



## THE IMPACT OF INITIAL DATA ON THE LOGISTICS PERFORMANCE INDEX ESTIMATION: ESTONIAN AND RUSSIAN STUDY

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**ABSTRACT. Background:** Logistics activities form a network of services that support the physical movement of goods, trade across borders, and commerce within borders. Well-functioning logistics, with its international trade and transport organisation, is a precondition of comprehensive national competitiveness. The World Bank (World Bank Group) Logistics Performance Index (LPI) is a unique benchmarking tool, used since 2007, providing logistics performance measurement for more than 160 countries. As the LPI is a crucial part of global efforts to understand better logistics performance in the context of increasingly complex supply chains, this indicator must be evaluated objectively and adequately. The current paper focuses on studying subjective aspects within current methodology with regards the possible impact of initial data on the LPI estimation. The research aims to ensure a more objective approach to global and cross-countries performance measurement by studying possible constraints mentioned above.

**Methods:** The paper presents a quantitative case study research strategy based on the evaluation of LPI in Estonia and Russia. The principal component analysis (PCA) as the primary method of analysis is a multivariate statistical technique that can help identify correlations between data points of the study. The primary data was collected by questioning representatives directly involved in the logistics sector by standardized questionnaire of the World Bank.

**Results:** The modified methodological approach for evaluating LPI draws attention to comprehensive generalization concerning the improved outcome of the score and the final position of both countries. As a criticism, the significant impact of the answer of just one uncommon respondent to the final score of the LPI can be pointed out.

**Conclusions:** Further research related to the issue of objective and more advanced estimation of LPI should be a continuous process with the focus on improving the quality of input data for the assessment. In addition to LPI as a primary measure, parallel use of alternative figure for evaluation of the development of logistics on a global scale.

**Key words:** performance measurement, logistics performance index (LPI), country-level logistics, principal component analysis (PCA), initial data.

### INTRODUCTION

In modern conditions, logistics plays a key, and in some cases - a decisive role in country development [Ермакова, 2020]. Today, logistics in Customs Union countries form 10-12% of GDP (transport sector - 7-8% of GDP) [Курочкин, 2013]. In the European Union

(EU) countries, this number is equal to 20-25% [Eurostat, 2019]. The main goal of logistics development is to reduce logistics costs in the final cost of products, as well as to increase the transit potential.

The digitalization of the economy and social sphere is proceeding dynamically; both from a qualitative and quantitative point of

view [Saliola and Islam, 2020]. The changes brought about by digital transformation in business, and several sectors of the economy make it necessary to assess logistics processes, both at the level of one country and the world as a whole.

For an adequate assessment of the development of logistics, a high-quality methodology is needed that allows one to assess the current state of the logistics industry in the countries of the world [Ермакова, 2020]. In 2007, the World Bank, together with the University of Turku (Finland), for the first time developed a methodology for assessing the level of logistics development in various countries [Arvis et al. 2018]. As a basis for determining the logistics rating, the experts took six most important criteria for assessing the development of logistics in a particular country, based on which the Logistics Performance Index (LPI) was calculated. The components analyzed in the LPI in 2007 were chosen based on theoretical and empirical research and on the practical experience of logistics professionals involved in international freight forwarding: customs, infrastructure, ease of arranging shipments, competence, tracking and tracing, logistics cost, timeliness [Portugal-Perez, Wilson, 2008]. Today, the LPI consists of six indicators such as customs, infrastructure, international shipments, logistics quality and competence, tracking and tracing. Timeliness ranks the countries in terms of their logistics performance and guides countries aiming at improving their logistics performance [World Bank Group, 2015 (a)]. Analysing the LPI scores in detail, countries can determine challenges and opportunities in their logistics supply chain and improve their performance [Işik et al. 2020].

The study of the efficiency of logistics in various countries is carried out every two years. Taking into the account generally accepted methodology of calculation of logistics efficiency, the impact of initial data on the estimation of LPI has not been so far under the focus. The current paper aims to study this matter based on Estonian and Russian data and conclude if some fundamental changes in the methodology of LPI could be considered.

## LITERATURE OVERVIEW

Similarly, to the many-dimensional concept of logistics, it has the multidisciplinary nature in measuring and summarizing logistics performance across countries. Although the global situation in the scope of logistics and transportation has been changing a lot lately, due to the pandemic situation concerning COVID19, it is vital to measure these changes uninterruptedly to ensure comparability of the same indicator compared to previous periods. To study further the LPI from the scope of its methodology, a review of existing literature is executed on this subject.

Firstly, many literature is available to underline the importance of different factors that are vital for logistics performance or economic gains associated with logistics performance, i.e. customs, infrastructure, quality of services, timeliness, tracking and tracing, and ease of arranging shipments [ITF, 2015; Gillen and Waters II, 1996; Vickerman, Spiekermann and Wegener, 1999; Chapman, Soosay and Kandampully, 2003; Hummels 2001; Korinek and Sourdin, 2011; Hausman, Lee and Subramanian, 2012]. Secondly, previous studies focus on correlations between different focus indicators concerning the LPI:

- Studies showing that logistics is positively correlating to international trade through different analytical approaches.
- Studies linking logistical performance fluctuation with global trade volume changes [Beysenbaev, 2018; Gani, 2017], showing a correlation between key logistical indicators and world trade.
- Studies including analysis of product costs and logistics performance, showing that transport costs and distance between countries majorly contribute towards trade friction [Yip, 2012] and increase total landed costs [Hausman, Lee, and Subramanian, 2012], according to their calculations the effect of 1% cheaper shipping leads to 1.4% more trade and a reduction of 1% in total costs can lead to a 0.4% increase in trade.

Concerning hybrid performance evaluation model-based studies, Statistical Variance (SV) and the Multi-Attributive Border

Approximation area Comparison (MABAC) methods have been used to form a decision-making model in evaluating the logistic performance. The results obtained has demonstrated that timeliness and infrastructure are the most and least significant performance criteria, respectively. The fact that the ranking of the SV and MABA hybrid model is the same as the original LPI ranking of the study suggests that the proposed model is consistent [Işik et al. 2020].

In addition to different approaches within LPI model Transport Intelligence (Ti) developed in 2010, the Agility Emerging Market Logistics Index (AEMLI). The AEMLI reflects the degree of attractiveness of the logistics market for foreign investment by assessing emerging markets offer the best logistics opportunities through three lenses:

- a survey of over 500 logistics executives
- an examination of the largest and fastest-growing emerging market air and sea trade lanes
- the methodology examines three key areas for logistics market development: domestic and International logistics opportunities, business fundamentals [Transport Intelligence, 2020].

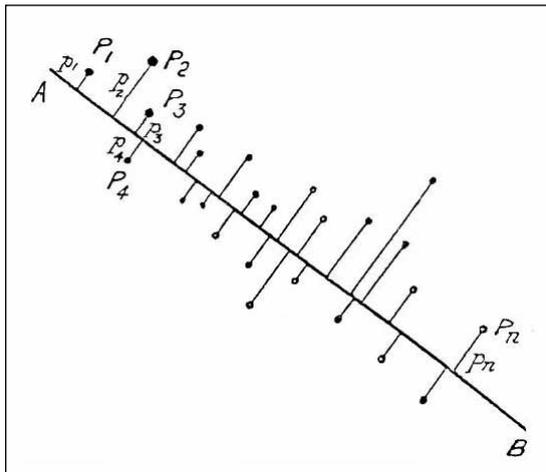
The methodological approach today to LPI is constructed based on a survey with respondents that are experts in the field of international shipping and logistics. For all the countries experts that are not based in that country are asked to give a rating on the six main components of LPI. With regards to proposals for improving the LPI, a modified index has been proposed that qualitatively and quantitatively represents an objective view of countries' logistics systems and subsystems, based on international statistical data [Beysenbaev and Dus, 2020]. The possible constraint of this approach with direct impact on results might be the fact that respondents (the sample) might not give an objective and complete overview of countries due to not having the precise opinion about the local logistics performance. It is therefore vital to examine the impact of the sample on the outcome of the LPI and to summarize logistics performance across countries based on modified methodology.

## MATERIALS AND METHODS

In 2010, the World Bank made some changes to the methodology for calculating the index and removed such an assessment criterion as the logistics costs. The fact is that in many countries, there is no statistics on logistics costs, and it is not possible to collect reliable data on this indicator. Besides, the indicator of the competence was transformed and specified into the competence and quality of logistics services. Thus, the number of criteria for assessing the development of logistics was reduced from seven to six final dimensions:

- the efficiency of customs and border management clearance (“Customs”);
- the quality of trade and transport infrastructure (“Infrastructure”);
- the ease of arranging competitively priced shipments (“Ease of arranging shipments”);
- the competence and quality of logistics services - trucking, forwarding, and customs brokerage (“Quality of logistics services”);
- the ability to track and trace consignments (“Tracking and tracing”);
- the frequency with which shipments reach consignees within scheduled or expected delivery Times (“Timeliness”) [World Bank Group, 2015 (a)].

The LPI is constructed from these six indicators using principal component analysis (PCA), a standard statistical technique used to reduce the dimensionality of a dataset [Arvis et al. 2018]. Principal Component Analysis (PCA) by Karl Pearson (invented in 1901) can be used in a wide variety of tasks: when there are many variables, and it is required to present a dataset and visualize it, or to store the maximum information about the data in a minimum number of variables. It is also useful in combating multicollinearity. The key idea of PCA is that it allows reducing the number of variables by choosing the most volatile ones as it is presented below (Figure 1). From the point of view of mathematics, it is just a transition to new variables [Pearson, 1901].



Source: Pearson, 1901

Fig. 1. Illustration of Closest Fit to Systems of Points in Space by Pearson

As an example, there are two-centred variables (mean is equal to zero). So, PCA will provide two new non-correlated variables that represent the original weighted variables. The main requirement is that the sum of the squares of the weights of the principal components equals to one. Since the most volatile variables are selected, the PCA algorithm calculates the weights so that the first principal component will have the maximum sample variance. Then it is possible to build the second principal component. On the one hand, it should be uncorrelated with the first component, and on the other, it should again have the maximum sample variance. And then the weights of each subsequent component can also be found. Further, since the components are selected so that the sample variance of each principal component is maximum, in most cases, it turns out that the first principal component (its sample variance) absorbs a significant part of the total spread of all initial variables (more than 90%). Thus, it turns out that it is possible to replace the initial set of variables with only one new principal component, which contains almost all the information of the original data set. Therefore the key advantages of PCA are the following:

- visualization of a complex dataset;
- determination of the most informative variables;
- determine outliers;

- transition to uncorrelated variables [Karamizadeh et al. 2013].

In the LPI, the inputs for PCA are country scores on questions of a questionnaire, averaged across all respondents providing data on a given overseas market. Scores are normalized by subtracting the sample mean and dividing by the standard deviation before conducting PCA. The output from PCA is a single indicator—the LPI—that is a weighted average of those scores. The weights are chosen to maximize the percentage of variation in the LPI's original six indicators that is accounted for by the summary indicator [Arvis et al. 2018].

The LPI for each country is calculated based on surveys of international, national and regional logistics operators, freight forwarding companies that provide services for organizing the transportation of goods by rail, road, sea, river or air, as well as warehouse operators [Arvis et al. 2018]. This survey consists of two parts. The first part defines the international LPI - respondents rate each of six criteria on a 5-point scale, reflecting the efficiency of the logistics system concerning eight countries with which the company works. The second part of the survey allows to calculate the domestic LPI: respondents assess the logistics system of the country in which they work on a 5-point scale. The result is LPI, which determines the place of the country among other countries of the world participating in the ranking.

The last update of the LPI was made in 2018 for 160 countries altogether. The following report on LPI will be issued on the basis of the year 2020. The position of Russia, according to 2018 rose from 99th to 75th place. The position of Ukraine rose from 80 to 66. The position of Kazakhstan rose from 77 to 71. The position of Finland rose from 15 to 10. Estonia rose from the position 38 to 36.

On the other hand, Lithuania fell from position 29 to 54, Latvia fell from position 43 to 70. The USA fell from position 10 to 14. As a result can be highlighted that higher than Russia according to 2018 results are Philippines, Rwanda, Cote d'Ivoire, Indonesia,

India, Iran, Kenya, Egypt. And above Estonia are Chile and Thailand. [World Bank Group, 2015 (b)].

The text of the report opens a table of averaged indices from 2012 to 2018. The authors find it to be an extraordinary practice. After all, the current index is a specific result of activities over the past two years. Averaging intermediate non-material totals is a bizarre practice. Further, non-specified respondents report that in Russia, only 69% of supplies meet the unspecified quality criteria.

On the other hand, in Papua New Guinea, this indicator is already 97% of all supplies. But in Canada, only 57%. In the USA and Great Britain - more than 90%. However, in Ethiopia - again 97%, while in Estonia and Finland - 93%. Accordingly, all the above raises questions concerning respondents giving the valuable input info forming the LPI and the specific criteria that are evaluated.

Many researchers, including Russian, indicate a particular subjectivity of the study of logistics efficiency conducted by the World Bank. The World Bank admits at this point that the developed methodology for assessing the efficiency of logistics is not purely scientific. The World Bank points out in its reports that the LPI is given through the global private sector's view of how countries are interconnected by trade. Therefore, it does not fully reflect the changes taking place at the level of a particular country. Such an assessment complements, rather than replaces, comprehensive studies of the logistics industry: the LPI allows to identify countries with advanced and lagging development of logistics, but a high rating does not necessarily mean equally high indicators of its efficiency throughout the country [Arvis et al. 2018].

It should also be noted that the analysis of the LPI calculation methodology raises certain doubts about the reliability of the research results. First, as stated above, the proposed methodology for assessing the effectiveness of logistics is not scientifically substantiated. The study is based on the results of surveys of mainly international (transnational) logistics companies, and the survey of consumers of

logistics services is not conducted. Further, a significant disadvantage of previously conducted studies on assessing the level of logistics in a particular country is the limited calculation of formal indicators, which were mainly associated with the assessment of the level of the information content of one respondent. No attempts were made to evaluate the questionnaire information for accuracy and reliability. Moreover, no attempt was made to find out if the respondents understand the questions correctly.

Based on this, the starting point of the current study is the provision that the respondents being surveyed can and should be considered as important data sources for evaluating logistics processes and their efficiency. To substantiate theses above, the authors conducted their own cross-country field study individually and calculated the LPI according to the World Bank methodology for Estonia and Russia.

The survey for computing LPI for Estonia was conducted in summer 2020, and in winter 2019-2020 it was held in Russia. The World Bank standardized questionnaire is represented as an online form to be filled in by companies operating in the logistics sector or related to the logistics activities (trade, e-commerce, industry, etc.).

An enclosed letter was added to the questionnaire, in which it was briefly described what the LPI means. The questionnaire also contained a remark that if the respondent does not know the exact answer to a question, then the respondent should mark the answer that is considered as closest. To exclude possible extreme impacts of COVID19 on logistics activities of companies in Estonia and for results to be comparable with initial data collected in Russia (winter 2019-2020), the questioning period was planned on economically less critical period. Besides, the respondents we asked to rely on so-called pre-crisis situational with their answers.

In the case of Russia, the data of Refenitiv Eikon was used as the basis for designing the sample, selecting transport and freight transport by road as the main criterion. In the

case of Estonia, the data of e-Business Register and the data of Statistics Estonia was used. Next step was to send to selected companies an e-mail asking them to take part in the survey. After sending the questionnaires to the e-mail addresses, some letters came back, as these addresses no longer exist. Several addressees also replied to the note that they were no longer active in the sector. Altogether 47 replies were received for Estonia and 62 for Russia. Questionnaires were sent to

respondents 06/15/2020 - 07/31/2020 (Estonia) and 12/12/2019-20/01/2020 (Russia).

After reviewing the answered questionnaires, 23 and 42 responses turned out to be suitable for further use in calculating the LPI for Estonia and Russia, respectively. The tables below (Table 1; Table 2) represent the answers of 23 and 42 respondents, respectively, according to the standards of the World Bank questionnaire for Estonia and Russia. The points are set on a five-point scale.

Table 1. Estonia

No	Position (No 1)	10	11	12	13	14	15
1	Department Manager	5	5	5	3	4	1
2	Operations	4	4	5	4	5	4
3	Department Manager	4	3	3	4	4	4
4	Operations	4	3	3	3	3	3
....	....	....	....	....	....	....	....
15	Owner	5	4	4	4	5	3
16	Supervisor	5	4	3	5	5	2
17	<b>CEO</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>1</b>
18	Department Manager	5	5	4	4	5	5
....	....	....	....	....	....	....	....
23	Supervisor	4	4	4	4	4	3

Source: own work

Table 2. Russia

No	Position (No 1)	10	11	12	13	14	15
1	Supervisor	3	3	3	3	4	4
2	Operations	3	2	5	3	4	4
3	Department Manager	2	2	3	2	3	4
4	Department Manager	2	2	4	4	3	4
....	....	....	....	....	....	....	....
42	Operations	5	5	3	3	4	5

Source: own work

As it is seen from the table above (Table 1), the answers of respondent no 17 are fundamentally different from all other assessments. Authors of the study assume the

respondent misunderstood the assessment scale by evaluating precisely the opposite. This was not observed in the questionnaires for Russia.

Table 3. Estonia

w1*10 - normalized	w2*11 - normalized	w3*12 - normalized	w4*13- normalized	w5*14- normalized	w6*15 - normalized	PC1	Sum
0,2675	0,4231	0,4917	-0,3245	-0,0437	-0,3535	0,4605	0,2121
-0,2058	0,0000	0,4917	0,1145	0,4592	0,2009	1,0605	1,1246
-0,2058	-0,4231	-0,2882	0,1145	-0,0437	0,2009	-0,6454	0,4166
....	....	....	....	....	....	....	....
<b>-1,6256</b>	<b>-1,2694</b>	<b>-1,0681</b>	<b>-1,2027</b>	<b>-1,0495</b>	<b>-0,3535</b>	<b>-6,5687</b>	<b>43,1481</b>
....	....	....	....	....	....	....	....
-0,2058	0,0000	0,1017	0,1145	-0,0437	0,0161	-0,0172	0,0003
-	-	-	-	-	-	-	-
-	-	-	-	-	-	<b>2,3896</b>	<b>3,4359</b>

Source: own work

Table 4. Russia

w1*10 - normalized	w2*11 - normalized	w3*12 - normalized	w4*13- normalized	w5*14- normalized	w6*15 - normalized	PC1	Sum
-0,21130	-0,22462	-0,08045	-0,24961	0,15958	-0,00976	-0,61615	0,37964
-0,21130	-0,80020	0,51927	-0,24961	0,15958	-0,00976	-0,59200	0,35047
-0,69260	-0,80020	-0,08045	-0,93188	-0,38566	-0,00976	-2,90053	8,41309
....	....	....	....	....	....	....	....
0,75129	0,92654	-0,08045	-0,24961	0,15958	0,39020	1,89756	3,60073
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	<b>2,83688</b>

Source: own work

The previous tables (Table 3, Table 4) show the results of LPI calculations for two countries. In the case of Russia, the result was relatively close (2.84 versus 2.76), but this is 65th place versus 75 placed in 2018 according to LPI evaluation. For Estonia, the results are much more interesting:

- Option one: 3.44 (versus 3.31) accordingly 30th place, not 36. The countries are different, the respondents are different, the sample sizes are different, but the lag of 6-10 places remains.
- Option two: an alternative calculation for Estonia (taking into account an unusual answer (no 17) and considering the fact that according to the methodology of the World Bank, no answers are rejected [Arvis et al. 2015], gives the total LPI score of 2.39 and places Estonia on 127th place. The difference in ~100 (30th or 127th place) places is resulted due to the impact of the answer of just one “unusual” respondent.

## CONCLUSION AND DISCUSSIONS

The study indicated that the respondent's misunderstanding of the rating scale leads to inaccurate and inexplicable results. A natural conclusion from the above example is the recommendation that the methodology should be understandable and focused on obtaining a valid assessment. The respondents must test each block in the questionnaire for the likelihood of errors when filling them out.

As one of the solutions, it is proposed to calculate the LPI of an individual monitored country on a semi-annual basis with a variable set of respondents. Further, the methodology

for calculating the index should meet the requirements of completeness, reliability, relevance, and sufficiency of information on the development of digital technologies in individual monitored countries. This will allow in the form of a generalized indicator to compare the logistics indicators occurring in each study region.

For this purpose, it is advisable to develop and regularly evaluate the index by independent institutions from different countries. Besides, it is assumed to conduct a comparative analysis of the results obtained, which will help to compare the level of logistics in a particular country and the index calculated according to the adopted methodology.

In conclusion, authors note that the methodology for assessing the development of logistics, developed by the World Bank, is not the only one. The comprehensive indicator of the AEMLI by the Ti is calculated based on three intermediate indicators: the size and dynamics of market development, market compatibility, and the development of transport communications [Transport Intelligence, 2020]. Improving and monitoring the calculation of the LPI on an ongoing basis will allow investors to objectively track the development of a competitive economy in a particular country and to adjust the work in this region in time.

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## WPLYW DANYCH WEJŚCIOWYCH NA WYCENĘ WSPÓŁCZYNNIKA DZIAŁALNOŚCI LOGISTYCZNEJ (LPI): ESTONIA VS ROSJA

**STRESZCZENIE. Wstęp:** Działalność logistyczna tworzy sieć usług wspomagającą fizyczne przepływy dóbr materialnych, handel międzynarodowy jak i krajowy. Dobrze funkcjonująca logistyka obejmująca swym działaniem handel zagraniczny i transport, jest warunkiem wstępnym przewagi konkurencyjnej danego kraju. Wskaźnik działalności logistycznej Banku Światowego (LPI) jest unikalnym narzędziem dla benchmarkingu, stosowanym od 2007 do oceny działalności logistycznej ponad 160 krajów. Ponieważ LPI jest krytycznym czynnikiem globalnych dążeń dla lepszego zrozumienia i oceny działalności logistycznej, musi on być wyliczany obiektywnie i precyzyjnie. Praca koncentruje się na zbadaniu aspektów podmiotowych opierając się na obecnej metodologii przy uwzględnieniu możliwego wpływu danych wejściowych na wycenę LPI. Celem pracy jest umożliwienie bardziej obiektywnego podejścia do oceny działalności na poziomie globalnym i międzynarodowym poprzez dokładną analizę wyżej wymienionych czynników ograniczających tą ocenę.

**Metody:** W pracy zastosowano strategię ilościowej analizy opartej na wycenie LPI w Estonii i Rosji. Analiza PCA (Principal component analysis), jako podstawowa metoda analizy jest wieloczynnikową techniką statystyczną, która umożliwia identyfikację korelacji pomiędzy różnymi danymi. Dane wejściowe zostały zebrane poprzez przeprowadzenie ankiety, stworzonej według standardów Banku Światowego, wśród osób bezpośrednio związanych z logistyką.

**Wyniki:** Zmodyfikowane metodologiczne podejście do wyceny LPI kładzie nacisk na uogólnienie wyników, poprawiające wynik końcowy oraz pozycjonowanie obu krajów. Ceną negatywną jest fakt dużego wpływu na wynik końcowy odbiegającego wyniku ankiety jednego z badanych respondentów.

**Wnioski:** Należałoby przeprowadzić dalsze badania zmierzające do lepszej i bardziej obiektywnej wyceny LPI, które powinny być procesem ciągłym, zorientowanych na poprawie jakości danych wejściowych. Niezależnie od LPI, jako podstawowego wskaźnika, równoległe wskazane jest używanie alternatywnego wskaźnika dla oceny rozwoju logistycznej w skali globalnej.

**Słowa kluczowe:** ocena działania, wskaźnik działalności logistycznej (LPI), logistyka na poziomie krajowym, analiza PCA, dane wejściowe

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