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MAKING HINTERLAND TRANSPORT MORE SUSTAINABLE
A MULTI ACTOR MULTI CRITERIA ANALYSIS

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Abstract
As the key nodes in our global transport system, ports are increasingly pushed to improve the sustainability of their hinterland transport system. In this paper, we use the Multi Actor Multi Criteria Analysis to evaluate four possible measures for improving the sustainability of the ports' hinterland transport systems. This methodology allows explicitly the evaluation of criteria considered relevant by all stakeholders. The analysis shows that additional port handling costs and road pricing are the alternatives that score best overall, while modal split quota are the least preferred option.

Keywords: Ports, Sustainability, Multi Actor Multi Criteria Analysis, Transport, Stakeholders

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1. Introduction

The importance of the environmental friendliness of transport systems continues to increase. The trend toward less-polluting transport solutions and the quest for sustainable transport arose from a combination of customer demand and regulatory frameworks. The transport sector is one of the largest polluters, and the sector's stakeholders, especially its policy-makers, are aiming to construct regulatory frameworks that will facilitate the growth of sustainable transport solutions. The paper focuses on several stakeholders' evaluations of different measures to make ports more sustainable.

Ports are the key nodes in our global transport system. Making these nodes more sustainable will have a huge impact on the sustainability of the whole system. To characterise sustainable ports, the Brundtland report (WCED, 1987), which defines sustainable development from environmental, social, and economic perspectives, can be used as a starting point. Black (1996, p. 1) alters the report's definition and applies it to sustainable transport as 'satisfying current transport and mobility needs without compromising the ability of future generations to meet these needs'. Focusing on sustainable transport systems, Jeon *et al.* (2013) add transport system effectiveness to the classic triple bottom line in their framework. Due to the growing recognition of the environmental impact of the transport system, ports have already begun to develop environmental strategies and corporate social responsibility (CSR) strategies (cf. Carter & Jennings, 2002). CSR can take the form of infrastructure investments, such as the Environmental Ship Index (ESI), which addresses on-shore power supply or green port dues that are related to the environmental performance of the vessels, or investments related to hinterland transport, as proposed by Bergqvist & Egels-Zandén (2012). Another possibility is better cooperation between ports, which enables the segmentation and bundling of goods.

This paper explores various environmental strategies related to making ports more sustainable with regard to the hinterland they serve. The term "hinterland" often refers to the effective market or the geo-economic space in which the seaport sells its services (cf. Slack, 1993). A similar definition is presented by van Klink & van den Berg (1998), who define hinterland as the interior region served by the port. The logistics related to the hinterland involve many actors and activities, and require intense collaboration and coordination to work effectively and efficiently. The demand for more environmentally friendly transport solutions has had a great impact on the design of the hinterland transport system, both in terms of the technology used and modes of transport applied. Hence, ports' hinterland strategies have become a crucial part of ensuring efficient and more sustainable supply chains. The increased focus of sustainability in ports calls for environmental strategies and governance mechanisms focusing not only on sea transport but also on the hinterland transport system. One example of this development is the development of concepts such as dry ports where port activities are moved inland (cf. Roso et al. 2009; Roso & Lumsden 2010; Bergqvist et al. 2013). Governance is here defined as a process of distributing authority, allocating resources, and managing relationships in order to achieve a desired outcome. The complexity of hinterland logistics, in combination with the quest for sustainable and cost-efficient services, highlights the importance for developing hinterland strategies that maximise the combined output in terms of environmental performance, cost-efficiency, and logistics quality.

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Implementing these strategies is, however, very difficult, because the numerous stakeholders involved often operate under conflicting objectives. The aim of this paper is to explore different options and the advantages and disadvantages these options might have for the various stakeholders. This exploration will identify the reasons why certain strategies are quite difficult to implement and which implementation paths are most suitable.

2. Literature review

Developing hinterland strategies with the purpose of maximising the combined output in terms of environmental performance, cost-efficiency and logistics quality is complex. Many considerations have to be done because of the many stakeholders involved. Besides the stakeholder perspective, there are different alternatives for achieving hinterland strategies. From previous research we have identified four main alternatives that are then compared to the current business as usual base scenario. In this section we describe and analyse the different alternatives based on previous research. All alternatives should be understood as a bonus-malus system where total costs remain the same but distributed differently between stakeholders based on their performance on goal variables.

The first alternative is labelled *internalisation* of external cost and consists of a hinterland transport index that calculates the external costs of hinterland transportation. This would mean that the societal costs caused by transport through emissions, accidents, noise, infrastructure damage etc. would be calculated for each individual transport chain. In average circumstances the intermodal transport options will generate lower external costs compared to road-only transport (Macharis & Van Mierlo, 2010). This can however not be generalised, as for instance long post-haul post-rail transport distances and low loading capacity utilisation might make the road-only alternative perform better. Macharis et al. (2010) and Iannone (2012) found that the competitiveness of intermodal transport in solutions hinterland transport increases when externalities are internalised. The external costs of transport can be (partly) internalised using different methods (Gibson et al., 2014). This alternative would push to use each transport alternative where it can bring the greatest societal gains compared to the other modes.

A second alternative relates to the introduction of a system of *road pricing* whereby road transport is charged per kilometre driven. The rationale behind road pricing is to decrease the road traffic volume and finance infrastructure. As such, it is related to fuel taxes, used for covering investment and maintenance costs of road infrastructure but separate environmental taxes can also be levied on fuel and thus it adds to the distance dependent cost. Effects of road pricing on hinterland transport has been analysed by Aronietis et al. (2010) and Meersman et al. (2014) studied its effect on the competitiveness of Flemish ports. The implementation of road pricing systems can however be hindered by *inter alia* technological, legal, financial and political constraints (Shepherd, 2003; Ubbels, 2006) and often, the public acceptability is very low. The suggested kilometre charge can be differentiated according to the level of pollution of the vehicle, by for example distinguishing between EURO-norm classes. Therefore road pricing can be used to internalise external pollution costs but compared to a system where no differentiation is made in function of time and space, a variable scheme performs better in decreasing congestion. An example of road pricing is the German LKW-MAUT system. In Belgium, an advanced road pricing system for trucks over 3.5 ton is planned to be implemented in 2016 to replace the current Eurovignette. In this case, a differentiation will be

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made according to location and vehicle characteristics (Viapass, 2014). In Sweden, no national road pricing is in place, but in Stockholm and Gothenburg, time-dependent congestion charging schemes exist.

As a third possible alternative, a system of *modal split quota* is defined whereby the ports need to achieve specific levels of modal split to adhere to environmental and air quality legislation or get permissions to expand. As an example, the environmental permit of Stockholm Arlanda Airport considers emissions from aircrafts, from vehicular traffic to, from and within the airport as well as from the terminal buildings (Swedavia, 2014). To increase air traffic, the airport operator Swedavia thus needs to get passengers to and from the airport by rail or bus rather than by own cars. According to Woxenius & Bergqvist (2010), the petrochemical industry in Stenungsund, Sweden, had to adhere to a similar emission cap when extending their production facilities and investigated a 50 km rail shuttle to Port of Gothenburg. These emission caps have been disputed due to rather obvious governance issues since transport to and from facilities are often beyond the control of a terminal operator or industry. A port can, however, influence the modal split by restricting capacity or prolonging handling times at the port-lorry interface or by selective pricing for transshipment services. A certain modal split can also be defined in the port concession agreement as thoroughly investigated by Van den Berg & De Langen (2014). A modal split clause was introduced by Port of Rotterdam as part of the concessions for the Rotterdam World Gateway terminal at Maasvlakte 2 to DP World in 2007 (de Langen et al., 2012). The motives to include modal split requirements included sustainability improvement, curbing congestion on the main access highway and to ensure that port development would not be constrained by future air quality regulations. Also APM Terminals' concession at Maasvlakte 2 includes modal split targets and it has decided to apply equal prices for truck and barge moves (Van den Berg & De Langen, 2014) although transshipment to a barge is likely to incur higher costs.

The fourth and final alternative is labelled *additional port dues*. The fundamental idea of a port dues system related to hinterland transport is to construct a port due scheme based on cost recovery (i.e. IMO, 2000). A differentiated port due system can provide a tool for not only promoting modal shift but also influences inter-mode competition. A differentiated port due system would enable better opportunities for traffic allocation of different modes of transport. Previous research related to port dues have mainly been directed towards areas such as waste, oil pollution (Carpenter & MacGill, 2001), air pollution (Michaellowa & Krause, 2000; Swahn, 2002; Kågeson, 1999), port facilities and charging structures (Bergantino & Coppejans, 2000; Haralambides et al. 2001; Heggie, 1974; Suykens, 1986). Research, such as Gardner et al. (2006), show that ports are aware of the externalities related to hinterland traffic for example but chose not the assess it, rather they focus solely on complying to environmental legislations on the local, regional and international level. Based on existing research it is evident that little research has been directed towards port due systems of port's hinterland activities at the same time it is recognised as an important environmental factor.

3. Methodology

Very few methodologies can include different stakeholders simultaneously in a decision problem. Evaluation studies often use social cost benefit analysis to calculate the impact of a project on society at large, but this type of analysis does not allow researchers to compare explicitly the impact of a decision on a specific stakeholder or stakeholder category.

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Furthermore, the monetisation of the criteria considered often leads to generalisations and possible loss of information (Damart & Roy, 2009; Tsamboulas *et al.*, 1999; Scannella & Beuthe, 2003). As an alternative or complementary methodology, the Multi Actor Multi Criteria Analysis (MAMCA), which is an extension of the traditional multi-criteria decision analysis (MCDA), allows researchers to include the objectives of different stakeholders or stakeholder categories without needing to monetise their considered criteria. The MAMCA is different from other multi-criteria group decision making methods, because a separate value tree for each individual stakeholder can be constructed, which relates to the stakeholder's individual criteria. In addition, the MAMCA allows including the stakeholders in a very early stage of the analysis. The MAMCA was developed by Macharis (2000, 2004) and has been applied in several cases in the transport sector (for an overview of the theory and lessons learned from the cases, see Macharis *et al.*, 2012). Using the MAMCA allows one to compare easily the preferred decision preference of different stakeholders in a numerical and visual way. In this section, the different steps entailing a MAMCA are explained (Figure 1).

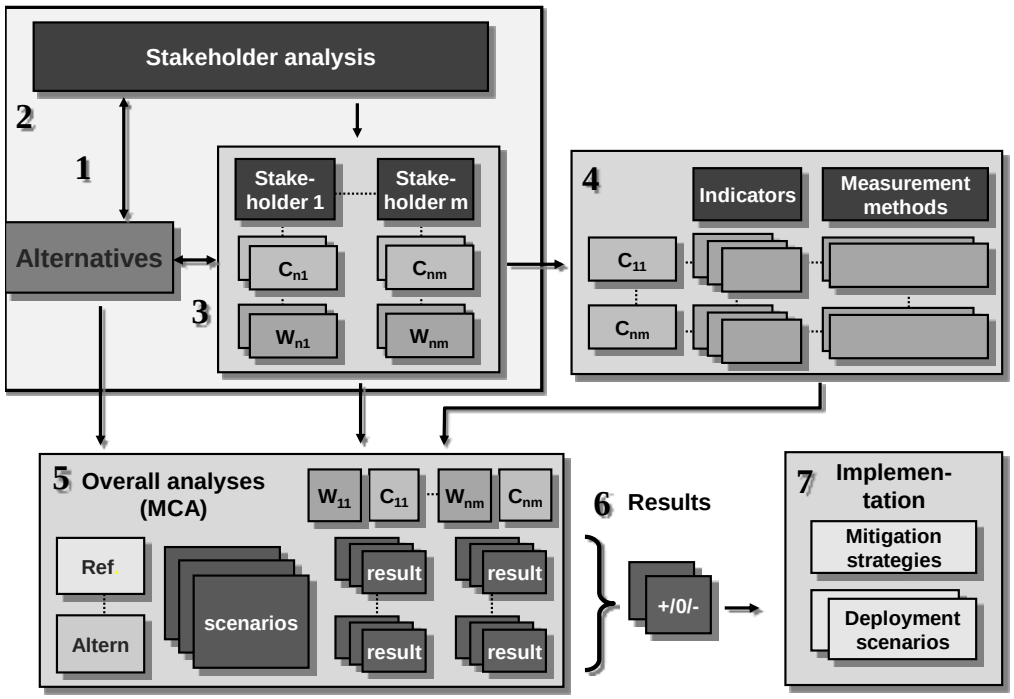

Figure 1 – General framework of the MAMCA methodology (Macharis *et al.*, 2004)

In order to perform a robust analysis, a survey was conducted in Sweden and Belgium. Several stakeholders have been interviewed to gather insights into the objectives of the stakeholders, their priorities, and the possible alternatives. Most stakeholders were eager to participate and, if not, other stakeholders belonging to the same stakeholder category were contacted and questioned. For all of the targeted actor categories, representatives collaborated in Belgium, Sweden, or, in some cases, both countries.

The first steps in the MAMCA are to define the problem and to identify the alternatives. The problem in the present case is how to make seaports more sustainable. Several possible alternative measures with a focus on hinterland transport have been proposed in this case. The

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analysis compares these alternatives to each other and to the business as usual (BAU) scenario, i.e., a projection of the current situation into the future following trends and not involving significant framework changes. The different alternatives were introduced to the stakeholders (see below), and they were invited to add any other possible alternatives.

The MAMCA differs from the classical approach of MCDA in the explicit introduction of stakeholders at a very early stage (step 2). Stakeholders can be defined as the people or organisations who can be affected directly or indirectly by putting an alternative into practice. This impact can be financial, but not necessarily. These discussions need the participation of the stakeholders to identify accurately the criteria, which are here equal to the objectives of the stakeholders. In the case of the port system, the stakeholders are numerous. The different stakeholders were identified by the analysts, and questioned directly by phone calls or face-to-face contact.

In the third step, the primary objectives of each stakeholder are questioned. These objectives are then translated into criteria and structured in a decision tree. To compare the mutual importance of one criterion to another, the criteria are weighted. During the survey, the stakeholders were asked which criteria they would consider when evaluating alternatives for greening strategies. The analysts presented an evaluation scale range and asked the stakeholders to what level these criteria should be taken into account when evaluating the proposed scenarios.

In the fourth step, one or more indicators are linked to each criterion. As mentioned, these indicators can be quantitative (e.g., time savings expressed in minutes) or ordinal qualitative (e.g., a score of good/average/bad for criteria that cannot be expressed quantitatively). The measurement methods for the indicator should be made explicit (for instance, willingness to pay and quantitative scores based on macroscopic computer simulation) to measure each alternative performance in terms of its contribution to the objectives of specific stakeholder categories. The first four steps are mainly analytical, and they precede the 'overall analysis', which takes into account the objectives of all stakeholder categories simultaneously and is more 'synthetic' in nature.

For the fifth step, an evaluation matrix is constructed by aggregating the contribution of each alternative to the objectives of the stakeholders. A traditional MCDA method can now be performed for every stakeholder or stakeholder category. Usually we use the PROMETHEE method or the Analytical Hierarchy Process method. This MCDA yields a ranking of the various alternatives during step six and thus reveals the strengths and weaknesses of the proposed alternatives. The stability of this ranking can be assessed through a sensitivity analysis. The last stage of the methodology (step 7) relates to implementation.

4. Results

In this section, the steps of the MAMCA will be discussed for this specific case, including a discussion of the results. As indicated, the analysis starts by defining the considered alternatives that might aid in making ports more sustainable. Four different alternatives were compared to a BAU base scenario. A first alternative relates to a hinterland transport index that calculates the external costs of the hinterland transport and adds that transport as an

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additional cost. This is referred to as the *internalisation* of external costs of transport, which can enhance a modal shift towards a more environmentally sustainable modal split. The internalisation alternative takes consideration to external costs and then relates the external costs to an index for which port dues then relates to. A second alternative relates to the introduction of a system of *road pricing* whereby road transport is charged per kilometre driven. As a third possible alternative, a system of *modal split quota* can be introduced whereby additional shipments can be accepted only when a pre-set modal split is guaranteed. Finally, as a last alternative, *additional port dues* can be introduced where additional costs should be paid per tonnage handled in the port, regardless of the modal split of the hinterland transport.

Examples of stakeholders involved in or affected by strategies to make ports more sustainable are the *port authority, port terminal operators, inland terminal operators, local government, state government, logistics service providers (LSPs), shippers, NGOs,* and *labour unions*. All of these actors have objectives, such as the further growth of volumes handled in the port (profit), the lowering of the environmental impact of transport-related activities (planet), and the welfare of citizens (people). However, the weight they attach to these different objectives might differ considerably, ranging from totally unimportant to of main importance.

The analysts proposed an initial list of criteria for each stakeholder category, but individual stakeholders could add additional criteria to this list. An overview of the criteria of each stakeholder category can be found in Figure 2. It is clear that some stakeholder categories consider the same criteria important: for instance, the local and the state government have partly overlapping criteria. To compare the situation and the judgments of stakeholders in different countries, stakeholders in Sweden and Belgium were interviewed and questioned. When Belgium (BE) or Sweden (SE) is indicated in the figure, this means that only stakeholders from this country were included in the analysis or that only stakeholders from this country mentioned the corresponding criteria as relevant. As not all actor groups were questioned in both countries, it was not possible to make a full comparison.

It should be noted that the two countries have distinct market situations. Sweden has experienced a turbulent period in the intermodal rail segment since the main operator CargoNet decided to greatly decrease its operations (Flodén & Woxenius, 2013). At the same time, Sweden's intermodal rail segment has experienced significant growth in seaport-dryport rail shuttles, especially related to Port of Gothenburg (Bergqvist, 2012). The hinterland transport system related to Port of Gothenburg is comprised of 24 direct rail shuttles to inland terminals in Scandinavia (Port of Gothenburg, 2014). Belgium still has incumbent Inter Ferry Boats offering a bundle of services towards destinations in Europe, complemented with new services offered by new operators, but these services are quite limited and focus mainly on long-distance transport. Belgium's barge services also persist on the shorter distances, mainly serving the Belgian hinterland. However, the ambitions of the Port of Antwerp are to increase the modal share of barges from 35% in 2012 to 42% in 2030 and the share of rail from 9% to 15% in the same period for the hinterland transport of containers (Port of Antwerp, 2014). In terms of port management, Belgium's two main ports of Antwerp and Zeebrugge face fierce competition from the Port of Rotterdam, which has similar aspiration of modal split changes (Van den Berg & De Langen, 2014). Decisions are always made in light of this competitive setting.

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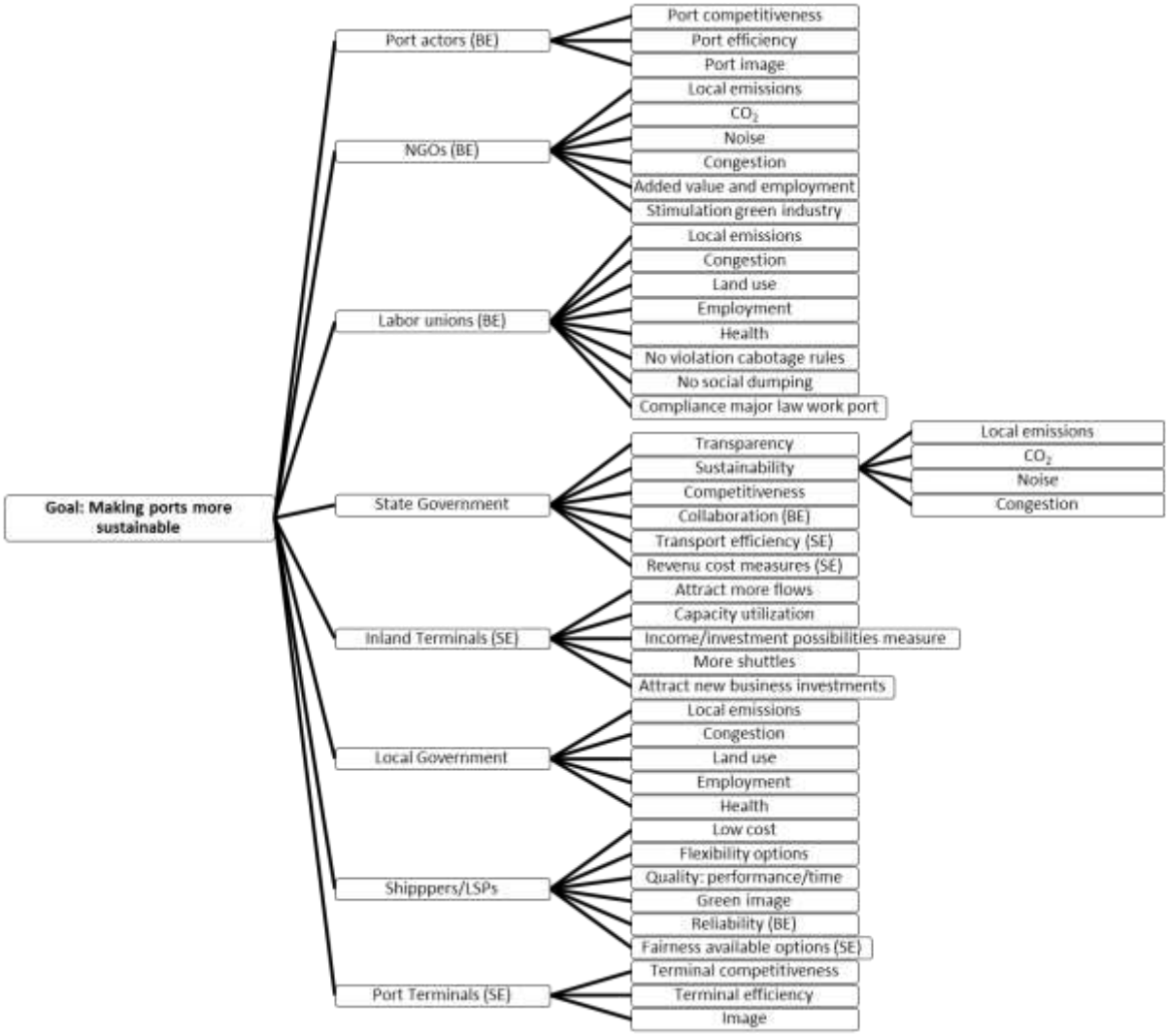

Figure 2 – Decision tree from left to right: the overall objective, the stakeholders, their criteria, and possibly their sub-criteria.

To weigh the different criteria, the stakeholders scored the considered criteria on a Likert scale ranging from –2 (not important) to +2 (very important). To translate these judgments into weights, these scores were first transformed into scores ranging from 1 to 1/9 (Table 1). These values are used as input for pairwise comparisons, a method developed by Saaty (1980). The Analytical Hierarchy Process (AHP) software Expert Choice was used for this purpose. The eventual weight distribution can be found in Table 2.

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Table 1 – Conversion table

	-2	**-1**	**0**	**1**	**2**
-2	1	1/3	1/5	1/7	1/9
-1	3	1	1/3	1/5	1/7
0	5	3	1	1/3	1/5
1	7	5	3	1	1/3
2	9	7	5	3	1

Table 2 – Distribution of the weights allocated by the stakeholders to each criterion, based on the outcome of the pairwise comparisons (BE=Belgium, SE=Sweden)

Actor	**Criterion**	**Weight BE**	**Weight SE**
Local Government	Local emissions	18%	29%
	Congestion	27%	20%
	Land use	18%	13%
	Employment	27%	33%
	Health	9%	6%
Shipppers/LSPs	Low cost	25%	30%
	Flexibility options	25%	20%
	Quality: performance/time	17%	30%
	Green image	8%	9%
	Reliability	25%	n.w.
	Fairness available options	n.w.	10%
State Government	Transparency	13%	20%
	Sustainability	25%	30%
	Competitiveness	25%	20%
	Collaboration	38%	n.w.
	Transport efficiency	n.w.	20%
	Revenue cost measures	n.w.	10%
Port actors	Port competitiveness	38%	n.a.
	Port efficiency	38%	n.a.
	Port image	25%	n.a.
NGOs	Local emissions	17%	n.a.
	CO2	25%	n.a.
	Noise	17%	n.a.
	Congestion	8%	n.a.
	Added value and employment	17%	n.a.
	Stimulation green industry	17%	n.a.
Labour unions	Local emissions	11%	n.a.
	Congestion	11%	n.a.
	Land use	5%	n.a.
	Employment	16%	n.a.
	Health	11%	n.a.
	No violation cabotage rules	16%	n.a.

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	No social dumping	16%	n.a.
	Compliance major law work port	16%	n.a.
Inland Terminals	Attract more flows	n.a.	31%
	Capacity utilisation	n.a.	15%
	Income/investment possibilities	n.a.	18%
	More shuttles	n.a.	28%
	Attract new business investments	n.a.	8%

n.w.=not weight derived from survey, n.a.=no actor questioned

Evaluation

The authors evaluated the different scenarios on the criteria of the stakeholders with pairwise comparisons on a 1 to 9 scale. This evaluation is based on the knowledge of the impact of the proposed scenarios generated by multi-year research on intermodal transport. The pairwise comparison table is then resulting in a score for each scenario (based on the eigenvalue method).

The general outcome of the MAMCA is depicted in Figure 3. This multi-actor view depicts each stakeholder category on the horizontal axis. On the right axis, the scores of the scenarios are given. The bars indicate the weights (scaled on the left axis) that are given to each stakeholder category. These weights are here set to be equal, because the opinion of each stakeholder category is equally important. The overall score indicates the total score when the opinions of all stakeholder categories are combined and equally weighted. It is a weighted average of the individual scores.

In general, the port handling costs and the road pricing alternative score highest, while the BAU scenario ranks only fourth out of five. For most stakeholders, the additional port dues are ranked first or second out of the alternatives considered. In contrast, for NGOs, Local Governments, and Shippers/LSP, these additional port dues are only the third preferred option. For the alternative of road pricing, the biggest opponents seem to be the port actors, terminals operators, and again the shippers/LSP. Modal split quota seems to be the worst solution, because it is ranked lowest overall, and no stakeholder seems to prefer that scenario.

Although the multi-actor view allows a clear comparison between the preferences of the stakeholder categories, it is important to grasp why stakeholders support or oppose certain alternatives. An understanding of these individual preferences can be obtained from single-actors views (Figures 4-12).

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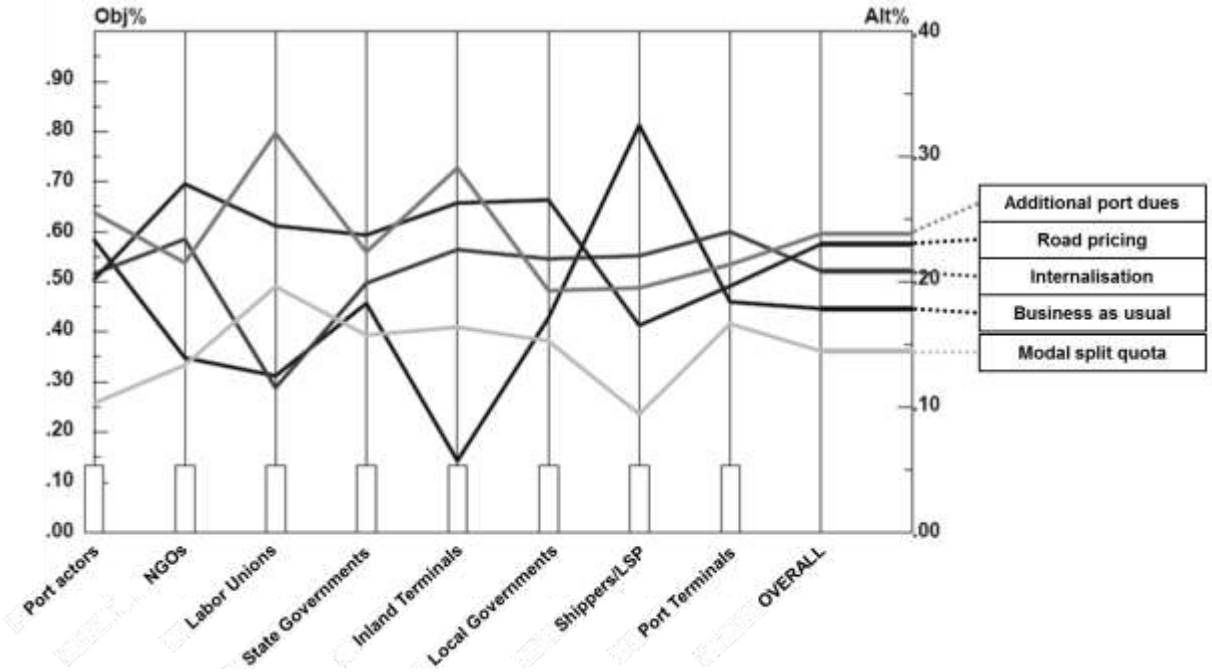

Figure 3– Multi-actor view

Overall, most stakeholders favour alternatives for making ports more sustainable with the exception of shippers and LSPs. This result was expected, because shippers and LSPs are the ones most directly affected. At first glance, the modal split quota alternative seems also less favourable from a stakeholder perspective. We can also check whether the evaluation differs between stakeholders in different countries. As stated before, the context is rather different in Sweden and Belgium. Nevertheless, the shippers/LSPs and the local governments rank the alternatives in the same order in both countries. Only the state governments have a slight difference in ranking of their alternatives. The Swedish state government ranks road pricing higher than additional port dues, while the Belgian state government does the opposite (Figure 4-5), because the two governments were considering unique criteria and thus attached other weights to them. The Belgian government attaches more importance to collaboration whereas the Swedish one considers transport efficiency and revenue cost measures as extra criteria.

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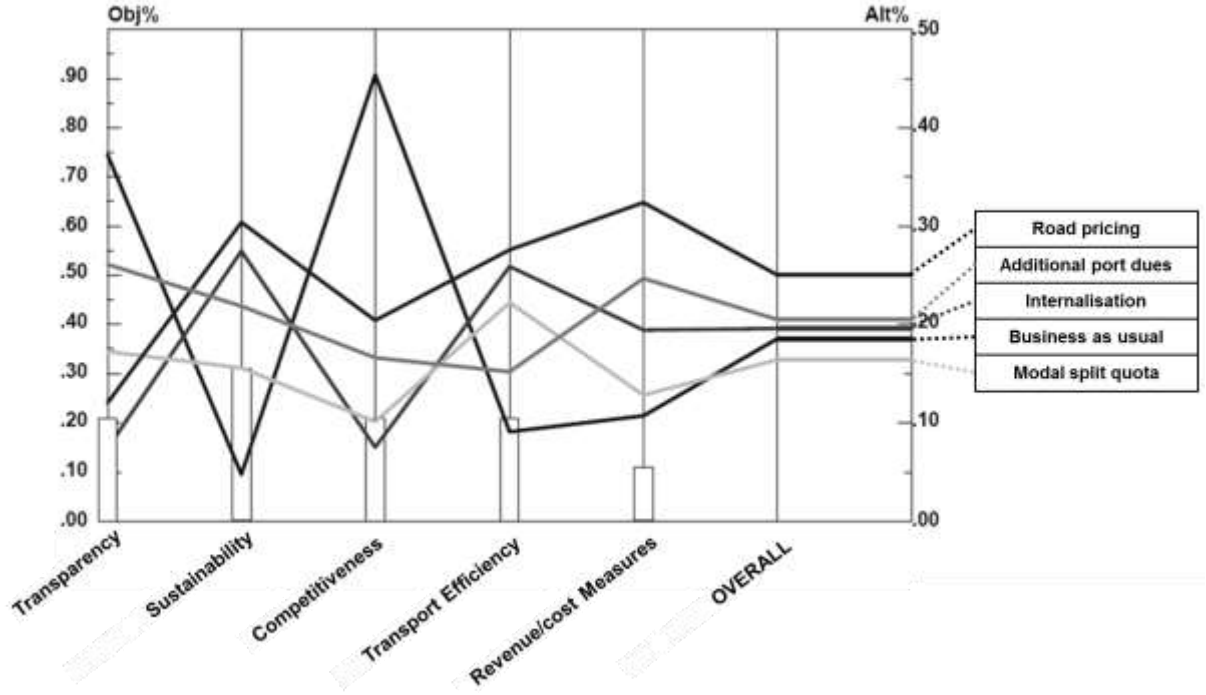

Figure 4 – Single actor view: Swedish state government

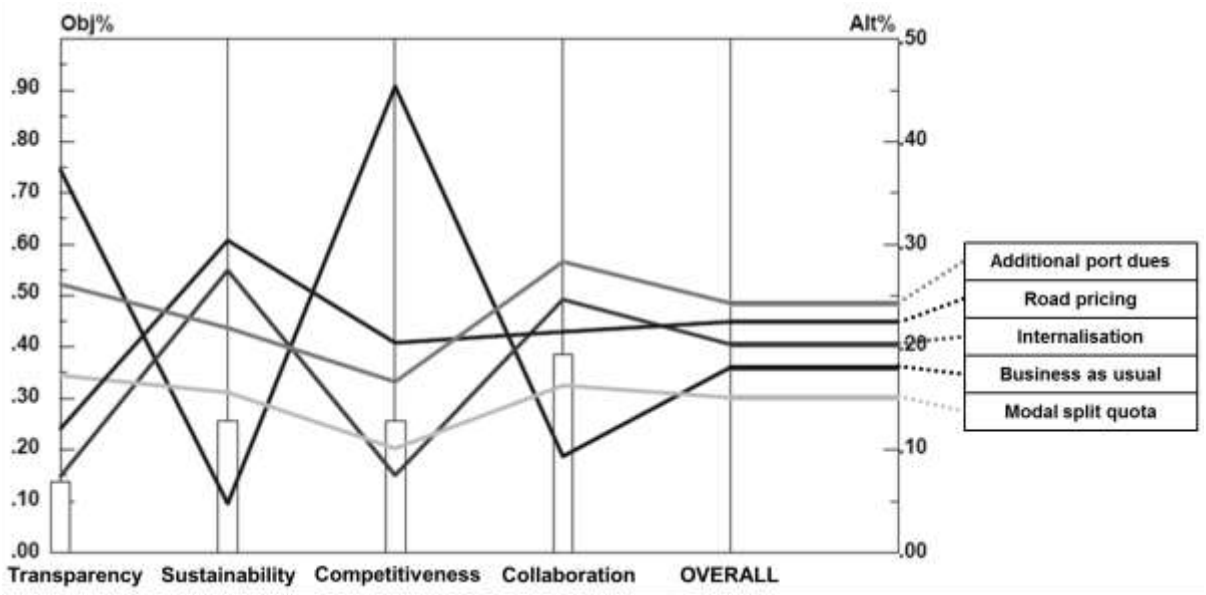

Figure 5– Single actor view: Belgian state government

The port actors (Figure 6) attach the greatest importance to the criteria of port competition and port efficiency. The BAU scores the highest on these criteria, but scores very poorly on the criterion of port image. Therefore, the additional port dues are preferred, scoring well on the three considered criteria. Road pricing is less preferred, because it is estimated to have a negative influence on port competition and thus efficiency. Although recent research suggests

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that the impact of road pricing in Belgium would have minor effects on the port competitiveness (Meersman et al., 2014).

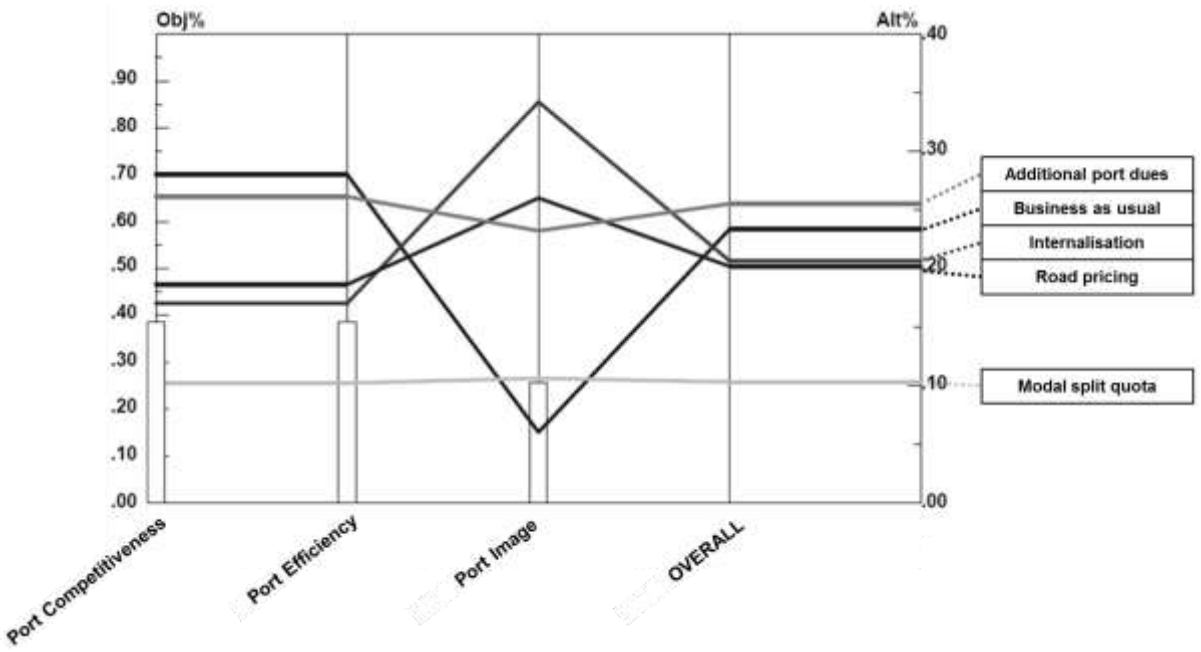

Figure 6– Single actor view: port actors

The interpretation is less straightforward for the third category of stakeholders (Figure 7), because the NGOs considered many criteria. Road pricing scores very well for most of the NGOs' criteria, apart from the creation of added value and the stimulation of a green industry, two criteria with relatively high weights. Nevertheless, road pricing seems to be the preferred option.

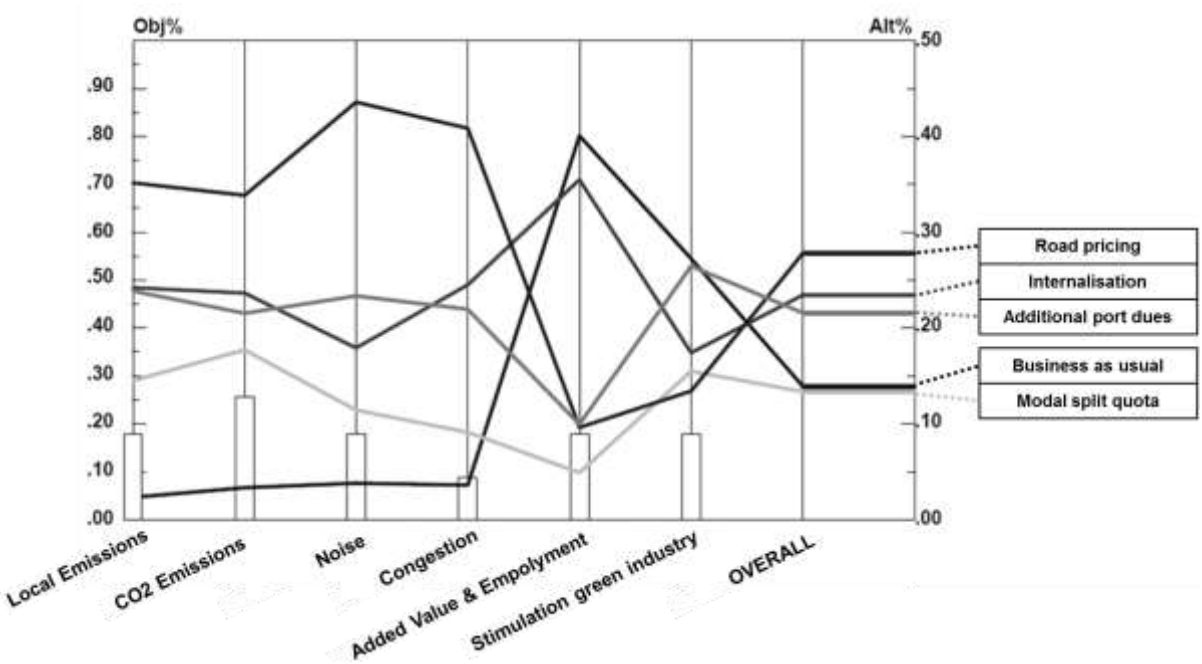

Figure 7– Single actor view: NGOs

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As the fourth category of stakeholders, the labour unions rank additional port dues and road pricing as their preferred alternatives (Figure 8). Both alternatives score well among labour unions, and all criteria, apart from the employment criterion, received high weight.

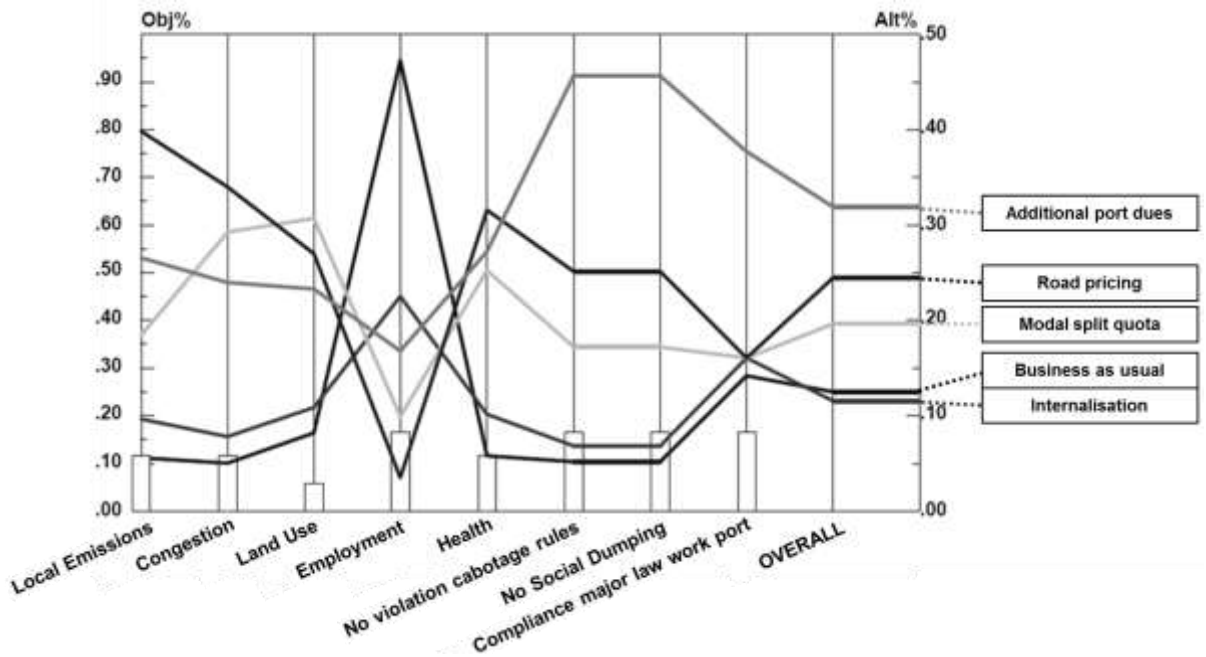

Figure 8– Single actor view: labour unions

Inland terminal operators attach the highest importance to attracting more flows and setting up additional shuttle services (Figure 9). The BAU scores worst for each criterion, and, overall, the operators favour the additional port dues and the road pricing alternatives.

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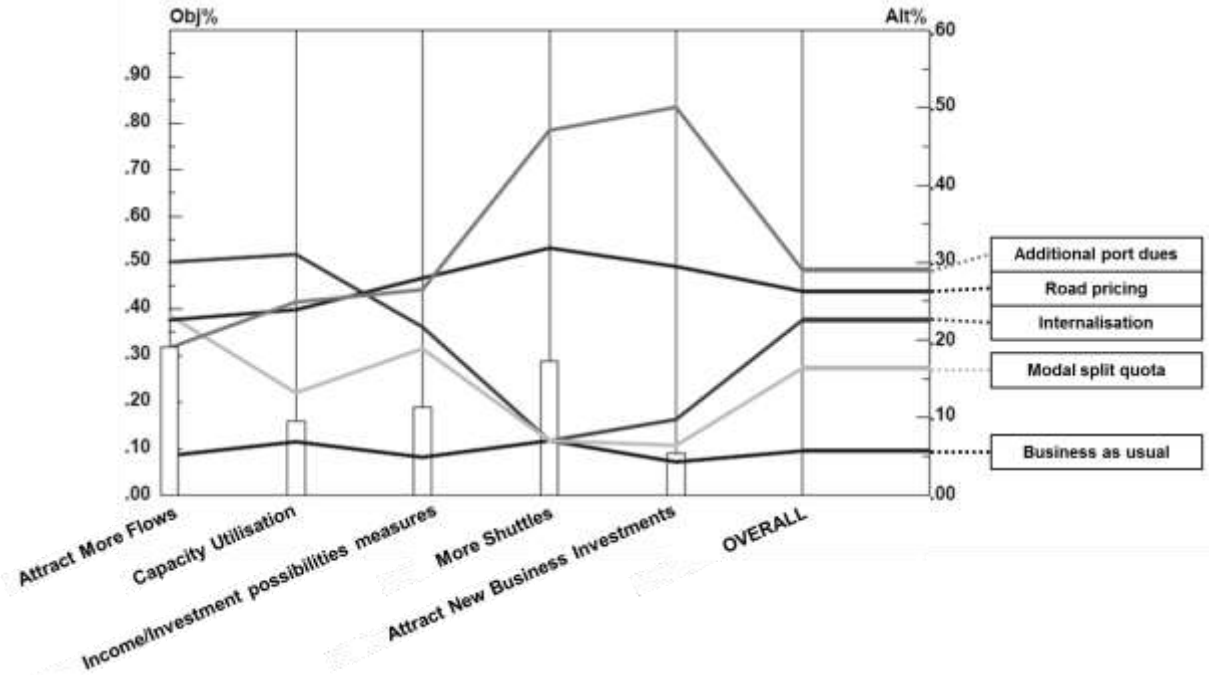

Figure 9– Single actor view: inland terminal operators

Unlike the inland terminal operators, the port terminal operators evaluate the internalisation alternative the highest overall (Figure 10). This alternative scores best on the most important criterion, namely image. Additional port dues and road pricing respectively score second and third, because they perform poorly on the criterion of terminal competitiveness. Most other actors prefer these alternatives, so future studies might investigate how terminal competiveness can be improved while implementing these alternatives to convince the port terminal operators that port dues and road pricing are valuable.

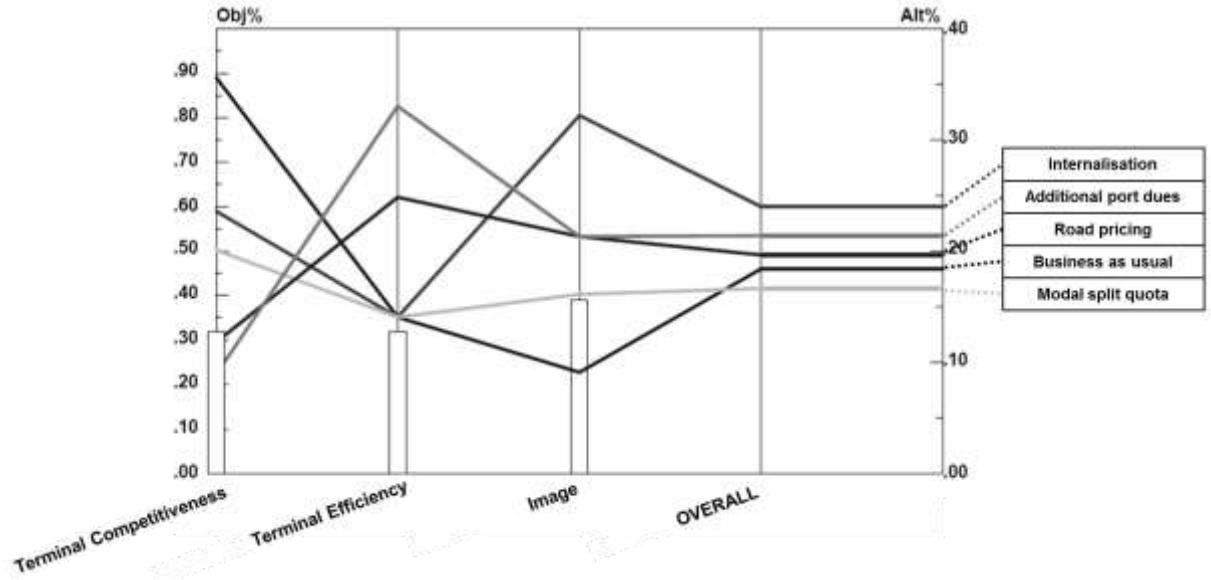

Figure 10 – Single actor view: port terminal operators

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For the shippers/LSPs, the BAU alternative ranked as the preferred option (Figure 11). Belgian and Swedish shippers gave the same overall ranking, even though they attached different weights to the criteria, and each added one criterion that had not been considered by their counterparts abroad. This stakeholder category seems to be more difficult to convince that the additional port dues or the road pricing alternatives are preferable. Regarding the additional port dues, their objections relate to the criteria of quality performance and green image, because road pricing performs badly on cost and fairness.

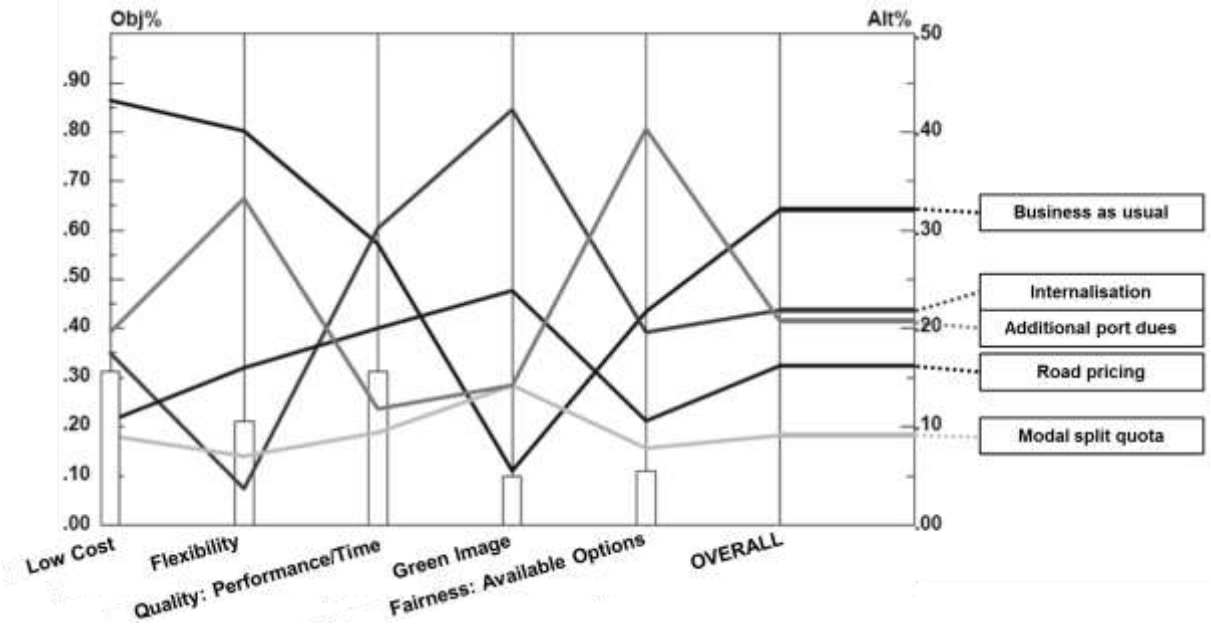

Figure 11 – Single actor view: Swedish shippers/LSP

Belgian and Swedish local governments rated the same criteria, but weighted their importance differently. Nevertheless, their ranking of alternatives is the same. Road pricing performs best overall, while additional port dues score lower due to their poor performance on the criterion of local emissions (Figure 12).

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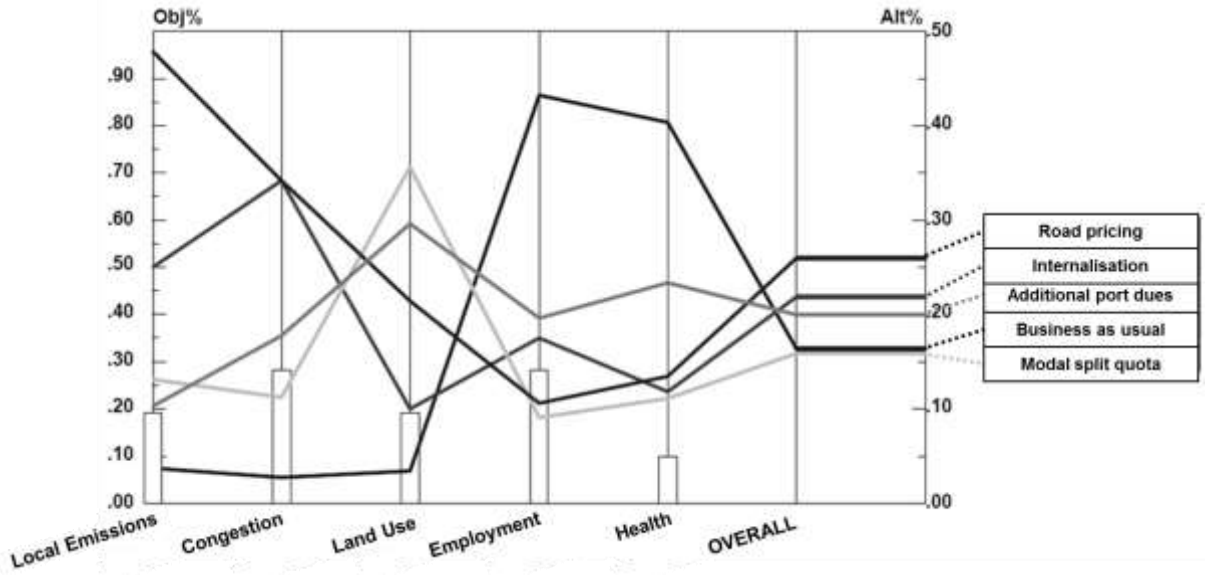

Figure 12 – Single actor view: Belgian local governments

Thus, the analysis revealed strong trends in preferences. Firstly, port handling costs and road pricing scored high as preferred alternatives. These alternatives are very direct in their approach and can easily be translated into direct costs for users. The modal split quota alternative is ranked lowest, which is probably due to its very restrictive construct, making the alternative less flexible than other alternatives. The port terminal operators view this alternative as particularly unattractive. The internalisation alternative could be an interesting option, because it scores high in terms of marketing aspects and image creation. Marketing and image are probably very important factors for implementation, since they are more easily understood by different stakeholders as well as offering the payer of the charges greater transparency and predictability in the source of costs, thereby reducing uncertainty. The internalisation option probably also enjoys more acceptance given other already existing indices, such as ESI. Given the preference for port handling costs, there is an interesting opportunity to connect differentiated port handling cost with an environmental hinterland performance index.

5. Conclusions

In this paper, we used multi actor multi criteria analysis to evaluate different alternatives for making ports' hinterland transport systems more sustainable. From this analysis, it seems evident that the business as usual option is not preferred and that there is a demand for alternatives. Only the shippers and the LSPs have a preference for the BAU scenario and do not seem to be convinced of the alternatives that are preferred by the other actors questioned. There seems to be consensus that the modal split quota alternative is a less attractive alternative. This is a little surprising, given that some port authorities use this option in their governance of ports' hinterland systems (e.g., concessions for Maasvlakte 2 in the Port of Rotterdam).

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Port handling fees and road pricing are preferred by many actors. These alternatives have the common characteristic of being directly connected to single hinterland transports. The potential disadvantage of the former is that it might struggle to target accurately intermodal transport solutions, because either the final leg is travelled by road and not directly by rail into the port terminal, or a short leg goes by barge to a container terminal where the container is transshipped and transported over a longer distance by road. For that reason, the internalisation option could be useful for overcoming that type of problem, given that the internalisation index, when constructed accurately, portrays the actual hinterland situation and performance of the entire intermodal transport chain. The challenge is to construct an index that is both valid and easy to use and map.

Research implications

Combining the insights of corporate social responsibility and stakeholder management within ports with the innovative MAMCA methodology is a new approach for considering different options for port/hinterland community management and governance. The present analysis provides evidence that port handling costs is a preferred option; at the same time, the internalisation option scores high in green image creation. These findings indicate an interesting combination and opportunity for further research in constructing and evaluating a system with differentiated port handling costs based on an internalisation index. The interviews conducted in two countries, i.e. Belgium and Sweden, showed how the same actors might have other priorities given a different economic-political situation. Further research that broadens the scope of the geographical scale might be useful to analyse other differences. The design and construction of an internalisation index that captures the externalities of hinterland transport is of particular interest for future research. Such an index has the potential to be what the Clean Shipping Index and the Environmental Ship Index is for shipping. Combining indexes for shipping and for hinterland transport has the potential for environmental targeting of fees and dues throughout the transport chain. This should be of particular importance for stakeholders such as ports, shippers, infrastructure authorities. More research is also needed about the objectives of the different stakeholders. Within this study we observed quite some differences between the stakeholders in different regions. The underlying reasons for that should be further investigated as it shows that not only the stakeholders matter but also the context in which they live and work. Next to that, the MAMCA gives a photograph at a specific moment in time and the development over time is a further potential for future research.

Implications for managerial practice

The paper provides valuable insights into the difficult position ports are in, as they are pressured by different, sometimes conflicting, aims of various stakeholders in the public, private and NGO sectors. These insights will allow the different actors to better analyse their long-term goals and will provide a framework in which they can discuss possible future scenarios with each other. The paper also suggests alternatives for governance of more sustainable hinterland transport systems, and provides an understanding of different stakeholders' views on the alternatives proposed. The next steps for the practitioners are clear: Within the MAMCA, the points of view were made clear and are now on the surface. Actors can now start negotiating which options could be implemented or further improved in order to guarantee the sustainability of the hinterland connections. Hopefully, the results from this paper can facilitate the implementation of differentiated port dues related to hinterland transport with the aim to stimulate and incentivise a more sustainable hinterland transport system.

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