Measuring trade facilitation for the emerging seven countries (E7) using multi-criteria decision-making methods

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Abstract. Countries provide opportunities for traders not only in imports but also in export performance by simplification and harmonization of documents in order to facilitate certain policy areas that have a tremendous impact on trade volumes. The OECD has established various indicators at different levels and compared countries to measure the trade facilitation between countries. This study aims to compare the procedures applied by the emerging seven countries (E7- Brazil, China, India, Indonesia, Mexico, Russia, and Türkiye) using trade facilitation indicators (TFIs) and multi-criteria decision-making methods. We employ MEREC, WENSLO, ENTROPY, LOPCOW, CVM, CRITIC, ANGLE, and GINI methods to determine the weights of 11 TFIs identified by the OECD. The most suitable weighting method is established through multi-dimensional analysis. E7 countries are then evaluated using the MABAC and ARTASI methods, with a sensitivity analysis comparing results against 38 OECD member countries. In terms of performance across all TFIs, Russia ranks first (MABAC-0.253, ARTASI-1.821), Mexico second (MABAC-0.186, ARTASI-1.802), and Türkiye third (MABAC-0.117, ARTASI-1.731).

Keywords: ANGLE, emerging seven, OECD, MABAC, trade facilitation

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1. Introduction

The value of global merchandise trade (exports), segmented by product groups, showed a continuous increase from 2020 to 2022: in 2020 (-7,4 percent: 17.65 trillion USD), 2021 (+26.5: 22.32 trillion USD) and 2022 (+12.2: 24.92 trillion USD). However, there was a partial decrease in 2023 (-4.5: 23.78 trillion USD) compared to the previous year according to WTO (World Trade Organization) data. Similarly, global merchandise imports also increased continuously during this period: in 2020 (-7.9: 17.88 trillion USD), 2021 (+26.4: 22.59 trillion USD) and 2022 (+14.3: 25.7 trillion USD). Nonetheless there was a partial decrease in 2023 (-5.7: 24.23 trillion USD) compared to the previous year [30]. According to the WTO's 2024 annual report, trade in goods is expected to decline in 2023 as the continuing effects of inflation and high energy prices affect demand for trade-intensive manufactured goods. Conversely, trade in commercial services continues to expand. The WTO anticipates that trade in goods is expected to recover gradually in 2024 and 2025 as low inflation increases real household incomes and boosts import demand [31].

The world economy has undergone a rapid transformation in recent years, leading to an increase in international trade necessitates that necessitates removal of trade barriers. The

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OECD measures the economic and trade impact of specific trade facilitation initiatives for countries. Research indicates that, integrating these trade facilitation indicators (TFIs), could potentially lower trade costs by nearly 10 percent [15]. In WTO negotiations on trade facilitation, the costs to developing countries of implementing trade facilitation measures have been a central concern. The total capital expenditure required to introduce trade facilitation measures in the reviewed countries ranged from €3.5 to €19 million, while annual operating costs -both direct or indirect- did not exceed €2.5 million in any of these countries [17]. Another study found that cost reduction potentials to reach approximately 14.5 percent of trade costs for low-income countries, 15.5 percent for lower-middle-income countries, and 13.2 percent for upper-middle-income countries [16].

Trade facilitation refers to policies and measures aimed at reducing trade costs by increasing effectiveness at all stages of the international trade chain. Regardless of its definition and scope, economic analyses of trade facilitation generally draw on the concept of lowering trade transaction costs and aim to assess the benefits of trade facilitation measures by increasing efficiency in various policy areas affecting the movement of goods [15, 16]. Wilson et al. [28] explained that trade facilitation typically means improving efficiency in administration, procedures, and logistics at ports and customs. It also includes streamlined regulatory conditions, deeper harmonization of standards, and compliance with international regulations. The traditional perspective on trade facilitation aims to enhance border and transit management procedures and their implementation, thereby removing barriers to trade in goods at the borders. Trade facilitation can efficiently decrease the cost of international trade, ease trade conflicts, encourage trade between countries, and assist countries in reducing overall trade costs. Eventually, trade facilitation involves the simplification, harmonization, standardization and modernization of trade procedures- an agenda item of many customs-related activities aimed at lowering trade transaction costs at the interface between business and government. While there is no universally accepted definition for trade facilitation, in a narrow sense, trade facilitation efforts may handle the logistics of moving goods through ports or improving transportation efficiency associated with cross-border trade [27].

This study makes important contributions to the literature through several unique aspects. It is the first to examine trade facilitation across countries using numerical evidence, specifically TFIs are investigated for E7 countries while utilizing comprehensive data from OECD countries for comparison. The methods and analyses employed in this study are quite comprehensive, focusing on identifying the most appropriate decision-making method rather than relying on a single approach -an important consideration in the field of decision-making. Multiple comparisons of multiple methods have been successfully implemented with a high level of robustness. This study aims to compare the procedures applied by emerging countries for TFIs using multicriteria decision-making (MCDM) methods. Indicators are analyzed through multiple decision methods and multi-dimensional thinking. Specifically, this study utilizes MEREC, WENSLO, ENTROPY, LOPCOW, CVM, CRITIC, ANGLE, and GINI methods to analyze the indicators more effectively. Multi-dimensional thinking comes into play here to decide which method is most appropriate. Additionally, the MABAC and ARTASI methods are used to evaluate different countries within defined limits. The MABAC method provides robust decision support by calculating the "border approximation area" for each alternative. It effectively reflects the impact of criteria weights on the overall decision, offering more accurate results when the priority of criteria changes significantly. The ARTASI method is effective in decision problems where similarity comparisons are key, using "approximate ratios and total area-based similarity indices". The ARTASI method can adjust data of different sizes using various areas or ranges, such as (1, 10), (1, 100), (0, 1), (0, 2), or (1, 1000). The underlying calculation logic of these methods is similar: both present calculations within a defined limit range. Given the detailed calculation stages of multiple mathematical methods, it is crucial that findings are presented accurately, and that careful calculations are made. The remainder of the paper is organized

as follows: the second section reviews the relevant literature; the third section explains the methods and materials used in the study; the results are presented in the fourth section; a sensitivity analysis is conducted in the fifth section; the sixth section discusses the findings and their managerial implications; and finally, the concluding remarks and future perspectives of the study are provided in the last section.

2. Literature review

In international trade, tariffs have been remarkably reduced through a combination of multilateral, regional and unilateral efforts, and on the other hand, countries that have actively pursued trade facilitation have gained from lower trade costs while participating in the ongoing multilateral negotiations. This indicates that trade facilitation is particularly important for development prospects as two conflicting dynamics in today's international trading system [21]. The new trade issues introduced at the multilateral trade negotiations in December 1996 at the Singapore Ministerial meeting: labeled as "Singapore Issues", include competition policy, investment, transparency in government procurement, and trade facilitation [27]. The impact of the TFIs is important not only in specifications regarding emerging countries as importers, but also when emerging countries are exporting to the rest of the countries (emerging and developed economies) in the overall sample [16]. Empirical research on trade facilitation faces three challenges: defining and measuring trade facilitation; choosing a modeling methodology to estimate the significance of trade facilitation; and designing a scenario to evaluate the impact of improved trade facilitation on trade flows [28].

Wilson et al. [29] developed four measures of trade facilitation: customs environment, port efficiency, regulatory environment, service sector infrastructure, and included them in a gravity model for trade flows: these set of indicators offer more details to policymakers about what kind of trade facilitation actions might provide the largest improvements in terms of increasing trade flow. Shepherd and Wilson [21] examined trade facilitation -including port infrastructure, customs administration air transport infrastructure, and services sector development- within ASEAN member countries and found that import and export costs vary significantly across member countries, from very low to moderately high levels, and tariff and non-tariff barriers are low to moderate. Sénquiz-Díaz [23] analyzed the impacts of tariff-related and trade barriers, trade facilitation, logistics, and trade using a sample of 80 countries: the results show that transportation infrastructure has a substantial direct impact on trade facilitation and logistics has a comparatively smaller direct effect.

Trade facilitation measures have become essential tools for creating a better trading environment. The international community recognizes that for many low-income countries, improved market access to industrialized countries is insufficient unless their trading capabilities are also enhanced. Efficient trade facilitation, such as improving the efficiency of border procedures by investing in infrastructure and human resources, can help reduce trade transaction costs, thereby reduce the spread between domestic and international prices, benefiting both consumers and producers [14] The prime trade drivers of the growth process are the Emerging Seven (hereafter E7) countries rather than other countries. The remarkable growth experienced by the E7 over the last two decades has allowed it to catch up with the G7, and such a high growth indicator also makes the E7 sensitive to trade flows due to rising demand for goods.

3. Material and methods

The OECD developed a set of TFIs that specify areas of reforms to help governments prioritize actions and mobilize more targeted technical assistance and capacity-building efforts for developing countries. The TFIs set by the OECD also help countries identifying their strengths and

weaknesses in trade facilitation. Initially, the TFIs were designed to measure seven different categories of trade facilitation efforts: port logistics, customs procedures, own regulatory environment, standards harmonization, business mobility, e-business activity, and administrative transparency and professionalism, which consisted of surveys and economic evidence on trade facilitation [27]. Subsequently, twelve TFIs were constructed to correspond to the main policy areas under negotiation at the WTO (Moïsé et al., 2011:5). The TFIs provide a structured overview of the trade facilitation policy environment and closely follow the structure in over 160 economies including 155 measures in total [24]. The OECD TFIs measure the extent to which countries implement trade facilitation measures and their performance compared to others. The indicators take values between 0 to 2, where 2 indicates the best possible performance. The TFIs currently applied by the OECD are presented in Table 1.

TFIs	Indicators	Explanations
TFIs1	Information availability	-availability of access to applicable and published legislation information;
TFIs2	Involvement of the trade community	-represents the participation of the entire trading community and consultations;
TFIs3	Advance rulings	-accessibility of rulings to the general trade, length of time a ruling is in effect, timeliness of issuance;
TFIs4	Appeal procedures	-the transparency, fairness, accessibility, timeliness, and effectiveness of the applicable rules and of outcomes;
TFIs5	Fees and charges	-availability of publicly available information about applicable fees and charges;
TFIs6	Formalities - documents	-harmonization of trade documents, simplification of documentary requirements, the use of copies, and the reduction of the number and complexity of required documentation;
TFIs7	Formalities - automation	-automated procedures, electronic interchange of documents (EDI), the application of risk management procedures;
TFIs8	Formalities - procedures	-single windows, pre-arrival processing, physical inspections, post-clearance audits, separation of release from clearance, authorized traders;
TFIs9	Internal border agency co-operation	-one-time documentary controls and coordinated physical inspections, average clearance times;
TFIs10	External border agency co-operation	-extensive co-operation and exchange programmes with neighboring and third countries;
TFIs11	Governance and impartiality	-good governance characteristics, clearly established and transparent structures and functions, ethics policy, a code of conduct, internal audits and transparent provisions for financing and sanctions.

Table 1: *Set of trade facilitation indicators.*

The relative economic and trade impact of specific trade facilitation measures offers countries with significant gains. This study examines trade facilitation as a means to enhance trade in emerging countries, enabling them to advance move rapidly in their development. The Emerging Seven (E7) is not an actual forum nor alliance, but merely a concept of the economic potential of emerging countries versus developed economies. The E7 countries consist of Brazil,

China, India, Indonesia, Mexico, Russia, and Türkiye. The advantages offered by emerging countries are closely monitored around the globe. Representing the world's largest emerging economies, the E7 countries hold an important position among emerging markets in terms of size and potential, population, resources and production, market size, investment attractiveness, technological and industrial developments, and have a major impact on global economic dynamics. By simplifying and harmonizing processes, trade facilitation enhances trade by providing convenience to all parties involved. Trade facilitation is achieved through a variety of tools and varies from country to country. This study compares the trade facilitation performance of the seven emerging countries using indicators determined by the OECD. Making comparisons based on a robust mathematical structure is essential for stakeholders who will benefit from these results when measuring multiple indicators across different countries [11]. A structured framework that considers various criteria and alternatives is critical for decision-making. MCDM methods provide a structured and systematic approach to evaluating decisions with multiple conflicting criteria, challenging traditional analytical methods. Depending on the objective of decision-making and application area, each MCDM method has different specifications and calculation stages [20, 10, 11]. This study uses MEREC, WENSLO, ENTROPY, LOPCOW, CVM, CRITIC, ANGLE, and GINI methods to analyze the indicators effectively. Additionally, the MABAC and ARTASI methods are used to rank different countries. Instead of explaining all mathematical methods one by one, citing the studies from which they emerged and the solution stages provides a significant accelerating effect for this study and allows a greater focus on trade facilitation.

The MEREC method was introduced to the literature as a new objective method for decision-making. The WENSLO method was introduced to the literature by [18], is a novel weighting method. The ENTROPY method has been frequently used as the oldest weighting method in the MCDM area since it was introduced to the literature as information uncertainty measure by Shannon [10]. The LOPCOW method is a relatively new method introduced to the literature with the idea of obtaining reasonable weights by evaluating data of different dimensions together and reducing the gap between the weights of the criteria. The Coefficient of Variation (CVM) method is used in the MCDM field to find the criteria weights as a statistical measure of the distribution of data points around the mean in a data-series. The CVM method represents the ratio of the standard deviation to the mean. Even if the means are very different from each other, it can be used to find the criteria weights and a useful statistic to measure the difference between criteria [22, 8]. The CRITIC method was introduced with an approach that considers the correlations between the criteria in order to find the criteria weights objectively. The CRITIC method finds the criteria weights closer to each other and objectively based on real data in its calculations. The ANGLE/Angular method by [22] uses the weights of objective criteria as references to measure the angles between itself and other attributes geometrically. The GINI method [12] was used as the Gini coefficient-based criterion weight determination method. The MABAC method calculates the values of the criterion functions and ranks the alternatives by their distance to the border approximation area. The ARTASI method, introduced by [19], ranks alternatives based on distance measurement at standardized intervals. Recent studies in the literature using the 10 different MCDM methods mentioned in this study are presented in Table 2.

Although the MCDM family does not have a very long history, it has come a long way in recent times. New methods are introduced to the literature and practitioners/academics make a choice among them by the most suitable one for their purposes.

4. Results

The TFIs are used to effectively compare selected countries. However, determining the weights of these indicators is an important aspect of the decision problem. There are multiple methods in

Method	Applications of the study, Researcher(s)
MEREC	Evaluating the social factors within the circular economy [7]
MEREC	Ranking the Asian countries for quality of life index [3]
WENSLO	Measuring sustainable brand equity performance [5]
ENTROPY	Selection of an optimal renewable energy source [4]
LOPCOW	Comparison of indexed business journals [8]
LOPCOW	Ranking the Asian countries for quality of life index [3]
CVM	Green electricity generation assessment [25]
CVM	Comparison of indexed business journals [8]
CRITIC	Evaluating the social factors within the circular economy [7]
CRITIC	A hybrid MCDM model to improve decision-making stability, reliability [2]
ANGLE	A Python library for determining criteria significance [1]
ANGLE	Green electricity generation assessment [25]
ANGLE	The most advantageous renewable energy storage devices [9]
GINI	Green electricity generation assessment [25]
GINI	A Python library for determining criteria significance [1]
MABAC	Selection of an optimal renewable energy source [4]
MABAC	A hybrid MCDM model to improve decision-making stability, reliability [2]
MABAC	Evaluation of urban quality improvement [13]
ARTASI	Website performance analysis [6]

Table 2: *Studies using objective methods.*

the MCDM literature, each with its own calculation stages [26]. When performing calculations with MCDM methods, an initial decision matrix is required, as shown in Table 3.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
Brazil	1.667	1.500	1.545	1.333	1.846	1.778	1.538	1.607	1.273	1.182	1.889
China	1.619	1.857	1.857	1.667	1.923	1.556	1.538	1.556	1.455	0.900	1.875
Indonesia	1.524	1.571	1.400	1.556	1.538	1.375	1.200	1.630	1.400	1.000	1.556
India	1.905	1.429	1.300	1.417	1.769	1.556	1.692	1.515	1.909	1.000	1.750
Mexico	1.571	1.750	1.500	1.364	1.846	1.625	2.000	1.600	1.636	1.545	1.889
Russia	1.905	1.875	1.700	1.462	1.857	1.750	1.769	1.594	1.636	1.182	2.000
Turkey	1.667	1.875	1.364	1.455	1.692	1.875	1.667	1.645	1.800	1.091	1.889

Table 3: *An initial overview of trade facilitations for E7 countries.*

This study employs multiple methods, and the weights for TFIs are determined using objective methods via their calculation stages outlined in Table 4.

Considering the calculations from the WENSLO (0.263), ENTROPY (0.231), ANGLE (0.158) and GINI (0.153) methods, the "w10-external border agency co-operation" indicator was found to be more important than the others.

In these same calculations, the "w7-Formalities – automation" indicator is found to be the second most important indicator, and then in the MEREC method, the most important (0.167) indicator. Both of these indicators (w10-0.143 and w7-0.131) also occupy the top two positions in the "mean" rankings, where the criteria weights are combined. Therefore, it is thought that better results can be achieved by averaging the criteria weights [7].

The linear relationship between the values found by the methods can be examined using correlation analysis. Analyzing the Pearson correlations between the criteria reveals that the high-

	MEREC	WENSLO	ENTROPY	LOPCOW	CVM	CRITIC	ANGLE	GINI	mean
w1	0.058	0.059	0.056	0.062	0.069	0.113	0.077	0.076	0.071
w2	0.093	0.065	0.090	0.085	0.086	0.091	0.096	0.097	0.088
w3	0.086	0.125	0.115	0.063	0.070	0.091	0.111	0.114	0.097
w4	0.053	0.042	0.042	0.065	0.071	0.123	0.067	0.068	0.066
w5	0.082	0.041	0.038	0.123	0.116	0.076	0.063	0.061	0.075
w6	0.099	0.063	0.074	0.102	0.099	0.075	0.088	0.090	0.086
w7	0.167	0.174	0.163	0.113	0.108	0.066	0.129	0.129	0.131
w8	0.028	0.006	0.005	0.114	0.108	0.114	0.024	0.024	0.053
w9	0.121	0.118	0.141	0.086	0.086	0.103	0.121	0.127	0.113
w10	0.121	0.263	0.231	0.059	0.067	0.089	0.158	0.153	0.143
w11	0.092	0.044	0.044	0.128	0.121	0.059	0.067	0.062	0.077
MEREC	1								
WENSLO	0.731	1							
ENTROPY	0.788	0.981	1						
LOPCOW	0.109	-0.407	-0.402	1					
CVM	0.103	-0.404	-0.404	1.000	1				
CRITIC	-0.641	-0.235	-0.235	-0.617	-0.623	1			
ANGLE	0.818	0.938	0.976	-0.440	-0.442	-0.275	1		
GINI	0.814	0.917	0.966	-0.455	-0.459	-0.240	0.996	1	
mean	0.887	0.957	0.981	-0.236	-0.239	-0.380	0.962	0.951	1

Table 4: *Weights and correlations of trade facilitation indicators.*

est correlations are between GINI-ANGLE (0.996): ENTROPY-WENSLO and ENTROPY-Mean (0.981): ENTROPY-ANGLE (0.976): ENTROPY-GINI (0.966): ANGLE-Mean (0.962). These correlations are notably high (See Table 3).

However, knowing which method provides the best results when multiple methods are used can be challenging for decision-makers and practitioners. In such cases, the decision maker's subjective judgment emerges and a method is selected based on the structure of the problem. On the other hand, when more than one method is used, taking their averages can make things easier, but also determining the most appropriate method via distance between the methods or their distance from the mean can make things easier. The distances of the eight methods to the mean were analyzed, considering that multidimensional scaling analysis could be useful, as shown in Figure 1.

Although the GINI method also appears to be close, the ANGLE method is the most suitable for this decision problem. Multidimensional analysis, as shown in Figure 1, along with correlation analysis, indicates that the ANGLE method provided results that were more similar to the mean compared to the other methods. Once criterion weights are found using various methods, the next stage in the decision problem involves ranking the alternatives. In this case, the ANGLE weighted MABAC-ARTASI methods are used to rank the alternatives, as shown in Table 5.

	ANGLE- MABAC		ANGLE- ARTASI	
Brazil	-0.050	6	1.622	6
China	0.074	4	1.681	4
Indonesia	-0.290	7	1.440	7
India	-0.038	5	1.635	5
Mexico	0.186	2	1.802	2
Russia	0.253	1	1.821	1
Türkiye	0.117	3	1.731	3

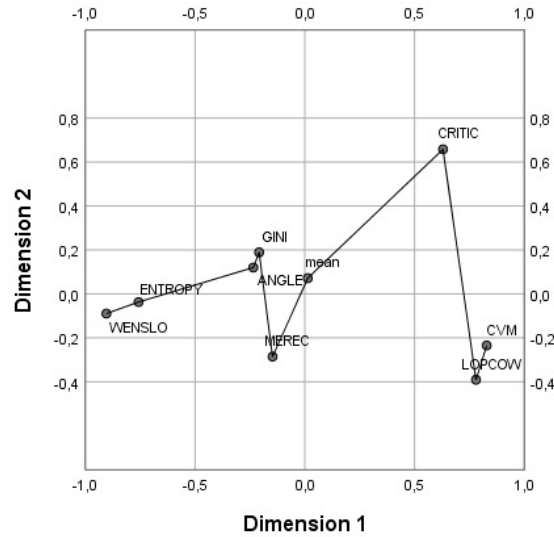Table 5: *Ranking of the E7 countries.*

Figure 1: *Results of the multidimensional scale analysis.*

In both methods (MABAC and ARTASI), Russia ranks first, followed by Mexico, Türkiye, China, India, Brazil, and Indonesia (see Table 4). When the TFIs criteria values are compared using MCDM methods, Russia is found to have the most favorable values among the E7 countries. Russia stands out from other alternatives, consistently ranking at or near the top across most TFIs indicators. Conversely, Indonesia ranks at the bottom, having the lowest or near-lowest TFIs indicator values.

5. Sensitivity analysis

To emphasize the robustness of the study, different sensitivity analysis scenarios can be performed, and the results compared with the initial findings. This study applies eight weighting methods, along with mean weights, for sensitivity analysis.

MABAC	MEREC	WENSLO	ENTROPY	LOPCOW	CVM	CRITIC	ANGLE	GINI	mean
Brazil	-0.041	-0.037	-0.057	-0.003	-0.008	-0.054	-0.050	-0.054	-0.038
China	0.068	0.015	0.025	0.087	0.090	0.104	0.074	0.076	0.067
Indonesia	-0.325	-0.292	-0.294	-0.290	-0.282	-0.201	-0.290	-0.288	-0.283
India	-0.034	-0.031	-0.027	-0.089	-0.085	-0.064	-0.038	-0.035	-0.051
Mexico	0.196	0.275	0.255	0.140	0.136	0.090	0.186	0.182	0.183
Russia	0.252	0.232	0.237	0.250	0.251	0.245	0.253	0.252	0.246
Türkiye	0.133	0.080	0.108	0.157	0.151	0.139	0.117	0.120	0.125
Brazil	6	6	6	5	5	5	6	6	5
China	4	4	4	4	4	3	4	4	4
Indonesia	7	7	7	7	7	7	7	7	7
India	5	5	5	6	6	6	5	5	6
Mexico	2	1	1	3	3	4	2	2	2
Russia	1	2	2	1	1	1	1	1	1
Türkiye	3	3	3	2	2	2	3	3	3

Table 6: *MABAC method findings based on the different weighting methods.*

In the MABAC method (see Table 6), which ranks the alternatives based on the determined approximation areas, different rankings were obtained depending on the criteria weights used.

Russia consistently ranks first, except when using the WENSLO and ENTROPY weights, while Indonesia consistently ranks last. In other words, minimal change was observed compared to the rankings found using the ANGLE weights as shown in Figure 2.
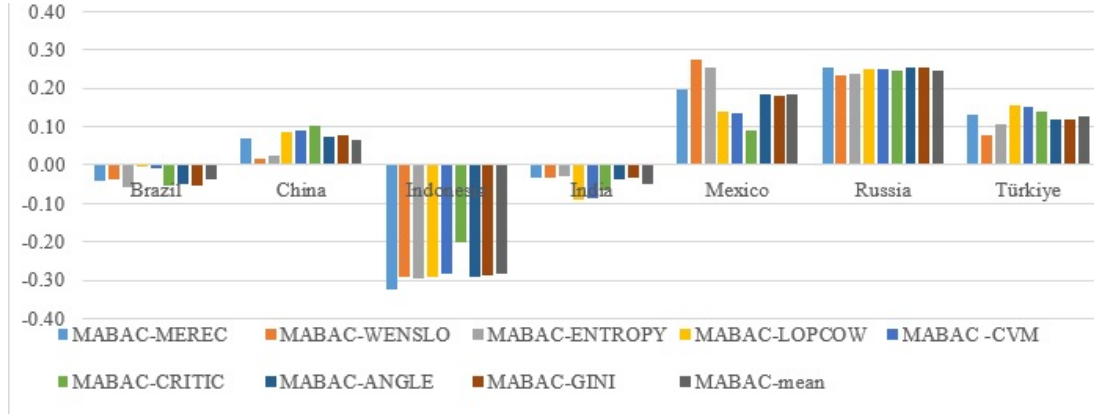

Figure 2: *MABAC method rankings.*

The rankings and sensitivity analysis of alternatives can be found based on previously calculated criteria weights not only for the MABAC method but also for the ARTASI method. The findings of the ARTASI method, using different methods, are presented in Table 7.

ARTASI	MEREC	WENSLO	ENTROPY	LOPCOW	CVM	CRITIC	ANGLE	GINI	mean
Brazil	1.635	1.597	1.589	1.701	1.694	1.656	1.622	1.619	1.639
China	1.690	1.600	1.615	1.760	1.757	1.750	1.681	1.682	1.692
Indonesia	1.424	1.393	1.401	1.495	1.496	1.538	1.440	1.441	1.453
India	1.654	1.596	1.608	1.686	1.681	1.677	1.635	1.636	1.647
Mexico	1.817	1.832	1.824	1.815	1.809	1.770	1.802	1.799	1.808
Russia	1.831	1.780	1.789	1.866	1.863	1.846	1.821	1.821	1.827
Türkiye	1.752	1.676	1.700	1.796	1.789	1.767	1.731	1.732	1.743
Brazil	6	5	6	5	5	6	6	6	6
China	4	4	4	4	4	4	4	4	4
Indonesia	7	7	7	7	7	7	7	7	7
India	5	6	5	6	6	5	5	5	5
Mexico	2	1	1	2	2	2	2	2	2
Russia	1	2	2	1	1	1	1	1	1
Türkiye	3	3	3	3	3	3	3	3	3
MEREC	1								
WENSLO	0.929	1							
ENTROPY	0.964	0.964	1						
LOPCOW	0.964	0.964	0.929	1					
CVM	0.964	0.964	0.929	1	1				
CRITIC	1	0.929	0.964	0.964	0.964	1			
ANGLE	1	0.929	0.964	0.964	0.964	1	1		
GINI	1	0.929	0.964	0.964	0.964	1	1	1	
mean	1	0.929	0.964	0.964	0.964	1	1	1	1

Table 7: *ARTASI method findings based on the different weighting methods.*

The ARTASI method, which ranks alternatives within specified limits, produces identical rankings when using MEREC, CRITIC, ANGLE, GINI and mean weights. The WENSLO, ENTROPY, LOPCOW, and CVM methods show strong positive correlations, with the lowest correlation at 0.929.

As in the MABAC findings, Russia ranks first, except when using WENSLO and ENTROPY weights, and Indonesia consistently ranks last. Given the narrow evaluation range (0-2), the ARTASI method produces values that are close but sortable. When all rankings obtained using MABAC and ARTASI methods were evaluated, identical rankings were produced across different methods in both approaches except for WENSLO and CRITIC.

6. Discussion and managerial implications

Since no prior studies have addressed TFI calculations, this study aimed to make a comparison through a unique application by diversifying and increasing the number of alternatives. TFIs data from 38 OECD members were used to make comparisons, with calculations conducted on a more comprehensive decision matrix using the same methods, as shown in Table 8.

	MEREC	WENSLO	ENTROPY	LOPCOW	CVM	CRITIC	ANGLE	GINI	mean
w1	0.057	0.042	0.042	0.091	0.089	0.076	0.068	0.071	0.067
w2	0.055	0.055	0.06	0.075	0.072	0.1	0.081	0.083	0.073
w3	0.091	0.086	0.12	0.085	0.082	0.113	0.112	0.099	0.098
w4	0.062	0.109	0.096	0.066	0.064	0.096	0.103	0.111	0.088
w5	0.033	0.023	0.024	0.074	0.071	0.133	0.052	0.054	0.058
w6	0.099	0.091	0.113	0.093	0.091	0.093	0.108	0.104	0.099
w7	0.074	0.051	0.053	0.100	0.099	0.101	0.076	0.079	0.079
w8	0.036	0.033	0.031	0.070	0.067	0.09	0.059	0.063	0.056
w9	0.101	0.141	0.149	0.082	0.079	0.077	0.127	0.135	0.111
w10	0.317	0.343	0.288	0.127	0.137	0.06	0.166	0.161	0.200
w11	0.074	0.026	0.023	0.136	0.151	0.062	0.05	0.04	0.070
MEREC	1								
WENSLO	0.958	1							
ENTROPY	0.929	0.978	1						
LOPCOW	0.601	0.386	0.334	1					
CVM	0.590	0.380	0.318	0.996	1				
CRITIC	-0.539	-0.477	-0.409	-0.680	-0.688	1			
ANGLE	0.825	0.915	0.971	0.190	0.168	-0.333	1		
GINI	0.766	0.895	0.939	0.073	0.052	-0.313	0.981	1	
mean	0.977	0.985	0.984	0.479	0.465	-0.479	0.923	0.878	1
E7-OECD	0.403	0.798	0.799	0.112	0.148	-0.063	0.756	0.735	0.746

Table 8: *Comparisons for a different data set based on the same weighting methods.*

Table 8 shows the TFIs calculated using the same methods as before, this time for OECD countries. Notably, the "w10-External border agency co-operation" indicator was found to be more important than the others, but this time even more important (0.200). Another noteworthy is "w9-Internal border agency co-operation" indicator, which was previously the third most important, emerged as the second most important criterion (0.111) this time. Again, very high correlations were found between LOPCOW-CVM (0.996), ANGLE-GINI (0.981), and ENTROPY-WENSLO (0.978). Furthermore, when analyzing the calculations/weightings for E7 (seven countries) and OECD (38 countries) in the last row of Table 8, it turns out that the weights before and after analysis are highly correlated in the ENTROPY (0.799) and WENSLO (0.798) methods. The ANGLE and GINI methods again emerged as the most appropriate methods when examining the distances of eight methods to the mean using multidimensional scaling analysis for OECD countries. Additionally, the ANGEL-based MABAC and ARTASI methods were applied to OECD countries, Korea, Netherlands, Sweden, Japan, and Norway ranking in the top five as trade-facilitating countries. On the other hand, the study also offers important theoretical and managerial implications, contributing to the literature.

Trade facilitation offers consumers with a wider range of products and services while providing employment and greater profit opportunities for producers. Facilitating factors can attract

international investments, leading to new job opportunities for investors through more predictable trade practices. Trade facilitation helps countries to transfer technology, thus increasing their competitiveness. Trade facilitation increases cooperation between countries, promoting more peaceful solutions. It also increases overall social welfare by indirectly contributing to countries in areas such as infrastructure, health and social development. The benefits of trade facilitation for countries include encouraging economic growth, increasing productivity and efficiency, benefiting both producers and consumers, increasing investments, indirectly providing technology transfer, increasing international cooperation and communication, ensuring sustainable development and long-term welfare.

Policymakers should take measures to trade facilitation, develop long-term strategic plans in this direction, and prioritize external-internal border agency co-operation, which this study identifies as particularly important. At the same time, countries should enhance trade facilitation by increasing the use of digital systems and automation to make customs procedures and transactions faster and more efficient, making customs duties and transactions more transparent and predictable, reducing trade barriers and tariffs, developing logistics and digital infrastructure, guiding companies in foreign trade, being transparent in governance, increasing human resources and entrepreneurship, supporting technology and innovation, and implementing a sustainable trade policy by effectively using international diplomacy. Policymakers need to prioritize reforms, such as reducing export costs, facilitate customs clearance, and support small and medium-sized enterprises, even though they are often costly and difficult to implement. Ultimately, it is recommended to prioritize policy tools and reform measures to accelerate export growth and economic development through trade facilitation.

7. Concluding remarks and future perspectives

The globalizing world is becoming more complex, prompting countries to introduce new measures in their trade with other countries to protect their domestic producers. On the other hand, countries that aim to support growth and development through increased trade are making efforts to eliminate trade barriers. This study analyses trade facilitation, using different methodologies, to develop a comprehensive understanding of trade facilitation for the E7 and comparable OECD countries. It also examines the effectiveness and usability of different methods, illustrated with diverse examples. The empirical results show that: 1. Among trade facilitation indicators, external border agency cooperation is the most significant factor 2. In the MABAC and ARTASI calculations, the E7 countries that are leading in trade facilitations, in order, are Russia, Mexico, Turkey, China, India, Brazil and Indonesia. 3. Russia ranks first among the E7 countries in terms of trade facilitation. However, since Russia's full-scale invasion of Ukraine, its international trade has undergone significant changes in both overall size and geographic composition of exports and imports. A coalition of Western countries has imposed comprehensive economic sanctions, which include restrictions on access to export markets, imports, logistics and financing. Additionally, measuers such as freezing the assets of the Russia's Central Bank, blocking access to foreign currency reserves, excluding Russia from SWIFT, and targeting certain individuals, have been implemented. 4. The study demonstrated that the ANGLE-MABAC model can be effectively used in future studies involving similar decision-making problem.

Trade facilitation contributes the volume of foreign trade and enhances the economic growth of countries, indirectly supporting job creation, reducing unemployment, increasing incomes, and improving overall economic welfare. Trade facilitation plays a positive role in eliminating competitive barriers in the trade of goods between countries, simplifying customs procedures, and encouraging companies to become more efficient and develop innovative solutions. This article could be improved in the following aspects. First, the proposed methodology could be applied to a comparison across all countries, globally. Additionally, current and newly intro-

duced methods could be compared to assess the proposed methodology's robustness. Another limitation to note is the use of secondary data; instead, a study could involve subjective methods by directly obtaining opinions from experts on the subject, but in this case, it would have been quite limiting both in terms of reaching the right experts and in terms of time and resource constraints.

Acknowledgements

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