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Innovation in the maritime sector: aligning strategy with outcomes

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ABSTRACT

Innovation is identified as one of the main avenues to maintain competitiveness and its importance is well established in business studies. Along maritime logistics chains, innovation is being increasingly recognized as a determinant of success. However, beyond the naval architecture literature, little attention has been given to the role that innovation plays in maritime business. Notwithstanding the increasing number of innovation efforts that can be traced in the industry, little is known of the processes and mechanisms that make innovation successful, with the result that initiatives are often uncoordinated, unfocused, poorly managed, and do not deliver the expected results. In order to improve innovation processes, better insight is needed into what motivates innovation along maritime supply chains, in particular for ocean carriers, (inland) terminal operators, port managers, and hinterland transport operators. To this end, the paper proposes an index-based approach using data collected for 59 innovation cases to capture the degree of alignment between innovation strategy and outcomes in various maritime logistics business sectors. Substantial misalignment exists between company strategies and innovation success, and efforts should be made to improve the strategic processes that lead to collaborative innovation in maritime supply chains.

KEYWORDS

Innovation; shipping; ports; maritime supply chain; homogeneity index

1. Introduction

One of the main determinants of competitive advantage for service providers is the ability to offer new and better propositions to their customers at competitive costs (e.g. Bharadwaj, Varadarajan, and Fahy 1993). In such endeavour, the role of innovation is central (e.g. Ireland and Webb 2007). In the logistics sector, innovation contributes to the development of value propositions that entail either the ability to offer services at a lower price, primarily by means of better asset utilisation, reduced fuel consumption and lower unit costs, or being able to differentiate services, and plays a critical role in fostering environmental performance improvements (Beltrán-Esteve and Picazo-Tadeo 2015). Innovation has also offered important avenues to reduce regulation compliance costs (Ambec et al. 2013). In addition, logistics firms have made use of innovation to differentiate their service offer from that of their competitors primarily by expanding their network reach and increasing customer services by means, for example, of advanced ICT technologies; by providing service add-ons, such as increased shipment traceability or carbon foot-printing; and by offering integrated door-to-door services (e.g. Busse and Wallenburg 2011; Flint et al. 2005; Arlbjørn, de Haas, and Munksgaard 2011; Kwak, Seo, and Mason 2018).

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While the role of innovation is undisputed in the transport and logistics sector, few studies have looked into how innovation is dealt with by firms and how it influences the firm strategy processes (e.g. Dodgson et al. 2015; Wagner 2008), especially in the maritime industry with a few exceptions (e.g. Acciaro et al. 2018; Rehmatulla, Calleya, and Smith 2017). A large number of papers have focused on assessing the impact of innovation on performance (e.g. Yang, Marlow, and Lu 2009; Jenssen and Randøy 2002, 2006), but to date, however, no study has been dedicated to investigating the nexus between strategic processes and innovation outcome in maritime logistics firms. This is particularly disconcerting, as the degree of innovation is not sufficient to explain firm performance (e.g. Calantone, Cavusgil, and Zhao 2002; Baer and Frese 2003) and as shown by Vivanco, Kemp, and van der Voet (2015) for eco-innovation, innovation can even be counterproductive to its stated aims.

This paper looks precisely at this issue in the context of shipping, ports and (inland) terminals, hinterland transport operators, and other maritime-logistics-chain-related businesses with the objective of identifying specific patterns in the way innovation strategy influences the degree of success in innovation implementation and whether there are significant differences among innovation types. The paper proposes a method to measure and evaluate the alignment between firm goals and innovation strategy that can be used to inform firm innovation processes and increase success rates.

The paper is structured in the following way. In the next section, a brief literature review on the topic of innovation in the maritime sector is provided. The research method used is outlined in section 3. Section 4 provides details on the identification of objectives and the results of the index-based approach. Section 5 concludes and formulates future research directions.

2. Literature review

Several reasons can be advanced to explain limited interest among scholars and practitioners in how innovation is accounted for in transport firm strategic processes, ranging from the specific industry structure of some transport segments, characterised by small firms lacking resources to engage in innovation processes, the relatively riskier nature of some transport businesses, the governance models adopted by some transport firms, the relatively greater role played by the public sectors, and the lack of technical and managerial know-how, to mention but a few (e.g. Naor, Druehl, and Bernardes 2018; Arduino et al. 2013; Mathauer and Hofmann 2019; Carlan, Sys, and Vanelslander 2019). Innovation that does not generate value will not improve firm performance (Weston and Robinson 2008; Woodruff 1997), and it is the main task of strategic processes to define how customer value is generated (Ireland and Webb 2007). In addition, strategy is often formulated at a company level in a rather generic form while innovation projects are often very specific. It is essential therefore to look at how innovation is implemented and whether innovation processes match the firm strategy and work within the strategy to improve the firm strategic fit.

Maritime logistics firms are no exception, since, notwithstanding the critical role played historically by innovation in maintaining and increasing competitive advantage, such as the deployment of maritime containers, limited attention has been given until recently to this topic (Acciaro et al. 2014, 2018; Rehmatulla, Calleya, and Smith (2017). Especially in view of the increasing environmental pressure on the sector (e.g. Andersson et al. 2016), innovation has been identified as one of the main avenues to reconcile sectoral growth and environmental demands (e.g. Lai et al. 2011).

As observed, for example, in Rehmatulla, Calleya, and Smith (2017), however, the uptake of innovation aimed at decarbonising the sector has been limited. The energy efficiency gap in shipping is peculiar, albeit well-documented in the literature (e.g. Rehmatulla and Smith 2015), especially in the face of growing regulatory efforts to curb emissions and the potential economic advantages resulting from higher fuel efficiency. Rehmatulla, Calleya, and Smith (2017) survey energy-efficiency-related technology uptakes in 200 shipping companies and conclude that the most commonly adopted technologies are not necessarily those able to deliver major emission reductions. As a consequence, the innovation processes that have resulted in the uptake of technologies and operational measures aimed at reducing the environmental burdens of shipping did not lead to what Pettit et al. (2018) refer to as '*the socio-technical system "regime" shift that international maritime logistics requires in order to contribute to improved sustainability*'.

The energy efficiency gap case highlights that more attention is needed in the analysis of the strategic processes leading to innovation uptake in maritime logistics. Even if maritime logistics has been characterized by a high degree of technical and organizational innovation, the processes that lead to innovation in this sector have been the subject of limited academic scrutiny. Notwithstanding the large opportunities afforded by new technologies and organizational concepts to the industry, the incidence of innovation in comparison to other service sectors has rarely been studied (e.g. Bass and Ernst-Siebert 2007; Doloreux and Melançon 2008), but evidence seems to suggest that, similarly to other transport sectors (e.g. Wagner 2008), innovation rates are lower than other service industries (Doloreux and Melançon 2008), and innovation initiatives are often uncoordinated, unfocused, poorly managed and do not deliver the expected results (Jenssen 2003; Jenssen and Randøy 2002).

In order to understand how to better capture innovation processes in maritime supply chains, some authors have tried to develop innovation taxonomies (e.g. Bessant and Tidd 2007; Carlan et al. 2017; Carlan, Sys, and Vanelslander 2019), but so far little understanding has emerged on how these taxonomies are linked to internal firm strategic processes. And yet, the main objective of these new technologies, products, systems, or processes is that of generating value for the organization! Innovation capabilities can be regarded as the ability of a firm to transform ideas, experiences, knowhow into new processes, technologies, systems, or products (Hurley and Hult 1998; Lawson and Samson 2001). For this to happen, it is important that the innovation process within the firm is well-aligned with the firm vision and the strategy it aims to pursue. As shown by Jenssen and Randøy (2006), and more recently in the context of energy efficiency (e.g. Rehmatulla, Calleya, and Smith 2017) an explicit strategy that promotes innovation is very important for the actual level of innovation within shipping companies' and in general for maritime-related firms.

According to Doloreux and Melançon (2008), in a study of the Quebec maritime cluster, obstacles to innovation are generally identified as firm sizes, barriers to collaboration and knowledge sharing. On the contrary the study by Bass and Ernst-Siebert (2007) focusing on SMEs in the German maritime industry indicates that these firms are strong innovators, albeit limited access to subsidies and low levels of interfirm collaboration. The same authors also show evidence that the strength of vertical integration is not relevant for the degree of innovative activity of an SME in the German maritime industry, although internationalisation appears to be associated with innovativeness. Regarding digital innovation, Carlan et al. (2017) also support these findings and add that regulation was not identified as a barrier nor as a facilitator, but it is uncertainty about regulation that impairs innovation uptake. Interviewees in that study argue also for the need for better cooperation and further integration along the maritime supply chain.

In a study on Taiwanese container shipping firms (Yang, Marlow, and Lu 2009) the authors show that resources, such as marine equipment, information equipment, network, and corporate reputation have higher innovation capabilities. Along the maritime supply chain then the lack of innovation uptake could be attributed to the conservative approach taken by managers in these firms, the limited resources available in certain sectors, such as bulk transportation where competitive pressure limits capital availability for innovation, or the high risks associated with the maritime business (Yang, Marlow, and Lu 2009).

The deep-sea shipping sector, for example, has shown a remarkable ability to respond to economic pressure by developing radical forms of innovation, such as the adoption of the maritime container (e.g. Taudal Poulsen 2007), or the use of bulbous bows, pre/post swirl devices, and waste heat-recovery systems (Rehmatulla, Calleya, and Smith 2017). In the last decade, the sector has been responding to environmental challenges through the study of alternative forms of propulsion, unconventional fuels, and operational strategies aiming at reducing regulatory compliance costs or improving fuel efficiency (e.g. Eide et al. 2011; Stevens et al. 2015; Aronietis, Sys, and Vanelslander 2016; Rehmatulla, Calleya, and Smith 2017).

Innovation has been shaping also the maritime industry through digitalisation and automation. In a recent literature review, Fruth and Teuteberg (2017) subdivide the emerging literature in digitalization in shipping in six areas (automation, big data, simulation and modelling, software, sustainable maritime transport, risks), and argue that there is a lack of theoretical studies and alternative explanatory approaches that investigate the behaviour of actors in the maritime logistics chain. In another review (Sanchez-Gonzalez et al. 2019) on digitalisation in maritime logistics, the authors do not report of any study investigating the interaction between strategy and digitalisation and stress the emerging nature of the literature in this area. In another review (Munim 2019) the author highlights that business models have been marginally explored in the maritime logistics automation literature.

It is clear that a structured innovation process does not guide many of these developments, or at least these processes have not been studied in the literature, and firms fail to appreciate the need to adapt operations or strategy to ensure that such initiatives deliver the expected outcomes. Although implicitly, most innovation studies that deal with maritime logistics make reference to a diffusion of innovation theory (e.g. Roso, Russell, and Rhoades 2019; Karslen, Papachristos, and Rehmatulla 2019; Mander 2017; Wijnolst, Wergeland, and Levander 2009). It is beyond the scope of this review to discuss the merits and limitations of innovation diffusion approaches in maritime logistics; however, it would be recommendable that attention is given to these frameworks, to their applicability in the various maritime segments, and the relationships between innovation diffusion and innovation policy and between maritime firm strategies and innovation diffusion. To date, these topics have not been looked at in detail.

The port sector has witnessed major changes aimed at improving the efficiency of cargo handling operations, at better coordination with hinterland transport modes and in infrastructure use, and at reducing environmental external effects. In most of these cases, such changes are not framed as innovation processes, unless there are substantial technological components, resulting potentially in uncoordinated initiatives, poorly managed processes, and unsatisfactory outcomes. As highlighted in Acciaro et al. (2014), innovation practices in the port sector appear unstructured, and success, when achieved, is incidental especially for innovation tackling environmental issues. It can be argued that probably, as environmental issues are salient for a larger group of stakeholders with potentially conflicting interests, successful innovation initiatives would benefit from a structured stakeholders' inclusion process. These issues, however, notwithstanding recent contributions (e.g. Arduino et al. 2013; Aronietis et al. 2012; Wiegmans and Geerlings 2010; Wiegmans, Hekkert, and Langstraat 2007; Wiegmans 2005) remain still little understood.

Alongside the environmental perspective, chain actor co-operation also has emerged as an important logistics industry feature (e.g. Cruijssen, Dullaert, and Fleuren 2007; Mclaughlin and Fearon 2013). In most strategic and operational decisions, innovative concepts need to induce benefits along the supply chain (Soosay, Hyland, and Ferrer 2008). Sys et al. (2015b) found that initial attempts at working with an upstream and downstream stakeholder in the maritime logistics industry often failed. Hence, collaborative innovation or co-innovation is expected to be the most important challenge for the industry studied in the decades ahead. According to Sys et al. (2015), '*co-innovation is a new form of innovation whereby the various stakeholders jointly acquire new expertise and create opportunities in the supply chain for new partnerships*.' In such a context, it is even more important that strategic processes are aligned with innovation strategy of the firm to better take advantage of supply chain collaboration (e.g. Craighead, Hult, and Ketchen 2009).

3. Research method[1]

3.1. Research approach

Each innovation initiative is developed with one or more objectives in mind, sometimes implicitly. Each firm will have different targets for its innovation, and these might differ also from industry to industry. These objectives will be enshrined in the firm strategy, to which, ideally innovation should contribute. Given the diversity of the innovation objectives, the success of an innovation initiative can be measured only in relation to the objectives with which the innovation was developed. Figure 1 provides an outline of research method proposed that consists of six sequential steps.

Step 1 in the methodology requires the selection of innovation cases and the identification of firms willing to collaborate with the researchers. As data collection can be a rather time-consuming process, it is recommended that firms with an interest in the outcomes of the research are selected (Acciaro et al. 2014).

Based on the typology of firm and the scope of the analysis, a preliminary list of strategic objectives can be obtained from the literature (**step 2**). There are multiple avenues proposed in the literature for the identification of strategic objectives (e.g. Quezada et al. 2009), and for their refinement. The information needed for the application of the methodology is summarised in a table containing a list of strategic objectives and the rankings (on a Likert scale) to be obtained through survey.

Since, as in the applications presented later, the methodology can be applied to multiple firms, with different strategic objectives, it is important to find an agreement on the set of objectives that will be used in the analysis (**step 3**). This can be achieved through various iterative procedures, such

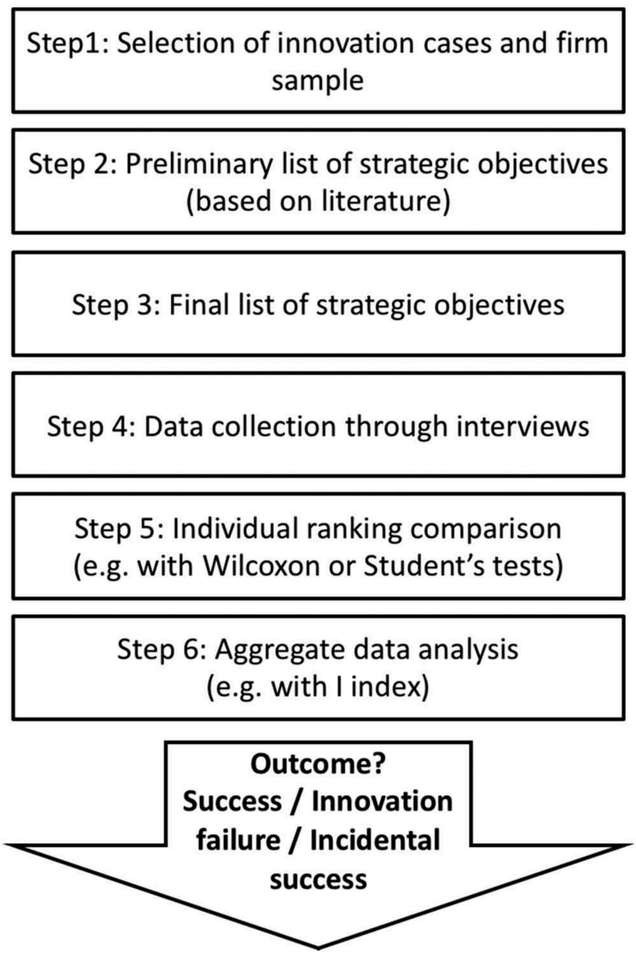

Figure 1. Outline research method.
Source: Authors.

as expert workshops or making use of the Delphi method (e.g. Landeta 2006; Linstone and Turoff 1979).

Once the final set of objectives has been agreed upon, interviews can be carried out (**step 4**). During the interviews, respondents are asked to rank, in relation to each innovation action being investigated, the relative importance of the innovation action and the degree of success that the innovation is perceived of having achieved in relation to each objective.

The information once coded will result in two rankings, that can be analysed descriptively (**step 5**) making use of standard ranking comparison tests (e.g. Wilcoxon 1945; Friedman 1940).

The last step (**step 6**) in the analysis is the use of aggregated indexes to make inferences on overall alignment between innovation outcomes and the strategy of the firm across different innovations in the same firm or in a sample of innovation cases. The present paper suggests a new technique to aggregate data based on the calculation of an index *I*, which will be explained in the following paragraph and that needs to be accompanied by the analysis of the homogeneity of the rankings among firms and innovation cases.

3.2. Aggregated data analysis: I and H index

The key idea of the *I* index is to be able to provide a synthetic indicator of the differences between rankings. Assuming N innovations are being surveyed, and indicating with i (i = 1, . . . N) a generic innovation, each innovation i can be ranked in terms of importance and success against M objectives that have been obtained from step 2 and 3 of the method described in the previous section. An objective is indicated with the letter j (j = 1, . . . M). Once data have been collected in step 5, for each objective and for each innovation we have two rankings, r and s, that indicate, respectively, the degree of importance and of success. Assuming the use of a Likert scale these will be r ∈{1, 2, 3, 4, 5} and s ∈{1, 2, 3, 4, 5}. The specific value obtained from interviews or surveys is indicated by the pair r_{ij} and s_{ij}, so two matrices can be defined as R and S.

$$R \equiv \begin{bmatrix} r_{11} & \dots & r_{i1} & \dots & r_{N1} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ r_{1j} & \dots & r_{ij} & \dots & r_{Nj} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ r_{1M} & \cdots & r_{iM} & \cdots & r_{NM} \end{bmatrix}; \; S \equiv \begin{bmatrix} s_{11} & \dots & s_{i1} & \dots & s_{N1} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ s_{1j} & \dots & s_{ij} & \dots & s_{Nj} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ s_{1M} & \cdots & s_{iM} & \cdots & s_{NM} \end{bmatrix} \tag{1}$$

By subtracting R and S, we obtain the matrix D = R - S. Each element of D can be identified as d_{ij} and represents the difference between rankings for each innovation and objective pair (ij), so that $d_{ij} = r_{ij} - s_{ij}$, and d_{ij} ∈{-4,-3,-2,-1, 0, 1, 2, 3, 4}. For example, if for a specific objective j innovation i achieves a degree of success ranked as a 4 (i.e. $s_{ij} = 4$), but the importance of the objective for that innovation is ranked as a 3 (i.e. $r_{ij} = 3$), d_{ij} will be -1. We can define the vector v as the vector comprising the sorted potential values of d_{ij}, v ≡ { -4, -3, -2, -1, 0, 1, 2, 3, 4}.

A simple index can be calculated for each innovation i as the arithmetic average:

$$\mu_i = \frac{\sum_{(j=1)}^{M} d_i j}{M} \tag{2}$$

The value of μ_i is comprised between -4 and 4. The value can be normalised to change between -1 and 1 by dividing μ_i by 4. The $\bar{\mu}_i$ index is then defined as:

$$\bar{\mu}_i = \frac{\mu_i}{4}; \bar{\mu}_i \in [-1; 1] \tag{3}$$

This index, although appealing, has a fundamental problem: summing together these averages changes the result as opposite values will tend to cancel each other. This index in other words will tend to overestimate the alignment between the rankings.

In order to overcome such an issue, another approach has been considered. For each innovation i, how many times the d_{ij} assumes a certain value *a* can be calculated, which is the absolute frequency $F_{i,a}$ of d_{ij}, with $a \in \{-4, -3, -2, -1, 0, 1, 2, 3, 4\}$. Dividing $F_{i,a}$ for the total number of objectives M (or more precisely the number of objectives for which a ranking has been provided) will give a relative frequency $f_{i,a}$, so that for every innovation i the following vector can be obtained:

$$\boldsymbol{f}_i = \{f_{i,a}\} = \{f_{i,-4}; f_{i,-3}; f_{i,-2}; f_{i,-1}; f_{i,0}; f_{i,1}; f_{i,2}; f_{i,3}; f_{i,4}\} \tag{4}$$

Where by definition $\sum_{a=-4}^{4} f_{(i,a)} = 1$. The vector $\boldsymbol{f_i}$ can then be used as the weight vector to calculate an index ι given by the product of **v** and ***fi***.

$$\iota = \mathbf{v}f_i = \{-4f_{i,-4} - 3f_{i,-3} - 2f_{i,-2} - f_{i,-1} + f_{i,1} + 2f_{i,2} + 3f_{i,3} + 4f_{i,4}\} \tag{5}$$

The index ι has its maximum value at 4 and its minimum value at -4. A normalised index can then be calculated for every innovation as:

$$I == \frac{\iota + 4}{8} \tag{6}$$

The index can be calculated for subgroups of objectives or of innovations and in general is presented as a negative number to ensure that negative values of the index are associated with innovation failure. However, a measure of homogeneity of the fi needs to be calculated as suggested in Acciaro et al. (2014) to make sure that there is no weighting out of **v** values. The measure is calculated as

$$h_i = \sum\nolimits_a f_{i,a}^2 \tag{7}$$

The index h_i assumes value 1, when all innovations are given the same ranking (maximum homogeneity), and value *1/9 = 9*(1/9)2*, when all innovations are ranked uniformly on the ranking scale (maximum heterogeneity). Hence, a relative homogeneity index can be defined as follows:

$$H_i = \frac{h_i - \min(h_i)}{max(h_i) - \min(h_i)} = \frac{9h_i - 1}{8} \tag{8}$$

The index H_i can be easily calculated for subsets of innovations.

The *I* and *H* indexes. The value of the *I* index is comprised between 0 and 1, and it has been devised as the weighted average of the simple differences d_{ij}, so that the value 0 is obtained when the differences between the success ranking and the importance ranking are zero, implying that there is an identity between importance ranking and success ranking. A positive (or negative) value indicates that the success ranking is lower (or respectively higher) than the importance ranking. Admittedly, as the index is obtained making use of simple differences, it is possible that values close to zero are obtained when at the same time similar frequencies of the same positive and negative values of *a* are observed, or in other words, in case of heterogeneity in the distribution of the differences. In order to overcome this issue, it is recommended to monitor the heterogeneity of the differences by means of an homogeneity index.

In this research, the homogeneity index (H-index) is used which is one of the traditional statistical measures of heterogeneity, similar to distribution variance or entropy (e.g. Leti 1983). This indicator works well for the analysis of rankings, as it is simple and intuitive and provides an indication of how much agreement there is on the results obtained from the data collection. In

Acciaro et al. (2014), the analysis is built using the heterogeneity index and is expanded including hypothesis testing (Wald sign test), although these are not required for the use of the methodology.

4. Application

Section 4 provides details on the identification of objectives and the results of the index-based approach and follows the structure of the research approach described above.

4.1. Selection of innovation cases and firm sample

The first step in the proposed methodology is the selection of innovation cases and firm sample. It should be stressed that the innovation cases are not intended to represent an exhaustive list of recent initiatives and have not been selected neither in terms of saliency or impact. Over the 2013–2015 period, data for 75 innovation cases[2] were collected in the context of a research project supported by BNP-Paribas Fortis Chair Transport, Logistics and Ports. About 30 private port operators located in 10 different countries contributed to the research by sharing their opinions and knowledge of (past, present, and future) innovation drives in which they and/or their respective companies were involved. Companies suggested the cases and their selection was not guided by the researchers. This approach was necessary to ensure a wide participation of companies and is coherent with the exploratory nature of the data collection.

Of the initial 75 innovation cases, only 59 were retained for this research. This is because the implementation of the innovation should have already been completed for the proposed methodology. The innovation cases are listed in Appendix A and refer to multiple industry segments, such as stevedoring, trucking, and ocean transportation (Figure 2).

4.2. Individual ranking comparison

Steps 2 and 3 in the methodology are the proposal and selection of the strategic objectives that are relevant for the firm or for the industry under analysis. For the present paper, the objectives are grouped into economic (16), environmental (10) and social objectives (8). Researchers and company experts or executives were involved in the final formulation of the list that had been drafted on the basis of academic literature with the help of industry expert interviews.

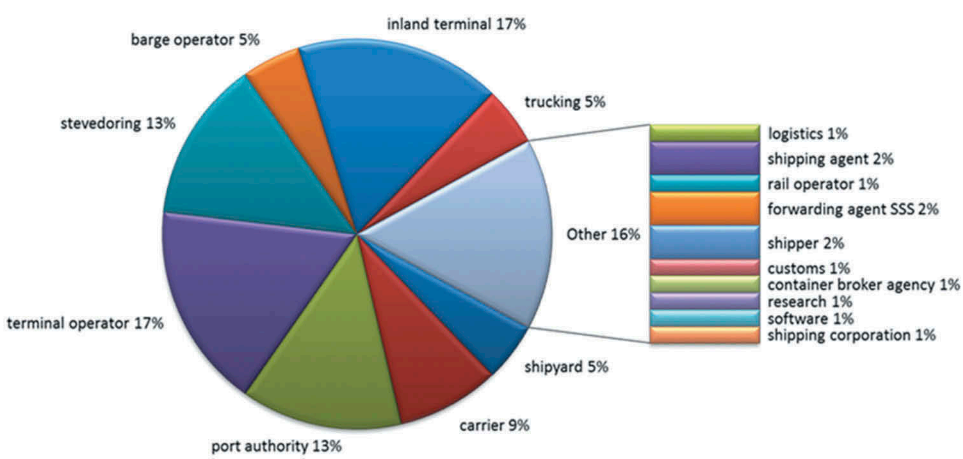

Figure 2. Typology for firms providing innovation cases.
Source: Sys, Vanelslander, and Carlan (2015).

The list of objectives is reported in the appendix. Interviews were carried out in the spring of 2015, and firm representatives, selected on the basis of their knowledge of the innovation case and of the firm strategy were asked to indicate the relevance of each strategic objective for the specific innovation—in other words, what the innovation was aiming at achieving—and how successful the innovation was in achieving this objective.

4.3. Ranking comparison

After completion of the survey (step 4) for all 59 innovation cases, the research team obtained the two rankings referring to the same list of 34 objectives. The 59 individual innovation ranking comparisons (step 5) are omitted; however, for all 59 innovation cases collectively, Tables B1, B2 and B3 in the appendix summarize the relative frequency of differences between the two rankings and the homogeneity index. The subdivision into three major categories of objective, namely *Economic value added, Environmental impacts & climate change*, and *Social value added* seems to be meaningful. Economic objectives appear to be ranked higher on average in terms of importance than the other objectives (3.75 against 1.4 and 2). However, innovation does not achieve comparable degrees of success for these objectives. This could be due to the use of more quantitative measures to assess the success of innovation in the economically driven innovation processes. Social and environmental objectives seem to be achieved, but often are ranked as not important suggesting that innovation success, when achieved is often incidental. The additional objectives surveyed partially during interviews are reported in Appendix C. Table 1 summarizes the relative frequency of ranking differences.

The comparison among the objectives shows that for the 59 innovation cases there are substantive differences on how the strategic objectives are ranked in terms of importance and success. Table 1 shows that in 68 percent of the innovation cases ranked the 16 *Economic added value* objectives equally both in terms of innovation success and in terms of importance. This percentage was higher for *Environmental impacts & climate change* (87%) and *Social added value* (80%), implying that overall on average in the sample there is a certain alignment between strategy and innovation. However, it should be observed that the innovation cases are not homogenous. The homogeneity in the ranking is between 23 and 96. The lower the H score the highest are the similarities among the innovations. So especially for *Environmental impacts & climate change* (72) and *Social added value* (60), a more detailed analysis at individual innovation level would be recommended.

4.4. Aggregate data comparison

The analysis of the I and H index indicates that considering all objectives there is some misalignment between the importance ranking (i.e. company strategies) and the success ranking in the maritime and port sector, and that efforts should be made to improve the strategic processes that lead to innovation in these industries. On average, in the sample, there seems to be a slight occurrence of incidental success, i.e. success is achieved on objectives that are perceived as non-critical.

Table 1. Relative frequency of ranking differences, number of cases and H index.

		Difference in ranking (percentage)									
Objectives	No	−4	−3	−2	−1	0	1	2	3	4	H
Economic added value (16)	58	0	1	6	7	68	8	6	2	2	42
Environmental impacts & climate change (10)	10	1	1	5	4	87	1	2	0	—	72
Social added value (8)	8	1	2	7	6	80	2	1	1	1	60

Source: author on BNP Paribas Fortis case data.

In order to gain more insight into the analysis, a comparison across the main groups of objectives (i.e. economics added value (profit), environmental impact (planet), and social added value (people)) was also conducted. We observe that across cases, economic added value shows that there is a relative difficulty in achieving important objectives (I index = —3%), while objectives in the environmental and social added value, success is achieved incidentally (I index for both 4%). Analysis by company (omitted) showed that there are differences among companies, implying that there is scope of benchmarking and carrying out these types of analyses further.

Although the analysis was kept anonymous to hide the identity of the companies, it was possible to group the sampled innovation into nine categories, depending on the typology of the port and shipping company. Table 2 summarizes these results. We observe that in our sample the companies that did not rank very highly their success rates at achieving important objectives are trucking companies followed by terminal operators. Some terminal operators considered the innovation cases to be rather successful and the lower values are characterised by high variability. Break-bulk terminals, ship operators and shipping companies, as well as inland terminals show success in achieving objectives that are not considered to be important, while a difference is there with terminal operators and ports, where the main difficulty seems to be achieved in the area of economic objectives, whereas social and environmental objectives are achieved although they are not considered as critical. This is in line with the findings of Acciaro et al. (2014) that arrived at the same conclusion for environmental objectives in ports.

In addition to grouping innovations by company type, it was also possible to group them on the basis of innovation type (Table 3).

Innovation in dredging seems to show a higher degree of failure in achieving important objectives. This is, however, likely to be related to the very strict requirements that are used for this typology, where a particularly critical innovation assessment method has been used.

Table 2. I index results among company types.

	Econ.	Environ.	Social	Average
All companies	−3%	4%	4%	1%
Trucking companies	−10%	−2%	−2%	−5%
Break-bulk terminals	8%	2%	17%	8%
Terminal operators	−8%	2%	5%	−2%
Ports	−2%	3%	7%	1%
Ship operators and shipping companies	1%	7%	1%	2%
Inland terminal	2%	3%	1%	2%
Other	−9%	11%	0%	0%

Source: author on BNP Paribas Fortis case data.

Table 3. I index results grouped by innovation typology.

	Econ.	Environ.	Social	Average
All types of innovation	**−3%**	**4%**	**4%**	**1%**
Equipment innovation	2%	0%	0%	3%
Electronic data interchange innovation	1%	5%	3%	2%
Inland navigation innovation within urban context	13%	0%	0%	13%
Space innovation	−14%	3%	4%	−5%
Innovation in dredging	−35%	15%	−10%	−14%
Innovation supporting efficiency in loading/unloading	−3%	1%	9%	1%
IT innovation supporting the cargo flow	3%	0%	11%	3%
Management innovation	−4%	3%	2%	−1%
Monitoring innovation—vehicles & cargo	1%	3%	2%	2%
Technological innovation—reducing operating vehicle costs	NA	NA	NA	NA
Technological innovation supporting the transfer of containers from one mode to another	−7%	1%	−2%	−3%
Technological innovations supporting inland waterways	23%	23%	22%	19%

Source: author on BNP Paribas Fortis case data.

Table 4. I index results grouped by type, level, and nature of the innovation.

	Econ.	Environ.	Social	Average
Type				
Cargo Flow	−1%	3%	7%	2%
Information flow	−3%	4%	4%	1%
Equipment	−9%	−3%	−1%	−5%
Other	−7%	8%	2%	0%
Level				
Initiation	0%	4%	1%	2%
Development	4%	2%	10%	4%
Implementation	−6%	4%	3%	−1%
Nature of innovation				
Modular	−2%	3%	7%	2%
System	−4%	4%	6%	1%
Radical	2%	3%	2%	2%
Incremental	−7%	5%	0%	−1%
All	**−3%**	**4%**	**4%**	**1%**

Source: author on BNP Paribas Fortis case data.

Inland navigation innovation within urban context and *Technological innovations supporting inland waterways* seem to be the category of innovation that achieves success incidentally.

Further analysis could be performed considering the innovation type and level, where for type, it is intended whether the innovation preliminarily deals with cargo flow, information flow, equipment or other;, and with level, it is intended what the stage of innovation is (initiation, development, or implementation) (Table 4).

While for *Cargo flow* and *Information flow* the general pattern of failure in economic objectives and incidental success on environmental and social objectives is observed, for equipment-related innovation for all objectives there is a lack of success. This can be related to the more accurate figures that are often used in assessing the outcomes of innovation in equipment. With respect to IT applications, stakeholders find themselves in a lock-in situation. In previous decades, there was a general interest in developing stand-alone IT systems. Such systems are often incompatible with IT applications of other stakeholders. However, new IT applications will make it possible to move innovation forward faster. To this end, the concept of open innovation, which is already adopted in many other sectors of industry, must be fully embraced in the maritime supply chain.

Case analysis already suggests that there are benefits and costs for every stakeholder. However, the benefits are not always readily visible, often resulting in a low willingness to pay. Another way of grouping innovation cases is by looking at their nature (modular, system, radical, or incremental). It can be observed that radical innovations achieve success incidentally, while modular, system and incremental innovations follow the pattern of showing more difficulty in achieving success for economic objectives.

5. Conclusions

This paper investigated the relationship between strategic alignment and the degree of success in 59 innovation cases in 35 maritime logistics firms. To do this, the paper proposes a new methodology based on the comparison of innovation success rankings and strategic importance rankings. This is an intuitive and simple method to investigate the relationship between innovation and strategy and also allows firms to increase awareness on the need to ensure an alignment between the two.

After having defined a set of objectives that are perceived to be relevant for the firms and the innovation cases under study, firm representatives are asked to rank each objective. Subsequently, firm representatives are asked to express their judgment on the degree of success of an innovation action in achieving each strategic objective. This exercise results in two rankings that can be statistically compared to assess whether there are significant differences between the importance that each firm assigns to an innovation and the degree of success achieved by the innovation in its implementation.

An index, indicated with *I*, has been devised to summarize for each innovation the degree of variance between the rankings. The use of this index is associated with some measure of heterogeneity—that is the degree of diversity within each ranking and among respondents—to account for dissimilarities among innovation cases. The analysis can be repeated for groups of innovations and trends can be identified for individual companies, specific industry clusters, or types of innovation. Further improvements in the index calculations would be required, for example, to improve comparability among firms and also to integrate measures of heterogeneity into the index so as to ensure meaningful comparisons.

Results show that innovation success is often misaligned with the strategic objectives of a firm in the maritime logistics sectors. In some cases, it appears that success is achieved for those objectives that are not perceived as critical by the firm (incidental success), while in other cases, innovation fails to achieve important objectives (innovation failure). It is the objective of management in these cases to plan and monitor the development of the innovation in accordance with the firm's strategy. Further analysis should be conducted to investigate why innovation programmes are often not aligned with firm strategies and whether this is a peculiarity of the maritime industry.

Moreover, the research suggests that more efforts should be made within firms to ensure that strategic relevance and strategic alignment are taken into account when developing innovation programmes. Management could also use the *H* and *I* indexes presented in this paper as a diagnostic tool to provide further insights into innovation processes within a firm. The research project from which this paper originated facilitated the setting-up of an innovation-monitoring scheme, with the aim of offering a benchmark for innovation based on the cases put forward by companies. The comparison between the average scores of all innovation initiatives and the scores of one specific innovation supports a focus on those strategic areas where there is a higher deviation between importance and innovation success.

This research offers potential for expansion and improvement in multiple directions. On the one side, it is possible to strengthen the methodology by refining the indexes used. Possible investigation should include using ratios or quadratic means for the *I* index. In terms of analysis, further studies should address the comparison of the rankings in order to reduce the influence of sample biases and minimise the subjectivity of answers. From a conceptual point of view, further analysis should address the relationship between strategic fit and innovation success. The research is particularly relevant for firms that want to implement innovations successfully in alignment with strategy.

Beyond the specific methodology proposed in this paper, the study of innovation diffusion processes in the maritime sector is an area that would offer valuable research opportunities. Notwithstanding recent efforts in this direction (e.g. Roso, Russell, and Rhoades 2019; Karslen, Papachristos, and Rehmatulla 2019), the underlying assumptions of innovation diffusion theories and their applicability in maritime logistics, are worth investigating. In particular, the interaction of firm strategy with innovation diffusion and policy opens important avenues for research.

Notes

1. The research method used in this paper builds on the one developed in Acciaro et al. (2014).
2. For an overview of the 75 innovative concepts along the maritime supply chain, arranged by stakeholder type, see Sys, Vanelslander, and Carlan (2015).

Highlights

- Alignment between innovation actions and firm strategy is understudied

- New method compares success and importance ranking of innovation cases
- Misalignments between innovation actions and strategy in maritime logistics firms
- Efforts should be made to ensure that strategic relevance is taken into account when developing innovation programmes

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Appendix A

Table A1. List of innovation cases.

Firm	Case	Innovation case	Type	Level
A	A1	Full Automated Truck System (FATS)	Cargo Flow	Implementation
A	A2	Administration	Information Flow	Implementation
A	A3	Inland terminal	Cargo Flow	Implementation
A	A4	Automated Stacking Cranes	Space	Implementation
A	A5	Weighbridges	Equipment	Initiation
A	A6	Tandem Lift	Crane handling	Implementation
A	A7	Straddle carriers	Fuel change	Initiation
A	A8	Truck Appointment System	Cargo Flow	Implementation
A	A9	Inland container	Cargo Flow	Initiation
B	B1	Paperless Customs flow: import—extended gate up to the end consumer	Information Flow	Development
B	B2	Paperless Customs flow: import—paperless NCTS pilot	Information Flow	Development
B	B3	Paperless Customs flow: export—paperless until deep-sea terminal	Information Flow	Implementation
B	B4	Expansion OCR capabilities	Information Flow	Initiation
B	B5	Portal with clients	Information Flow	Implementation
B	B6	Pre-notification deep-sea terminals 1	Information Flow	Initiation
B	B7	Pre-notification deep-sea terminals 2	Information Flow	Development
B	B8	Port Wide Lighter Schedule Port of Antwerp	Cargo Flow	Development
B	B9	Barge slots	Cargo Flow	Development
B	B10	Corridor management system	Fleet mgmt.	Development
B	B11	Digital CMR	Information Flow	Initiation
B	B12	Empty equipment	Cargo Flow	Initiation
B	B13	Transferium	Cargo Flow	Development
B	B14	CY Meerhout	Cargo Flow	Initiation
C	C 1	10\6 container	Space	Implementation
C	C 2	SEA 45	Equipment	Implementation
D	D 1	ECO Combi	Vehicles technology handling	Initiation
D	D 2	Transport hub	Cargo Flow	Implementation
D	D 3	Platform EuroTranscon (import export + re-use)	Cargo Flow	Implementation
D	D 4	ECO chassis	Vehicles technology handling	Implementation
E	E 1	Distribution urbaine	Cargo Flow	Initiation
E	E 2	Barge heavy lift Ro-Ro hybrid	Crane handling	Implementation
E	E 3	Vehicle urban distribution	Cargo Flow	Initiation
F	F 1	Extended-GATE 1.0	Information Flow	Implementation
F	F 2	Extended-GATE 2.0	Information Flow	Development
F	F 3	Extended-GATE 3.0	Information Flow	Initiation
G	G 1	Port Single Window	Information Flow	Implementation
G	G 2	Port Single Window	Information Flow	Implementation
G	G 3	Port Single Window	Information Flow	Implementation
G	G 4	Port Single Window	Information Flow	Implementation
G	G 5	Port Single Window	Information Flow	Implementation
G	G 6	Port Single Window	Information Flow	Implementation
G	G 7	Port Single Window	Information Flow	Implementation
G	G 8	Port Single Window	Information Flow	Implementation
G	G 9	Port Single Window	Information Flow	Implementation
H	H 1	3PL—Primary Gate of Leixões Port	Cargo Flow	Implementation
H	H 2	3PL—Primary Gate of Leixões Port	Cargo Flow	Implementation
K	K 1	Modal shift (ROC)	Cargo Flow	Development
K	K 2	Modal shift (collaboration)	Cargo Flow	implementation
L	L 1	Terminal	Information Flow	Initiation
M	M 1	Port gate	Space	Development
N	N 1	Foldable Container	Equipment	Implementation
O	O 1	Loading and unloading	Space	Initiation
P	P 1	Loading and unloading	Space	Initiation
S	S 1	Vehicle tracker	Cargo Flow	Implementation
T	T 1	IT data management	Information Flow	Implementation
U	U 1	Pallet shuttle barge—PSB	Handling	Implementation
V	V 1	Small barges and reactivation of small inland waterways	Inland flow	Initiation

(*Continued*)

Table A1. (Continued).

Firm	Case	Innovation case	Type	Level
Z	Z 1	All-weather terminal	Equipment	Implementation
AG	AG 1	All-weather terminal	Equipment	Implementation
W	W 1	Port community system	Information Flow	Implementation
X	X 1	Efficiency leadership programme	Management	Implementation
Y	Y 1	Terminal carbon footprint tracking	Management	Initiation
AA	AA 1	Carbon footprint assessment	Management	Development
AB	AB 1	Carbon footprint assessment	Management	Development
AC	AC 1	Bulk carrier self-loading/unloading cranes	Equipment	Implementation
AD	AD 1	S-BEND on LPG carriers	Equipment	Implementation
AE	AE 1	APCS case: central port community system for break-bulk	Information Flow	Initiation
AE	AE 2	Organisational innovation	Cargo Flow	Initiation
AE	AE 3	Cranes	Equipment	Implementation
AE	AE 4	Vans from diesel to cng	Fuel change	Implementation
F	F 4	Cargo transit	Information Flow	Implementation
AF	AF 1	Dynamic operation in dredging and offshore	Dredging equipment	Implementation
AF	AF 2	New dredging system to suit a certain type of soil	Dredging equipment	implementation
AF	AF 3	Cut-dredger extended to work at sea	Dredging equipment	Implementation
AF	AF 4	Series of different pumps, flexible combination of certain components)	Dredging equipment	Implementation
AH	AH 1	All-weather terminal	Equipment	Implementation
AI	AI 1	All-weather terminal 1	Equipment	Implementation
AI	AI 2	All-weather terminal 2	Cargo Flow	implementation
AI	AI 3	All-weather terminal 3	Cargo Flow	Implementation
AI	AI 4	All-weather terminal 4	Cargo Flow	Development
AJ	AJ 1	Port community system	Cargo Flow	Implementation
AJ	AJ 2	APCS	Cargo Flow	Implementation
AK	AK 2	CNG Class 8 Heavy Duty Drayage Truck	Equipment	Implementation
AL	AL 2	Emission scrubber on containership	Management	Implementation

Appendix B

Table B1. Relative frequency of ranking differences, number of cases, and H index—*economic added value objectives.*

		Difference in ranking (percentage)									
	No	−4	−3	−2	−1	0	1	2	3	4	H
All economic added value	**940**	**0**	**1**	**6**	**7**	**68**	**8**	**6**	**2**	**2**	**42**
Avoid depletion of resources	59	—	2	5	8	76	2	5	2	—	54
Cost minimization	59	—	—	12	14	51	14	7	3	—	23
Differentiation from competitors	59	—	—	10	5	64	3	5	5	7	37
Efficient use of resources (equipment, land, etc.)	59	2	—	—	3	75	10	3	5	2	52
Employment (substitution of labour by capital)	59	—	2	10	8	68	7	3	—	2	42
Encourage other investments	59	—	3	8	8	68	7	3	—	2	42
Facilitate transfer of official documents	56	—	—	2	4	84	4	4	2	2	67
Gain market share	59	—	2	5	3	61	12	12	5	—	33
Growth (marketing)	59	—	—	5	14	59	14	5	3	—	32
Improve energy efficiency	59	—	—	5	3	86	3	2	—	—	72
Increase scale of operations	59	—	—	5	14	69	3	7	—	2	45
Integration with other actors	58	—	—	3	5	67	10	10	—	3	41
Obtain first mover advantage	59	—	2	5	3	66	14	5	2	3	40
Offer larger and equitable access to service	59	—	—	5	5	73	10	2	3	2	49
Optimize of operations	59	—	3	3	12	61	12	3	3	2	33
Positive impact on competitiveness	59	—	—	7	5	61	5	19	—	3	35

Source: authors on BNP Paribas Fortis case data.

Table B2. Relative frequency of ranking differences, number of cases, and H index—environmental impacts & climate change objectives.

		Difference in ranking (percentage)									
	No	−4	−3	−2	−1	0	1	2	3	4	H
All environmental impacts & climate change	**584**	**1**	**1**	**5**	**4**	**87**	**1**	**2**	**0**	**—**	**72**
Comply with environmental regulation	59	—	—	5	7	88	—	—	—	—	76
Improve management of waste	58	—	—	3	3	91	—	2	—	—	82
Integrate other developments which have a sustainability orientation	58	—	2	7	2	90	—	—	—	—	79
Minimize impact of activity on landscape (or territory)	58	2	—	—	5	91	—	2	—	—	82
Recycling	58	—	—	2	—	98	—	—	—	—	96
Reduce congestion	59	3	—	5	2	80	2	7	2	—	60
Reduce noise	59	2	2	3	8	85	—	—	—	—	69
Reduce water/soil pollution	57	—	—	5	—	95	—	—	—	—	89
Reduction of air pollutants	59	2	2	12	3	76	2	3	—	—	55
Reduction of CO_2	59	2	3	10	5	73	2	5	—	—	49

Source: authors on BNP Paribas Fortis case data.

Table B3. Relative frequency of ranking differences, number of cases, and H index—*social added value objectives*.

		Difference in ranking (percentage)									
	No	−4	−3	−2	−1	0	1	2	3	4	H
All social added value	**472**	**1**	**2**	**7**	**6**	**80**	**2**	**1**	**1**	**1**	**60**
Comply with safety regulation	59	—	—	5	7	86	—	—	—	2	72
Comply with social and labour regulation	59	—	—	7	—	93	—	—	—	—	86
Improve relations with local communities	59	—	5	—	3	81	3	2	3	2	63
Improve the efficiency of security requirements	59	2	—	7	5	78	3	2	—	3	57
Offer new employment opportunities	59	2	2	17	12	61	3	2	2	—	34
Reduce fraud attempts	59	2	2	5	5	81	3	2	—	—	63
Reduce number of accidents	59	—	3	5	5	85	—	2	—	—	69
Retain human capital	59	—	3	8	7	73	3	—	3	2	49

Source: author on BNP Paribas Fortis case data.

Appendix C

Table C1. Relative frequency of ranking differences, number of cases, and H index—other objectives.

	No	Difference in ranking (percentage)									H
		−4	−3	−2	−1	0	1	2	3	4	
Other (obtained during interview)	298	2	1	3	7	75	6	4	1	1	52
Improve service	27	—	—	4	—	74	15	4	—	4	52
Increase interactivity with clients	25	4	—	—	20	52	16	8	—	—	26
Shift in modal split	14	—	7	7	21	43	7	7	7	—	16
Comply with local legislation	19	—	5	—	—	95	—	—	—	—	89
Increase third party satisfaction	20	—	—	10	—	80	—	10	—	—	62
Location in port	15	—	—	—	—	100	—	—	—	—	100
Customer retention	17	—	—	6	6	71	12	—	—	6	46
Shift of VAT	14	—	—	—	—	100	—	—	—	—	100
Paperless efficiency	15	—	—	—	—	73	—	27	—	—	56
Trust	19	—	5	5	11	74	5	—	—	—	51
Encourage other innovation	14	7	7	7	29	50	—	—	—	—	27
Advertising	13	—	—	—	8	85	—	—	8	—	69
Efficient access to information	12	—	—	8	—	75	—	8	8	—	53
Improve documentation accuracy	12	—	—	—	—	92	8	—	—	—	83
Improve safety	14	7	—	—	7	86	—	—	—	—	71
Create a mind shift in related industry	11	—	—	—	—	91	—	9	—	—	81
Improve overall financial performance	1	—	—	—	—	—	100	—	—	—	100
Environmental impact and performance accounting	1	—	—	—	—	100	—	—	—	—	100
Reduce damage	11	—	—	—	—	64	36	—	—	—	48
Customers demand	2	—	—	—	50	50	—	—	—	—	44
Changing market	2	—	—	—	—	100	—	—	—	—	100
Changing technology	2	—	—	—	—	100	—	—	—	—	100
Protecting your business	2	—	—	—	—	100	—	—	—	—	100
Ethical considerations	2	—	—	—	50	50	—	—	—	—	44
Competitiveness of cruise terminal	1	—	—	—	—	—	—	100	—	—	100
Shareholder value	1	—	—	—	—	100	—	—	—	—	100
Company image	1	—	—	—	—	100	—	—	—	—	100
Transparency of activities	2	—	—	—	—	100	—	—	—	—	100
Risk and reliability	5	20	—	—	20	60	—	—	—	—	37
Integration with partners (economic power)	1	—	—	—	—	100	—	—	—	—	100
Knowledge development	3	33	—	67	—	—	—	—	—	—	50
Improve overall financial performance	1	—	—	—	—	—	100	—	—	—	100