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Developing a cost calculation model for inland navigation

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ABSTRACT

The inland waterway transport sector in Western Europe is a competitive market with an excess of supply over demand. Overcapacity puts pressure on prices, and has caused a decline in profitability, particularly since the economic crisis of 2008. In this competitive environment, it is crucial for ship owners to have accurate information on the cost of their service in order to avoid setting freight rates at non-profitable levels. For this reason, a scientific instrument to calculate the cost of inland waterway transport is needed.

Following upon a literature review, the aim of the paper is to develop a new cost calculation model by vessel type, taking into account internal fixed and variable out-of-pocket costs, from the ship owner's perspective, as well as external cost elements of inland waterway transport. Subsequently, the methodology behind the input parameters, the model computations, and the output is discussed and supported with a case study.

The paper reveals that a model for use in the inland navigation sector needs to be based on company-specific input parameters. Due to the variety of ship types and dimensions, operation modes, contracts, and specific trip considerations, models based on average values seldom provide accurate results. The collection of averages, however, can serve scientific purposes, such as the analysis of investment decisions, or the effect of changes to the charter agreement. As such, the model proposed in this paper is capable of collecting and processing user input for the generation of average values, for further insights into the inland navigation sector.

1. Introduction

The European inland waterway transport (IWT) industry is characterized by a fragmented market structure, intense competition, and a limited reinvestment ability. The market currently experiences an excess of supply over demand, in both the dry cargo and liquid bulk markets. The excessive supply particularly concentrates on major waterways, since most of the newly added capacity to the sector consists of larger vessels, incapable of navigating smaller rivers and canals. As such, price competition is intense on major routes, whereas smaller waterways become increasingly underutilized. Especially the financial crisis of 2008 and the subsequent recession led to a decrease in freight rates in the Western European IWT sector (Lendjel & Fischman, 2010; van Hassel, Vanelslander, & Sys, 2017).

Different measures have been proposed or legally enforced, respectively, according to which the sector could achieve sustainable profitability. These include increased cooperation, the abolition of freight rates below the cost of the service, as well as the availability of an instrument to calculate the cost of IWT (see, for instance, Lendjel & Fischman, 2010; Belgisch Staatsblad, 2013; van Hassel et al., 2017).

A cost calculation instrument for IWT operators would provide insights into the costs incurred per trip. Consequently, ship owners would be better informed and less inclined to set freight rates too low to recover the cost of their service (Lendjel & Fischman, 2010). This could also possibly increase their negotiating power.

In other transport sectors, such as road transport, cost models which can be used by the transport operators already exist (ITLB, 2016). Comparable models for the IWT sector mostly focus on single, self-propelled vessels and do not take coupled trains[1] or smaller push-tows[2] into account (see, for instance, Kantoor Binnenvaart, 2000), or do not consider individual adjustments to relevant parameters for the cost calculation, such as the effect of the installation of a new engine on the capital cost per year (see, for instance, Rijkswaterstaat, 2015). Therefore, developing a scientifically sound model will fulfil a real need of the sector.

Besides the more practical need for such model, there is a scientific objective. In the literature, the heterogeneity of the IWT market was already underlined in van Hassel et al. (2017). This should also be reflected in the cost calculation models. There are significant differences in the technical, operational and cost aspects between inland vessels operating in the tank barge market and in the dry cargo sector. But also within the same sub-sector, different ship sizes are operating in different markets. And even the heterogeneity in the group of vessels of the

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[1] Under a coupled train, the following is understood: a combination of a self-propelled ordinary vessel and unpowered barges, or two connected self-propelled vessels.
[2] A push-tow consists of one towboat ('pusher') and one or more unpowered barges.

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same size and operating in the same sub-sector and market is large. This is reflected, for instance, in differences in crewing and in the purchase price of a vessel, which impacts on the fixed cost (van Hassel, 2015). Therefore, the newly developed cost model from this paper should incorporate this heterogeneity.

The cost model should also serve for the sector to increase their insights in the actual cost of operation. To that extent, also a comparison with other vessels that are sailing in the same market can be useful. This can be done by comparing the calculated cost with the benchmark average. This could give insights into whether a ship owner is above or below the benchmark average. By collecting and analyzing these data, the users of the model can steer their behavior or retrofitting and/or investment decisions, while for academia, more insights can be obtained in the heterogeneity in the cost for inland shipping.

Aside from obtaining more insight in the internal costs (private cost) for the ship owner, another important challenge for the IWT sector concerns the emission of air polluting gases, which has become particularly relevant with the rise of environmental policies focusing on the internalization of transport externalities, largely driven by European policymakers. Most of the internalization approaches are based on the polluter-pays principle, according to which external costs are attributed to the actual polluters, instead of making the society as a whole pay for transport externalities (EC, 2008, 2011, 2013). Generally, external costs are costs that a transport user causes to a third party and for which he does not pay (Blauwens & Van de Voorde, 1985).

Although inland navigation is generally assumed to be an efficient, safe and environment-friendly mode of transport, more stringent emission standards in the road transport sector are increasingly contesting the advantage in the environmental sustainability of shipping goods on the waterway (Panteia et al., 2013). In case of a binding legislation on the internalization of transport externalities, external costs will be incorporated in the overall cost of shipping services. As such, a cost calculation instrument for ship owners in the IWT sector would not only need to include private costs, but also external costs of transport as a separate category. External cost calculations can also be of importance if the cargo owners have requirements on GHG and air polluting emissions due to green image ambitions. The approach for developing the IWT cost model is given in Fig. 1. The methodology starts with a literature review, considering existing cost structures and applications, enabling to identify a research gap. Based on the available cost structures in the literature, an initial cost model was developed, which was presented to different IWT sector actors. These actors shared insights, which led to add-ons and more detailed cost calculations than could be found in the literature. These additions further contribute to differentiating the final model from the models found in literature.

This contribution is structured as follows. Section 2 presents the literature review of existing cost models for IWT. Section 3 provides the results of in-depth sector interviews regarding the structure and the application of the cost model to check its validity and to align it with the current-day practice of operating an inland vessel. Section 4 gives an overview of the structure of a cost model, with general user input and specific adjustments to the calculation of individual cost elements. Section 5 presents a case study to show how the developed model functions. Ultimately, Section 6 addresses the implications of the cost model for managerial practice and discusses future research applications.

2. Literature review of cost models for inland waterway transport

In this section, a literature review of different cost models is performed. The purpose of this overview is twofold. The first objective is to determine the main characteristics of a selection of existing studies, models, and applications developed for calculating the overall cost of IWT. It specifically addresses the basic methodology behind the calculation of costs. Secondly, the review is to determine specific gaps in the current cost models.

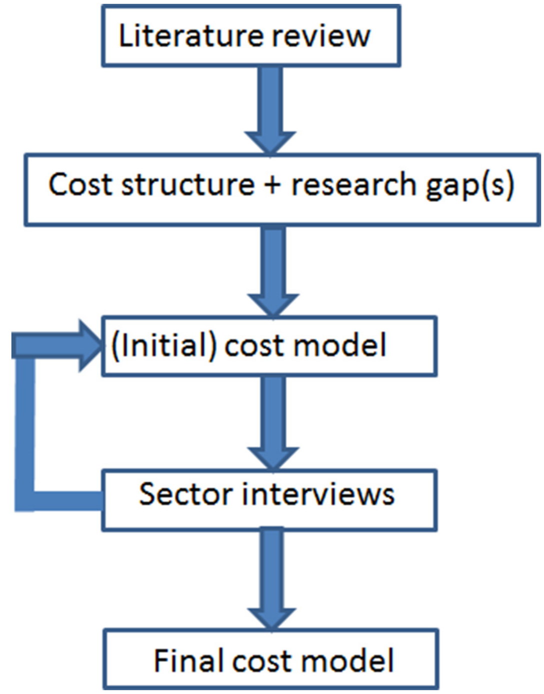

Fig. 1. Overview of the applied methodology.
Source: Own illustration.

Generally, the costs of the provision of a transportation service can be divided into time and distance costs. While time costs, often referred to as fixed or standby costs, do not change with the activity of the vehicle, distance costs are superimposed on time costs, and only occur in case of actual vehicle activity (Blauwens, De Baere, & Van de Voorde, 2010; Wiegmans & Konings, 2015).

Cost models for IWT have been addressed in a limited number of publications. Recent literature by researchers includes models and applications by Blankmann (2008a, 2008b), Beelen (2011), Hekkenberg (2012), Lu and Yan (2015), and Wiegmans and Konings (2015). Recent contributions by consultancies and special interest groups include Kantoor Binnenvaart (2000), PINE (2004), Via Donau (2005), PLANCO (2007), BDS-Binnenschifffahrt (2008), NEA (2009) and Rijkswaterstaat (2015), as well as LogoS (2015). The different models can be further classified according to the main target group (such as researchers, policymakers, or IWT businesses), the main purpose of the calculation, the method to calculate costs, and the range of the input and output parameters considered. Another classification by Beelen (2011) distinguishes among theoretical, general cost models, also used for more elaborate studies, specific models or ad-hoc calculations used in the sector, and studies aimed at specific cases. Finally, models relying on average values and estimations can be distinguished from those wholly dependent on the user's input.

Blankmann (2008a, 2008b) provides an introduction into accounting practices for ship owners, and presents a generic cost function to calculate the cost per trip. An overview of different cost elements is given, distinguishing between the costs of personnel, fuel, depreciation, repair, insurance, administration, as well as overhead costs, in addition to other costs of shipping operations. Ultimately, a formula for practitioners is presented, which allows calculating a profitable freight rate.

The general cost calculation model by Beelen (2011), considers a variety of factors for modelling the internal costs of IWT, divided into fixed and variable components. Not taking push-tows or coupled trains into account, it simulates costs for eight typical classes of single, self-propelled, inland vessels, used in the Western-European inland navigation sector. The model also distinguishes among dry cargo and tanker ships, and a variety of other factors, especially concerning ship exploitation,

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