITIME TECHNOLOGY | iRO | TNO innovation for life | MARIN | Koninklijke Vereniging van Nederlandse Reders | Ministerie van Infrastructuur en Waterstaat | Ministerie van Economische Zaken en Klimaat

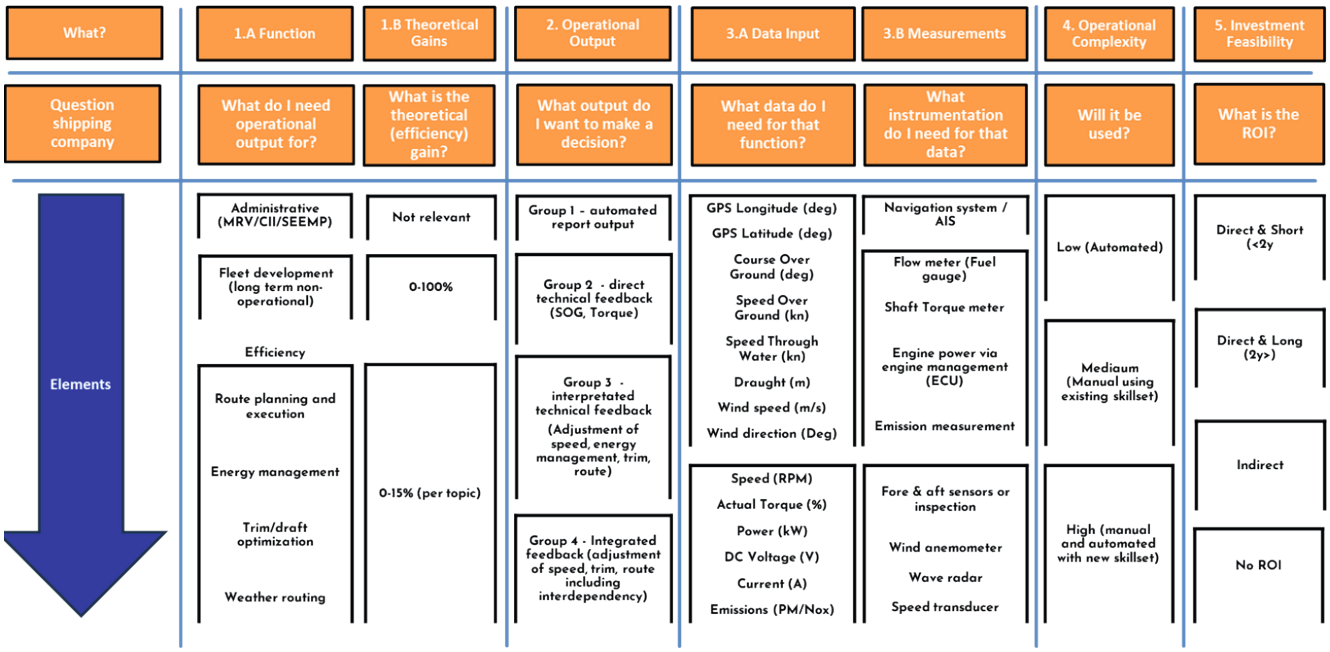
Description

To reduce emissions in ship operations, there are two options: you can change the ship or you can change the operation. In this research we looked at the latter. How can we change the use of the ship, such that, in the operations it is carrying out, the emissions are reduced?
This asks two things: (1) to know what your ships performance is (now and once changes are implemented) and (2) what operational measures could be implemented and how much reduction can be achieved.

Market readiness & availability

Many decision support tools and advisory/information systems already exist in the market. However, it is difficult to define or find out what the realistic benefit would be under the specific circumstances that ship owners deal with. Independent evaluation of the tools is scarce and realized benefits are highly dependent on e.g. the specific ship, its route and goal, the environment and possibilities to e.g. change course or speed within the commercial schedules. As specific tool evaluation was outside the scope of this project, instead the qualitative flowchart below was developed together with sector stakeholders.

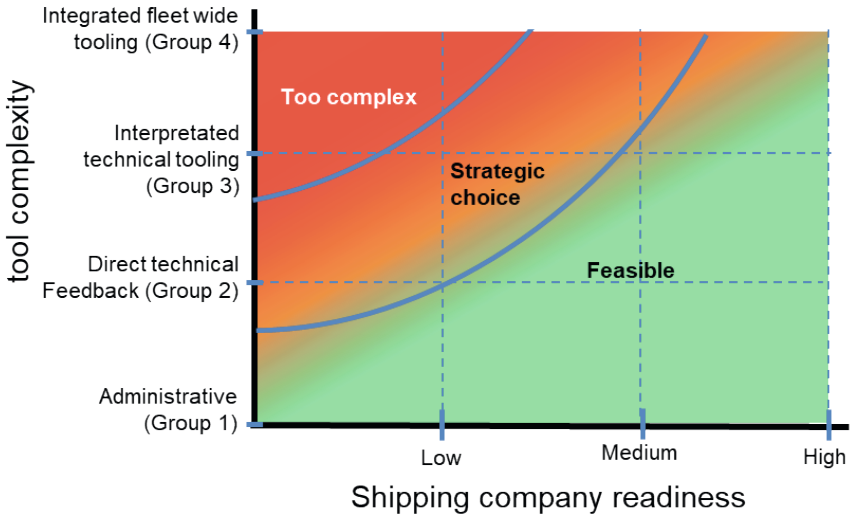
Based upon the line of reasoning related to “What is the return on investment and environmental gain of the operational measures and/or required instrumentation?”, The goal of this chart is not to provide specific answers, but to create a mutual line of reasoning on the considerations between ship owners and tool/instrumentation providers when discussing what type of tooling could provide what kind of efficiency increase in the voyage, given the availability and use of (interpretated) data from onboard measurements.



The flowchart shows, from left to right, five steps starting from the functionality towards the theoretical gains, operational output, required data input, via operational complexity to an assessment of the investment feasibility. In the second row the typical questions are presented and under that the different options are roughly grouped from low (top) to high (bottom) effort and effect.

Costs

Costs can vary largely depending on the path taken, e.g. installation of sensors and measurement tools, also including decision support tools and in the house versus purchasing knowledge from outside. Depending on a shipping company's strategy and readiness, a qualitative differentiation can be made on what complexity level of tooling is feasible (figure below). Compared to the possible savings, investigating these options is definitely a good choice, however the uncertainty and variation in gain is high.



Emission reduction effectiveness

In the end the ship owner has to make specific decisions for his specific fleet. Literature shows that benefits of operational changes can raise up to several tens of percentages (Bouman et al, 2017). However, depending on the ship, its tasks, routes and limitations different measures and gains will be possible. Qualitatively, the flowchart can help in the decision-making process, quantitatively the methods described below can strengthen insights and decision-making.

Applicability for reference ships

To acquire qualitative insight in the ship's performance three different methods where investigated, tested during a trial on a standard container ship.

- Reciprocal runs according to ISO15016 – a well-known and reliable measure for speed power performance. Downside is these trials are relatively expensive and only give results for one specific moment in time.
- Zig-zag runs – This novel steady-state method can be applied during operation to create a performance baseline in a non-invasive way. It is expected that the zig-zag runs will perform better in milder weather conditions, and in general need a lower limit on wind speed and wave height than the reciprocal run protocol.
- Operational data based Bayesian modelling – this method results in a combination of multi variable regression while keeping track of uncertainties and the likelihood of a complete range of possible fits. Depending on the available (meta)data the method shows promising results using operational data. For example we can distinguish design and ballast draft and reveal outliers between ships.

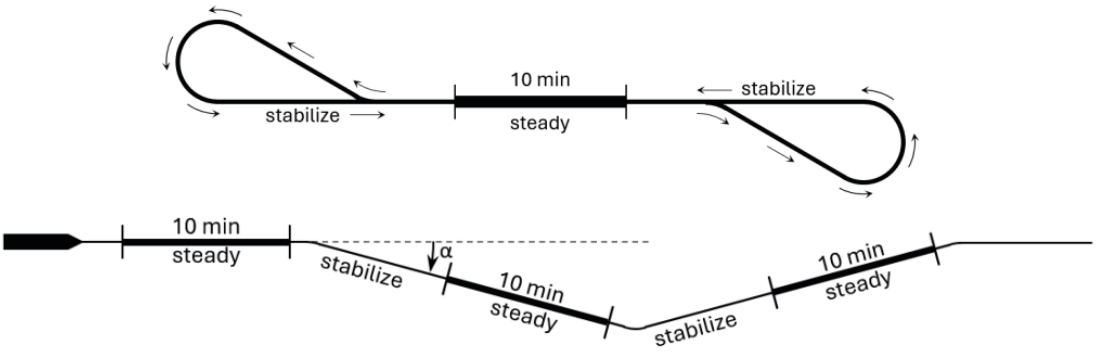


Figure 1: Reciprocal speed trial runs using Williamson turns (upper) and proposed in-service protocol using a zig-zag pattern (lower)

Next to the trials, two desk studies were carried out in which use cases for a container vessel showed the insight and benefit operational data and simulations can give in the decision process.

Development prospect

The prospect of these operational measures is promising, the main need is reduction of the uncertainty on the gain for a specific ship/fleet. Next to that the crew is key for implementing changes effectively in the operation.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