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Competitiveness and the Logistics Performance Index: The ANOVA method application for Africa, Asia, and the EU regions

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ABSTRACT

This paper analyses the impact of strategic sub-components of the Global Competitiveness Index (GCI) on the Logistics Performance Index (LPI). As a hypothesis, it is assumed that there is a relationship between the LPI and selected factors in GCI, which were grouped into three clusters: infrastructure, human factor, and institutions. The purpose is to investigate which of those groups has the most significant impact on the LPI - an interactive comparative analysis tool created by the World Bank that addresses logistics issues in a broad context against world regions' development or countries' economies. For this purpose, the LPI was used as the dependent variable, while a linear regression model measured some GCI components' influence. The study was conducted for Africa, Asia, and the EU, employing the ANOVA method. The paper finds the three clusters are related to higher efficiency. While the new method shows these clusters are essential for improving the logistics performance index, an extensive range of factors might affect logistics sector performance in both geography and stage of development. In Europe, human factor is far more critical for progressively improving the LPI, while necessary infrastructure remains crucial in Asia. All three factors are central to Africa's logistics development.

1. Introduction

To operationalize within research needs, scientists use quantitative methods that require the study objects to be reduced to a countable form and with data appropriately prepared. Only then are the data reduced with their help to information that implies a specific interpretation. Logistics has proved itself a competitive weapon for companies and territories: continents, nations, regions, and districts, including urban/metropolitan areas. In an increasingly global world, a territory without efficient supply logistics, such as infrastructure networks, can seriously compromise its economic development. The physical space can become one context infrastructure, which must be planned and designed to be attractive and balanced, creating a more cohesive living and work environment. However, the physical space's value does not end with infrastructure networks' strengthening and qualification: Infrastructure is necessary but not sufficient for competitiveness development. Globalization has extended the concept of competitiveness: Competition affects territories, defined as operating systems that create the conditions of economic and social development, support local businesses, and attract new entrepreneurship.

This paper assumed a relationship between the Logistics Performance Index and the factors we chose in the Global Competitiveness Index, which we grouped into three clusters: infrastructure, human factor, and institutions. The research is about which of the three groups has the most significant impact on the logistics performance index. For this purpose, the LPI was taken as the dependent variable, while a linear

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regression model measured some GCI components' influence. The study was conducted for Africa, Asia, and the EU using the ANOVA method. The paper is organised in this introductory section, focused on highlighting the research issue and the geographic investigation areas; Literature review summarises and grouped a selected representative critical aspects that, based on also recent references, allowing to identify key concepts, actors and indicators, and experiences; National performance section is focused on static and dynamic components for competitive assessment; based on the preliminary work presented in the previous sections, the authors develop the Research Model section aimed to detect the relationship between the LPI and the relevant factors chosen in GCI that are carried out in Econometric results section. Discussion and conclusions offer a comprehensive perspective of future research from logistics, economics, and social point of view, emphasising the multidimensionality of the problem strongly affected by geographic-regional conditions.

2. Literature review

Emphasizing the logistics role for the economy, many logistics reports, especially global ones, are published. One of them is the World Bank's Logistics Performance Index (LPI) Report. Based on the assumptions developed in 2007 by the Finnish professor Lauri Ojala from the Turku School of Economics, logistic issues are presented in a broad context - against the background of developing the economies of individual regions of the world and individual countries. The LPI index is a tool that allows you to identify challenges and opportunities in logistics of the region/country studied and indicates what needs to be done to improve logistics efficiency. It is the weighted average of the score on the six key criteria. They are the effectiveness of the border control process (including customs), quality of infrastructure (e.g., ports, railways, roads, information technologies), ease of organising shipments at competitive prices, competence and quality of logistics services, the ability to identify and track shipments, timely delivery of freight within the scheduled delivery time. An index is a benchmarking tool used by managers in the logistics industry and decision-makers - economists, politicians, representatives of financial institutions, representatives of institutions supporting development, and investors. The LPI is published by the World Bank every two years.

The concept of competitiveness may refer to both specific economic entities and entire sectors, branches, regions, nations/states/economy as the whole of a given country, cities, and supranational organisations. Our study focuses on the competitiveness of an assigned territory, so the Global Competitiveness Index (GCI) has been considered. This type of competitiveness is defined in The Global Competitiveness Report WEF (2013) as a set of institutions, policies, and factors that determine the level of efficiency/productivity of a country. This level of efficiency determines the level of wealth and income of citizens. The concept of competitiveness, therefore, includes static and dynamic components. A country's productivity determines its ability to maintain a high level of income and is also one of the critical determinants of investment returns, a key factor explaining its growth potential. Such an approach emphasises the role of the achieved level of economic growth and development as determinants of the sources of competitiveness. Thanks to this, this approach also combines elements of the definition of factor and result in competitiveness.

The author finds a gap that represents a critical point for research development. Indeed, such an approach does not develop the problem of competitiveness factors, speaking about the national economy but draws attention to the effects generated by its subsystems, such as local governments and cities. This relationship is visible in the concept's example of green or smart city, which is presented as an element of sustainable development of the economy or circular economy (Addanki & Venkataraman, 2017; Ali, Bakhsh, & Yasin, 2019; Chen, 2020; Ioppolo, Cucurachi, Salomone, Shi, & Yigitcanlar, 2019; Iwan, 2014; Zhua, Liab, & Fengc, 2019) or of the role of cities in economic development (Ioppolo, Heijungs, Cucurachi, Salomone, & Kleijn, 2014; Yadava, Kumar, Sunil, Dhiraj, & Raid, 2019).

In an empirical study based on two fundamental indexes - GCI and LPI - to analyse logistics performance, Kabak, Ekici, & Ülengin (2020) find that the most critical GCI pillars affecting a country's logistics performance are "Business Sophistication," "Financial Market Development," "Infrastructure," "Good Market Efficiency" and "Higher Education and Training." Other studies reveal a variety of factors beyond infrastructure. Walker, Di Sisto, & McBain (2008)) conducted a fascinating study of the factors that drive logistics management initiatives. They identify the major categories of internal and external factors, including regulation and organizational aspects. They conclude external factors influence supply chain management and identify other drivers concerning infrastructure. To evaluate supply chains, Wattanutchariya and Kuaites (2018) also use the LPI.

Founou (2002) stresses the importance of information technology in the logistics sector to create a competitive advantage. There is a strong integration of IT systems with a robust top management commitment and an exact strategic alignment. In the last two years, studies have used LPI in a variety of ways: to explore the potential for the development of a country logistics performance assessment approach based upon textual big data analytics (Kinra, Hald, Mukkamala, & Vatrapu, 2020); to examine the impact of IT on the logistics industry sector globally, primarily to provide positive contributions to Indonesia's development (Kurniawan, Kuncoro, Wijanarko, & Ikhsan, 2019); to examine the influence of information communication technology (ICT) penetration on national logistics performance (Wang, Kang, & Valentine, 2020); and to group countries within significant impact areas of Industry 4.0 (Anuşlu & Firat, 2019).

An essential aspect of considering the infrastructure factor may also be environmental protection - the use of, for example, transport infrastructure with reduced CO_2 emissions and oil consumption (Karaduman, Karaman-Akgül, Çağlar, & Akbaş, 2020; Lu, Xie, Chen, Zou, & Tang, 2019; Sałabun, Palczewski, & Wątróbski, 2019). The environmental aspect has been raised by many researchers who use LPI for their analyses, including Karaman, Kilic, and Uyar (2020); Khan, Zhang, Kumar, Zavadskas, and Streimikiene (2020); Liu, Yuan, Hafeez, and Yuan (2018); Wang, Dong, Peng, Khan, and Tarasov (2018) and Zaman (2018).

Van Hoek, Chatham, and Wilding (2002) conducted a study related to the human factor, focusing on logistics managers, the capabilities they need and the importance they have in the logistics sector. Other authors have drawn attention to the human factor in their research by assessing the impact of corruption on trade facilitation using LPI (Koh, Wong, Tang, & Lim, 2018) and developing and testing theory-driven hypotheses on the influence of corruption and gender inequality on logistics performance (Larson, 2019).

Our study identifies the factors determining logistics sector performance (e.g., D'Aleo & Sergi, 2016) and analyses 80 countries from three different continents to evaluate if the same determinants affect logistics. One aim is to examine the need to test analysis models in different economic contexts. This alternative model, trying to fill the gap, is easily usable both among researchers and public decision-makers who can identify the variables that most affect competitiveness through this model. The peculiarity of this model is its adaptability to and applicability within different contexts. The aim here is not to trace similarities or dissimilarities but to create a common superstructure to find different developmental processes.

The index, developed by World Bank, facilitates identifying a logistics system's strengths and weaknesses and taking actions to improve it. The index is estimated according to a worldwide survey given to forwarders and express carriers. It relies on the experience and knowledge of professionals. D'Aleo (2015) has already employed the LPI using an explanatory linear regression model to analyse its mediator role in the relation between the Global Competitiveness Index (GCI) and the Gross Domestic Product (GDP) in Europe from 2007 to 2014 (EU 28). Lin and

Cheng (2018) have also spatially analysed data from 2016 on logistics performance and national wealth using a linear regression framework to determine the relationships between a country's LPI and its GDP per capita and between its LPI and those of its neighbours. Katrakylidis and Madas (2019) analyse the dynamic linkages among the LPI, trade openness as a percentage of GDP, and GDP growth based on a sample of 39 countries worldwide over the years 2007–2018.

This analysis of the literature[1] shows that LPI is often used to achieve various research purposes: for example, to provide logistics performance scores of selected countries for a given period (Mercangoz, Yildirim, & Yildirim, 2020), to analyze the different factors that influence international tourism (Khan et al., 2019), to determine the relationship between logistics performance and the entrepreneurship rate for selected EU countries (Mesjasz-Lech, 2019), to improve a country's transport and logistics (TL) performance assessment by exploring the possibility of using international commercial terms (Stojanović & Ivetić, 2020a), to investigate the relationship between logistics performance and national exports (Kabak, Ülengin, & Ekici, 2018), and to empirically explain the influencing factors of CBEC volume scale between "Belt and Road" countries and China (Zhao, 2020). Several studies investigate the relationship between LPI and trade: for example, Stojanović and Ivetić (2020) illuminate the relationship between the LPIs of trade countries and sharing obligations related to logistics services in delivery among parties in international sales contracts, Bugarčić, Skvarciany, & Stanišić (2020) assess the impact of logistics performance on trade volume, Çelebi (2019) considers the extent to which logistics performance constitutes a facilitator to international trade, Host, Skender, & Zaninović (2019) empirically examine the impact of trade facilitation on international trade from the perspective of logistics, distinguishing between low, middle and high income importing countries. Other researchers considering LPI in the trade's context include Chen and Li (2018), Espolov et al. (2019), Jia, Lan, and Zhou (2018), Takele (2019), Takele and Buvik (2019) and Roy, Mitra, Chattopadhyay, and Sahay (2018). See also Giusti, Manerba, Bruno, and Tadei (2019) and Yavas, Deniz, and Ozkan-Ozen (2020).

3. National performance

International competitiveness drives a country's economic success. The World Economic Forum began issuing the annual World Competitiveness Index in 1980, and its rankings have become the primary criteria to judge national performance. The Global Competitiveness Report, a comprehensive tool that measures the microeconomic and macroeconomic foundations of national competitiveness, has studied and benchmarked the many factors underpinning national competitiveness. The concept of competitiveness involves static and dynamic components grouped into 12 pillars: Institutions, Infrastructure, ICT adoption, Macroeconomic stability, Health, Skills, Product market, Labour market, Financial systems, Market size, Business dynamism, and Innovation capability. These are not independent factors: They tend to reinforce each other, and a weakness in one area often hurts others (Table 1).

The composition of the top ten has remained relatively unchanged since 2007 and, as expected, high-income European countries dominate the top 10 rankings (1. Germany, 2. Sweden, 3. Belgium, 4. Austria, 6. Netherlands, 8. Denmark, 9. the United Kingdom, and 10. Finland). Many of these countries are prominent and well-established logistics players with a dominant role in global or regional supply chains. Wealthy European countries are among the top 20 countries globally (16. France, 17. Spain, 19. Italy), and even those European countries that showed the worst performance do not go lower than the 70th position (70. Latvia). This shows that Europe is the most efficient logistics hub in the world. Within the Asia & Oceania group, only two countries (5. Japan and 7. Singapore) are among the top ten. It is important to emphasise that many countries show logistics efficiency levels comparable to the European Continent (12. Hong Kong, 18. Australia, 27. Taiwan, 25. Rep. of Korea, 15. New Zealand, 41. Malaysia, and 26. China). In contrast, the lowest scores come close to the African continent's performance, showing a substantial heterogeneity of the sector's development. As for the African continent, except 33. In South Africa, the level of industry efficiency is deficient, with 159. Angola is receiving the worst score. The GCI results of European nations are different from the LPI; in fact, only five EU member states appear in the GCI top ten rankings (3. Germany, 6. Netherlands, 8. The United Kingdom, 9. Sweden, and 10. Denmark). Except for 17. France, wealthy nations that appeared in the top 20 on LPI ranking, have lower GCI rankings (26. Spain, 31. Italy); and only 19. Luxemburg scores a better result than the LPI. The least competitive European country is 68. Croatia. The competitiveness of Asia & Oceania's efficiency can be subdivided into two subgroups: competitive nations, headed by 2. Singapore and 5. Japan; and uncompetitive nations, with 103. Bangladesh, 107. Pakistan, 109. Nepal, 110. Cambodia and 112. Laos PDR in the last five positions. In Africa, as with the LPI index, GCI performance is very low for all nations, from 50. Rwanda and 57. Côte d'Ivoire to 133. Mozambique and 130. Lesotho.

4. Research model

We aim to detect the relationship between the Logistic Performance Index (LPI) and the relevant factors that we have selected in the Global Competitiveness Index (GCI), which are grouped as shown in Table 2. We have chosen the most significant GCI sub-components and grouped them into three clusters: Infrastructure, Human Factor, and Institutions.

The cluster tree (14 sub-components from more than 98 available) derives from factors that have been linked to the logistics sector. If the choice of sub-components that make up the Infrastructure cluster was immediate, the composition of the two other clusters (Institutions and Human Factor) required more careful evaluation and a thorough study of all the index components. Analysing the LPI structure, we noticed that Institutions playing a pivotal role in competition development through national policies should focus on procedures, border flow management, infrastructure policies and land transport regulations. The variables used in the LPI that identify the primary role of institutions are enucleated in major "macro factors," namely "international expedition", "domestic logistics competence", "national logistics costs" and "timely." These have been analysed and defined in relation to GCI, resulting in our new cluster, Institutions. As for the Human Factor cluster, we have investigated which fundamental constant is present in all logistics procedures. The most precise answer is the human factor in all its components (i.e., from top managers to employees). Trucking companies show the use of training as a tool for actual business development, well above any other type of structure investment; this view also incorporates European guidelines that offer the training tool as a specific duty of government with the human factor being an essential element of competitiveness.

The first cluster, the model I, represents Infrastructure and contains the following sub-components of GCI: Quality of Roads, Efficiency of train services, Efficiency of air transport services, Efficiency of seaport services, and Electrification.

The second cluster (model II) represents the Human Factor. It contains the following sub-components of GCI: Extent of staff training, Skillset of graduates, Critical thinking in teaching, Diversity of workforce, and Multi-stakeholder collaboration. The third cluster (model III)

[1] The literature review was made from the SCOPUS database for the keywords "Logistics Performance Index" (LPI); 96 articles were obtained with the following number in subsequent years: 18 articles in 2020, 25 publications in 2019, 22 in 2018 and 18 in 2017, 10 in 2016, and three in 2015. The publications from 2018, 2019 and 2020 were analysed in more detail, as only they might refer to the secondary data analysed in this study - LPI and GCI from 2018.

Table 1
Logistics Performance Index and Global Competitiveness Index rank.

EU 28	2018 LPI (rank)	2018 GCI (rank)	AFRICA 27	2018 LPI (rank)	2018 GCI (rank)	ASIA&OCEANIA 25	2018 LPI (rank)	2018 GCI (rank)
Austria	4	22	South Africa	33	67	Singapore	7	2
Belgium	3	21	Egypt, Arab Rep.	67	94	Japan	5	5
Bulgaria	52	51	Malawi	97	129	Hong Kong	12	7
Croatia	49	68	Kenya	68	93	Australia	18	14
Cyprus	45	44	Nigeria	110	115	Taiwan	27	13
Czech Republic	22	29	Côte d'Ivoire	50	114	Korea (Rep. of)	25	15
Denmark	8	10	Rwanda	57	108	New Zealand	15	18
Estonia	36	32	Namibia	m.v.*	100	Malaysia	41	25
Finland	10	11	Algeria	117	92	China	26	28
France	16	17	Burkina Faso	91	124	Qatar	30	30
Germany	1	3	Ghana	106	106	Thailand	32	38
Greece	42	57	Senegal	141	113	Vietnam	39	77
Hungary	31	48	Ethiopia	m. v.	122	Indonesia	46	45
Ireland	29	23	Burundi	158	136	Saudi Arabia	55	39
Italy	19	31	Tunisia	105	87	Bahrain	59	50
Latvia	70	42	Angola	159	137	India	44	58
Lithuania	54	40	Chad	123	140	Kuwait	63	54
Luxembourg	24	19	Mauritius	78	49	Philippines	60	56
Malta	69	36	Libya	155	n/a**	Oman	43	47
Netherlands	6	6	Botswana	m. v.	90	Pakistan	122	107
Poland	28	37	Guinea	145	126	Cambodia	98	110
Portugal	23	34	Zambia	111	118	Nepal	114	109
Romania	48	52	Madagascar	128	n/a	Bangladesh	100	103
Slovak Republic	53	41	Lesotho	139	130	Laos PDR	82	112
Slovenia	35	35	Zimbabwe	152	128	Mongolia	130	99
Spain	17	26	Tanzania	m. v.	116	Myanmar	137	n/a
Sweden	2	9	Cameroon	95	121			
The United Kingdom	9	8	Gambia	127	119			
			Mozambique	m.v.	133			
			Mauritania	135	131			
			Gabon	150	n/a			
			Benin	76	123			
			Liberia	143	132			

*m.v -LPI - missing values for 2018, **n/a – GCI - data for 2018 not available.
Sources: LPI World Bank and GCI World Economic Forum, 2018 editions.

Table 2
Variables used in the cluster analysis.

Clusters	Dependent Variable	Independent Variable
I INFRASTRUCTURE	LPI	Quality of roads Efficiency of train services Efficiency of seaport services Efficiency of air transport services Electrification
II HUMAN FACTOR	LPI	Skillset of graduates Critical thinking in teaching Multi-stakeholder collaboration Diversity of workforce The extent of staff training
III INSTITUTIONS	LPI	Efficiency of the legal framework in settling disputes Organised crime Incidence of corruption Judicial independence

Source: (World Economic Forum, 2018).

represents the Institutions. It comprises the following sub-components of GCI: Judicial independence, Corruption Perception, Efficiency of the legal framework in settling disputes and Organised crime. This paper's ultimate aim is to understand which of the three groups most influence the Logistic Performance Index.

For this purpose, the LPI is taken as the dependent variable. The effects of some components of the Global Competitiveness Index (GCI) are measured using a linear regression model.

5. Econometric results

When examining the results for models I, II, and III (Table 3), a strong correspondence is seen between the LPI and some GCI components. However, the models are descriptive (model I R2 = 0.619, 0.513, 0.828; model II R2 = 0.642, 0.215, 0.685; model III R2 = 0.613, 0.468, 0.760). R2 is a statistical method that explains how much of a factor's variability can be caused or explained by its relationship to another factor; it is computed as a value between 0 (0 per cent) and 1 (100 per cent). The higher the value, the better the fit. As shown in Table 3, the model perfectly fits in the EU and Asia & Oceania groups; in contrast, the Africa group results indicate that the statistical method is less accurate.

When carrying out the regression analysis, the significance level of 95 % was considered. A graph of residual plots and fitted line plots were prepared for each variable. The residual plot shows the size of the errors

Table 3
Model summary (EU, AFRICA and ASIA & OCEANIA).

Model	R	R Square	Adjusted R Square	Std. error of the estimation
	.787*	.619	.533	.28998
I INFRASTRUCTURE	.716*	.513	.402	.24595
	.910*	.828	.783	.23904
	.820**	.642	.561	.28110
II HUMAN FACTOR	.464**	.215	.037	.31220
	.828**	.685	.602	.32367
	.783***	.613	.545	.28618
III INSTITUTIONS	.684***	.468	.376	.25140
	.872***	.760	.712	.27533

Note: *Predictors: (Constant), Quality of Roads, Efficiency of train services, Efficiency of seaport services, Efficiency of air transport services and Electrification; **Predictors: (Constant), Skillset of graduates, Critical thinking in teaching, Extent of staff training, Multi-stakeholder collaboration and Diversity of workforce; ***Predictors: (Constant), Incidence of corruption, Judicial independence, Efficiency of the legal framework in settling disputes and Organised crime.
Source: LPI and GCI, appendix tables.

for the individual values of the explanatory variable. The fitted line plot shows the superimposed model prediction and actual values. Both graphs for all variables show that models I, II and III are accurate and have a low error rate, and the predictors' fit is very good.

As seen with the results of Anova (Table 4), the model is significant. Indeed, in model

I, F = 7.136, 4.636, 18.300; in model II, F = 7.906, 1.208, 8.255; and in model III, F = 9.090, 5.060, 15.824.

Legend of Anova table: SS = Sum of Squares; Residual MS = mean squared error (Residual SS/Residual degrees of freedom); F: Overall F test for the null hypothesis; Significance F: The significance associated P-Value. From the Anova table, it is clear how the Infrastructure cluster is statistically significant and correctly defines the logistics performance of the Asia & Oceania group; in the same way, the Human Factor cluster is statistically significant and accurately portrays the logistics performance of the EU group. For the Africa group, is evident that the clustering tree is statistically less significant.

Table 5 shows the positive linear relationship between almost all variables. High (0.5−0.7), very high (0.7−0.9) and nearly absolute correlation occurs for all variables in model I. The situation is like model II, but only for European and Asian countries. In contrast, for African countries, the correlation between the LPI and the variables in model II is either weak (0.1−0.3) or average (0.3−0.5). In addition, the variables in model III are positively correlated with the LPI; the *Organized crime* variable shows only a weak correlation for European and African countries. Overall, the statistical performance is better in the EU and Asia & Oceania groups, while the African group's correlations are insignificant. (Table 6)

We analyzed data for each observation with attention to descriptive statistics. We noted the LPI Asia & Oceania mean value of 3,21 approached the EU LPI 3,54 mean value; this means that their logistics sectors have a similar development level. If we examine the variables that make up the Infrastructure cluster, we see the average value rewards the EU group, but in all variables, Asia & Oceania record the best

Table 4
Anova model (EU, AFRICA and ASIA & OCEANIA).

	Model	SS	df	MS	F	Sig.
		3.012	5	.602	7.163	.000*
	Regression	1.402	5	.280	4.636	.005*
		5.229	5	1.046	18.300	.000*
		1.850	22	.084		
I INFRASTRUCTURE	Residual	1.331	22	.060		
		1.086	19	.057		
		4.862	27			
	Total	2.733	27			
		6.314	24			
		3.123	5	.625	7.906	.000**
	Regression	.589	5	.118	1.208	.338**
		4.324	5	.865	8.255	.000**
		1.738	22	.079		
II HUMAN FACTOR	Residual	2.144	22	.097		
		1.990	190	.105		
		4.862	27			
	Total	2.7333	27			
		6.314	24			
		2.978	4	.744	9.090	.000***
	Regression	1.279	4	.320	5.060	.004***
		4.798	4	1.200	15.824	.000***
		1.884	23	.082		
III INSTITUTIONS	Residual	1.454	23	.063		
		1.516	20	.076		
		4.862	27			
	Total	2.733	27			
		6.314	24			

Note: *Predictors: (Constant), Quality of education system, Quality of management school, Extent of staff training, Capacity of Innovation and Availability of scientist and engineers; **Predictors: (Constant), Quality of education system, Quality of management school, Extent of staff training, Capacity of Innovation and Availability of scientist and engineers; ***Predictors: (Constant), Public trusts in politicians, irregular payments and bribes, Favouritism in decision government, Efficiency of legal framework in settling disputes and Organized crime.
Source: LPI and GCI, appendix tables.

Table 5
Correlation Coefficient for the tree models (EU, AFRICA and ASIA&OCEANIA).

P. CORRELATION	LPI	P. CORRELATION	LPI	P. CORRELATION	LPI
	.661		.663		.675
Quality of Roads	.558	*Skillset of graduates*	.246	*Judicial independence*	.539
	.770		.649		.756
Efficiency of Train Services (1−7)	.601	*Critical thinking in teaching*	.660	*Corruption (1−7)**	.743
	.507		.266		.523
	.762		.410		.860
Efficiency of Seaport Services	.487	*Extent of Staff Training*	.622	–	–
	.469		.321		
	.822		.788		
Efficiency of Air Transport Services	.620	*Multi-stakeholder collaboration*	.735	*Efficiency of Legal Framework in Setting Disp.*	.641
	.628		.363		.542
	.851		.732		.715
	-.208	*Diversity of workforce*	.394	*Organized Crime*	.211
Electrification	.463		.325		−.087
	.689		.504		.605

Source: LPI and GCI, appendix tables.

Table 6
Descriptive statistics.

Descriptive statistics cluster Infrastructure						
Variable	Obs.	Mean	Median	Std. Dev.	Min	Max
	28	3,54	3,58	0,4243	2,81	4,2
LPI	28	2,52	2,54	0,3181	2,05	3,38
	25	3,21	3,2	0,5129	2,37	4,03
	28	4,87	4,72	0,9027	2,96	6,18
Quality of Roads	28	3,28	3,34	0,8034	2,03	4,67
	25	4,55	4,58	1,1136	2,62	6,45
	28	4,25	4,41	0,9036	2	5,54
Efficiency of Train Services	28	2,46	2,24	0,8158	1	4,22
	25	3,97	4,58	1,4082	1,31	6,64
	28	4,75	4,69	0,7946	3,26	6,3
Efficiency of Seaport Services	28	3,26	3,04	0,7785	2,2	4,88
	25	4,39	4,59	1,1928	1,64	6,43
	28	5,19	5,31	0,5904	3,91	6,3
Efficiency of Air Transport Services	28	3,71	3,59	0,9525	1,15	5,31
	25	4,87	5,01	0,9954	3,01	6,7
	28	7	7	0	7	7
Electrification	28	3,43	2,42	2,2716	0,62	7
	25	6,51	6,94	0,7712	4,18	7

Source: LPI and GCI, appendix tables.

max value results. It is thanks to Singapore (6.4) and Hong Kong (6.1) in *Quality of Roads*; Japan (6.6) and Hong Kong (6.4) in *Efficiency of Train Services*; Singapore (6.7) and Hong Kong (6.5) in *Efficiency of Seaport Services*; and Singapore (6.4) and Hong Kong (6.2) in *Efficiency of Air Transport Services*. The Africa group records the worst results in all four variables. Electrification max values are 7.0 in all groups.

Table 7 reports the descriptive statistics related to the Human Factor cluster. According to the average values of the variables for individual countries, Asia & Oceania is the leader in four out of five variables: *Skillset of graduates, Critical thinking in teaching, Multi-stakeholder collaboration,* and *workforce diversity*. The fifth variable, *Extent of Staff Training,* is almost at the same level for Asia & Oceania and the EU: 4.42 and 4.43, respectively. In general, the average levels for Asia & Oceania and the EU are similar; therefore, the max values for four out of five variables were achieved not by Asian but by European countries. These are Germany (5.4) for the variable *Multi-stakeholder collaboration*, Luxembourg (5.5) for the variable *Extent of Staff Training*, Denmark (5.5) for the variable *Critical thinking in teaching,* and Netherlands (5.5) for the variable *Skillset of graduates.* An Asian country, Singapore (5.8 reached the max value of only one variable, *Diversity of workforce*).

Germany, the Netherlands, and Sweden are among the European countries with very high max values for all five variables. For the Africa group, the statistics show it performs better than in the Infrastructures

Table 7
Descriptive statistics.

Descriptive statistics cluster Human Factor						
Variable	Obs.	Mean	Median	Std. Dev.	Min	Max
	28	3,54	3,58	0,4243	2,81	4,2
LPI	28	2,52	2,54	0,3181	2,05	3,38
	25	3,21	3,2	0,5129	2,37	4,03
	28	4,15	4,69	0,6713	3,27	5,50
Skillset of graduates	28	3,63	3,8	0,4945	2,2	4,37
	25	4,38	4,51	0,6174	3,32	5,36
	28	3,87	3,73	0,9212	2,28	5,66
Critical thinking in teaching	28	3,04	3,08	0,5172	1,87	4,13
	25	3,91	3,87	0,7831	2,81	5,35
	28	4,43	4,42	0,6986	3,08	5,54
Extent of Staff Training	28	3,64	3,63	0,5499	2,45	5,31
	25	4,42	4,5	0,6039	3,29	5,36
	28	4,12	4,01	0,7978	2,85	5,40
Multi-stakeholder collaboration	28	3,34	3,29	0,5108	2,05	4,73
	25	4,19	4,28	0,6403	2,96	5,31
	28	4,43	4,49	0,7727	2,78	5,66
Diversity of workforce	28	4,16	4,12	0,4948	3,25	5,13
	24	4,84	4,88	0,5962	3,97	5,80

Source: LPI and GCI, appendix tables.

cluster, but the median value is far from the other two groups.

Table 8 shows the Institution cluster's descriptive statistics. The average values indicate how EU countries perform better than the Asia & Oceania group. Only one variable, *Efficiency of Legal Framework in Setting Disp.*, achieved a higher average in Asian countries. Also, the max value comes from an Asian country, Singapore, reaching 6.2. Although the European countries achieved higher mean values for the other variables, the max value for *Corruption* (6.25) was achieved by a country in the Asia & Oceania group, New Zealand. For Institutions (model III), African countries are also characterised by lower mean values for all variables, especially *Corruption* (2.36).

6. Discussion

The descriptive statistics highlight how the chosen variables provide a useful reading key to reconstruct the historical evolution and predict possible growth scenarios of the sector. LPI and GCI are taken together as good predictors of national performance and general regional area performance logistics. The first result is how the importance of human resources as a fundamental element has been discussed and is demonstrated through other methodological approaches. It is detected here in a well-defined geographical context (EU) respect the relevance of the

Table 8
Descriptive statistics.

Descriptive statistics cluster Institutions						
Variable	Obs.	Mean	Median	Std. Dev.	Min	Max
	28	3,54	3,58	0,4243	2,81	4,2
LPI	28	2,52	2,54	0,3181	2,05	3,38
	25	3,21	3,2	0,5129	2,37	4,03
	28	4,67	4,7	1,2262	2,53	6,7
Judicial indepedence	28	3,48	3,49	0,9099	1,83	5,16
	25	4,54	4,49	1,1248	2,5	6,34
	28	4,53	4,24	0,9828	3,01	6,16
Corruption	28	2,36	2,21	0,6428	1,33	3,85
	25	3,35	2,8	1,3489	1,47	6,23
Efficiency of Legal	28	3,87	3,78	1,1520	1,86	5,9
Framework in Setting	28	3,67	3,71	0,7182	2,19	5,03
Disp.	25	4,33	4,12	0,9386	2,9	6,16
	28	5,32	5,36	0,6562	3,54	6,8
Organized Crime	28	4,50	4,5	0,7511	3,24	6,01
	25	5,05	5,09	0,7841	3,76	6,47

Source: LPI and GCI, appendix tables.

Infrastructures for the well-defined but not very homogeneous geographical context (ASIA). Although it might seem that it gives little meaningful results for the African countries' group, the used method provides us with a different interpretation and a multidirectional approach towards a widespread investment on all the identified clusters. The statistical evidence of this study is probably the initial step for a multitasking approach and the identification of endogenous and exogenous variables for the understanding of African countries.

In the relationship between spending on education and training in European countries, the average value compared to GDP stood at 4.6 % in 2017. This shows that all countries should distribute a significant percentage of national programming. The proportion has been slightly but continuously decreasing since 2014 when it stood at 4.9 % (European Commission, 2019). In countries where the incidence is higher than 6 per cent (Sweden, Denmark, Belgium), it positively affects logistics competitiveness indices. It is important to note that the European Commission has defined its priority: "The investment in human resources, ensure a sufficient supply of science, mathematics, and engineering and to focus school curricula on creativity, innovation, and entrepreneurship, to prioritize knowledge expenditure by using tax incentives and other financial instruments to promote more private investment" (European Commission, 2019).

A relevant study by the Institute for Emerging Markets Studies at the Moscow School of Management (Kvint, 2004) points out that Asia will focus on infrastructure development, considering in particular that 350 million births over the next years will fuel a great demand for transport and communication, especially infrastructure (roads, bridges, power plants and infrastructure networks). Infrastructure, physical and digital, for the development of the Asian continent are the foundation of an economic activity that produces and distributes goods efficiently and effectively worldwide. The infrastructure market is thriving and vibrant in Asia, while in Europe, public investment in recent years has withstood most of the austerity imposed by the crisis. The marked differentiation revealed in our study highlights the unique needs determined by demographic changes in different continents. The quality of life and the patterns of earning connected to these new requirements directly affect competitiveness. A study by PricewaterhouseCoopers supported by research from Oxford Economics (Hart, 2010) points out that in 2025 the world will come to spend each year over 9,000 billion dollars in the five key areas of infrastructure: extraction of raw materials, utilities, manufacturing, transportation, and social services. Around an investment of 78 thousand, the Asia-Pacific market held billion, the lion's share, driven by China's growth.

After 15 years of high economic growth rates, well above 5 % per year, the African continent has slowed its run because of global economic factors. The first factor is the drop in the prices of raw materials on international markets. The African economy heavily depends on oil and minerals, such as copper and iron; agricultural products, such as cotton and cocoa, are the basis of African economies' exports. Africa is suffering and contracting in direct relation to the growth of the Chinese giant. China is the largest trading partner on the Asian continent, with exchanges in 200 billion dollars. In addition, political instability in many countries is an ever-present threat to economic growth in Africa. After a positive phase between ninety and two thousand years and many conflicts have been resolved in recent years, violence is again on the rise in many African countries, mainly because of religious disputes that often result in jihadist riots. Despite these problems, the IMF and World Bank stimulate economic growth in Africa to more than 5 % per year for the rest of the decade, after a protracted slowdown until 2016. The largest African economies have diversified and created sophisticated financial mechanisms to cushion the economic contraction in the most unfavourable circumstances. Africa must deal with colossal investments in infrastructure (including rural areas, where poverty is more concentrated, and education) and diversifying their investment, thus creating a more stable economy less tied to commodity price fluctuations.

7. Conclusions

Our goal was to investigate the relationship between the logistics performance index (LPI) and the factors we chose in the global competitiveness index (GCI), which we grouped into three clusters: infrastructure, human factor, and institutions. We tried to answer which of the three groups has the most significant impact on the logistics performance index. Our research shows that the logistics sector's competitiveness depends on multiple variables which affect trends over time, defining their shape and direction. Though all the identified variables are essential for proper sector development, certain variables or clusters decisively influence performance according to regional economic development, geographically found with the continents. This paper's unique contribution is finding the Human Factor as the dominant factor in the European logistics sector. Simultaneously, Infrastructure is the logistics driving force of the Asia & Oceania group. The statistical evidence shows that in a context characterised by a substantial homogeneity of economic and cultural development, the human factor must be developed to improve overall performance.

Conversely, in contexts characterised by considerable heterogeneity of economic and democratic development, investment in physical infrastructure is the key to bridging intracontinental gaps. The African continent is characterised by general economic and institutional underdevelopment. As a result, the statistical model does not help identify the logistics performance drivers; however, our results show that the two variables linked to the human element are more relevant in contexts with underdeveloped infrastructure. In conclusion, the present study is useful in addressing macroeconomic and managerial decisions and direct investment policies to enhance the logistics sector and improve overall competitiveness.

The chosen variables and the described results will be an excellent starting point for the logistics sector reconstruction and relaunch stressed and destroyed by the pandemic impact and adapted to the needs of the health driver. Also, for logistics, it is not a question of merely returning to normality but finding new balances that allow us to face future challenges such as those linked to a possible prolonged economic recession and increasingly sudden climate change. It is precisely in this perspective that it is necessary to assess whether the reported variables will continue to be drivers of change and importance or whether new variables are imposed, such as resilience to change, adaptability and social co-responsibility.

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CRediT authorship contribution statement

Bruno S. Sergi: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Supervision. **Vittorio D'Aleo:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization. **Sylwia Konecka:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization. **Katarzyna Szopik-Depczyńska:** Conceptualization, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization, Supervision. **Izabela Dembińska:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization. **Giuseppe Ioppolo:** Conceptualization, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Supervision.

Declaration of Competing Interest

The authors declare no conflict of interest.

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