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Measuring the relative importance of the logistics performance index indicators using Best Worst Method

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ABSTRACT

Globalization has led to an increased need for international freight transportation and, with it, international logistics. To measure the performance of countries in terms of logistics, in 2007 the World Bank created the Logistics Performance Index (LPI), which uses six core indicators to rank countries with regard to their overall logistics performance. In the past decade, the LPI has been widely used by policymakers and researchers to formulate measures on logistics and freight transportation. At the moment, however, the different indicators are all regarded as being equally important when the overall index score is calculated, which seems highly unlikely within the complex system of logistics. This research assigns weights to the six components using the Best Worst Method (BWM), a multi-criteria decision-analysis method. A questionnaire among 107 experts from different countries found significant differences with the equal weights used in the current LPI. Infrastructure is considered the most important component for logistics performance, with a weight of 0.24, more than twice as important as tracking and tracing, which is considered to be the least important factor, with a weight of 0.10. The findings are relevant for policymakers in transportation and logistics. Although the weights now have only a mild effect on rankings due to the correlation between the LPI indicators, they may point towards different policy priorities compared to the current LPI. Our results also point out some possible weaknesses in the LPI methodology.

1. Introduction

Trade between countries has developed strongly over the past decades. Before globalization, countries mostly competed with other countries in their region, but globalization has increased the playing field to include almost all countries in the world, which has increased the importance of logistics in international trade and made it one of the key elements in the development of a country (Martí et al., 2014; Razzaque, 1997), which in turn created a need for a logistics performance measuring system. There are many different scales that can be used to measure logistics performance. At a micro level, the performance of a single company or even a department of a company can be analysed, while, at a macro level, the performance of a country or an entire continent can be measured. Several methods have been proposed over time, varying from using hard metrics, such as trade flows and productivity, to soft metrics, such as customer satisfaction (Chow et al., 1994). The importance of logistics to a country's economy also meant that a large-scale measurement was needed, and, in 2007, the Logistics Performance Index (LPI) was created by researchers at the World Bank. The LPI is an interactive benchmarking tool that countries can use to identify possible challenges and opportunities they face in their performance involving trade logistics. Updated versions were published in 2010, 2012, 2014 and, most recently, in 2016 (Arvis et al., 2016). All these versions featured a ranking of all the countries on which information was available, with 160 countries included in the most recent ranking. To determine the scores of each country, experts from all over the world are asked to score countries on six components. Each expert is asked to score eight different countries with a score between 1 (poor performance) and 5 (excellent performance) on each of the components. Table 1 shows the six components, with the explanation provided to the experts in the questionnaire used to create the LPI report.

The LPI score of each country is then calculated using the normalized scores of each component multiplied by their corresponding components loadings and then summed. It has been reported that the components loadings have been equal during the past years, which implies the components loading have no impact on the overall score of each country. In other words, the LPI can be seen as a weighted normalized average with equal weights. The components loading which have been considered as *weights*, in fact, account for variation in the data, and might not reflect the importance of the components. The fact

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Table 1
Core components of LPI (Source: World Bank).

Component	Definition
Customs	The efficiency of customs and border management clearing.
Infrastructure	The quality of trade and transport infrastructure.
Services	The competence and quality of logistics services.
Timeliness	The frequency with which shipments reach consignees within expected delivery times.
Tracking and tracing	The ability to track and trace consignments.
International shipments	The ease of arranging competitively priced shipments.

that the LPI is constructed by taking the average (with equal weight) of the scores on the six components assumes that all the components are equally important. It seems unlikely that, in reality, all the components are indeed equally important. Relevant literature provides insufficient information on the importance of the various components, and other factors, with regard to logistics performance. Addressing the relative importance of factors for logistics performance will provide a valuable insight into what determines how well a country performs. This insight could help countries determine where to focus projects and how to improve their performance in the most efficient way.

The aim of this study is to assign weights to the six core components of the LPI, using the 'Best Worst Method' (BWM). This can improve logistics performance measurement and help countries gain insight into how to focus their efforts concerning logistics. The LPI is selected as the subject of this study because it is the only available tool to measure worldwide logistics performance and it is respected everywhere. This study has societal and scientific implications, providing countries greater insight into where to focus their logistics projects, while the method and weights can be used for further research.

The remainder of this paper is organized as follows. Section 2 provides an in-depth analysis of the LPI methodology and a literature review regarding its components and other studies in which the LPI is used. In section 3, we discuss the methodology used in this study and provide more information on the BWM used to identify the weights. Section 4 presents the results and analysis. Finally, in Section 5, we present recommendations for further research based on the results of this study.

2. Literature review

2.1. Logistics performance index (LPI)

The LPI is used in many studies to provide insight into the logistical situation in countries like Malaysia (Jumandi and Zailani, 2010), Finland (Solakivi et al., 2015) and Turkey (ITF, 2015; Ekici et al., 2016). These studies show the acceptance of the LPI as a measure of assessing the logistics performance of a country and relate logistics performance to trade and transport policy. Many other studies used either the LPI score or a score on different components for other research purposes. Hoekman and Nicita (2011) review different indices of the World Bank regarding trade restrictions and facilitation, and apply them to developing countries. The LPI score is used as a reflection of logistical performance that can be influenced by certain policy measures. The authors found out that, to increase trade, it is more beneficial to implement policy measures that affect the LPI scores than to apply other measures, such as tariff barriers and known non-tariff measures. Çemberci et al. (2015) studied the moderator effect of the Global Competitiveness Index (GCI) on the LPI and concluded that a higher score on the GCI can be achieved by improving the LPI components timeliness, tracking and tracing, and international shipments. Kim and Min (2011) combined the LPI score and the Environmental Performance Index (EPI) to create the Green logistics performance index, which presented a completely different ranking than either the LPI or the EPI. Martí et al. (2014) examined the importance of each of the components of the LPI with regard to trade in emerging economies, using a gravity model, and concluded that all the component scores have a positive relation with the amount of international trade, which means that they all are factors that facilitate trade. Erkan (2014) looked at the connection between the infrastructure-weighted indicators of the GCI and the LPI. The infrastructure components of the GCI that were used are quality of roads, quality of railroad infrastructure, quality of port infrastructure, quality of air transport infrastructure, value chain breadth, and company spending on R&D. A regression analysis was made with data from 113 countries to determine whether there is a significant relationship between the overall LPI score and each of the indicators. The conclusion was that only two of the six indicators (quality of port infrastructure and quality of road infrastructure) have a significant relationship with the overall LPI score. Civelek et al. (2015) applied hierarchical regression analysis, in this case to the mediator effect of the logistics performance index on the relation between global competitiveness index and gross domestic product. First, the relationships between LPI and GCI, between LPI and GDP, and between GCI and GDP were calculated, and they were all found to be statistically significant. The last hypothesis tests whether there is a significant relationship between LPI and the relationship between GCI and GDP of a country. This last hypothesis was also found significant meaning that the logistics ability of a country dominated the relationship between competitiveness and prosperity. Another study that applied hierarchical regression analysis was Uca et al. (2016), which was similar to the previous one, but focused on the mediator effect of the LPI on the relationship between the Corruption Perception Index (CPI) and Foreign Trade Volume (FTV). The study, which was carried out in the same way as Civelek et al. (2015), concluded that the logistics ability of a country triggers the relationship between corruption and foreign trade volume. It is conceivable that all these studies would have presented different results if the weights of the components had been different from the averages used in LPI.

The LPI is constructed on the basis of a survey among experts in the area of international shipping and logistics. For every country, experts who are not based in that country are asked to rate six different components between 1 and 5: customs, infrastructure, quality of services, timeliness, tracking and tracing, and ease of arranging shipments. The reason experts are used is that, because of lack of data, performance cannot be assessed globally using only hard data, like cost and time information (Arvis et al., 2016). In the LPI survey, respondents are asked to rate eight overseas countries, whereby the countries are assigned randomly based on the most important import and export markets in the country in which the respondent is located. For landlocked countries, the characteristics of the country determine which countries are rated by the respondent from the landlocked country. The average scores on the different components make up the overall LPI score that is used to produce the ranking. In the most recent ranking, Germany is the top performer, with a score of 4.23, while the worst performer is the republic of Syria, with a score of 1.60.

The authors of the 2016 LPI report mention two limitations with regard to the methods that are used to construct the LPI, the first of which is that, for the poorer countries, large international freight forwarders may not represent the broader logistics environment, since these poorer countries mostly rely on more traditional smaller operators, which means that the expert opinions involving the poorer countries may be different from the actual situation. Also, different freight forwarders can have different experiences with the same country. It is likely that large international operators have different experiences with government officials, for instance custom officers, than regional smaller operators. The opinion of the respondents on the quality of services will be based on their experience with the service providers in that country, which may vary per provider, especially in the poorer countries. The second limitation concerns the landlocked countries and small island states, for which the LPI may reflect access problems that are located

outside of the countries in question, due to a dependence on neighbouring infrastructures or customs services, which means that it is possible that a low rating for landlocked countries is not the correct reflection of their trade.

2.2. Core components of LPI

Many studies are available on different factors that are important to logistics. This section focuses on literature involving the importance of the components for logistics performance or economic gains associated with logistics performance.

The *Customs* component of the LPI determines the effectiveness and efficiency of custom procedures in terms of speed, simplicity and predictability (ITF, 2015). Many studies see customs as an important factor in logistics and transport efficiency, and, especially in relatively less developed countries, small measures in customs can increase the efficiency of the total logistics system (Ekici et al., 2016; Yang and Chen, 2016; Heaver, 1992; Devlin and Yee, 2005). In the transport and trade literature, customs are seen as an important factor for trade facilitation (Hausman et al., 2013).

Infrastructure is an essential factor in trade. To transport policy makers, the volume of freight users is not only the major determinant of infrastructure construction and maintenance costs, it also generates significant benefits. Many studies link transport infrastructure to economic and trade volume growth, with logistics services as critical link (Ekici et al., 2016; Lakshmanan, 2011; Gillen and Waters, 1996; Vickerman et al., 1999). These effects have been described for both developing and developed countries.

Chapman et al. (2003) studied the effects of innovations in logistics *services* and concluded that they have significant advantages for supply chains, such as greater efficiency and customer satisfaction. Daugherty et al. (1998) found that high levels of logistics services have an indirect positive effect on economic indicators. Transport policy can have an influence on the quality of logistics services through regulatory measures for the transport sector or through direct support to services in the form of e.g. traffic management.

Timeliness refers to whether shipments arrive at the right place at the right time. Hummels and Schaur (2013) concluded that a 1% reduction in the processing time of a container at the exporter can lead to 0.4% more bilateral trade, while 1% less variability in shipping times can lead to up to 0.2% increase in bilateral trade, meaning that better timeliness and prediction of when shipments will arrive increases trade. In value terms, a day in transit is equivalent to a tariff of 0.6–2.1 percent of the goods' value (Hummels and Schaur, 2013). The reduction of time in transport is one of the important objectives of transport policy; policies will often be evaluated in cost-benefit analysis using the effect on this performance measure.

Tracking and tracing will be a major area for investments in the near future, because all parties in a supply chain can benefit from an improved ability to locate their products (Korinek and Sourdin, 2011). The importance of tracking and tracing is confirmed by Shamsuzzoha and Helo (2011). Transport policies are relevant insofar it concerns stimulating ICT innovations for transport management systems in logistics.

International shipments is the final component of LPI. Hausman et al. (2013) calculated that 1% cheaper shipping leads to 1.4% more trade, while a 1% reduction in overall costs can lead to a 0.4% increase in trade. The ease of arranging for international shipping is dependent on transport regulations related to safety and security.

All these studies together support the notion that all the components are indeed relevant factors for logistics performance and should be included in the LPI.

Several conclusions can be drawn from our literature review. The six components of the LPI are all factors in logistics performance based on literature involving the individual components. However, to date, no study has examined how important they are compared to each other, which underlines the need for weight assignment. To address logistics performance, it is important to take all factors into consideration. The LPI and its factors have been used in many studies since its introduction, and the results could be different if weights would have been assigned to the factors.

3. Methodology

In this section, we discuss the methods used in this study, starting with the selection of the weight assignment method and a description of how this method is applied and how the respondents were approached. Also, statistics on the actual respondents will be presented.

The problem examined in this research is a multi-criteria decision analysis (MCDA) problem that can be represented by the matrix in Equation (1) (Rezaei, 2015):

$$D= \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \\ (w_1 & w_2 & \cdots & w_n) \end{array} \\ \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1n} \\ p_{21} & p_{22} & \cdots & p_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ p_{m1} & p_{m2} & \cdots & p_{mn} \end{bmatrix} \end{array} \quad (1)$$

In this matrix, the top row $\{C_1, C_2, ..., C_n\}$ represents a set of decision analysis criteria used to evaluate the alternatives. $\{A_1, A_2, ..., A_m\}$ are the alternatives that will be scored on the criteria. p_{ij} represent the scores of the different alternatives on the criteria. The goal is to evaluate (and rank) the alternatives based on the criteria provided. A common way to evaluate an alternative is to assign weights $w_j \left(w_j \geq 0, \ \sum_j w_j = 1 \right)$ to the different criteria and calculate the value of the alternative (V_i) using the weight additive function shown in Equation (2) (Rezaei, 2015).

$$V_i = \sum_{j=1}^{n} w_j p_{ij} \quad (2)$$

Over time, a number of different MCDA techniques have been proposed to assign weights to different criteria. The method selected for this study is the Best Worst Method (BWM), as introduced by Rezaei (2015), for several reasons. Pairwise comparison methods mainly face two problems. The first problem is that, because of the number of comparisons that have to be made for a full pairwise comparison matrix, it is a lengthy process. The second problem is the inconsistency between the comparisons, which can be caused by several reasons, such as a lack of concentration or information (Forman and Selly, 2001). By using only two vectors, instead of a complete pairwise comparison matrix, the BWM requires fewer comparisons compared to a full pairwise comparison matrix, making the process less lengthy and increasing consistency between the comparisons, since the comparison is conducted in a very structured way. As such, the problems of pairwise comparison are reduced by using the BWM. Another advantage is that the BWM uses a very structured and understandable way of gathering the data required for the pairwise comparisons, which results in highly reliable results that are easy to understand by the evaluator and can be easily revised to increase consistency. The method was introduced in 2015 and is therefore relatively new, but it has already been applied in a number of studies. Serrai et al. (2017) used BWM together with some other MCDA methods for web service selection problem. Gupta (2018) used BWM for evaluating service quality of airline industry, while Salimi and Rezaei (2016), Salimi (2017) used the method for evaluating university-industry collaboration and scientific outputs respectively. Ahmad et al. (2017) used BWM for evaluating the external factors affecting the sustainability of oil and gas supply chains. BWM has also been used for supplier selection and supplier segmentation (Gupta and Barua, 2017; Rezaei et al., 2015, 2016).

The BWM is described in the next subsection.

3.1. Best Worst Method (BWM)

The BWM contains five steps to determine the weights. Steps 2–4 are carried out using an expert questionnaire. The contents of which and of the respondent are described after the description of the five steps.

Step 1: Determine a set of evaluation criteria.

In the first step, a set of evaluation criteria $\{C_1, C_2, ..., C_n\}$ is considered that should be used to evaluate the alternatives. In our study, these are the LPI indicators.

Step 2: Determine the best (most important) and worst (least important) criteria.

In this step, the evaluator (expert, decision-maker) has to identify the best criterion (e.g. the most important criterion to evaluate the alternatives) and the worst criterion (e.g. the least important criterion to evaluate the alternative) in general.

Step 3: Determine the preference of the best criterion over the other criteria.

The evaluator then has to indicate the preference of the most important criterion over the other criteria, using a number between 1 and 9, where 1 indicates equal importance, while 9 means that the best criterion is a lot more important compared to the criterion in question, resulting in a Best-to-Others vector, A_B:

$$A_B = (a_{B1}, a_{B2}, ..., a_{Bn}) \tag{3}$$

Step 4: Determine the preference of the criteria over the worst criterion.

The evaluator has to indicate the preference of all the other criteria over the criterion selected as being the least important, using a number between 1 and 9, where 1 indicates equal importance and 9 indicates that the criterion in question is a lot more important than the least important criterion, resulting in an Others-to-Worst vector, A_W:

$$A_W = (a_{1W}, a_{2W}, ..., a_{nW}) \tag{4}$$

Step 5: Find the optimal weights.

In this step, the optimal weights $(w_1^*, w_2^*, ..., w_n^*)$ are identified. Two different models have been proposed for BWM, the former of which (Rezaei, 2015) could lead to multiple optimal solutions, while the latter (Rezaei, 2016) aims at finding unique weights. This linear model is used in this study to determine unique weights.

The set of optimal weights for the linear model is the one where the maximum absolute difference for the following set $\{|w_B - a_{Bj}w_j|, |w_j - a_{jw}w_W|\}$ is minimized. The sum of the weights has to be equal to 1 and none of the weights can be negative, leading to model (5) to find the optimal solution.

$$\min \max_j \left\{ |w_B - a_{Bj}w_j|, |w_j - a_{jw}w_W| \right\}$$

s.t

$$\sum_{j=1}^{n} w_j = 1$$
$$w_j \geq 1, \ for\ all\ j \tag{5}$$

This problem can be solved by transferring it to a linear programming problem (6).

$$\min \xi^L$$

s.t.

$$|w_B - a_{Bj}w_j| \leq \xi^L, \ for\ all\ j$$
$$|w_j - a_{jW}w_W| \leq \xi^L, \ for\ all\ j \tag{6}$$

$$\sum_{j=1}^{n} w_j = 1$$
$$w_j \geq 1, \ for\ all\ j$$

Solving this linear programming problem will lead to a single solution in which the optimal weights $(w_1^*, w_2^*, ..., w_n^*)$ and ξ^{L*} are obtained. ξ^{L*} is a direct indicator of the consistency of the comparisons that are made in the method. The value for ξ^{L*} shows the reliability of the outcomes based on the consistency of the comparisons. A value close to zero indicates a high consistency and therefore a high reliability. Complete consistency is reached when $a_{Bj} \times a_{jW} = a_{BW}$ for all j.

3.2. Questionnaire and respondent selection

We used an online questionnaire with specialised survey software. In addition to the questions that are needed for the BWM, the respondents were asked to answer two other questions to identify possible differences in weights between different groups. The first extra question is: In which country do you live? This question is used to identify differences between groups based on the development of the country in which they live. Secondly, they were asked to state the countries for which they have the most information with regard to their logistics performance. The answers could vary between 1 and 5 countries. The results of the survey are discussed in Section 4.

To identify reliable weights, the respondents need to have enough information on international logistics, which is why all the persons who were approached to fill in the questionnaire are experts in international logistics. To include educational as well as professional experts, half of the respondents we approached work at a university or research institute, while the other half have relevant jobs in international logistics. The university experts were found online and were approached by e-mail. All the experts we approached have at least a master degree in a relevant area. The professionals were approached via LinkedIn. Table 2 shows more information on the experts involved. The Development Group shown in the table is the World Bank development group of the country where the expert in question is located. It proved very difficult to find experts the lowest income countries, mainly because they have limited Internet access and do not provide information online. It also proved hard to find respondents in South-America due to language barriers. The respondents and their demographics are discussed in the next section.

3.3. Respondents

In all, we asked 1075 experts to fill in the questionnaire, while 193 experts opened the link to the questionnaire we sent them via e-mail or LinkedIn. Of these 193 experts, 72 opened the questionnaire but did not actually start answering, while 11 other respondents started answering, but failed to complete the questionnaire. Three complete questionnaires had to be excluded because of some obvious mistakes. This left 107 useful responses, 57 experts from universities and 50 professionals. Table 3 shows additional statistics on the respondents. As expected, the number of respondents from countries in the lowest income group is low.

4. Results and discussion

In this section, we discuss the results of the study, including the expert responses, the resulting weights and an analysis of these weights.

Table 2
Approached experts.

	Universities	Professionals
Total experts	539	536
Different countries	56	58
Different continents	6	6
Development group		
High income	358	305
Middle income	180	211
Low income	1	20

Table 3
Respondents per group.

	Professionals	Universities	Total
Respondents	50	57	107
Countries	33	30	47
Continents			
Europe	16	25	41
North America	10	6	16
Asia	7	14	21
Australia	0	5	5
Africa	12	4	16
South America	5	3	8
Development group			
High income	25	39	64
Middle income	22	18	40
Low income	3	0	3

4.1. Questionnaire answers

In the first question of the questionnaire, the respondents were asked: in which country do they live (experts) or in which country does their company operate (professionals). This resulted in respondents from 47 different countries. Based on the low number of respondents from the lowest income group, we decided to combine the respondents from the middle income group with the low income group for the remainder of the study. This new group is indicated as the low income group from now on. After combining these two groups, 64 respondents fall into the high income category, and 43 respondents into the low income category. At a later stage, the weights for these different groups are compared, to identify differences in weights based on income categories.

The next questions were the questions used in the BWM to determine the weights. The respondents were asked to indicate which they consider the most and least important criteria. The answers are shown in Fig. 1. The blue bars (left) represent the answers on the most important criterion and the red bars (right) on the least important criterion. The components are placed in the following order (from left to right): customs (C), infrastructure (I), services (S), timeliness (T), tracking and tracing (TT) and international shipments (IS).

Fig. 2 clearly shows that infrastructure (with 44 out of 107 respondents) and services (with 35 out of 107) are considered to be the most important criteria, while tracking and tracing (with 42) and ease of arranging international shipments (with 30) are considered to be the least important. All the criteria were selected at least three times as most and least important criterion. In the remaining questions, the respondents were asked to state the preference of the most important criterion over the other criteria and the preference of the other criteria over the least important criterion. The answers are used as input for the BWM and to calculate the weights.

4.2. Weights

Table 4 shows the weights identified using the BWM and the answers of the 107 respondents. In addition to the weights (in the mean column), the minimum value, maximum value and the standard deviation (s.d.) are also included. Fig. 2 shows a box plot with the distributions of the weights.

Most respondents considered transport infrastructure to be the most important criterion followed by logistics services, as reflected in the final weights. The lowest weight was assigned to tracking and tracing, which most respondents considered to be the least important criterion.

If each component were to be equally important, the weights would have been 0.1667 for each of the components. A one-sample *t*-test is performed to determine if there is a significant difference between the weights and 0.1667. The results (see Appendix A) show that the customs component and the timeliness component are not significantly different from the average weight, but that the other four weights are significantly different. This indicates that assigning weights provides a better insight into what is important when addressing logistics performance. This is a new result in the field of analysis of national level logistics performance indicators.

We also analysed the score of different subgroups. The first comparison in weights is made between the professionals and the university experts. Table 5 shows the variation in the appearance of factors as most and least important.

ANOVA is used to test if there is a significant difference between the weights of the LPI components between the groups. The null hypothesis for each of the comparisons is H_0: There is no significant difference between the groups. The hypothesis to be tested is H_1: There is a significant difference between the groups. The results show that there is only a significant difference in weights only for the customs component, for which the university experts' weight is significantly lower (0.1395) than the professionals' weight (0.1822). For the other components, the differences are too small to be significant.

Regarding the development group of the country in which the respondent lives there is no significant difference in any of the weights between the high and low income groups. The same applies to the

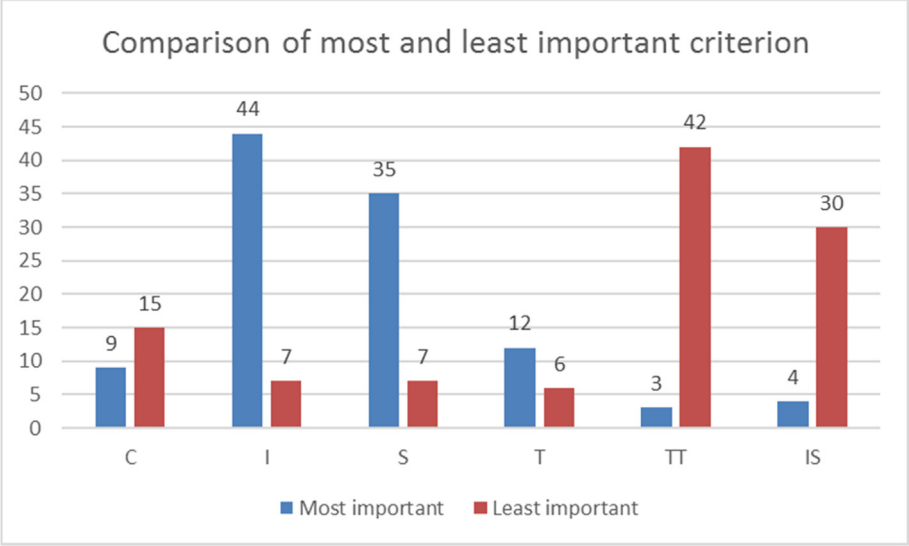

Fig. 1. Most and least important criteria.

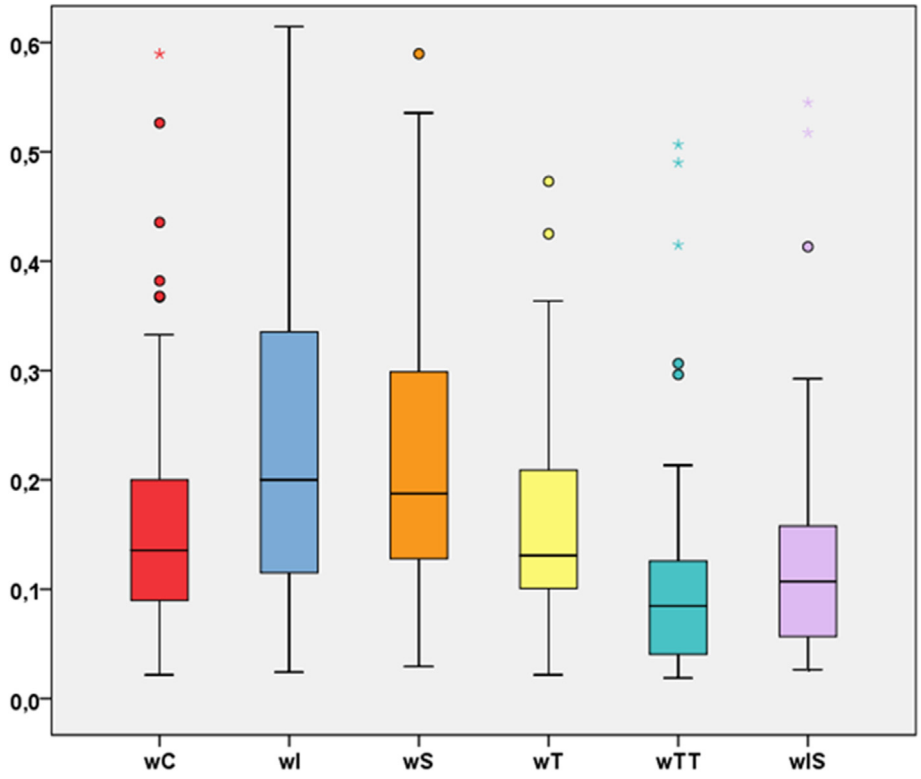

Fig. 2. Box plot of the LPI components weights.

Table 4
Summary statistics of LPI components weights (N = 107).

	Mean	Min	Max	s.d.
Customs	0.1594	0.0216	0.5897	0.1050
Infrastructure	0.2354	0.0242	0.6146	0.1463
Services	0.2169	0.0295	0.5897	0.1234
Timeliness	0.1601	0.0217	0.4729	0.0870
Tracking and tracing	0.1025	0.0189	0.5066	0.0866
International shipment	0.1256	0.0263	0.545	0.0914

Table 5
Number of times factors score most and least important, by subgroup.

	Most important		Least important	
	University	Professionals	University	Professionals
Customs	4	5	11	4
Infrastructure	24	20	2	5
Services	19	16	2	5
Timeliness	7	5	1	5
Tracking and tracing	3	0	23	19
International shipment	0	4	18	12

Table 6
Customs weights per continent.

Continent	Customs weight	Standard deviation
Europe	0.1322	0.0128
North America	0.2133	0.0375
Asia	0.1421	0.0160
Australia	0.0919	0.0309
Africa	0.2170	0.0312
South America	0.1542	0.0255

countries on which the respondents have information. Again, there are no significant differences between the high and low income groups. If the differences between continents are tested, only the customs component shows a significant difference. Table 6 shows the weights for each of the continents on the customs component.

Africa and North-America consider customs to be more important than the other continents, whereas Australia considers it to be less important. Because, overall, only the customs component weight is influenced by respondent groups, generally speaking, the weights are robust and should be considered when addressing logistics performance. The weights can also be applied to the current LPI ranking, using the scores the experts provided for the 2016 report. The new and old ranking can be compared to observe the effects of assigning the weights.

4.3. Ranking comparison

To create the weighted LPI, the scores of the last LPI report on each of the components are multiplied with the weights we identified. The complete ranking can be found in appendix B. Several statistics can be found by comparing the rankings. Table 7 shows that 110 countries are on a different place in the new ranking, with an average place movement of 1.56 places. It also shows the biggest rising and falling countries.

When comparing the lists, we note that the differences between the two rankings are relatively small, due to the small difference in the overall scores with and without the weights. When these scores are compared, they have a correlation of 0.9988, which means that the overall w-LPI score can be almost perfectly predicted using the overall LPI score. The main reason for this is that in the LPI there is a very high correlation (between 0.902 and 0.984) between the different components. Correlation between the components might be explained in real-world terms by the phenomenon that more developed countries invest more broadly in the various factors in the logistical system. However, the correlations between the LPI scores on the different components

Table 7
Ranking comparison.

Statistics w-LPI		
Number of countries with rank difference		110
Average rank difference[a]		1.56
Average percentile score difference		0.82%
Top 5 rank increasing countries		
	Iran	7
	Bosnia Herzegovina	7
	Congo	6
	Namibia	5
	Cuba	5
Top 5 rank decreasing countries		
	Cambodia	−7
	Guinee-Bissau	−7
	Mozambique	−7
	Costa Rica	−5
	Togo	−5

[a] Averaging the absolute rank changes per country.

seems to be too high to be realistic. What is more likely is that the correlations are caused by the approach towards measurement of the indicators. This can have several reasons, among which the selection of respondents and the way of questioning, where overall impressions of countries and perceptions about general performance dominate the scoring over local expert knowledge about specific performance dimensions.

The small difference in ranking does not mean that weight assignment is not useful for addressing logistics performance. The relatively large differences in weights for the six core components show that, when measuring logistics performance, some factors are more important than others. As we will explain below, this can have consequences for policy development, system wide and for specific countries. Conversely, an improved selection and more differentiated scoring will lead to a more accurate representation of overall logistics performance, but not obviate the need for weights.

4.4. Policy relevance

The relevance of our findings for policymakers can be summarized as follows. The generalized relevance of the quantitative findings of our survey lies at the global level. Experts have been shown to be able to differentiate between factors when it comes to their importance for overall logistics performance. A detailed national assessment of current performance, in combination with the weights we identified, is expected to provide a different and more accurate global ranking, in line with the relative importance of performance indicators. Although an assessment of global performance lies outside the bounds of the study, we can already indicate that including weights in a policy analysis may produce different conclusions than with the current LPI, at global and at national level. We provide a more detailed argumentation out below.

Firstly, we can already say that the question, which areas of intervention could be most effective for going up in the LPI ranking, is answered differently if weights are applied. At the global level, our weighting suggests that investments in infrastructure and services have become relatively more important to allow countries to move up the LPI ladder. Surprisingly, transport infrastructure came out as most important determinant of logistics performance, closely followed by logistics services. Apparently, whether infrastructures and services are of high or low quality matters more to users, in general, than a country's performance in other areas.

Secondly, the way in which this translates to individual countries depends on the combined effect of LPI scores and weights. Despite the fact that the LPI indicators for individual countries are so much correlated, we can still draw some conclusions on the general changes in patterns caused by the addition of the weighting, illustrated by examples. These patterns will become more pronounced and systematic if score become less correlated. Looking at differences in scores within the list between subsequent countries, we can already see with the unweighted LPI which weaker scores need improvement to obtain a higher rank. We note that this is a different task than to design a policy; one needs to take into account the effectiveness and efficiency of specific instruments, besides looking merely at the area of intervention, which we are doing here. However, despite that these numbers do not provide sufficient guidance for a policy design, identifying relatively weak scores will be an important starting point. With the weighted LPI, the combined effect of change in ranking of countries and the change in component scores may lead to a change in these comparatively weaker scores. We can spot clear changes for specific countries, for example:

- Austria, placed 7th, currently would need to improve mostly its service quality, while in the new situation would need to focus on customs.
- Iceland, 39th, would need to revisit its priority from customs to infrastructure.
- Kenya, placed 40th in the LPI list, lags furthest behind on international shipments in the current LPI but, in the new LPI, service quality and customs become equally relevant.
- Iran, placed 97th on the current list, would need to reprioritize from customs improvement to tracking & tracing and international shipments.
- Nepal, 123rd, would have to consider strengthening infrastructure more instead of customs improvements, in order to improve its score.

With these illustrations of the possible policy impact of weighting, we argue that the approach is relevant for the selection of improvements in national logistics systems.

Thirdly, in order to investigate this combined effect at a system level, we can determine whether there is an overall shift in emphasis in terms of differences between countries' individual scores. We use a simple aggregate indicator to measure this here, in a similar way as the examples above, by summing the differences in scores between subsequent countries, for those components where improvement is needed to reach the level of the next country on the list:

$$d_C = w_C \sum_{s=2}^{n} \max(0, (C_s - C_{s-1}))$$

Where.

d_C = aggregated difference per component C,
w_C = weight of component C,
C_s = Score of country (state) s with respect to component C; countries are sorted according to their total (weighted) LPI score.

Note that if we add the $d_C's$ for all criteria the results will be the same for the unweighted and weighted LPIs as the countries and their LPI scores remain the same, and the new weights add up to 1. We can calculate these differences in the conventional and the weighted LPI list, per component of the LPI. The aggregated distances between countries for each component show which ones are most important, for countries to climb on the list. The result shows some notable changes (Fig. 3) that could not be predicted based on only the weights or the LPI list.

Whereas in the unweighted LPI list the component "customs" creates the highest distance between countries, now this has become "infrastructure". It is interesting to see that this could not have been predicted with only knowledge of the weights. The component "international shipments" had a weight well below the average, but will require ongoing attention to improve national logistics systems. It is the combined effect of changes of ranking of countries and weights on

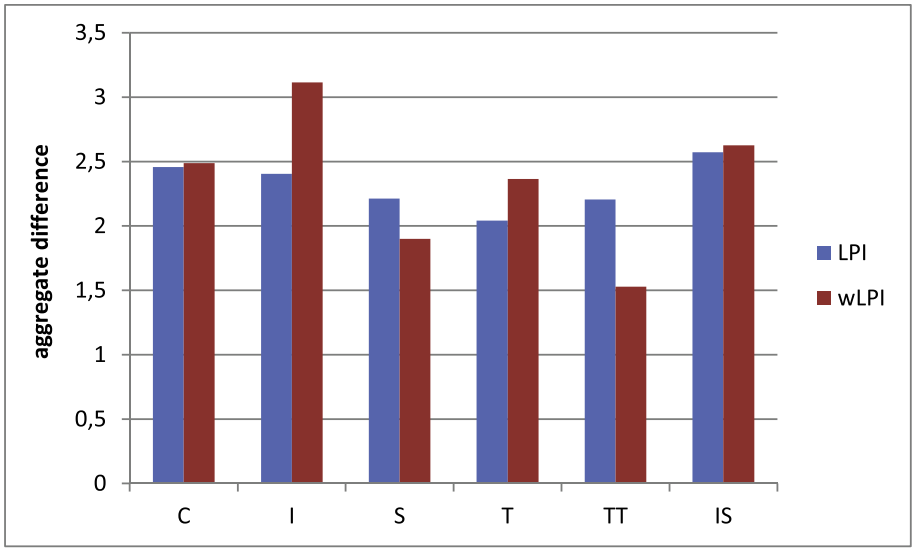

Fig. 3. Aggregated differences *d* between countries in the two LPI lists.

individual scores that changes the emphasis in policy needs.

Detailed investigations into specific countries' logistics policies will require a more comprehensive approach, including a definition of objectives, instruments and policy impacts. An analysis of LPI scores is only the first step towards such a policy analysis.

5. Conclusions and recommendations

The logistics performance index (LPI) was introduced as a tool to gain insight into the logistics performance of different countries. It was the first tool to provide countries the ability to compare themselves to other countries on different factors concerning logistics. Experts rate countries on six components, so that the overall score can be calculated by taking the average of the component scores. No previous studies have examined the relative importance of the components of the LPI or other factors for logistics performance. In the LPI, all components are considered to be equally important, with the overall score being the average of the scores of the individual components. However, since the different factors all contribute to logistics performance in their own way, this does not appear to be the correct approach. In this study, we used the original components and a multi-criteria decision analysis (MCDA) method called the Best Worst Method (BWM) to assign weights to the six components of the LPI. A questionnaire was answered by 107 respondents from all six continents. The results show a relatively high difference in components weights: infrastructure (0.24) comes up as most important, followed by logistics services (0.22), timeliness (0.16), customs (0.16), international shipments (0.13) and tracking and tracing (0.10). The resulting scores provide countries with insights on how to improve their logistical situation in the most efficient way.

The weights have been applied to the ranking of the 2016 LPI report. The resulting new ranking has a very high correlation with the old ranking. The correlation could be caused by the LPI methodology and the questionnaire. This should be tested by further research. Due to this high correlation, the weights matter little for the w-LPI score as compared to the LPI score. Nevertheless, interesting findings could already be obtained concerning (1) the ranking of individual countries, where changes of up to 7 places up (Iran) or down (Mozambique) are no exception; (2) changes in the policy prioritization for individual countries, as shown by different examples and (3) the combined effect of the above two at system level, indicating that infrastructure development has to be prioritized more strongly.

This study identified a number of areas for further research, including research into logistics performance measuring and the LPI methodology. More research is needed into the implications of the weights identified in this study. These weights prove to be significantly different for each other and have implications for what determines logistical performance. However, the weights still have to be transformed into actual policy measures to improve logistics performance. To that end, further research is needed into different projects that affect the scores and the weights to determine which projects are the most efficient to invest in as a country.

One of the limitations of the study is that the sample of respondents had only limited representation from the so-called Development Group 3, or lowest income countries. Although developing countries and the middle income countries are well presented (e.g. Africa, Asia and South-America combined had 45% of the respondents), due to a very low availability and a low response rate of experts from the lowest income group, we had to combine these with those of Development Group 2 (together forming around 40% of the sample). A further refinement of preferences of countries with a GNI < $12,476 would be necessary, to allow a representation of the lowest income countries. Only then one could establish whether their valuation of performance indicators deviates from the preferences established in this study.

It is also advised to further examine and change the LPI methodology, to test whether a list can be obtained with less strongly correlated indicators. We suggest to start at the base of respondents to try out possible improvements. Also, some factors that may be important to logistics performance have not yet been included in the LPI, although they are present in the literature. The transportation and shipping sector has a significant effect on carbon emissions worldwide. Maritime transport was responsible for 2.5% of worldwide greenhouse gas emissions in 2014, and expectations are that these emissions will have increased between 50% and 250% by 2050 (International Maritime Organization, 2014). Environment is a key issue on many political agendas and many proposals have been made to reduce emissions worldwide. Therefore, it is likely that environmental factors will play a role in measuring logistics performance. There is empirical support in literature on the relationship between the performance of a company and its environmental practices (Goldsby and Stank, 2000; Rao and Holt, 2005) and, more recently also at the level of individual countries (Mariano et al., 2017). In addition to the environment, innovation is also a factor in logistics. Innovations have led to significant changes in the shipping industry, for example the introduction of containers, and the application of Radio Frequency Identification (RFID) (Grawe, 2009). Grawe (2009) also discusses various studies on innovation in businesses and supply chains that all show that innovation is essential

to gaining a competitive advantage. Chapman et al. (2003) examined the drivers for innovations in the logistics sector and discussed the effects of these innovations on the competitiveness of companies. They conclude that investments in knowledge and ICT can improve efficiency, decision-making and supply chain management, which implies that they can improve logistics performance. However, it can be argued that innovation is not a factor in itself, but that it only affects the scores on other factors. To examine this relationship, further research is recommended.

Appendix A. Results of significance test for differences between equal weights and identified weights

95% Confidence Interval of the Difference						
	t	df	Sig. (2-tailed)	Mean Diff.	Lower	Upper
wC	−0.712	106	0.478	−0.007	−0.027	0.013
wI	4.860	106	0	0.069	0.041	0.097
wS	4.211	106	0	0.050	0.027	0.074
wT	−0.777	106	0.439	−0.007	−0.023	0.010
wTT	−7.664	106	0	−0.064	−0.081	−0.048
wIS	−4.646	106	0	−0.041	−0.059	−0.024

Appendix B. w-LPI ranking

Criteria[a]		C	I		IS		S		TT		T
Weights		0.159	0.2354		0.126		0.217		0.102		0.1601
Rank	Country	score	score	score	score	score	score	LPI score	w-LPI score	LPI rank	w-LPI rank	Rank difference
1	Germany	4.12	4.44	3.86	4.28	4.27	4.45	4.230	4.265	1	1	0
2	Sweden	3.92	4.27	4.00	4.25	4.38	4.45	4.205	4.215	3	2	1
3	Netherlands	4.12	4.29	3.94	4.22	4.17	4.41	4.188	4.211	4	3	1
4	Luxembourg	3.90	4.24	4.24	4.01	4.12	4.80	4.219	4.211	2	4	−2
5	Singapore	4.18	4.20	3.96	4.09	4.05	4.40	4.144	4.160	5	5	0
6	Austria	3.79	4.08	3.85	4.18	4.36	4.37	4.098	4.102	7	6	1
7	Belgium	3.83	4.05	4.05	4.07	4.22	4.43	4.109	4.098	6	7	−1
8	UK	3.98	4.21	3.77	4.05	4.13	4.33	4.070	4.093	8	8	0
9	Hong Kong	3.94	4.10	4.05	4.00	4.03	4.29	4.069	4.070	9	9	0
10	United States	3.75	4.15	3.65	4.01	4.20	4.25	3.992	4.016	10	10	0
11	Switzerland	3.88	4.19	3.69	3.95	4.04	4.24	3.987	4.016	11	11	0
12	Japan	3.85	4.10	3.69	3.99	4.03	4.21	3.970	3.994	12	12	0
13	Canada	3.95	4.14	3.56	3.90	4.10	4.01	3.931	3.960	14	13	1
14	UAE	3.84	4.07	3.89	3.82	3.91	4.13	3.942	3.950	13	14	−1
15	Finland	4.01	4.01	3.51	3.88	4.04	4.14	3.921	3.942	15	15	0
16	France	3.71	4.01	3.64	3.82	4.02	4.25	3.901	3.913	16	16	0
17	Denmark	3.82	3.75	3.66	4.01	3.74	3.92	3.816	3.832	17	17	0
18	Australia	3.54	3.82	3.63	3.87	3.87	4.04	3.793	3.804	19	18	1
19	Ireland	3.47	3.77	3.83	3.79	3.98	3.94	3.795	3.782	18	19	−1
20	South Africa	3.60	3.78	3.62	3.75	3.92	4.02	3.775	3.775	20	20	0
21	Italy	3.45	3.79	3.65	3.77	3.86	4.03	3.755	3.760	21	21	0
22	Norway	3.57	3.95	3.62	3.70	3.82	3.77	3.732	3.753	22	22	0
23	Spain	3.48	3.72	3.63	3.73	3.82	4.00	3.727	3.727	23	23	0
24	Korea. Rep.	3.45	3.79	3.58	3.69	3.78	4.03	3.717	3.726	24	24	0
25	Taiwan. China	3.23	3.57	3.57	3.95	3.59	4.25	3.698	3.710	25	25	0
26	China	3.32	3.75	3.70	3.62	3.68	3.90	3.661	3.664	27	26	1
27	Israel	3.50	3.49	3.38	3.60	3.72	4.27	3.660	3.651	28	27	1
28	Czech Republic	3.58	3.36	3.65	3.65	3.84	3.94	3.674	3.637	26	28	−2
29	Lithuania	3.42	3.57	3.49	3.49	3.68	4.14	3.632	3.622	29	29	0
30	Qatar	3.55	3.57	3.58	3.54	3.50	3.83	3.599	3.598	30	30	0
31	Hungary	3.02	3.48	3.44	3.35	3.40	3.88	3.429	3.430	31	31	0
32	Turkey	3.18	3.49	3.41	3.31	3.39	3.75	3.424	3.425	34	32	2
33	Malaysia	3.17	3.45	3.48	3.34	3.46	3.65	3.426	3.419	32	33	−1
34	New Zealand	3.18	3.55	2.77	3.22	3.58	4.12	3.388	3.415	37	34	3
35	India	3.17	3.34	3.36	3.39	3.52	3.74	3.420	3.408	35	35	0
36	Poland	3.27	3.17	3.44	3.39	3.46	3.80	3.426	3.397	33	36	−3
37	Portugal	3.37	3.09	3.24	3.15	3.65	3.95	3.409	3.362	36	37	−1

38	Estonia	3.41	3.18	3.07	3.18	3.25	4.08	3.363	3.353	38	38	0
39	Panama	3.13	3.28	3.65	3.18	2.95	3.74	3.338	3.324	40	39	1
40	Slovak Republic	3.28	3.24	3.41	3.12	3.12	3.81	3.337	3.321	41	40	1
41	Kenya	3.17	3.21	3.24	3.24	3.42	3.70	3.331	3.315	42	41	1
42	Latvia	3.11	3.24	3.28	3.29	3.42	3.62	3.327	3.314	43	42	1
43	Iceland	3.13	3.02	3.32	3.26	3.42	3.88	3.346	3.307	39	43	−4
44	Bahrain	3.14	3.10	3.33	3.38	3.32	3.58	3.314	3.296	44	44	0
45	Oman	2.76	3.44	3.35	3.26	3.09	3.50	3.234	3.255	48	45	3
46	Thailand	3.11	3.12	3.37	3.14	3.20	3.56	3.255	3.232	45	44	1
47	Greece	2.85	3.32	2.97	2.91	3.59	3.85	3.240	3.225	47	47	0
48	Slovenia	2.88	3.19	3.10	3.20	3.27	3.47	3.185	3.186	50	48	2
49	Chile	3.19	2.77	3.30	2.97	3.50	3.71	3.248	3.173	46	49	−3
50	Egypt	2.75	3.07	3.27	3.20	3.15	3.63	3.185	3.172	49	50	−1
51	Croatia	3.07	2.99	3.12	3.21	3.16	3.39	3.161	3.150	51	51	0
52	Saudi Arabia	2.69	3.24	3.23	3.00	3.25	3.53	3.156	3.146	52	52	0
53	Brazil	2.76	3.11	2.90	3.12	3.28	3.39	3.088	3.093	55	53	2
54	Mexico	2.88	2.89	3.00	3.14	3.40	3.38	3.114	3.087	54	54	0
55	Kuwait	2.83	2.92	3.62	2.79	3.16	3.51	3.152	3.084	53	55	−2
56	Malta	2.78	2.94	3.09	2.85	3.12	3.61	3.069	3.041	56	56	0
57	Botswana	3.05	2.96	2.91	2.74	2.89	3.72	3.045	3.032	57	57	0
58	Uganda	2.97	2.74	2.88	2.93	3.01	3.70	3.043	3.017	58	58	0
59	Cyprus	3.11	3.00	2.80	2.72	2.54	3.79	2.999	3.012	59	59	0
60	Romania	3.00	2.88	3.06	2.82	2.95	3.22	2.993	2.971	60	60	0
61	Tanzania	2.78	2.81	2.98	2.92	2.98	3.44	2.990	2.969	61	61	0
62	Uruguay	2.78	2.79	2.91	3.01	2.84	3.47	2.975	2.968	65	62	3
63	Indonesia	2.69	2.65	2.90	3.00	3.19	3.46	2.985	2.948	63	63	0
64	Vietnam	2.75	2.70	3.12	2.88	2.84	3.50	2.977	2.942	64	64	0
65	Argentina	2.63	2.86	2.76	2.83	3.26	3.47	2.963	2.941	66	65	1
66	Rwanda	2.93	2.62	3.05	2.87	3.04	3.35	2.986	2.939	62	66	−4
67	Jordan	2.55	2.77	3.17	2.89	2.96	3.34	2.957	2.924	67	67	0
68	Pakistan	2.66	2.70	2.93	2.82	2.91	3.48	2.923	2.895	68	68	0
69	Peru	2.76	2.62	2.91	2.87	2.94	3.23	2.893	2.863	69	69	0
70	Brunei	2.78	2.75	3.00	2.57	2.91	3.19	2.870	2.833	70	70	0
71	Philippines	2.61	2.55	3.01	2.70	2.86	3.35	2.856	2.810	71	71	0
72	Bulgaria	2.40	2.35	2.93	3.06	2.72	3.31	2.808	2.776	72	72	0
73	Algeria	2.37	2.58	2.80	2.91	2.86	3.08	2.770	2.754	75	73	2
74	Namibia	2.65	2.76	2.69	2.63	2.52	3.19	2.745	2.751	79	74	5
75	Bahamas. The	2.65	2.72	2.80	2.74	2.64	2.93	2.750	2.749	78	75	3
76	Ecuador	2.64	2.47	2.95	2.66	2.65	3.23	2.779	2.739	74	76	−2
77	Burkina Faso	2.55	2.67	2.73	2.78	2.49	3.13	2.731	2.738	81	77	4
78	Serbia	2.50	2.49	2.63	2.79	2.92	3.23	2.763	2.738	76	78	−2
79	Kazakhstan	2.52	2.76	2.75	2.57	2.86	3.06	2.752	2.737	77	79	−2
80	Cambodia	2.62	2.36	3.11	2.60	2.70	3.30	2.801	2.736	73	80	−7
81	Ukraine	2.30	2.49	2.59	2.55	2.96	3.51	2.737	2.699	80	81	−1
82	Lebanon	2.73	2.64	2.84	2.45	2.75	2.86	2.717	2.687	82	82	0
83	El Salvador	2.37	2.25	2.82	2.66	2.78	3.29	2.706	2.650	83	83	0
84	Bangladesh	2.57	2.48	2.73	2.67	2.59	2.90	2.664	2.646	87	84	3
85	Ghana	2.46	2.48	2.71	2.54	2.52	3.21	2.661	2.640	88	85	3
86	Morocco	2.22	2.46	3.09	2.59	2.34	3.20	2.666	2.634	86	86	0
87	Nigeria	2.46	2.40	2.43	2.74	2.70	3.04	2.628	2.619	90	87	3
88	Guyana	2.40	2.24	2.66	2.66	2.90	3.12	2.667	2.616	85	88	−3
89	Iran	2.33	2.67	2.67	2.67	2.44	2.81	2.601	2.614	96	89	7
90	Bosnia and Herzegovina	2.69	2.61	2.28	2.52	2.56	2.94	2.596	2.610	97	90	7
91	Mozambique	2.49	2.24	3.06	2.44	2.75	3.04	2.684	2.606	84	91	−7
92	Colombia	2.21	2.43	2.55	2.67	2.55	3.23	2.612	2.603	94	92	2
93	Dominican Republic	2.39	2.29	2.67	2.68	2.63	3.06	2.627	2.596	91	93	−2
94	Costa Rica	2.33	2.32	2.89	2.55	2.77	2.98	2.649	2.594	89	94	−5
95	Côte d'Ivoire	2.67	2.46	2.54	2.62	2.62	2.71	2.603	2.593	95	95	0
96	Moldova	2.39	2.35	2.60	2.48	2.67	3.16	2.614	2.579	93	96	−3
97	Togo	2.49	2.24	2.62	2.46	2.60	3.24	2.618	2.572	92	97	−5
98	Russia	2.01	2.43	2.45	2.76	2.62	3.15	2.571	2.572	99	98	1
99	Paraguay	2.38	2.45	2.58	2.69	2.30	2.93	2.561	2.568	101	99	2
100	Comoros	2.63	2.36	2.58	2.60	2.44	2.82	2.579	2.566	98	100	−2
101	Nicaragua	2.48	2.50	2.50	2.55	2.47	2.68	2.531	2.533	102	101	1
102	Niger	2.59	2.22	2.63	2.50	2.35	3.02	2.562	2.531	100	102	−2
103	Maldives	2.39	2.57	2.34	2.44	2.49	2.88	2.513	2.523	104	103	1

104	Macedonia. FYR	2.21	2.58	2.45	2.36	2.32	3.13	2.510	2.518	106	104	2
105	Tunisia	1.96	2.44	2.33	2.59	2.67	3.00	2.497	2.497	110	105	5
106	Sudan	2.23	2.20	2.57	2.36	2.49	3.28	2.530	2.488	103	106	−3
107	Mali	2.45	2.30	2.48	2.46	2.36	2.93	2.503	2.488	109	107	2
108	Papua New Guinea	2.55	2.32	2.46	2.35	2.58	2.78	2.511	2.483	105	108	−3
109	Mongolia	2.39	2.05	2.37	2.31	2.47	3.40	2.506	2.459	108	109	−1
110	Burundi	2.02	1.98	2.42	2.46	2.68	3.45	2.510	2.453	107	110	−3
111	Myanmar	2.43	2.33	2.23	2.36	2.57	2.85	2.459	2.447	113	111	2
112	Guatemala	2.47	2.20	2.41	2.30	2.46	2.98	2.476	2.443	111	112	−1
113	Benin	2.20	2.39	2.55	2.47	2.23	2.69	2.428	2.429	115	113	2
114	Uzbekistan	2.32	2.45	2.36	2.39	2.05	2.83	2.405	2.424	118	114	4
115	Solomon Islands	2.60	2.21	2.28	2.43	2.18	2.76	2.417	2.415	116	115	1
116	Honduras	2.21	2.04	2.58	2.44	2.53	2.91	2.463	2.412	112	116	−4
117	Zambia	2.25	2.26	2.51	2.42	2.36	2.74	2.430	2.411	114	117	−3
118	Trinidad and Tobago	2.38	2.34	2.31	2.28	2.28	2.79	2.398	2.395	121	118	3
119	Congo. Rep.	2.00	2.60	2.37	2.26	2.48	2.57	2.377	2.386	125	119	6
120	Albania	2.23	1.98	2.48	2.48	2.15	3.05	2.412	2.383	117	120	−3
121	Jamaica	2.37	2.23	2.44	2.31	2.38	2.64	2.400	2.378	119	121	−2
122	Venezuela. RB	1.99	2.35	2.47	2.34	2.48	2.71	2.391	2.375	122	122	0
123	Belarus	2.06	2.10	2.62	2.32	2.16	3.04	2.399	2.364	120	123	−3
124	Ethiopia	2.60	2.12	2.56	2.37	2.18	2.37	2.377	2.351	126	124	2
125	Nepal	1.93	2.27	2.50	2.13	2.47	2.93	2.377	2.341	124	125	−1
126	Cuba	2.38	2.31	2.31	2.25	2.31	2.51	2.346	2.341	131	126	5
127	Congo. Dem. Rep.	2.22	2.01	2.33	2.33	2.37	2.94	2.376	2.341	127	127	0
128	Montenegro	2.22	2.07	2.56	2.31	2.37	2.69	2.380	2.337	123	128	−5
129	Senegal	2.31	2.23	2.25	2.39	2.15	2.61	2.328	2.334	132	129	3
130	Guinea	2.28	2.01	2.38	2.54	2.54	2.38	2.359	2.328	129	130	−1
131	São Tomé and Principe	2.24	2.12	2.26	2.42	2.14	2.75	2.326	2.322	133	131	2
132	Georgia	2.26	2.17	2.35	2.08	2.44	2.80	2.353	2.315	130	132	−2
133	Fiji	2.33	2.25	2.21	2.25	2.25	2.60	2.316	2.314	136	133	3
134	Djibouti	2.37	2.30	2.48	1.96	2.09	2.69	2.323	2.301	134	134	0
135	Guinea-Bissau	2.44	1.91	2.57	2.07	2.41	2.74	2.371	2.298	128	135	−7
136	Bhutan	2.21	1.96	2.50	2.30	2.20	2.70	2.321	2.281	135	136	−1
137	Libya	1.88	2.04	2.40	2.50	1.85	2.83	2.264	2.267	137	137	0
138	Angola	1.80	2.13	2.37	2.31	2.21	2.59	2.241	2.229	139	138	1
139	Turkmenistan	2.00	2.34	2.37	2.09	1.84	2.59	2.211	2.223	140	139	1
140	Armenia	1.95	2.22	2.22	2.21	2.02	2.60	2.206	2.213	141	140	1
141	Bolivia	1.97	2.11	2.40	1.90	2.31	2.79	2.251	2.207	138	141	−3
142	Liberia	2.07	2.01	2.22	2.07	2.07	2.73	2.204	2.182	142	142	0
143	Cameroon	2.09	2.21	1.98	2.32	2.04	2.29	2.151	2.179	148	143	5
144	Gabon	2.07	2.05	2.28	2.12	2.07	2.52	2.192	2.174	143	144	−1
145	Eritrea	2.01	2.06	2.16	2.25	2.03	2.50	2.172	2.172	144	145	−1
146	Madagascar	2.33	2.12	2.17	1.93	2.01	2.35	2.155	2.143	147	146	1
147	Chad	2.08	2.07	2.41	2.06	2.07	2.25	2.164	2.142	145	147	−2
148	Kyrgyz Republic	1.80	1.96	2.10	1.96	2.39	2.72	2.156	2.118	146	148	−2
149	Afghanistan	2.01	1.84	2.38	2.15	1.77	2.61	2.141	2.116	150	149	1
150	Iraq	2.01	1.87	2.33	1.97	1.98	2.66	2.150	2.110	149	150	−1
151	Zimbabwe	2.00	2.21	2.08	2.13	1.95	2.13	2.082	2.103	151	151	0
152	Tajikistan	1.93	2.13	2.12	2.12	2.04	2.04	2.063	2.071	153	152	1
153	Lao PDR	1.85	1.76	2.18	2.10	1.76	2.68	2.067	2.047	152	153	−1
154	Lesotho	1.91	1.96	1.84	2.16	1.92	2.35	2.026	2.041	154	154	0
155	Sierra Leone	1.91	2.07	2.31	1.85	1.74	2.23	2.025	2.017	155	155	0
156	Mauritania	2.14	1.54	2.00	1.74	1.54	2.14	1.866	1.835	157	156	1
157	Equatorial Guinea	1.88	1.50	1.89	1.75	1.89	2.32	1.879	1.834	156	157	−1
158	Somalia	1.29	1.57	1.86	1.85	1.51	2.35	1.747	1.740	158	158	0
159	Haiti	1.70	1.47	1.81	1.68	1.56	2.02	1.716	1.693	159	159	0
160	Syrian Arab Republic	1.11	1.24	1.36	1.39	2.10	2.40	1.598	1.541	160	160	0

[a] C = Customs; I = Infrastructure; IS = International Shipments; S = Services; TT = tracking and tracing; T = Timelines.

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