A Regional Logistics Index:

Comparing Logistics Clusters in Europe

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Abstract: The Regional Logistics Index (RLI) is a regional level composite indicator that refers to logistics performance in terms of costs, competitiveness, accessibility and connectivity through road, rail, sea, and air transportation. This article compares the logistics performance of 5 regions i.e., Lombardy, Italy; Bayern, Germany; Catalonia, Spain, Ile de France; and West Netherlands, and provides guidance for future applications in other regions in the future. The RLI is built upon objective data and is steered by an Advisory Board of logisticians. The indicator is based on the use of secondary public data to ensure replicability of the index over time and across European regions, and it follows the for OECD/JRC methodology for the development of indicators. The results of the application of the RLI to the five European Logistics clusters present strengths and weaknesses of the analysed regions. For Lombardy, for example, the RLI shows several challenges, such as the scarce infrastructure, but also some strengths, such as high labour productivity and low labour costs. The RLI can motivate clusters policies, and support of national, regional and local policy and regulatory instruments to address the specific needs of the clusters. The future of the RLI is complement existing indicators, such as the Logistics Performance Index (LPI), for more complete logistics performance assessments, at national and regional levels.

Keywords: Composite indicators; regional logistics; cost of doing logistics; competitiveness; connectivity.

1. Introduction

The concept of "competitiveness" has been studied extensively during recent decades. In general, competitiveness is associated with the ability to compete, conquer and hold position in the market, improving profitability and market share (Filo, 2007). Scholars have defined three different dimensions of competitiveness; with different meaning based on the scale or level where this idea is used: macro, micro and meso (Barney, 1991; Fujita et al., 1999; Porter, 1990). The first represents the country's competitiveness, the second the firm competitiveness, and the third the local competitiveness. This last level is divided into two sub-levels: industrial districts (also called "clusters") and regions (Martin, Kitson and Tyler, 2012).

According to the Organisation for Economic Co-operation and Development, policymakers seek to enhance the competitiveness of specific clusters to preserve their countries' economic position in multiple areas, such as technology, production, commerce, transport infrastructure, etc. (OECD, 2019). The reason for governments to focus on cluster-based approaches is to increase exports, attract investments, drive up growth, generate employment, etc. (Porter, 2000). Initiatives at the cluster level help enterprises to take advantage of new opportunities, tuning and boosting the overall productivity of the clusters (Shakya, 2009).

Among the various clusters, logistics and transportation clusters play a prominent role in economic contribution and enabling the territory's international competitiveness. This is because geographical proximity, allows firms to access knowledge spilled over by co-located firms, build up a specialised supplier base, and get specialised skills. This, in turn, supports the formation of new businesses (models) and faster innovation. Indeed, what brings firms nearer are the logistics and transportation (Sheffi, 2013).

A 'logistics cluster' is a "geographical concentration of firms providing logistics services, such as third-party-logistics (3PLs), transportation carriers, warehousing providers and forwarders" (Sheffi, 2013) and suppliers for different activities related to this sector, such as packaging suppliers, etc. (Rivera, et al., 2014).

Logistics clusters function in specific locations, to link the most important global trade networks or as hinterland hubs for these links. Three aspects also characterize these clusters: a high amount of handled goods, a significant pool of specialized labour, and an excellent system of intermodal infrastructure facilities (Juchelka, et al., 2016). Because of all these aspects, and others, such as favourable taxes, trade policy and regulatory environment,

governments are key to the development and growth of logistics clusters (Rivera, et al., 2014). Logistics clusters may be circumscribed to cities, regions, or states, and their physical delimitations may not match administrative physical boundaries (Enright, 1993), such as Piedmont or Lombardy in Italy. What is more, they may be physically dislocated, as is the case of the initiative created by a set of 4 regions, Aragon in Spain, Netherlands South West & Flanders, Rhein-Main Region in Germany, and Øresund Region in Denmark/Sweden (Borbon-Galvez and Lu, 2013). Based on the nomenclature of territorial units for statistics of the European Commission, this article shows logistics clusters at NUTS-2 level, which addresses the regional level - a common delimitation of logistics clusters.

The goal of this work is to aid policy and decision makers with reliable and comparable information, to help them devise mechanisms and incentives and to attract transportation and logistics sector investors fit for the region. For this goal, a new composite indicator (CI) Regional Logistics Index (RLI) has been developed. The RLI aggregates numerous measures up to a single index. This tool has been designed following the guidelines of the OECD/JRC (2008) to compare logistic clusters or regions, from the competitive and performance points of view, highlighting their strengths and weaknesses. This article presents the RLI of 5 logistics clusters in Europe, and the results validated with a statistical coherence tool. The remaining of the articles is structured as follows: theoretical background; the methodology for the development of index; the rollout of the index; followed by discussion and conclusions.

2. Theoretical background

International rankings based on competitiveness of countries, evaluated with indexes, are highly regarded by firms and policymakers to guide investment choices (The European House – Ambrosetti, 2019).

CIs are widely used in policy making areas, such as innovation (Balcerzak, et al., 2017; DG IMIE and SMEs/EC, 2019; Hausken, et al., 2018), sustainability (Carlucci, et al., 2018; Gatto, 2019; Mastronardi, et al., 2019; Shen, et al., 2017) and competitiveness (The European House – Ambrosetti, 2019; Petrarca, et al., 2017, Carlucci, et al., 2015).

Storper (1997)'s notion of regional competitiveness, allows us to suggest a definition of regional logistics cluster competitiveness in a European context as 'logistics companies in a region able to sustain or improve their European market shares, employment levels, wages, and service levels'. Passing the competitiveness test depends on three factors: "Ownership advantages", "Location advantages" and "International advantages" (Mariotti, 2014). In the case of the present research, the focus is on the location-specific factors that make a region the best one for doing business (e.g. good infrastructure, labour cost); this is in line with the fact that the same drivers are relevant for the transportation and logistics sector (Mariotti, 2014). Fujita & Thisse (1996)'s seminal work states that in any framework, model, simulation, or demonstration, it has always been implicitly or explicitly proved that a key governing factor of the centrifugal (i.e., expulsion) forces of a region are high transportation costs. In other words, lower logistics costs will act as an incentive to cluster around a location.

The measuring and analysis of the logistic-infrastructural gaps has captured policymakers' attention from a multidisciplinary viewpoint. This is because logistics infrastructures drive the social, economic, and environmental efficiencies of the region upwards (Bröcker, et al., 2010).

There are several CIs in the logistics and transportation field, but one that stands out is the World Bank's Logistics Performance Index, or LPI (Ojala & Celebi, 2015). There are also the United Nations Conference on Trade and Development (UNCTAD)'s Liner Shipping Connectivity Index at Country and at Port Level (LSCI and PLSCI), and the Autoregulation, Compensation, Invariance and Transversality (ACIT) index. The main features of these indexes are reported in Table 1.

Table 1. The main composite indicators for the logistics and transportation cluster

International LPI	LSCI and PLSCI	ACIT
It investigates a broad range of trade logistics issues	Focus on connectivity in maritime transport	Focus on effects of improvement and construction generated by port logistics and maritime transport
EXTENSIVE It analyses more than 160 countries	EXTENSIVE LSCI analyses more than 170 countries and PLSCI more than 900 ports	TARGETED ACIT compares Northern Range and Southern Range port regions, with a focus on Italy
Comparison at country level	LSCI: comparison at country level PLSCI: comparison at port level	Port regions at level NUTS 2
Based on on-line survey respondents are logistics professionals (SUBJECTIVE)	Based on official UNCTAD statistics (OBJECTIVE)	Based official spatial data (OBJECTIVE)

A gap in the literature is the lack of a CI for comparing European regional logistics clusters through objective measures related to overall transportation and logistics industry, infrastructure and public administration processes.

Moreover, given that logistics activities tend to be clustered in specific locations and not evenly distributed

within a country, national indexes hardly ever represent the regional logistics clusters that operate behind the scenes of national economies.

It is evident how complex and multidimensional the study of the competitiveness in this sector at cluster level is and how several variables play key roles in driving competitiveness; therefore, it could be reductive to focus only on a single area (e.g. maritime transport, etc.). The described gap provides the rationale for the proposed research.

3. Methodology

The interest in CIs has risen significantly with the guidelines and contributions of many international organizations, such as the OECD, World Bank and the European Commission's Joint Research Centre (Carlucci et al., 2015). A CI is a system of measures aggregated into a single index. It helps decision-makers understand multidimensional problems (OECD/JRC, 2008). It is fundamental to be robust, clearly define the phenomenon measured, and breaking it down into key dimensions (OECD/JRC, 2008).

The OECD/JRC (2008)' methodological guidelines have been the basis for the development of widely recognized indexes, such as the Global Competitiveness Report (WEF, 2019) and Global Attractiveness Index (The European House – Ambrosetti, 2019). Given their popularity and robustness, this work relies on the same guidelines for the development of our Regional Logistics Index (RLI). The following paragraphs describe the phases followed for the development of the Index (see Figure 1).

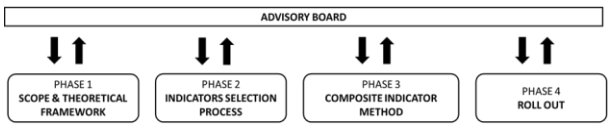

Figure 1. Composite Indicator Development

Phase 1, was a preliminary analysis of the literature on existing logistics and transport CIs analysed above. The main concepts and variables related to the competitiveness of the transportation and logistics sector were defined, which feed the theoretical framework of the RLI. The theoretical framework is the CI structure, which holds, supports and explains the multidimensional problem investigated through the RLI. It was essential to involve experts and stakeholders of the transportation and logistics sector in the definition of the RLI framework, and to keep them engaged during the whole research process through an Advisory Board (AB). Experts and stakeholders, in fact, know the sector and its competitive variables deeply, and the inclusion of different opinions improves the acceptability and robustness of the framework, legitimizing the results (Becker, W. et al., 2019). The AB of the present research was called upon according to Okoli and Pawlowski (2004), with variegated origins, including 15 experts coming from logistics trade associations, European international companies, as well as from researchers and professionals belonging to different segments of the logistics sector.

The AB highlighted the importance of starting the development of the RLI with three dimensions: 'cost of doing logistics', 'efficiency and competitiveness' and 'connectivity and accessibility'; and in four areas of the transportation and logistics sectors, including 'sea', 'air', 'road&rail' and 'logistics services' (NACE classification codes 49 and 52), which have also been said to be driving factors of firms' decisions regarding their spatial distribution structures (Onstein et al., 2019).

Phase 2, defined and selected the indicators for each dimension. In this phase, members of the AB from each area (i.e. sea, air, road&rail and logistics services) were involved. The aim of this step was to select the indicators and data sources. The preliminary selection of the indicators was performed through an iterative process that considered specific criteria proposed in the literature (Becker, W. et al., 2019, OECD/JRC, 2008), which included relevance, data availability and accessibility, value added, data reliability, interpretability, and differentiation. From the literature analysis, which was complemented with interviews with AB members, more than 50 indicators were collected. Several indicators were excluded from the initial list because they did not satisfy the previous six selection criteria. Through the described refinement process, a final list of indicators was compiled for the RLI. Five indicators were selected for each dimension, for a total number of 15 indicators. These indicators cover the four areas of the logistics and transportation sector. Table 2 reports the final framework of RLI, as well as the data sources for each indicator and its data granularity. Because each indicator is related to different themes, data granularity could be higher (e.g. the comparison of transportation and logistics reference infrastructures of different regional logistics clusters, such as ports or airports) or lower (e.g. the country level is representative of regional logistics cluster level) (Ducruet, C. et al., 2006).

Phase 3, consisted in defining a method to aggregate the different levels of the CI, based on two main steps: first, weighting the dimensions (macro-weights) and secondly the indicators (micro-weights).

For the macro-weights definition (Pd), it was decided to implement a two-round Delphi Method (Seuring et al., 2008) involving the AB (15 experts) through individual interviews, as well as a large panel of transportation and logistics firms, through on-line surveys (121 respondents). The 121 online 3PLs' company respondents were selected from among the top 500 operating in Europe (companies listed in the Orbis database).

Table 2. The dimensions and indicators of the RLI

5 INDICATORS x 3 DIMENSIONS			
Dimension 1 - Costs of doing logistics	**AREAS**	**Data source**	**Data granularity**
Road transport cost (€/day)	Road and Rail	Panel FFC	Regional cluster
Maritime transport cost port-to-port (€/TEU)	Sea	SCFI Panel FFC	Port
Airfreight cost airport-to-airport (€/kg)	Air	IATA	Airport
Warehouse unit handling cost (€/h)	Log Services	Panel FFC and logistics	Regional cluster
Warehouse rent (€/sqm per year)	Log services	Real estates	Regional cluster
Dimension 2 - Efficiency & competitiveness			
Turnover of top 100 3PLs (mln €)	Log services	Orbis database Aida database	Regional cluster
Customs operations and inspection efficiency (%)	Sea, Air and log services	World Bank IATA	Airport
Density of 3PLs' warehouses (n./sqm)	Log services	Eurostat Real estates	Regional cluster
Transit time (average) port-to-port (days)	Sea	Timetable shipping companies	Port
Freight Forwarding Productivity (tons/company)	Air	Eurostat IATA	Country
Dimension 3 -Connectivity & accessibility			
Infrastructure endowment (road and rail) (km/100.000 inhabitants)	Road and rail	Eurostat	Regional cluster
Index of maritime direct connections (%)	Sea	UNCTAD	Port
Accessibility to ports, airports and intermodal terminals (tons/year)	Sea, Air, Road and Rail	Eurostat Dynaliner Port authorities	Regional cluster
Number of direct air cargo destinations (weekly destinations)	Air	Airports sites	Airport
GDP catchment area reachable by road within 4 hours (mln euros)	Road and rail	Eurostat	Regional cluster

In both rounds, each respondent was asked to establish the macro-weights of each dimension on a percentage scale, with the sum of the three macro-weights for each respondent having to be 100%. At the end of the first round, results were collected and averaged for each dimension. Since the differences between the two rounds were not significant, there was no need for additional rounds.

For the micro-weights, an online survey utilizing a five-point Likert scale was used for each indicator. Respondents were asked to assign a score of 1 to 5 to the five indicators for each dimension (5 to the most important indicator, 1 to the least important). The micro-weight (*Pdi*) of each indicator was calculated through the ratio between the sum of levels of importance attributed by respondents for the current indicator and the overall sum of the levels of importance of all 5 indicators involved in the current dimension. The sum of the resulting micro-weights of the 5 indicators of the specific dimension is equal to 1.

Finally, the last phase was the aggregation of macro-weights and micro-weights to define the final RLI weights (*P'di*) of each indicator. Once the two previous steps were completed, it was necessary to multiply the macro-weight of the dimension by the micro-weight of each indicator included in the considered dimension.

The CI was built through the aggregation of many indicators characterised by different units and scales. In order to combine these different numbers, it was necessary to bring these indicators onto a common scale. In addition, the scale direction of some RLI indicators must be reversed; for example, the higher value for cost indicators is the opposite compared to others, as well as the accessibility indicators. There are several techniques useful to perform normalisation and bring the indicators into a common scale. In this occasion, the distance to the reference method was selected (OECD/JRC, 2008). Taking the top performing region as the reference in each indicator, and the rest of the regions being normalized with the top performing as the base.

Once the normalisation was completed, the final step for the calculation of RLI for each regional logistics cluster was the aggregation of indicators, normalised considering the final RLI weights (*P'di*). In this case the aggregation is arithmetic, this means that each normalised number of each indicator has been multiplied to its *P'di*, and the final weighted results have been added up. At times, the geometric aggregation helps indexes to capture slight variations of their indicators (OECD/JRC, 2008). The RLI, is sensitive enough to differences between regions, thus the decision to select the traditional weighted arithmetic aggregation rather than the geometric.

In addition to the final RLI ranking, to guide policymakers with their multidimensional approach it was decided to develop one sub-ranking for each dimension, thus evaluating the regional logistics cluster situation at the dimension level. The dimension score (D) was calculated for each regional logistics cluster, likewise to RLI score, through a linear aggregation. The final outputs of this methodology were consequently three sub-rankings, one for each dimension, and the final RLI ranking. Phase 4 of the methodology consists in the roll out, described the next section.

4. Roll out of the RLI

First, we selected five European regional logistics clusters:

- Regione Logistica Milanese (RLM) - This Italian logistics cluster includes the Lombardy region (NUTS 2, code ITC4), the provinces of Novara in Piedmont, and Piacenza in Emilia Romagna (Dallari, F. et al., 2010, Creazza A. et al., 2012). The centre of this cluster is Milan because it is the most important city of the territory.
- Catalonia (NUTS 2, ES51) - This Spanish logistics cluster is one of the motors of the European

economy. With Barcelona as its capital, it is home to both the port and airport of the regional logistics cluster. Another Spanish regional cluster evaluated was the Community of Madrid, but the large distance of this regional logistics cluster from its port led to Catalonia becoming the choice.

- West Netherlands (NUTS 1, NL3) is the regional logistics cluster of the Netherlands. Rotterdam was chosen as the centre of cluster because it is the most significant city from a logistics point of view and it is more barycentric than Amsterdam.
- For Germany, Bayern (NUTS 1, DE2), with Munich as its capital, was chosen as the regional logistics cluster. Another regional logistics cluster evaluated was the North Rhine-Westphalia (NUTS 1, DEA), but its closeness to West Netherlands led to choosing the Bayern regional logistics cluster.
- Île-de-France (NUTS 2, FR10) is the French regional logistics cluster. In this case, the logistics activities, such as in the Italian case, are polarized in a specific and unequivocal area, the Paris region.

The next step was the data collection for each indicator and each regional logistics cluster, through the data sources identified previously.

Then, the weight operationalization was carried out: macro-weights (1), micro-weights (2) and the final RLI weights (3). By using the Delphi Method, the macro-weights assigned to each dimension were Logistics Costs - 46%, Efficiency and Competitiveness - 30%, Connectivity and Accessibility - 24%.

Micro-weights were assigned to each indicator. The Likert Scale was used in the on-line survey and applied the reference formula defined above. The results are shown in the following table 3, which also shows the final RLI weights.

The outcomes of the application of the RLI to the sample of clusters, as far as the three dimensions are concerned, are reported in Figure 2.

The RLI ranking reports the final score of each regional logistics cluster, which is the aggregation of the three different dimensions, as reported in Figure 3.

5. Discussion and conclusions

The roll out of the RLI allowed for obtaining interesting results, West Netherlands was ranked as first place followed by Ile-de-France, Bayern, RLM and Catalonia.

Table 3. The micro-weights of the RLI

Indicators	Micro weights
Dimension 1-Costs of doing logistics	
Road transport cost (€/day)	10.9%
Maritime transport cost port-to-port (€/TEU)	9.7%
Airfreight cost airport-to-airport (€/kg)	9.7%
Warehouse unit handling cost (€/h)	8.4%
Warehouse rent (€/sqm per year)	7.6%
Dimension 2-Efficiency & competitiveness	
Turnover of top 100 3PLs (mln €)	4.6%
Custom operations & inspection efficiency (%)	6.3%
Density of 3PLs' warehouses (n./sqm)	5.7%
Transit time (average) port-to-port (days)	5.6%
Freight Forwarding Productivity (tons/firm)	7.3%
Dimension 3-Connectivity & accessibility	
Infrastructure endowment (road and rail) (km/100,000 inhabitants)	6.0%
Index of maritime direct connections (%)	5.2%
Accessibility to ports, airports and IM terminals (tons/year)	4.9%
Number of direct air cargo destinations (weekly destinations)	4.6%
GDP catchment area reachable by road within 4 hours (mln euros)	3.4%

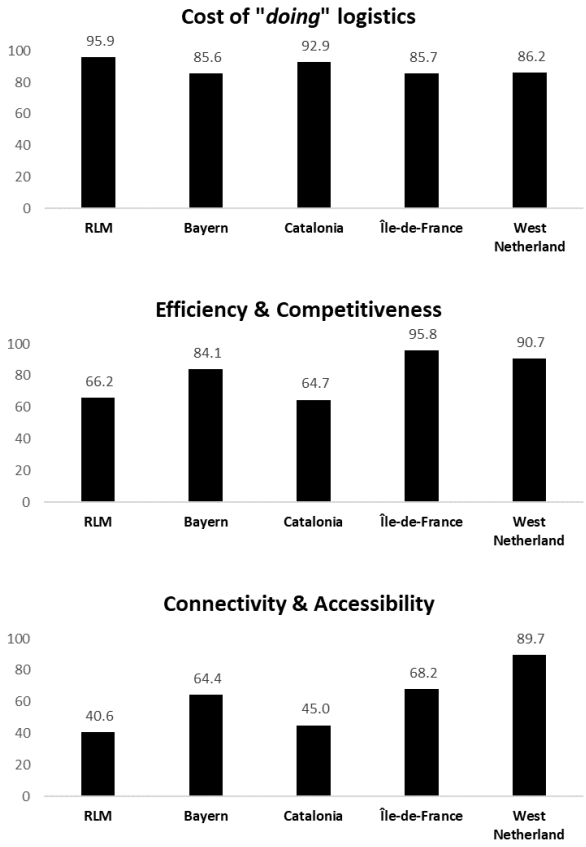

Figure 2. The results of the three dimensions

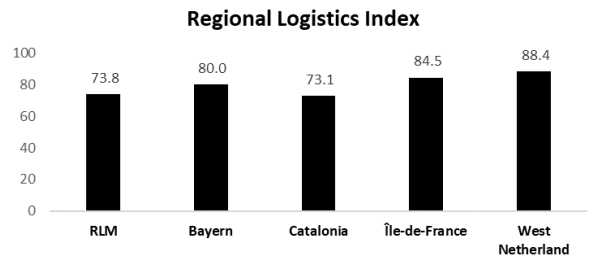

Figure 3. The overall results of the RLI roll out

Comparing these results with the outcomes of the latest LPI ranking, it is possible to notice that the RLI tends to also confirm the LPI results in terms of gaps from the top performing country, with some differences in terms of ranking of the top three countries (e.g. Germany ranks first according to the LPI and third according to the RLI). Similar to what happens when the LPI is applied, with the application of the RLI it is also possible to obtain different rankings when the dimensions building the CIs are concerned (e.g. RLM is ranked first for the costs of doing logistics, but fifth when connectivity & accessibility are regarded).

The value and novelty of RLI compared to LPI lies in the fact that RLI allows for assessing the performance of a single region within a country, rather than the performance of the country, as happens with the LPI. The whole-country perspective tends to soften the differences between the strengths and weaknesses of a nation, and consequently misses the local perspective, which is extremely important when logistics clusters are investigated. This is even more evident in countries such as Italy, where the differences in terms of level of development of the logistics systems in the Northern and Southern regions of the country are considerable.

By focusing on the regional level, it is possible to compare the different levels of logistics performance and attractiveness of the various logistics (regional) clusters and not of the whole countries. This confirms the relevance of building a CI able to target the regional logistics cluster level rather than the whole country logistics level. Similar considerations can be made by looking at the original LSCI index and its most recent version (PLSCI), which targets the level of connectivity of specific ports instead of the whole port-system of a country. Thus, the authors believe that analysts of the World Bank's LPI will benefit significantly by complementing their assessments with our RLI.

This work has some limitations though. First, the small number of clusters used to roll the RLI out affects the possibility to carry out extensive analyses of statistical coherence. By extending the sample, it would be possible to overcome this limitation. The same applies to the number of respondents involved in the data collection and weighting process: more respondents would help to make the indicator more robust. Also, alternative methodologies, such as Data Envelopment Analysis (DEA), could be evaluated as alternative tools to perform the weighting processes and overcome the limitations of the Delphi approach. The indicators included in the framework of the RLI are based on today's necessities, features and drivers of the performance of regional logistics clusters: similar to what happened to the LSCI (originally presented in 2006) that was extended to include the single port perspective through the PLSCI in 2019, in the future it will be possible to revise the set of indicators composing the RLI to better reflect and embrace the latest developments of the field of logistics.

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