Improving international logistics performance measurement

A study to improve logistics performance measuring by assigning weights to the core components of the Logistics Performance Index (LPI).

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Abstract: Globalization has led to an increased need for international transportation of goods and therefore international logistics. To measure the performance of countries regarding logistics the Logistics Performance Index (LPI) was created in 2007. The LPI uses scores on six core components to determine overall logistics performance, and ranks countries accordingly. However, these components are all regarded equally important when the overall score is calculated, which seems highly unlikely in the complex system of logistics. This research assigned weights to the six components using the Best-Worst Method, a relatively new multi criterion decision making method. A questionnaire answered by 107 respondents found significantly different weights. Infrastructure is considered the most important factor in logistics performance with a weight of 0.24 and tracking and tracing the least important with 0,10. The weights are significantly different from the averages used for the LPI. This research contributes to science and society, since it is the first time weights have been assigned in logistics performance measuring and countries can use these weights to improve logistics more efficiently.

Keywords: LPI, Weight assignment, Best-Worst Method, Logistics performance, weighted-LPI.

1. Introduction

Trade between countries has developed over the past decades. Before the globalization countries were mostly competing with other countries in the region, whereas the globalization trend has increased the amount of competitors to almost all countries in the world. These developments have increased the importance of logistics in international trade and made it one of the key elements in the development of a country (Marti, Puertas & Garcia, 2014; Razzaque, 1997). The importance of logistics to economies has led to the need for a measuring system of logistics performance. Many different scales of logistics performance measuring are possible. On a micro level the performance of a single company or even a department of a company can be analysed. At a macro level the logistics performance of a country or an entire continent can be measured. Several methods of measuring the performance of a company have been proposed over time, varying from using hard metrics such as trade flows and productivity as well as soft metrics, such as customer satisfaction (Chow, Heaver & Henriksson, 1994). The importance of logistics for the economy of a country also led to the need for measurement on a larger scale. To address this need the Logistics Performance Index (LPI) was created in 2007 by researchers commissioned by 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 on trade logistics (Arvis et al, 2016). Since the first report in 2007, new versions have been published in 2010, 2012, 2014, and the most recent version in 2016. All of these versions featured a ranking of all the countries on which information was available, with 160 countries in the most recent ranking. To determine the scores of each country, experts from over the world are asked to score countries on six components. The average of the scores on these components is the overall LPI score. This score is then used to determine the ranking. Each of the expert is asked to score 8 different countries with a score between 1 (poor performance) and 5 (excellent

performance) on each of the components. Table 1 presents the six components with an explanation as provided to the experts in the questionnaire used to create the LPI report.

Table 1: Core components

Component	**World Bank explanation**
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 & Tracing	The ability to track and trace consignments.
International shipments	The ease of arranging competitively priced shipments.

Since the LPI is constructed by taking the average of the scores on the six components, it is assumed that all the components are of equal importance for logistics performance. No research has been done into the importance of each of the components for logistics performance. This is one of the shortcomings of the LPI, since it is unlikely that in reality all of the components are equally important for logistics performance. Literature on logistics performance does not provide enough information on the importance of each of the components, and other factors, for 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 in understanding where to focus projects and how to improve their performance in the most efficient way. One way to address this relative importance is to assign weights to the components of the LPI.

This study aims to assign weights to the six core components of the LPI, using the Best-Worst method. This method is selected out of multiple other Multi Criterion Decision Making methods based on its use for this specific topic. This can improve logistics performance measurement and help countries get an insight in how to focus their efforts concerning logistics. The LPI is chosen as the subject of this research based on the fact that it is the only available tool for worldwide logistics performance measuring and is respected worldwide. The research will answer the following main research question: *"How can the Logistics Performance Index (LPI) be improved by assigning weights to its six core components?*. When this question is answered an advice is produced based on the weights. This is the first time weights are assigned to the components of the LPI or to any factor in logistics performance. This research will have implications for society and science. Countries will be provided with an insight in where to focus logistics projects and the method and weights can be used for further research.

The remainder of this paper consists of 4 chapters. Chapter 2 will provide a more in-depth analysis of the LPI methodology as well as a literature overview on the components of the LPI. Also, it will identify other researches in which the LPI is used. Chapter 3 will present the methodology used in this research and provide more information on the Best-Worst method used to identify the weights. Chapter 4 will present the results and analysis. Finally, chapter 5 will conclude the research and include the advice and recommendations for further research derived from this study.

2. Current state of literature

To further investigate the LPI, its components and its uses, a review of existing literature is executed. Firstly, the LPI methodology will be analysed further. Then, the current components of the LPI and their

importance for logistics performance are reviewed and other possible components currently not included in the LPI are identified. Finally, the use of the LPI in other researches is presented to confirm its worldwide use.

LPI methodology

The LPI is constructed based on an 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 between 1 and 5 on the six different components: Customs, infrastructure, quality of services, timeliness, tracking and tracing, and ease of arranging shipments. The reason experts are used to determine the logistical performance of a country is that other statistical cannot be assessed using only available hard data such as cost and time information (Arvis et al., 2016). Each of the survey respondents is asked to rate 8 overseas countries on the six components, these 8 overseas markets are randomly assigned based on the most important import and export markets in the country the respondent is located in. For landlocked countries (countries completely surrounded by other countries and not by the sea) the characteristics of the country determine which countries are rated by the respondent from the landlocked country. The average scores on the different components is the overall LPI score used to produce the ranking. In the most recent ranking Germany is the top performer with a score of 4.23. The worst performer is the republic of Syria, with a score of 1.60.

The authors of the 2016 LPI report mention two limitations of the methods used for the construction of the LPI. The first limitation is that for the poorer countries, large international freight forwarders might not represent the broader logistics environment. This is caused by the fact that these poorer countries mostly rely on more traditional smaller operators. What this means is that the opinions of the expert on the poorer countries could be different than the real situation. The smaller operators are mostly not included in the respondents. 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, such as custom officers, than regional smaller operators. The opinion of the respondent on the quality of services will be based on his experience with the service providers in that country, which especially in the poorer countries differ per provider. The second limitation concerns the landlocked countries and small island states. Landlocked countries are completely surrounded by land or closed seas and therefore have no direct access to the sea and no ports. For the landlocked countries and small island the LPI might reflect access problems that are outside of the countries concerned. Therefore it is possible that a low rating for a landlocked country is not the correct reflection of the country's trade facilitation, since these countries are unable to take measures to correct the deficiencies in the countries surrounding them.

Core components

Many literature is available on different factors that are important for logistics. This paragraph will focus on literature found on the importance of each of the components for logistics performance or economic gains associated with logistics performance. The ***Customs*** component of the LPI determines the effectivity and efficiency of custom procedures in terms of speed, simplicity, and predictability (ITF, 2015). Many studies define customs as an important factor in logistics efficiency and transport efficiency and especially in relatively low developed countries small measures in customs can increase the efficiency of the total logistics system (Heaver, 1992; Devlin & Yee, 2005). ***Infrastructure*** is an essential factor in trade and many studies link the state of transport infrastructure to economic growth and a growth in trade volumes. (Gillen & Waters II, 1996; Vickerman, Spiekermann & Wegener, 1999). These effects have been described for both developing and developed countries. Chapman, Soosay and Kandampally (2003) studied the effects of innovations in logistics ***services*** and concluded that they have significant advantages for supply chains, such as higher efficiency and customer satisfaction. Daugherty,

Stank, and Ellinger (1998) found that high levels of logistics services have an indirect positive effect on economic indicators. ***Timeliness*** refers to whether shipments arrive at the right place at the right time. Hummels (2001) concluded that a 1% decrease 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. Korinek and Sourdin (2011) mention that it is likely that ***tracking and tracing*** will be a major area for investments in the close future since all the parties in the supply chain can benefit from improved ability to locate their products. The importance of tracking & tracing is confirmed by Shamsuzzhoa and Helo (2001). For the last component, ***international shipments***, Hausman, Lee, and Subramanian (2013) calculated the effect that 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. All these researches together make it likely that all the components of the LPI are indeed factors in logistics performance and should be included in the LPI.

Other factors

Some factors that are important for logistics performance have not been included in the LPI but are present in literature. The transportation and shipping sector has a significant effect on emissions worldwide. Maritime transport is responsible for 2.5% of the worldwide greenhouse gas emissions in 2014. The expectation is that these emissions will have increased with between 50% and 250% in 2050 (International Maritime Organization, 2014). Environment is a key point on many political agendas and many propositions have been made to decrease emissions worldwide. Therefore, it is likely that a part of logistics performance is the environmental friendliness of a country concerning logistics. Empirical support can be found in literature on the relation between the performance of a company and how responsibly their environmental practices (Goldsby & Stank, 2000; Rao & Holt, 2005). Besides environment, innovation is also a factor is logistics. Innovations have led to significant changes in the shipping industry, examples are the introduction of containers is 1958 and the application of Radio Frequency Identification (RFID) (Grawe, 2009). Grawe (2009) also presents different studies on innovation in businesses and supply chains which all show that innovation is essential to gain a competitive advantage. Chapman, Soosay, and Kandampally (2003) researched the drivers for innovations in the logistics sector and concluded the effects of these innovations on the competitiveness of companies. They conclude that investments in knowledge and ICT can lead to a higher efficiency, better decision making, and better supply chain management. This implies that these innovations can lead to a better logistics performance. However, it can be argued that innovation is not a factor on itself but only influences the scores on other factors. To investigate this relation further research is advised.

LPI in literature

The LPI is mentioned in many researches to provide insights in the logistical situations of countries, such as Malaysia (Jumadi & Zailani, 2010), Finland (Solakivi et al., 2014), and Turkey (ITF, 2015). These researches show the acceptance of the LPI as a measure of addressing the logistics performance of a country. Many other studies used either the LPI score or the score on different components for other research purposes. Hoekman & Nicita (2011) review different indices of the world bank that concern trade restrictiveness and trade 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. They found out that to increase trade, it is the more beneficial to implement policy measures that affect the LPI scores, than other measures such as tariff barriers and known non-tariff measures. Çemberci, Civelek, and Cambolat (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 & 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, that

presented a completely different ranking than either the LPI or the EPI. Marti, Puertas, and Garcia (2014) present a study on the importance of each of the components of the LPI for trade in emerging economies, using a gravity model. They conclude that all the components scores have a positive relation with the amount of international trade, meaning that they all are factors that facilitate trade. Erkan (2014) researched 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 is made with data of 113 countries to determine if there is a significant relation between the overall LPI score and each of the indicators. The conclusion is that only two of the six indicators have a significant relationship with the overall LPI score. These indicators are quality of port infrastructure and quality of quality of road infrastructure. Civelek, Uca, and Çemberci (2015) used hierarchical regression analysis but to the mediator effect of the logistics performance index on the relation between global competitiveness index and gross domestic product. First, the relation between the LPI and the GCI, between the LPI and GDP, and between the GCI and GDP were calculated. All these relations were found statistically significant. The last hypothesis tests if there is a significant relation between the LPI and the relation between the GCI and the GDP of a country. This last hypothesis was also found significant meaning that the logistics ability of a country dominated the relation between competitiveness and prosperity. Another study using hierarchical regression analysis was performed by Uca, Ince, and Sumen (2016). This study in almost the same as the previous one mentioned but this study is about the mediator effect of the LPI on the relation between the Corruption Perception Index (CPI) and Foreign Trade Volume (FTV). The research was performed in the same way as the one by Civelek et al (2015) and concluded that the logistics ability of a country triggers the relation between corruption and foreign trade volume. It is possible that all the mentioned researches would have presented different results if the weights of the components would have been different from the assumed averages in the LPI.

From the literature review several conclusions can be drawn. The six components of the LPI are all factors in logistics performance based on literature found on the individual components. However, no literature is available on how important they are compared to each other. This underlines the need for weight assignment. To address logistics performance, it is important that all factors are taken into consideration. Besides the six components, two other factors have been identified from literature as important factors in logistics performance, innovation and environment. Especially environment is becoming an important factor due to climate change and the regulation and guidelines concerning environment in the shipping and transport industry. The LPI and its factors have been used in many researches since its introduction, which could have different results if weights would have been assigned to the factors.

3. Methodology

This chapter will elaborate on the methods used in this research, starting with the selection of the weight assignment method and a description of how this method is applied and how the required respondents were approached. Also, statistics on the actual respondents will be presented.

The problem faced in this research is an example of a Multi Criteria Decision Making (MCDM) problem. The problem can be represented by the matrix in equation 2 (Rezaei, 2015; Triantaphyllou (2000):

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

In this matrix the top row ($C_1, C_2, \ldots, C_n$) represents a set of decision-making criteria used to determine which alternative is best. ($A_1, A_2, \ldots, A_m$) Are the alternatives that will be scored on the criteria. ($p_{11}, \ldots, p_{mn}$) represent the scores of the different alternatives on the Criteria. The goal is to select the best alternative based on the provided criteria. A common way to determine what the best alternative is, is to assign weights w_j ($w_j \geq 0,\ \Sigma w_j = 1$) to the different criteria and calculate the value of the alternative (V_i) using the weight additive function shown in equation 2 (Rezaei, 2015).

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

Many different MCDM techniques have been proposed over time to assign the weights to the different criteria. Some of the most used methods include (Triantaphyllou, 2000): the weighted sum model (WSM) (Fishburn, 1967), the Analytic Hierarchy Process (AHP) (Saaty, 1980), the revised AHP (Belton & Gear, 1983), the Weighed Product Model (WPM) (Miller & Star, 1969), the ELECTRE method (Benayoun, Roy & Sussman, 1966), the PROMETHEE method (Brans, 1982), and the TOPSIS method (Hwang & Yoon, 1981). Rezaei (2015) mentiones some newer methods, SIR (Yu, 2001), SWARA (Kersuliene & Turskis, 2000), and IMP (Jessop, 2014). The method chosen for this research is the Best-Worst Method (BWM), as introduced by Rezaei (2015). There are several reasons the BWM is chosen to assign the weights for this research. Pairwise comparison methods face mainly two problems. The first problem is that due to the all the comparisons that have to be made for a full pairwise comparison matrix, the process is lengthy (Sadegi, Rasouli & Jandaghi, 2016). The second problem is the inconsistency between the comparisons, which can be caused by several reasons, such as lack of concentration or lack of information (Forman & Selly, 2001). By using only two vectors instead of a complete pairwise comparison matrix, the BWM requires less comparisons than other pairwise comparison methods. Less comparison lead to a less lengthy project and higher consistency between the comparisons. Therefore, the problems of pairwise comparison are reduced by using the BWM. Another advantage of the BWM is that it uses a very structured and understandable way of gathering the data needed for the pairwise comparisons, which results in highly reliable results that are easy to understand by the evaluator and can be revised easily to increase consistency. The method was introduced in 2015 and is therefore relatively new but has been applied in several researches. Rezaei, Wang, and Tavasszy (2015) used the BWM to link supplier development to supplier segmentation. Rezaei, Nispeling, Sarkis, and Tavasszy (2016) used BWM to find the most suitable supplier from a pre-selected base of suppliers. The next paragraph will describe the BWM.

Best Worst Method (BWM)

The proposed method requires five steps to be carried out to determine the weights. Step 3 and 4 will be carried out using an expert questionnaire. The contents of this questionnaire and the respondent will be described after the description of the five steps.

***Step 1**: Determine a set of decision criteria*

In the first step a set of criteria {$C_1, C_2, \ldots, Cn$} is considered that should be used by the decision maker to come to a decision on the best alternative.

Step 2: *Determine the best (most important) and worst (Least important) criteria.*
In this step the decision maker has to identify the best criterion and the worst criterion in general. A comparison between the criteria is not yet made at this stage.

Step 3: *Determine the preference of the best criterion over the other criteria.*
The decision maker has to state the preference of the criterion he/she selected as most important over the other criteria using a number between 1 and 9. Selecting a 1 indicates equal importance and selecting a 9 indicates that the criterion is extremely less important than the most important criterion. This will lead to a Best-to-other vector A_B:

$$A_B = (a_{B1}, a_{B2}, \dots, a_{Bn})$$

In this vector $A_{BB} = 1$, since this indicates the preference of the best criterion over itself.

Step 4: *Determine the preference of the criteria over the worst criterion.*
The decision maker has to state the preference of all the criteria over the criterion he/she selected as least important using a number between 1 and 9. Selecting a 1 indicates equal importance and selecting a 9 indicates that the criterion is extremely more important than the least important criterion. This will lead to a Worst-to-other vector A_W:

$$A_W = (a_{1W}, a_{2W}, \dots, a_{nW})$$

In this vector $A_{WW} = 1$, since this indicates the preference of the worst criterion over itself

Step 5: *Find the optimal weights.*
In this step the optimal weights ($w^*_1, w^*_2, \dots, w^*_n$) are identified. As mentioned earlier two different models have been proposed for BWM, the first one could lead to multiple optimal solution, and the second one aims at finding unique weights. This linear model will be used for this research to come to 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 equal to 1 and none of the weights can be negative, leading to equation 3 to find the optimal solution.

$$\min \max_j \{|w_B - a_{Bj}w_j|, |w_j - a_{jw}w_w|\}$$

s.t

$$\sum_j w_j = 1$$
$$W_j \geq 1, for\ all\ j \qquad (3)$$

This problem can be solved by transferring it to a linear programming problem, equation 4.

$$\min \xi^L$$

s.t.

$$\begin{gathered} |w_B - a_{Bj}w_j| \leq \xi^L, for\ all\ j \\ |w_j - a_{jW}w_W| \leq \xi^L, for\ all\ j \\ \sum_j w_j = 1 \\ W_j \geq 1, for\ all\ j \end{gathered} \qquad (4)$$

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 how consistent the comparisons are. A value close to zero indicates a high consistency and a thereby a high reliability. A full consistency is reached when $a_{Bj} \text{x } a_{jW} = a_{BW}$ for all j.

Questionnaire and respondent selection

The questionnaire was be performed online using specialised survey software. Besides the questions that are needed for the BWM, the respondents are asked to answer two other questions to find possible differences in weights between different groups. The first extra question is: What country are you living in? This question is used to determine the continent the respondent is from and will also be used to find differences between groups based on the development of the country they are living in. Secondly, they are asked to state on which countries they have the most information regarding their logistics performance. Their answers can vary between 1 and 5 countries. The results of the survey are addressed in chapter 4.

To find the right weights the respondents need to have enough information on international logistics. Therefore all the persons that were approached to fill in the questionnaire are experts in international logistics. To find both experts from the educational side as the professional side, half of the approached respondents works at a university or research institute and the other half has a relevant job in international shipping. The experts working at universities were found online and were approached by e-mail. All of the approached experts have at least a master degree in a relevant area. The professionals were approached using LinkedIn. They were asked to make a connection on LinkedIn and then received the link to the questionnaire. Table 2 shows further information on the approached experts. The development group shown in the table is the World bank development group of the country in which the approached expert is living. It proved very hard to find experts from countries from the lowest income group. The main reason for this is that they have little access to internet and do not provide information online. It also proved hard to find respondents in South-America due to language barriers. The second column of table 2 shows information on the university experts and the last column on the professionals. The actual respondents and their demographics will be addressed in the next chapter.

Table 2: Approached experts

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

Respondents

A total of 1075 experts was approached to answer the questionnaire. This led to a total of 193 experts that opened the link to the questionnaire that was sent to them by e-mail or LinkedIn. Of these 193 experts, 72 opened the questionnaire but did not actually start answering the and 11 respondents did start answering but did not finish the complete questionnaire. The responses of 3 respondents had to be excluded because the respondents selected the same criterion as most and least important and did not provide consistent answers on the other questions indicating that they consider all criteria equally important. This led to 107 useful responses, 57 from experts from universities and 50 from professionals.

The response rate for the questionnaire is 9.95% and the completion rate is 56.99%. Table 3 shows further statistics on the respondents. As expected the amount of respondents from countries in the lowest income group is low.

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
Dev. group			
High	25	39	64
Middle	22	18	40
Low	3	0	3

4. Results

This section will describe the results of the research, starting with the respondents answers to the questions of the questionnaire and will present the weights and an analysis of these weights.

Questionnaire answers

The first question of the questionnaire asked the respondents either in which country they are living (universities) or from which country they or their company is operating. As can be seen in the respondents paragraph this resulted in respondents from 47 different countries. The country the respondents are living in or working from is also used to determine the World bank income group the respondent belongs to. Based on the low amount of respondents from the lowest income group, it was decided to combine the respondents from the middle income group with the low income group for the remainder of this research. This new group will be addressed as the low income group from now on. After combining these groups a total of 64 respondent are in the high income groups and 43 respondents are from the low income group. In a later stage the weights for these different groups will be compared to identify differences in weights based on income of the country of origin.

In the questionnaire the respondents are also asked to name between one and five countries on which they have the most information concerning their logistical performance. To make it possible to analyse the answers, the respondents are divided into groups based on the development group of the countries they gave as an answer. The same groups, high and low, as mentioned earlier in this section are used for respectively high income countries and low/middle income countries. If the majority of countries mentioned by the respondent is from the high income group, the respondent is marked high, if the majority is from the middle/low income group, he/she is marked as low. If a respondent has information on as many high as middle/low countries his answer to this question is excluded. A total of six respondent's answers to this question were excluded. From the remaining 101 respondents, 23

respondents had information mainly on the low income countries whereas the remaining 78 respondents had information on high income countries.

The next questions in the questionnaire are the questions used in the BWM to determine the weights. The respondents are asked to indicate which they consider the most and least important criteria. Figure 2 shows the answers the respondents gave. The blue bars represent the answers on the most important criterion and the red bar on the least important criterion. The components are placed in this order from left to right: Customs (C) , infrastructure (I), services (S), timeliness (T), tracking & tracing (TT), and international shipments (IS).

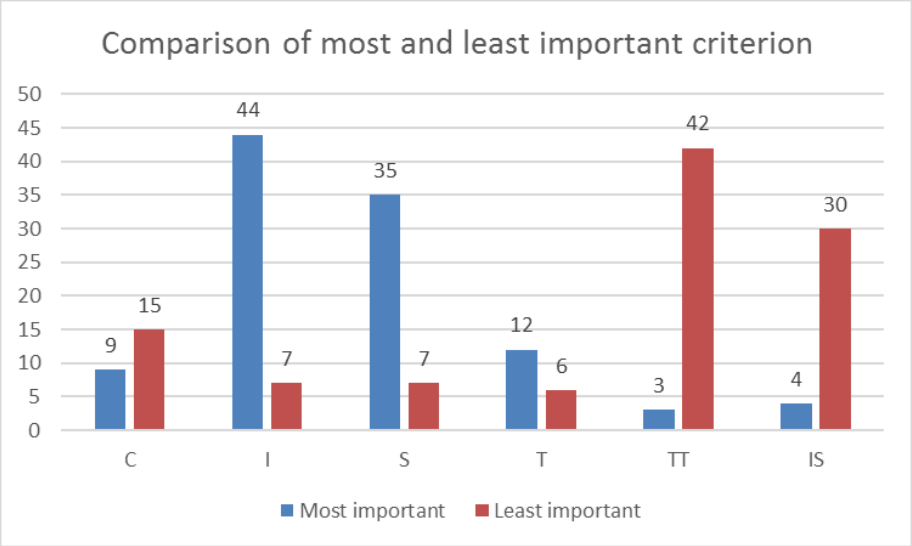

Figure 1: Most and least important

The figure 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. Tracking and tracing, with 42, and ease of arranging international shipments, with 30, are considered the least important criteria. At least all the criteria have been selected at least three times as most and least important criterion. The remaining questions are the questions in which the respondents are 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 criteria. The answers will be the input for the BWM and are used to calculate the weights.

Weights

Table 4 presents the weights found using the BWM and the answers of the 107 respondents. Besides the weights (in the mean column) the minimum value, maximum value, and the standard deviation are presented. Figure 2 shows a box plot with the distributions of the weights.

Table 4: Component weights

	N	Min	Max	**Mean**	Std. Dev
Customs	107	0.0216	0.5897	**0.1594**	0.105
Infrastructure	107	0.0242	0.6146	**0.2354**	0.1463
Services	107	0.0295	0.5897	**0.2169**	0.1234
Timeliness	107	0.0217	0.4729	**0.1601**	0.087
Tracking & tracing	107	0.0189	0.5066	**0.1025**	0.0866
International Shipments	107	0.0263	0.545	**0.1256**	0.0914

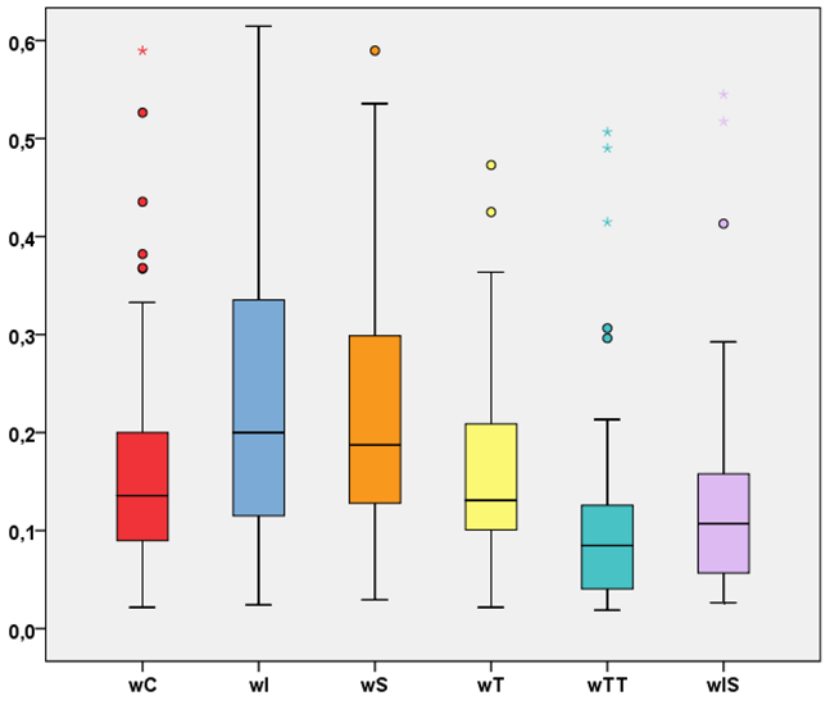

Figure 2:Box plot of the weights

Most respondents considered infrastructure and services as the most important criteria and this also shows in the final weights. The lowest weight is for tracking and tracing, which was also considered to be the least important criterion by the most respondents. If each component would have been 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 result show that the customs component and the timeliness component are not significantly different from average weight and the other four weights are significantly different. This indicates that assigning weights provides a better insight in what is important when addressing logistics performance and that the LPI score does not adequately represent logistics performance.

Several different groups can be identified based on the answers of the respondents. The weight for each of the components will be tested for significant differences between the groups. These differences in are tested using SPSS. The test performed is the ANOVA test. The null hypothesis for each of the comparisons is H_0: There are no significant differences between the groups. The hypothesis to be tested is H_1: There is a significant difference between the groups that are tested. To reject the null hypothesis and accept H_1, the P-value has to be below 0.05. All the results of the ANOVA tests can be found in appendix B. The first comparison in weights is made between the professionals and the university experts. The results show that there is a significant difference in weights for only one component, the customs component. 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. The development group of the country the respondent is living in does not have significant influence on the importance of the different components, meaning there is no significant difference in any of the weights between the high and low income group. The same applies for the countries the respondent has information on, there are so significant differences between the high and low income group. If the differences between continents are tested, only the customs components shows a significant difference. Table 5 shows the weights for each of the continents on the customs component.

Table 5: Custom weights per continent

Continent	Customs weight	Standard deviation
Europe	0.13217	0.0128
North America	0.21326	0.0375
Asia	0.14208	0.01598
Australia	0.09191	0.03088
Africa	0.21703	0.03117
South America	0.15418	0.02547

Africa and North-America consider customs to be more important than the other continents, whereas Australia considers it to be less important. In general, only the customs component weight is influenced by respondent groups. In general therefore 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. These new and old ranking can be compared to find out the effects of assigning the weights.

Ranking comparison

To create the weighted LPI, the scores of the last LPI report on each of the components are multiplied with the weights found. The complete ranking can be found in appendix A. Several statistics can be found by comparing the rankings. Table 6 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.

7Table 6: Ranking comparison

Statistics w-LPI	
Number of countries with diff rank	110
Average rank difference	1.56
Average percentile score difference	0.82%
Top 5 rank increase	
Iran	7
Bosnia Herzegovina	7
Congo	6
Namibia	5
Cuba	5
Top 5 rank decrease	
Cambodia	-7
Guinee-Bissau	-7
Mozambique	-7
Costa Rica	-5
Togo	-5

The differences between the two ranking are relatively small. This small difference is caused by the small difference in the overall scores with an without the weights. When these scores are compared they

have a correlation of 0.9988. This means that the overall w-LPI score can be almost perfectly predicted using the overall LPI score. The reason for this is a very high correlation between the different components. These correlations range between 0.902 and 0.984. Correlation between the component could have been expected beforehand since it is likely countries that are more developed will invest more in improving on all the different factors in the logistical system. However, the correlation between the LPI scores on the components seems to be too high to be realistic and if they would be really this high, it is useless to include all six components when determining logistics performance. What is more likely is that the correlation is caused by how the scores on the components are determined. This can have several reasons, but the most likely is that the way of questioning or the selected respondents cause the high correlations. When outcomes are different than the real situation due to the way of questioning, this is known as common method bias (Podsakoff, MacKenzie, Lee & Podsakoff, 2003). Method biases are a known error in different fields of science and can threaten the validity of the dataset or the measurements. Podsakoff et al. (2003) mention that systematic measurement errors can provide a set of outcomes that are highly influenced by the method of questioning and therefore these outcomes do not represent the real situation as well as they could. It is possible that methods errors are present in the LPI scores, due to the respondent selection method.

To create the original index, 1051 respondents were asked to rate countries between 1 and 5 on the six different components. Each of the respondents is asked to rate 8 countries. These 8 countries are determined based on the most important import and export countries of the respondents home country and some are determined randomly. This means that each country on average is scored by 52.55 respondents. In general 52 is a low number to find significant results. For the LPI report some of the respondents will be randomly assigned, meaning that for example a respondent from the Netherlands could be asked to score Lesotho on the components. It is unlikely that a respondent from the Netherlands has sufficient information on and experience with this country to provide an educated score. This increases the chance respondents will answer based on some general idea they have of a country, and therefore do not differentiate between the components based on knowledge. This would be common method bias, since the scores are not constructed based on the real situation of realistic scores on the components, but on a general of the logistics performance of a certain country, or even a general idea about a country. This could lead to biased scores and high correlation between scores.

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 to measure logistics performance, some factors are more important than others. The small differences in rankings might be caused by how the respondents for the LPI scores are selected.

5. Conclusions and recommendations

The logistics performance index (LPI) was introduced as a tool to gain insight in countries logistics performance. This was the first tool that provided countries were provided the ability to compare themselves with other countries on different factors concerning logistics. Six factors are included as components and experts rate these components so that the overall score can be calculated by taking the average of the component scores. Literature shows that the components used in the LPI (Customs, Infrastructure, quality of services, timeliness, tracking & tracing, and international shipments) are not the only important factors for the logistics performance of a country. Environment and innovation should be considered as additions to the components, due to their growing influence on modern logistics. No

earlier studies researched the relative importance of the components of the LPI or other factors for logistics performance. The LPI considers all component equally important since the overall score is the average of the component scores. This seems highly unlikely in a logistics system, since the many factors all contribute to logistics performance in their own way. This research used the original components and a Multi Criteria Decision making (MCDM) 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), services (0,22), timeliness (0,16), customs (0,16), international shipments (0,13) , and tracking and tracing (0,10). This is the first time weights are assigned to factors in logistics performance. The weights provide insights for countries in where to focus their logistics projects to improve their logistical situation in the most efficient way.

Discussion

The weights that have been found in this research are significantly different from the weights used for the construction of the original LPI and since this is the first time weights are assigned they provide new insights in logistics performance. The weights have also been applied to the ranking of the 2016 LPI report. The new ranking that followed from this has a very high correlation with the old ranking. This is due to high correlation between the scores on the different components as given by the experts used to create the LPI. Due to this high correlation the weights do not matter for the w-LPI score as compared to the LPI score. This correlation could be caused by the LPI methodology and the questionnaire. This should be tested by further research.

Recommendations

This research identified several needs for further research, concerning further research into logistics performance measuring as well as research into the LPI methodology. More research is needed into the implications of the weights found in this research. These weights prove to be significantly different for each other and have implications for what determines logistical performance. However, these weights still have to be transformed into actual policy measures to improve logistics performance. In order to do so, further research is needed into different projects that effect the scores and this weights to determine what projects are the most efficient to invest in as a country.

It is also advised to further research and change the LPI methodology. If the number of respondents is increased, respondents can be asked to only score the countries on which they have sufficient information on all the components. This will ensure that the LPI score is based on scores on the components, instead based on a general idea a respondent has on a country. To test the current LPI, a research into one or several countries can be done, where expert from one country are asked to rate their own country to see if the scores are close to the scores found using the LPI questionnaire. If they are different, this suggests that the questionnaire of the LPI should be changed. Besides the questionnaire of the LPI, the components should also be reviewed. Literature suggest that at least two factors in logistics performance have been left out. The first factor is innovation, which has an important impact on the countries possibilities to adopt new technologies and adapt to changing logistical systems. The second and probably most important factor is environment. The climate change has brought environment onto the political agenda and transport and logistics are an important factor in the climate change, mostly due to emission of CO2 and small particles. The world bank could review which factors should be added or left out before a new report is produced. The method of weight assignment that has been proposed in this report could be used to determine the weights of the components if their composition changes.

References

Arvis, J.F., Saslavsky, D., Ojala, L., Shepherd, B., Busch, C., Raj, A., Naula, T. (2016). *Connecting to Compete: Trade Logistics in the Global Economy,* World bank, Washington DC.

Çemberci, M., Civelek, M.E., & Canbolat, N. (2015). The moderator effect of global competitiveness index on dimensions of logistics performance index. *Procedia-Social and Behavioral Sciences*, *195*, 1514-1524.

Chapman, R.L., Soosay, C. & Kandampally, J. (2003), Innovation in logistics services and the new business model: a conceptual framework, *International Journal of Physical Distribution & Logistics Management*, *33*(7), 630-650.

Chow, G., Heaver, T.D., Henriksson, L.E. (1994) Logistics Performance: Definition and Measurement, *International Journal of Physical Distribution & Logistics Management*, *24*(1), 17 – 28, DOI: 10.1108/09600039410055981.

Civelek, M. E., Uca, N., & Cemberci, M. (2015). The mediator effect of logistics performance index on the relation between global competitiveness index and gross domestic product. *European Scientific Journal*, *11*(13).

Daugherty, P. J., Stank, T. P., Ellinger, A.E. (1998). Leveraging logistics/distribution capabilities: The effect of logistics service on market share, *Journal of Business Logistics*, *19*(2), 35-42.

Devlin, J., Yee, P. (2005). Trade Logistics in Developing Countries: The Case of the Middle East and North Africa, *The World Economy*, *28*(3), 435-456.

Erkan, B. (2014). The importance and determinants of logistics performance of selected countries. *Journal of Emerging Issues in Economics, Finance and Banking*, *3*(6), 1237-1254.

Gillen, D.W., Waters II, W.G. (1996). Introduction: Transport infrastructure investment and economic development, *Logistics and Transportation Review*, *32*(1).

Goldsby T. J., Stank T. P. (2000) World Class Logistics Performance and Environmentally Responsible Logistics Practices. *Journal of Business Logistics*, *21*(2), 187–208.

Hausman, W. H., Lee, H. L. & Subramanian, U. (2013). The Impact of Logistics Performance on Trade. *Production and Operations Management*, *22*(2), 236–252.

Heaver, T.D. (1992) The Role of Customs Administration in the Structure and Efficiency of International Logistics: An International Comparison. *The International Journal of Logistics Management*, *3*(1), 63 – 72.

Hoekman, B., Nicita, A. (2011). Trade Policy, Trade Costs, and Developing Country Trade. *World Development*, *39*(12), 2069–2079, DOI: 10.1016/j.worlddev.2011.05.013.

Hummels, D. (2001). *Time as a Trade Barrier. Working paper,* West Lafayette, IN.: Purdue University, department of Economics.

International Maritime Organization (IMO, 2014). *Third IMO Greenhouse gas study 2014,* Publication of International Maritime Organization, Micropress Printers, Suffolk, UK.

International Transport Forum (ITF, 2015). *Drivers of Logistics Performance: A Case Study of Turkey,* corporate partnership report, OECD.

Jumandi, H., Zailani, S. (2010). Integrating Green Innovations in Logistics Services Towards Logistics Services Sustainability: A Conceptual Paper. *Environmental Research Journal*, *4(*1), 261-271, DOI:10.3923/erj.2010.261.271.

Kim, I., & Min, H. (2011). Measuring supply chain efficiency from a green perspective. *Management Research Review*, *34*(11), 1169-1189.

Korinek, J., Sourdin, P. (2011). *To What Extent Are High-Quality Logistics Services Trade Facilitating,* OECD Trade Policy Working Papers, No. 108, Paris: OECD Publishing.

Martí, L., Puertas, R., & García, L. (2014). The importance of the Logistics Performance Index in International trade. *Applied Economics*, *46*(24), 2982-2992, DOI:10.1080/00036846.2014.916394.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of applied psychology*, *88*(5), 879.

Rao, P., Holt, D. (2005), Do green supply chains lead to competitiveness and economic performance?. *International Journal of Operations & Production Management*, *25*(9), 898 – 916.

Razzaque, M.A. (1997). Challenges to logistics development: the case of a Third World country - Bangladesh. *International Journal of Physical Distribution & Logistics Management*, *27*(1), 18 –38.

Rezaei, J. (2015). Best-worst multi-criteria decision-making method. *Omega (United Kingdom)*, *53*, 49-57.

Rezaei, J., Wang, J., & Tavasszy, L. (2015). Linking supplier development to supplier segmentation using Best Worst Method. *Expert Systems with Applications*, 9152-9164.

Rezaei, J., Nispeling, T., Sarkis, J., & Tavasszy, L. (2016). A supplier selection life cycle approach integrating traditional and environmental criteria using the best worst method. *Journal of Cleaner Production*, *135*, 577-588.

Sadeghi, S., Rasouli, N., & Jandaghi, G. (2016). Identifying and prioritizing contributing factors in supply chain competitiveness by using PLS-BWM techniques (case study: Payam shoes company). *World Scientific News*, *49*(2), 117.

Shamsuzzoha, A. , Helo, P.T. (2011). 'Real-time tracking and tracing system: potentials for the logistics network'. *Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management*. 22–24 January, Kuala Lumpur, Malaysia.

Solakivi, T., Ojala, L., Laari, S., Lorentz, H., Toyli, J., Malmsten, J., Viherlehto, N. (2015). *Finland state of logistics 2014*, Turun Kauppakorkeakoulun Julkaisuja Sarja E-1:2015.

Triantaphyllou, E. (2000). Multi-criteria decision making methods. In *Multi-criteria Decision Making Methods: A Comparative Study*, 5-21, USA:Springer.

Uca, N., Ince, H., & Sumen, H. (2016). The mediator effect of logistics performance index on the relation between corruption perception index and foreign trade volume. *European Scientific Journal*, *12*(25).

Vickerman, R., Spiekermann, K. & Michael Wegener (1999). Accessibility and Economic Development in Europe. *Regional Studies*, *33*(1), 1-15.

Appendix A: w-LPI ranking

		LPI	w-LPI	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	score	score	LPI rank	Rank dif	% dif	
1	Germany	4,230	4,265	4,12	4,44	3,86	4,28	4,27	4,45	1	0	0,838	0,8378
2	Sweden	4,205	4,215	3,92	4,27	4,00	4,25	4,38	4,45	3	1	0,254	0,2537
3	Netherlands	4,188	4,211	4,12	4,29	3,94	4,22	4,17	4,41	4	1	0,566	0,5657
4	Luxembourg	4,219	4,211	3,90	4,24	4,24	4,01	4,12	4,80	2	-2	-0,198	0,1984
5	Singapore	4,144	4,160	4,18	4,20	3,96	4,09	4,05	4,40	5	0	0,383	0,3834
6	Austria	4,098	4,102	3,79	4,08	3,85	4,18	4,36	4,37	7	1	0,091	0,0913
7	Belgium	4,109	4,098	3,83	4,05	4,05	4,07	4,22	4,43	6	-1	-0,246	0,2464
8	UK	4,070	4,093	3,98	4,21	3,77	4,05	4,13	4,33	8	0	0,577	0,577
9	Hong Kong	4,069	4,070	3,94	4,10	4,05	4,00	4,03	4,29	9	0	0,03	0,0297
10	United States	3,992	4,016	3,75	4,15	3,65	4,01	4,20	4,25	10	0	0,599	0,5991
11	Switzerland	3,987	4,016	3,88	4,19	3,69	3,95	4,04	4,24	11	0	0,725	0,7251
12	Japan	3,970	3,994	3,85	4,10	3,69	3,99	4,03	4,21	12	0	0,6	0,6003
13	Canada	3,931	3,960	3,95	4,14	3,56	3,90	4,10	4,01	14	1	0,739	0,739
14	UAE	3,942	3,950	3,84	4,07	3,89	3,82	3,91	4,13	13	-1	0,216	0,2162
15	Finland	3,921	3,942	4,01	4,01	3,51	3,88	4,04	4,14	15	0	0,543	0,543
16	France	3,901	3,913	3,71	4,01	3,64	3,82	4,02	4,25	16	0	0,321	0,321
17	Denmark	3,816	3,832	3,82	3,75	3,66	4,01	3,74	3,92	17	0	0,416	0,4164
18	Australia	3,793	3,804	3,54	3,82	3,63	3,87	3,87	4,04	19	1	0,285	0,2852

19	Ireland	3,795	3,782	3,47	3,77	3,83	3,79	3,98	3,94	18	-1	-0,331	0,3309
20	South Africa	3,775	3,775	3,60	3,78	3,62	3,75	3,92	4,02	20	0	-0,01	0,0099
21	Italy	3,755	3,760	3,45	3,79	3,65	3,77	3,86	4,03	21	0	0,111	0,111
22	Norway	3,732	3,753	3,57	3,95	3,62	3,70	3,82	3,77	22	0	0,559	0,5589
23	Spain	3,727	3,727	3,48	3,72	3,63	3,73	3,82	4,00	23	0	-0,021	0,0211
24	Korea, Rep,	3,717	3,726	3,45	3,79	3,58	3,69	3,78	4,03	24	0	0,231	0,231
25	Taiwan, China	3,698	3,710	3,23	3,57	3,57	3,95	3,59	4,25	25	0	0,346	0,3457
26	China	3,661	3,664	3,32	3,75	3,70	3,62	3,68	3,90	27	1	0,076	0,076
27	Israel	3,660	3,651	3,50	3,49	3,38	3,60	3,72	4,27	28	1	-0,248	0,2476
28	Czech Republic	3,674	3,637	3,58	3,36	3,65	3,65	3,84	3,94	26	-2	-1,028	1,0284
29	Lithuania	3,632	3,622	3,42	3,57	3,49	3,49	3,68	4,14	29	0	-0,271	0,2711
30	Qatar	3,599	3,598	3,55	3,57	3,58	3,54	3,50	3,83	30	0	-0,044	0,0442
31	Hungary	3,429	3,430	3,02	3,48	3,44	3,35	3,40	3,88	31	0	0,023	0,0229
32	Turkey	3,424	3,425	3,18	3,49	3,41	3,31	3,39	3,75	34	2	0,037	0,0374
33	Malaysia	3,426	3,419	3,17	3,45	3,48	3,34	3,46	3,65	32	-1	-0,224	0,2237
34	New Zealand	3,388	3,415	3,18	3,55	2,77	3,22	3,58	4,12	37	3	0,783	0,7834
35	India	3,420	3,408	3,17	3,34	3,36	3,39	3,52	3,74	35	0	-0,345	0,3447
36	Poland	3,426	3,397	3,27	3,17	3,44	3,39	3,46	3,80	33	-3	-0,844	0,8437
37	Portugal	3,409	3,362	3,37	3,09	3,24	3,15	3,65	3,95	36	-1	-1,399	1,3986
38	Estonia	3,363	3,353	3,41	3,18	3,07	3,18	3,25	4,08	38	0	-0,306	0,3063
39	Panama	3,338	3,324	3,13	3,28	3,65	3,18	2,95	3,74	40	1	-0,423	0,423
40	Slovak Republic	3,337	3,321	3,28	3,24	3,41	3,12	3,12	3,81	41	1	-0,485	0,4853
41	Kenya	3,331	3,315	3,17	3,21	3,24	3,24	3,42	3,70	42	1	-0,501	0,5005
42	Latvia	3,327	3,314	3,11	3,24	3,28	3,29	3,42	3,62	43	1	-0,387	0,3868
43	Iceland	3,346	3,307	3,13	3,02	3,32	3,26	3,42	3,88	39	-4	-1,143	1,1427
44	Bahrain	3,314	3,296	3,14	3,10	3,33	3,38	3,32	3,58	44	0	-0,549	0,5493
45	Oman	3,234	3,255	2,76	3,44	3,35	3,26	3,09	3,50	48	3	0,629	0,6288
46	Thailand	3,255	3,232	3,11	3,12	3,37	3,14	3,20	3,56	45	1	-0,714	0,7136
47	Greece	3,240	3,225	2,85	3,32	2,97	2,91	3,59	3,85	47	0	-0,457	0,4572
48	Slovenia	3,185	3,186	2,88	3,19	3,10	3,20	3,27	3,47	50	2	0,032	0,0325
49	Chile	3,248	3,173	3,19	2,77	3,30	2,97	3,50	3,71	46	-3	-2,308	2,3084
50	Egypt	3,185	3,172	2,75	3,07	3,27	3,20	3,15	3,63	49	-1	-0,418	0,4178
51	Croatia	3,161	3,150	3,07	2,99	3,12	3,21	3,16	3,39	51	0	-0,356	0,3557
52	Saudi Arabia	3,156	3,146	2,69	3,24	3,23	3,00	3,25	3,53	52	0	-0,316	0,3163
53	Brazil	3,088	3,093	2,76	3,11	2,90	3,12	3,28	3,39	55	2	0,15	0,1502
54	Mexico	3,114	3,087	2,88	2,89	3,00	3,14	3,40	3,38	54	0	-0,865	0,8654
55	Kuwait	3,152	3,084	2,83	2,92	3,62	2,79	3,16	3,51	53	-2	-2,133	2,1326
56	Malta	3,069	3,041	2,78	2,94	3,09	2,85	3,12	3,61	56	0	-0,929	0,9289
57	Botswana	3,045	3,032	3,05	2,96	2,91	2,74	2,89	3,72	57	0	-0,452	0,4518
58	Uganda	3,043	3,017	2,97	2,74	2,88	2,93	3,01	3,70	58	0	-0,867	0,8672
59	Cyprus	2,999	3,012	3,11	3,00	2,80	2,72	2,54	3,79	59	0	0,425	0,4247
60	Romania	2,993	2,971	3,00	2,88	3,06	2,82	2,95	3,22	60	0	-0,736	0,736
61	Tanzania	2,990	2,969	2,78	2,81	2,98	2,92	2,98	3,44	61	0	-0,709	0,709
62	Uruguay	2,975	2,968	2,78	2,79	2,91	3,01	2,84	3,47	65	3	-0,233	0,2326
63	Indonesia	2,985	2,948	2,69	2,65	2,90	3,00	3,19	3,46	63	0	-1,23	1,2296

64	Vietnam	2,977	2,942	2,75	2,70	3,12	2,88	2,84	3,50	64	0	-1,156	1,1565
65	Argentina	2,963	2,941	2,63	2,86	2,76	2,83	3,26	3,47	66	1	-0,73	0,7297
66	Rwanda	2,986	2,939	2,93	2,62	3,05	2,87	3,04	3,35	62	-4	-1,586	1,5857
67	Jordan	2,957	2,924	2,55	2,77	3,17	2,89	2,96	3,34	67	0	-1,103	1,1035
68	Pakistan	2,923	2,895	2,66	2,70	2,93	2,82	2,91	3,48	68	0	-0,975	0,975
69	Peru	2,893	2,863	2,76	2,62	2,91	2,87	2,94	3,23	69	0	-1,058	1,0585
70	Brunei	2,870	2,833	2,78	2,75	3,00	2,57	2,91	3,19	70	0	-1,311	1,3105
71	Philippines	2,856	2,810	2,61	2,55	3,01	2,70	2,86	3,35	71	0	-1,629	1,6288
72	Bulgaria	2,808	2,776	2,40	2,35	2,93	3,06	2,72	3,31	72	0	-1,129	1,1289
73	Algeria	2,770	2,754	2,37	2,58	2,80	2,91	2,86	3,08	75	2	-0,57	0,5698
74	Namibia	2,745	2,751	2,65	2,76	2,69	2,63	2,52	3,19	79	5	0,236	0,2359
75	Bahamas, The	2,750	2,749	2,65	2,72	2,80	2,74	2,64	2,93	78	3	-0,036	0,0361
76	Ecuador	2,779	2,739	2,64	2,47	2,95	2,66	2,65	3,23	74	-2	-1,438	1,4383
77	Burkina Faso	2,731	2,738	2,55	2,67	2,73	2,78	2,49	3,13	81	4	0,254	0,2542
78	Serbia	2,763	2,738	2,50	2,49	2,63	2,79	2,92	3,23	76	-2	-0,907	0,9067
79	Kazakhstan	2,752	2,737	2,52	2,76	2,75	2,57	2,86	3,06	77	-2	-0,539	0,5393
80	Cambodia	2,801	2,736	2,62	2,36	3,11	2,60	2,70	3,30	73	-7	-2,316	2,3164
81	Ukraine	2,737	2,699	2,30	2,49	2,59	2,55	2,96	3,51	80	-1	-1,373	1,3727
82	Lebanon	2,717	2,687	2,73	2,64	2,84	2,45	2,75	2,86	82	0	-1,113	1,1129
83	El Salvador	2,706	2,650	2,37	2,25	2,82	2,66	2,78	3,29	83	0	-2,045	2,0446
84	Bangladesh	2,664	2,646	2,57	2,48	2,73	2,67	2,59	2,90	87	3	-0,653	0,6533
85	Ghana	2,661	2,640	2,46	2,48	2,71	2,54	2,52	3,21	88	3	-0,792	0,7919
86	Morocco	2,666	2,634	2,22	2,46	3,09	2,59	2,34	3,20	86	0	-1,19	1,1902
87	Nigeria	2,628	2,619	2,46	2,40	2,43	2,74	2,70	3,04	90	3	-0,343	0,3428
88	Guyana	2,667	2,616	2,40	2,24	2,66	2,66	2,90	3,12	85	-3	-1,922	1,9223
89	Iran	2,601	2,614	2,33	2,67	2,67	2,67	2,44	2,81	96	7	0,498	0,4984
90	Bosnia and Herzegovina	2,596	2,610	2,69	2,61	2,28	2,52	2,56	2,94	97	7	0,528	0,5281
91	Mozambique	2,684	2,606	2,49	2,24	3,06	2,44	2,75	3,04	84	-7	-2,902	2,9021
92	Colombia	2,612	2,603	2,21	2,43	2,55	2,67	2,55	3,23	94	2	-0,354	0,3536
93	Dominican Republic	2,627	2,596	2,39	2,29	2,67	2,68	2,63	3,06	91	-2	-1,209	1,2087
94	Costa Rica	2,649	2,594	2,33	2,32	2,89	2,55	2,77	2,98	89	-5	-2,079	2,0788
95	Côte d'Ivoire	2,603	2,593	2,67	2,46	2,54	2,62	2,62	2,71	95	0	-0,371	0,3705
96	Moldova	2,614	2,579	2,39	2,35	2,60	2,48	2,67	3,16	93	-3	-1,342	1,3417
97	Togo	2,618	2,572	2,49	2,24	2,62	2,46	2,60	3,24	92	-5	-1,73	1,7304
98	Russia	2,571	2,572	2,01	2,43	2,45	2,76	2,62	3,15	99	1	0,025	0,0252
99	Paraguay	2,561	2,568	2,38	2,45	2,58	2,69	2,30	2,93	101	2	0,242	0,2417
100	Comoros	2,579	2,566	2,63	2,36	2,58	2,60	2,44	2,82	98	-2	-0,497	0,4975
101	Nicaragua	2,531	2,533	2,48	2,50	2,50	2,55	2,47	2,68	102	1	0,061	0,0605
102	Niger	2,562	2,531	2,59	2,22	2,63	2,50	2,35	3,02	100	-2	-1,189	1,1888
103	Maldives	2,513	2,523	2,39	2,57	2,34	2,44	2,49	2,88	104	1	0,396	0,3962
104	Macedonia, FYR	2,510	2,518	2,21	2,58	2,45	2,36	2,32	3,13	106	2	0,314	0,314
105	Tunisia	2,497	2,497	1,96	2,44	2,33	2,59	2,67	3,00	110	5	0,01	0,0096
106	Sudan	2,530	2,488	2,23	2,20	2,57	2,36	2,49	3,28	103	-3	-1,658	1,6582
107	Mali	2,503	2,488	2,45	2,30	2,48	2,46	2,36	2,93	109	2	-0,592	0,5925

108	Papua New Guinea	2,511	2,483	2,55	2,32	2,46	2,35	2,58	2,78	105	-3	-1,099	1,0989
109	Mongolia	2,506	2,459	2,39	2,05	2,37	2,31	2,47	3,40	108	-1	-1,877	1,8769
110	Burundi	2,510	2,453	2,02	1,98	2,42	2,46	2,68	3,45	107	-3	-2,25	2,2504
111	Myanmar	2,459	2,447	2,43	2,33	2,23	2,36	2,57	2,85	113	2	-0,483	0,4826
112	Guatemala	2,476	2,443	2,47	2,20	2,41	2,30	2,46	2,98	111	-1	-1,333	1,333
113	Benin	2,428	2,429	2,20	2,39	2,55	2,47	2,23	2,69	115	2	0,041	0,0413
114	Uzbekistan	2,405	2,424	2,32	2,45	2,36	2,39	2,05	2,83	118	4	0,812	0,8119
115	Solomon Islands	2,417	2,415	2,60	2,21	2,28	2,43	2,18	2,76	116	1	-0,105	0,1052
116	Honduras	2,463	2,412	2,21	2,04	2,58	2,44	2,53	2,91	112	-4	-2,057	2,0567
117	Zambia	2,430	2,411	2,25	2,26	2,51	2,42	2,36	2,74	114	-3	-0,76	0,7604
118	Trinidad and Tobago	2,398	2,395	2,38	2,34	2,31	2,28	2,28	2,79	121	3	-0,143	0,1432
119	Congo, Rep,	2,377	2,386	2,00	2,60	2,37	2,26	2,48	2,57	125	6	0,377	0,3768
120	Albania	2,412	2,383	2,23	1,98	2,48	2,48	2,15	3,05	117	-3	-1,235	1,2352
121	Jamaica	2,400	2,378	2,37	2,23	2,44	2,31	2,38	2,64	119	-2	-0,923	0,9234
122	Venezuela, RB	2,391	2,375	1,99	2,35	2,47	2,34	2,48	2,71	122	0	-0,651	0,6508
123	Belarus	2,399	2,364	2,06	2,10	2,62	2,32	2,16	3,04	120	-3	-1,47	1,4701
124	Ethiopia	2,377	2,351	2,60	2,12	2,56	2,37	2,18	2,37	126	2	-1,072	1,0725
125	Nepal	2,377	2,341	1,93	2,27	2,50	2,13	2,47	2,93	124	-1	-1,499	1,4988
126	Cuba	2,346	2,341	2,38	2,31	2,31	2,25	2,31	2,51	131	5	-0,25	0,2504
127	Congo, Dem, Rep,	2,376	2,341	2,22	2,01	2,33	2,33	2,37	2,94	127	0	-1,482	1,4821
128	Montenegro	2,380	2,337	2,22	2,07	2,56	2,31	2,37	2,69	123	-5	-1,793	1,7925
129	Senegal	2,328	2,334	2,31	2,23	2,25	2,39	2,15	2,61	132	3	0,269	0,2694
130	Guinea	2,359	2,328	2,28	2,01	2,38	2,54	2,54	2,38	129	-1	-1,304	1,3039
131	São Tomé and Principe	2,326	2,322	2,24	2,12	2,26	2,42	2,14	2,75	133	2	-0,146	0,146
132	Georgia	2,353	2,315	2,26	2,17	2,35	2,08	2,44	2,80	130	-2	-1,611	1,6112
133	Fiji	2,316	2,314	2,33	2,25	2,21	2,25	2,25	2,60	136	3	-0,107	0,1073
134	Djibouti	2,323	2,301	2,37	2,30	2,48	1,96	2,09	2,69	134	0	-0,948	0,9478
135	Guinea-Bissau	2,371	2,298	2,44	1,91	2,57	2,07	2,41	2,74	128	-7	-3,082	3,0817
136	Bhutan	2,321	2,281	2,21	1,96	2,50	2,30	2,20	2,70	135	-1	-1,726	1,7261
137	Libya	2,264	2,267	1,88	2,04	2,40	2,50	1,85	2,83	137	0	0,115	0,1147
138	Angola	2,241	2,229	1,80	2,13	2,37	2,31	2,21	2,59	139	1	-0,537	0,5373
139	Turkmenistan	2,211	2,223	2,00	2,34	2,37	2,09	1,84	2,59	140	1	0,544	0,5444
140	Armenia	2,206	2,213	1,95	2,22	2,22	2,21	2,02	2,60	141	1	0,353	0,3533
141	Bolivia	2,251	2,207	1,97	2,11	2,40	1,90	2,31	2,79	138	-3	-1,976	1,9764
142	Liberia	2,204	2,182	2,07	2,01	2,22	2,07	2,07	2,73	142	0	-0,991	0,9914
143	Cameroon	2,151	2,179	2,09	2,21	1,98	2,32	2,04	2,29	148	5	1,292	1,292
144	Gabon	2,192	2,174	2,07	2,05	2,28	2,12	2,07	2,52	143	-1	-0,799	0,7986
145	Eritrea	2,172	2,172	2,01	2,06	2,16	2,25	2,03	2,50	144	-1	0,021	0,021
146	Madagascar	2,155	2,143	2,33	2,12	2,17	1,93	2,01	2,35	147	1	-0,533	0,5326
147	Chad	2,164	2,142	2,08	2,07	2,41	2,06	2,07	2,25	145	-2	-1,057	1,0569
148	Kyrgyz Republic	2,156	2,118	1,80	1,96	2,10	1,96	2,39	2,72	146	-2	-1,769	1,7687
149	Afghanistan	2,141	2,116	2,01	1,84	2,38	2,15	1,77	2,61	150	1	-1,173	1,1725

150	Iraq	2,150	2,110	2,01	1,87	2,33	1,97	1,98	2,66	149	-1	-1,851	1,8505
151	Zimbabwe	2,082	2,103	2,00	2,21	2,08	2,13	1,95	2,13	151	0	1,004	1,0045
152	Tajikistan	2,063	2,071	1,93	2,13	2,12	2,12	2,04	2,04	153	1	0,39	0,3903
153	Lao PDR	2,067	2,047	1,85	1,76	2,18	2,10	1,76	2,68	152	-1	-0,994	0,9937
154	Lesotho	2,026	2,041	1,91	1,96	1,84	2,16	1,92	2,35	154	0	0,75	0,7503
155	Sierra Leone	2,025	2,017	1,91	2,07	2,31	1,85	1,74	2,23	155	0	-0,409	0,4085
156	Mauritania	1,866	1,835	2,14	1,54	2,00	1,74	1,54	2,14	157	1	-1,639	1,6391
157	Equatorial Guinea	1,879	1,834	1,88	1,50	1,89	1,75	1,89	2,32	156	-1	-2,389	2,3886
158	Somalia	1,747	1,740	1,29	1,57	1,86	1,85	1,51	2,35	158	0	-0,419	0,4188
159	Haiti	1,716	1,693	1,70	1,47	1,81	1,68	1,56	2,02	159	0	-1,359	1,3591
160	Syrian Arab Republic	1,598	1,541	1,11	1,24	1,36	1,39	2,10	2,40	160	0	-3,572	3,5722

Appendix B: ANOVA tests

ANOVA Professionals/universities

		Sum of Squares	df	Mean Square	F	Sig. (P-value)
wS	Between Groups	,001	1	,001	,055	,815
	Within Groups	1,614	105	,015		
	Total	1,614	106			
wT	Between Groups	,012	1	,012	1,552	,216
	Within Groups	,791	105	,008		
	Total	,803	106			
wTT	Between Groups	,029	1	,029	3,906	,051
	Within Groups	,767	105	,007		
	Total	,796	106			
wIS	Between Groups	,012	1	,012	1,419	,236
	Within Groups	,873	105	,008		
	Total	,885	106			
wC	Between Groups	,049	1	,049	4,573	,035
	Within Groups	1,119	105	,011		
	Total	1,168	106			
wI	Between Groups	,001	1	,001	,025	,874
	Within Groups	2,268	105	,022		
	Total	2,269	106			

ANOVA continents

		Sum of Squares	df	Mean Square	F	Sig.
wC	Between Groups	,152	5	,030	3,014	,014

	Within Groups	1,016	101	,010		
	Total	1,168	106			
wI	Between Groups	,165	5	,033	1,584	,171
	Within Groups	2,104	101	,021		
	Total	2,269	106			
wS	Between Groups	,153	5	,031	2,110	,070
	Within Groups	1,462	101	,014		
	Total	1,614	106			
wT	Between Groups	,048	5	,010	1,281	,278
	Within Groups	,755	101	,007		
	Total	,803	106			
wTT	Between Groups	,016	5	,003	,424	,831
	Within Groups	,779	101	,008		
	Total	,796	106			
wIS	Between Groups	,035	5	,007	,831	,530
	Within Groups	,850	101	,008		
	Total	,885	106			

ANOVA developments groups

		Sum of Squares	df	Mean Square	F	Sig.
wC	Between Groups	,026	1	,026	2,369	,127
	Within Groups	1,142	105	,011		
	Total	1,168	106			
wI	Between Groups	,015	1	,015	,684	,410
	Within Groups	2,254	105	,021		
	Total	2,269	106			
wS	Between Groups	,000	1	,000	,009	,926
	Within Groups	1,614	105	,015		
	Total	1,614	106			
wT	Between Groups	,006	1	,006	,828	,365
	Within Groups	,797	105	,008		
	Total	,803	106			
wTT	Between Groups	,001	1	,001	,075	,785
	Within Groups	,795	105	,008		
	Total	,796	106			
wIS	Between Groups	,028	1	,028	3,415	,067
	Within Groups	,857	105	,008		
	Total	,885	106			

ANOVA info on development groups

		Sum of Squares	df	Mean Square	F	Sig.
wC	Between Groups	,003	1	,003	,295	,588
	Within Groups	1,059	99	,011		
	Total	1,062	100			
wI	Between Groups	,000	1	,000	,002	,963
	Within Groups	2,185	99	,022		
	Total	2,185	100			
wS	Between Groups	,000	1	,000	,021	,885
	Within Groups	1,498	99	,015		
	Total	1,498	100			
wT	Between Groups	,006	1	,006	,827	,365
	Within Groups	,768	99	,008		
	Total	,774	100			
wTT	Between Groups	,003	1	,003	,448	,505
	Within Groups	,603	99	,006		
	Total	,606	100			
wIS	Between Groups	,000	1	,000	,001	,969
	Within Groups	,870	99	,009		
	Total	,870	100			