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ORIGINAL PAPER

ASSESSING THE LOGISTICS MARKET PERFORMANCE OF DEVELOPING COUNTRIES BY SWARA-CRITIC BASED CoCoSo METHODS

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ABSTRACT. Background: The logistics market performance of developing countries has been measured by the Agility Emerging Markets Logistics Index [AEMLI] report since 2014. The main objective of this study is to propose a new model to assess the logistics market performance of developing countries and rank them based on this performance. Correspondingly, the AEMLI indicators were selected as the main criteria for assessing the logistics market performance of developing countries in this study.

Methods: In the current study, the AEMLI indicators, which are domestic logistics opportunities [DLO], international logistics opportunities [ILO], business fundamentals [BF] and digital readiness [DR], were used as criteria to assess the logistics market performances of developing countries. First, the weights of the criteria were computed by a combination of subjective [SWARA] and objective [CRITIC] methods. Then, the CoCoSo method was used to rank developing countries according to their logistics market performance.

Results: The findings indicate that BF is the most significant criterion, followed by ILO, DR and DLO. Based on the results of the proposed model, China, India, the United Arab Emirates [UAE], Malaysia, and Saudi Arabia had the best logistics market performance in 2022, while Angola, Myanmar, Mozambique, Venezuela, and Libya had the worst logistics market performance in 2022. Additionally, some differences in the ranking of developing countries according to logistics market performance can be observed in the proposed model compared to the AEMLI 2023 report.

Conclusion: To the best of the author's knowledge, this is the first study to examine logistics market performance through the combination of two weighting methods (both subjective and objective). The current study also contributes to the existing literature by providing insight into logistics market performance for carriers, shippers, distributors, policy makers, and others who focus on the world's emerging markets.

Keywords: logistics, emerging markets, SWARA, CRITIC, CoCoSo

INTRODUCTION

Logistics plays a key role in the development of the global economy by enhancing international trade. During the COVID-19 pandemic, logistics experienced significant growth all around the world. The logistics industry worldwide was worth approximately 8.5 trillion Euros in 2021 and is expected to reach almost 14 trillion Euros by 2027. In parallel to this, global total logistics costs soared to 9 trillion U.S. dollars in 2020. That represents 10.7 percent of the global Gross Domestic Product [GDP] of 85.24 trillion U.S. dollars that year [Placek, 2023]. Particularly in the last few years, the cost of logistics, transport, and warehousing has increased exponentially due to the uncertainty and lack of resources in the logistics industry.

According to the latest report published by Gi Group [2022], the size of the global logistics market has been growing rapidly worldwide. In 2018, the global economic value of logistics was 8 trillion U.S. dollars, but by the end of 2024, it is estimated to exceed that by about 25% compared to 2018, reaching 9.9 trillion U.S. dollars. Moreover, developing countries are playing an active role in the growth of the global logistics market. Correspondingly, the importance of emerging markets in global

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logistics activity continues to increase. For instance, about 60% of the global logistics market is dominated by developing countries. 45% of the global logistics market is occupied by the Asia-Pacific region, followed by Africa, South America, and the Commonwealth of Independent States [CIS] region, which accounts for about 15% of the market. There are also interesting developments in other regions, such as the Middle East and North Africa [Gi Group, 2022, p. 4-6]. For this reason, it is important to compare the logistics performance of different nations.

Some international organizations, such as the World Bank [WB], Transport Intelligence [T*i*] and Agility, have developed indices to measure the logistics performance of nations. For instance, the Logistics Performance Index [LPI] and the Agility Emerging Markets Logistics Index [AEMLI] have been developed by the WB and Ti/Agility, respectively. The AEMLI report focuses on the assessment of the logistics market performance of 50 of the world's most promising emerging markets. This index has examined four key areas, namely domestic logistics opportunities [DLO], international logistics opportunities [ILO], business fundamentals [BF] and digital readiness [DR]. To determine the logistics market performance of 50 leading global emerging markets, data was collected from prestigious institutions around the world, including the International Monetary Fund [IMF], the World Economic Forum [WEF], the WB and T*i*. As a result, the index provides a snapshot of each country's current performance and future potential as a globally significant logistics market and investment destination [Agility, 2023, p.11].

In recent years, there has been an increasing amount of literature on the logistics performance of nations using Multi-Criteria Decision-Making [MCDM] methods. For example, the logistics performance index [LPI] of OECD countries [Çakır, 2017; Yıldırım and Adıgüzel Mercangöz, 2020; Çalık et al., 2023], Balkan and Western Balkan countries [Mešić et al., 2022; Stević et al., 2022], Central and Eastern European countries [Isik et al., 2020], European Union [EU] countries [Ulutaş and Karaköy, 2019], and Turkey and the EU [Senir, 2021] have all been examined by hybrid MCDM methods. However, there has been relatively little literature published on logistics market performance using MCDM methods. Kara et al. [2022] investigated the logistics market performance of developing countries using Entropy and MABAC methods. Another study, conducted by Kara and Yalçın [2022], reviewed the digital logistics market performance of developing countries using MEREC and RAFSI methods. Previous studies indicate that much of the current literature is concentrated on the LPI. A limited number of studies have reviewed the logistics market performance of countries. Additionally, much of the research in the existing literature has been conducted using a single approach, either subjective or objective.

Accordingly, the main objective of this study is to propose a new model to assess the logistics market performance of developing countries and to rank them based on their logistics market performance. At first, the weights of criteria were computed by a combination of subjective [SWARA] and objective [CRITIC] methods. Then, developing countries were ranked according to their logistics market performance by the CoCoSo method. The rest of this paper is structured as follows: the second section describes the MCDM methods used in the study; the third section is concerned with applications and results, and presents the findings of the study; finally, the conclusion gives a summary and critique of the findings.

LITERATURE REVIEW

The last decade has seen the publication of a significant number of studies examining the logistics performance of countries using MCDM methods. Table 1 provides a brief synopsis of the relevant literature.

Table 1. Overview of Previous Studies

Author(s)	Year	Indicators	Methods	Topic
Gergin & Baki	2015	WB LPI	AHP & TOPSIS	Analysis of the LPI of regions in Turkey
Çakır	2017	WB LPI	CRITIC & SAW & Peter's Fuzzy Regression	Measurement of the LPI of OECD countries
Candan	2019	WB LPI	Fuzzy AHP & Grey Relational	Evaluation of the LPI of selected countries in the OECD
Orhan	2019	WB LPI	ENTROPY & EDAS	Comparison of the LPI of Turkey and EU countries
Ulutaş & Karaköy	2019	WB LPI	SWARA & CRITIC & PIV	Analysis of the LPI of EU countries
Yıldırım & Adıgüzel Mercan	2020	WB LPI	Fuzzy AHP & ARAS-G	Evaluation of the LPI of OECD countries
Isık et al.	2020	WB LPI	SV & MABAC	Assessment of the LPI of Central and Eastern European countries
Adıgüzel et al.	2020	WB LPI	COPRAS-G	Examination of the LPI for a selected period: EU and 5 EU candidate countries
Senir	2021	WB LPI	CRITIC & COPRAS	Comparison of domestic logistics performance of Turkey and EU countries
Mešić et al.	2022	WB LPI	CRITIC & MARCOS	Evaluation of the LPI of the Western Balkan countries
Arıkan Kargı	2022	WB LPI	ENTROPY & WASPAS	Evaluation of the LPI of OECD countries
Kara et al.	2022	AEMLI Report	ENTROPY & MABAC	Determination of the logistics market performance of developing countries
Kara & Yalçın	2022	AEMLI & DCI Report	MEREC & RAFSI	Analysis of the digital logistics market performance of 19 developing countries
Çalık et al.	2023	WB LPI	AHP & TOPSIS, VIKOR & CODAS	Evaluation of the logistics performance of 160 OECD countries

This overview of previous studies indicates that the LPI has been widely used to evaluate the logistics performance of countries. In particular, the assessment and comparison of logistics performance were conducted using integrated MCDM methods. Most studies that evaluate logistics performance have been carried out with LPI by using various MCDM methods. However, a limited number of studies have examined the logistics market performance of countries. So far, no studies have been found that investigate logistics market performance by combining two weighting methods. Correspondingly, this study aims to contribute to this area of research by proposing a new model.

METHODOLOGY

In this study, hybrid MCDM methods were applied to evaluate the logistics market performance of developing countries. In this regard, two weighting methods, namely SWARA and CRITIC, were used to calculate the weights of criteria. The ranking of alternatives was carried out by the CoCoSo method. The steps of the methods used in this study are presented below.

Stepwise Weight Assessment Ratio Analysis [SWARA] Method

The Stepwise Weight Assessment Ratio Analysis [SWARA] method was introduced by Kersuliene, Zavadskas and Turkis in 2010. In this method, which is based on weightings, the relative importance and the initial prioritization of alternatives for each attribute are chosen by the decision-maker, and then the relative weight of each attribute is determined. The steps of the SWARA method are as follows [Keršuliene et al., 2010; Alinezhad & Khalili, 2019]:

Step 1. The Initial Prioritization of Attributes

First, the attributes are prioritized in terms of relative importance, determined by decision-makers.

Step 2. The Coefficient (K)

The coefficient (K) of an attribute for each decision-maker is calculated using Eq. [1].

$$K_j = \begin{cases} 1 & if \quad j = 1 \\ S_j + 1 & if \quad j > 1 \end{cases}; \qquad [1]$$

$$j = 1, \dots\dots\dots\dots\dots\dots, n$$

Step 3. The Initial Weight

At this stage, Eq. [2] is used to compute the initial weight of an attribute for each decision-maker.

$$K_j = \begin{cases} 1 & if \quad j = 1 \\ \dfrac{q_j}{K_j} & if \quad j > 1 \end{cases}; \qquad [2]$$

$$j = 1, \dots\dots\dots\dots\dots\dots, n$$

Step 4. The Relative Weight

Eq. [3] is applied to determine the relative weight of an attribute for each decision maker.

$$w_j = \frac{q_j}{\sum_{j=1}^{n} q_i} \qquad [3]$$

Step 5. The Final Ranking of Attributes

By determining the relative weight of each attribute, the values are arranged in descending order, producing the final ranking.

Criteria Importance Through Intercriteria Correlation [CRITIC] Method

The Criteria Importance Through Intercriteria Correlation [CRITIC] method was introduced by Diakoulaki, Mavrotas and Papayannakin in 1995. It is mostly utilized to calculate the weight of attributes and it is an objective weighting method. The attributes in the present method do not conflict with one another, and the decision matrix is used to calculate the weights of the attributes. The steps of the CRITIC method are as follows [Diakoulaki et al., 1995; Alinezhad & Khalili, 2019]:

Step 1. The Normalized Decision Matrix

In order to normalize the positive and negative attributes of the decision matrix, Eqs. [4] and [5] are utilized, respectively.

$$x_{ij} = \frac{r_{ij} - r_i^-}{r_i^t - r_i^-}; \qquad [4]$$
$$i = 1, \dots\dots, m \quad j = 1, \dots\dots, n$$

$$x_{ij} = \frac{r_{ij} - r_i^+}{r_i^- - r_i^+}; \qquad [5]$$
$$i = 1, \dots\dots, m \quad j = 1, \dots\dots, n$$

where x_{ij} represents a normalized value of the decision matrix for the *i*th alternative for the *j*th attribute, $r_i^+ = \max(r_1, r_2, \dots, r_m)$ and $r_i^- = \min(r_1, r_2, \dots, r_m)$.

Step 2. The Correlation Coefficient

Eq. [6] is used to determine the correlation coefficient among attributes.

$$\rho_{jk} = \sum_{i=1}^{m}(x_{ij} - \bar{x}_j)(x_{ik} - \bar{x}_k) \Big/ \sqrt{\sum_{i=1}^{m}(x_{ij} - \bar{x}_j)^2 \sum_{i=1}^{m}(x_{ik} - \bar{x}_k)^2} \qquad [6]$$

where $\bar{x}_j$ and $\bar{x}_k$ display the mean of the *j*th and *k*th attributes. $\bar{x}_j$ is computed from Eq. [7]. $\bar{x}_k$ is obtained in the same way. ρ_{jk} is the correlation coefficient between the *j*th and *k*th attributes.

$$\bar{x}_j = \frac{1}{n}\sum_{j=1}^{n} x_{ij}; \qquad [7]$$

$$i = 1, \dots\dots\dots\dots\dots\dots, m$$

Step 3. The Index (C)

At first, the standard deviation of each attribute is estimated by Eq. [8].

$$\sigma_j = \sqrt{\frac{1}{n-1}\sum_{j=1}^{n}\left(x_{ij} - \bar{x}_j\right)^2}; \qquad i \qquad [8]$$

$$= 1, \dots\dots\dots\dots, m$$

Then, the index (C) is calculated using Eq. [9].

$$C_J = \sigma_j \sum_{k=1}^{n} (1 - \rho_{jk}); \quad j = 1, \ldots\ldots\ldots\ldots\ldots, n \qquad [9]$$

Step 4. Weights of Attributes

The weights of the attributes are determined by Eq. [10].

$$w_j = \frac{C_j}{\sum_{j=1}^{n} C_j}; \quad j = 1, \ldots\ldots\ldots\ldots\ldots, n \qquad [10]$$

For the final ranking, the attribute weights are ranked in descending order.

Calculation of the Aggregated Weighting Method

By using Eq. [11], the aggregated weight is computed [Ighravwe & Babatunde, 2018; Ali et al., 2020];

$$W_{Aggregated} = \Delta W_{sj} + (1\text{-}\Delta)\ Woj \qquad [11]$$

where W_{sj} and W_{oj} represent the subjective and objective weights of the criteria respectively and Δ symbolizes the contribution factor. Keshavarz Ghorabaee et al. [2017] suggested using values of Δ from 0 to 1. For this study, Δ = 0.5 was selected.

Combined Compromise Solution [CoCoSo] Method

The Combined Compromise Solution [CoCoSo] was proposed by Yazdani, Zarate, Zavadskas and Turskis in 2019. This approach is based on an integrated simple additive weighting and exponentially weighted product model. It can function as a compendium of compromise solutions. To solve a CoCoSo decision problem, after determining the alternatives and the related criteria, the following steps are used [Yazdani et al., 2019]:

Step 1. The Initial Decision Matrix is Formed.

Step 2. The Normalized Decision Matrix

The normalization of criteria values is accomplished based on the compromise normalization equation.

$$r_{ij} = \frac{x_{ij} - \min\limits_{i} x_{ij}}{\max\limits_{i} x_{ij} - \min\limits_{i} x_{ij}}; \qquad [12]$$

$$r_{ij} = \frac{x_{ij} - \max\limits_{i} x_{ij} - x_{ij}}{\max\limits_{i} x_{ij} - \min\limits_{i} x_{ij}}; \qquad [13]$$

Step 3. The Calculation of S_i and P_i Values

The total of the weighted comparability sequence and the whole of the power weight of comparability sequences for each alternative sum of the weighted comparability sequence and also an amount of the power weight of comparability sequences for each alternative are denoted as S_i and P_i, respectively.

$$S_i = \sum_{j=1}^{n} (w_j r_{ij}), \qquad [14]$$

this S_i value is determined based on a grey relational generation approach:

$$P_i = \sum_{j=1}^{n} (r_{ij})^{w_j} \qquad [15]$$

this P_i value is determined according to the WASPAS multiplicative attitude.

Step 4.

The relative weights of the alternatives are computed using the following aggregation strategies. In this step, three appraisal score strategies are used to generate the relative weights of other options, which are derived using Eqs. [16]-[18]:

$$k_{ia} = \frac{P_i + S_i}{\sum_{i=1}^{m} (P_i + S_i)} \qquad [16]$$

$$k_{ib} = \frac{S_i}{\min\limits_{i} S_i} + \frac{P_i}{\min\limits_{i} P_i} \qquad [17]$$

$$k_{ic} = \frac{\lambda(S_i) + (1-\lambda)(P_i)}{\left(\lambda \underset{i}{max} S_i + (1-\lambda) \underset{i}{max} P_i\right)} \quad [18]$$

$$0 \leq \lambda \leq 1.$$

It is found that Eq. [16] expresses the arithmetic mean of the sums of the WSM and WPM scores, while Eq. [17] expresses a sum of relative scores of WSM and WPM compared to the best. Eq. [18] gives the balanced compromise of the WSM and WPM model scores. In Eq. [18] λ (usually λ = 0.5) is chosen by decision-makers. However, the flexibility and stability of the proposed CoCoSo can be affected by other values.

Step 5. The Final Ranking

The final ranking of the alternatives is determined based on k_i values (the more significant the better):

$$k_i = (k_{ia}k_{ib}k_{ic})^{\frac{1}{3}} + \frac{1}{3}(k_{ia}k_{ib}k_{ic}) \quad [19]$$

APPLICATION AND RESULTS

Results Obtained from the Subjective Method [SWARA]

Table 2 represents the initial prioritization of attributes based on the experts' opinions.

Table 2. The Initial Prioritization Matrix

Criteria	Decision Makers (DM)								Average Importance Scores
	DM_1	DM_2	DM_3	DM_4	DM_1	DM_2	DM_3	DM_4	
DLO	4	4	3	4	0.25	0.25	0.50	0.25	0.31
ILO	1	3	2	1	1.00	0.50	0.75	1.00	0.81
BF	2	1	1	2	0.75	1.00	1.00	0.75	0.88
DR	3	2	4	3	0.50	0.75	0.25	0.50	0.50

Using Eqs. [1], [2] and [3], the coefficient, the initial weight and the relative weight of the attributes for each decision-maker were computed. They are shown in Table 3.

Table 3. Results of s_j, K_j, q_j and w_j

Criteria	Average Importance Scores	The Comparative Value of the Average Importance Scores (s_j)	Coefficient Values (K_J)	Recalculated Weight (q_j)	Final Weight (w_j)
BF	0.88	-	1.0000	1.0000	0.3080
ILO	0.81	0.0700	1.0700	0.9345	0.2878
DR	0.50	0.3100	1.3100	0.7133	0.2197
DLO	0.31	0.1900	1.1900	0.5994	0.1846

Results Obtained from the Objective Method [CRITIC]

The decision matrix for assessing the logistics market performance of developing countries is presented in Table 4.

The normalized values of the decision matrix were calculated with respect to the positive or negative attributes as illustrated in Table 5.

The correlation coefficient was computed according to Eqs. [6] and [7] and is illustrated in Table 6.

The standard deviation of each attribute and the index (*C*) was calculated using Eqs. [8] and [9] and is shown in Table 7.

Table 4. Decision Matrix

Rank	Country	DLO	ILO	BF	DR	Rank	Country	DLO	ILO	BF	DR
1	China	8.47	9.75	7.11	6.63	26	Pakistan	5.16	4.63	4.13	5.06
2	India	8.04	7.45	5.94	7.61	27	Peru	4.72	5.12	4.48	4.58
3	UAE	5.60	5.89	9.10	7.37	28	Colombia	4.67	5.08	4.55	4.53
4	Malaysia	5.29	5.88	7.85	6.72	29	Ghana	4.61	4.44	5.00	5.14
5	Indonesia	6.34	5.89	5.77	6.21	30	Sri Lanka	4.49	4.73	4.32	5.12
6	Saudi Arabia	5.38	5.74	7.89	6.30	31	Argentina	4.87	4.63	4.24	4.68
7	Qatar	5.91	4.96	7.92	6.38	32	Tunisia	4.61	4.48	5.06	4.39
8	Thailand	5.11	5.98	5.77	6.04	33	Lebanon	4.81	4.61	3.79	4.80
9	Mexico	5.37	6.32	4.93	5.11	34	Nigeria	5.15	4.39	3.62	4.61
10	Vietnam	5.02	6.03	5.61	5.43	35	Bangladesh	5.02	4.48	3.53	4.63
11	Turkey	5.14	5.70	5.80	5.50	36	Iran	4.57	4.11	4.38	5.15
12	Oman	4.95	4.88	7.24	5.81	37	Tanzania	4.62	4.14	4.70	4.58
13	Chile	4.83	5.18	7.01	5.55	38	Cambodia	4.45	4.48	4.16	4.73
14	Bahrain	4.99	4.70	7.15	5.34	39	Ecuador	4.50	4.65	4.49	4.03
15	Kuwait	5.07	4.64	6.23	5.76	40	Paraguay	4.45	4.38	4.30	4.72
16	Jordan	4.88	4.75	6.72	5.14	41	Algeria	4.88	4.24	4.61	3.91
17	Russia	5.01	5.41	5.13	5.14	42	Ukraine	4.34	4.38	3.95	4.91
18	Philippines	5.02	5.28	4.31	5.99	43	Uganda	4.41	4.38	3.91	4.24
19	Brazil	5.42	5.42	4.13	5.19	44	Bolivia	4.44	4.46	3.74	3.45
20	Morocco	4.64	5.09	6.45	4.69	45	Ethiopia	4.42	4.40	3.21	3.64
21	Egypt	5.15	4.72	5.62	5.00	46	Mozambique	4.25	4.39	2.17	3.22
22	Kazakhstan	4.66	4.66	6.19	5.10	47	Venezuela	4.48	3.96	1.56	3.99
23	Uruguay	4.78	4.45	6.14	5.22	48	Angola	4.37	4.30	1.90	3.11
24	South Africa	4.81	5.00	4.99	5.01	49	Myanmar	4.44	4.27	2.04	2.79
25	Kenya	4.60	4.65	4.97	5.56	50	Libya	4.48	3.81	1.96	1.84

Table 5. Normalized Values of Decision Matrix

Rank	Country	DLO	ILO	BF	DR	Rank	Country	DLO	ILO	BF	DR
1	China	1.0000	1.0000	0.7361	0.8302	26	Pakistan	0.2156	0.1380	0.3408	0.5581
2	India	0.8981	0.6128	0.5809	1.0000	27	Peru	0.1114	0.2205	0.3873	0.4749
3	UAE	0.3199	0.3502	1.0000	0.9584	28	Colombia	0.0995	0.2138	0.3966	0.4662
4	Malaysia	0.2464	0.3485	0.8342	0.8458	29	Ghana	0.0853	0.1061	0.4562	0.5719
5	Indonesia	0.4953	0.3502	0.5584	0.7574	30	Sri Lanka	0.0569	0.1549	0.3660	0.5685
6	Saudi Arabia	0.2678	0.3249	0.8395	0.7730	31	Argentina	0.1469	0.1380	0.3554	0.4922
7	Qatar	0.3934	0.1936	0.8435	0.7868	32	Tunisia	0.0853	0.1128	0.4642	0.4419
8	Thailand	0.2038	0.3653	0.5584	0.7279	33	Lebanon	0.1327	0.1347	0.2958	0.5130
9	Mexico	0.2654	0.4226	0.4469	0.5667	34	Nigeria	0.2133	0.0976	0.2732	0.4801
10	Vietnam	0.1825	0.3737	0.5371	0.6222	35	Bangladesh	0.1825	0.1128	0.2613	0.4835
11	Turkey	0.2109	0.3182	0.5623	0.6343	36	Iran	0.0758	0.0505	0.3740	0.5737
12	Oman	0.1659	0.1801	0.7533	0.6880	37	Tanzania	0.0877	0.0556	0.4164	0.4749
13	Chile	0.1374	0.2306	0.7228	0.6430	38	Cambodia	0.0474	0.1128	0.3448	0.5009
14	Bahrain	0.1754	0.1498	0.7414	0.6066	39	Ecuador	0.0592	0.1414	0.3886	0.3795
15	Kuwait	0.1943	0.1397	0.6194	0.6794	40	Paraguay	0.0474	0.0960	0.3634	0.4991
16	Jordan	0.1493	0.1582	0.6844	0.5719	41	Algeria	0.1493	0.0724	0.4045	0.3588
17	Russia	0.1801	0.2694	0.4735	0.5719	42	Ukraine	0.0213	0.0960	0.3170	0.5321
18	Philippines	0.1825	0.2475	0.3647	0.7192	43	Uganda	0.0379	0.0960	0.3117	0.4159
19	Brazil	0.2773	0.2710	0.3408	0.5806	44	Bolivia	0.0450	0.1094	0.2891	0.2790
20	Morocco	0.0924	0.2155	0.6485	0.4939	45	Ethiopia	0.0403	0.0993	0.2188	0.3120
21	Egypt	0.2133	0.1532	0.5385	0.5477	46	Mozambique	0.0000	0.0976	0.0809	0.2392
22	Kazakhstan	0.0972	0.1431	0.6141	0.5650	47	Venezuela	0.0545	0.0253	0.0000	0.3726
23	Uruguay	0.1256	0.1077	0.6074	0.5858	48	Angola	0.0284	0.0825	0.0451	0.2201
24	South Africa	0.1327	0.2003	0.4549	0.5494	49	Myanmar	0.0450	0.0774	0.0637	0.1646
25	Kenya	0.0829	0.1414	0.4523	0.6447	50	Libya	0.0545	0.0000	0.0531	0.0000

Table 6. Correlation Coefficient

Criteria	DLO	ILO	BF	DR
DLO	**1.0000**	0.8761	0.4706	0.6684
ILO	0.8761	**1.0000**	0.5115	0.6600
BF	0.4706	0.5115	**1.0000**	0.8148
DR	0.6684	0.6600	0.8148	**1.0000**

Table 7. The Index (*C*)

Criteria	DLO	ILO	BF	DR
DLO	0.0000	0.1239	0.5294	0.3316
ILO	0.1239	0.0000	0.4885	0.3400
BF	0.5294	0.4885	0.0000	0.1852
DR	0.3316	0.3400	0.1852	0.0000

The final weights of the attributes was determined using Eq. [10] and are presented in Table 8.

Results Obtained from the Aggregated Weighting Method

The aggregated weights were obtained using Eq. [11]. The subjective [SWARA] weights, objective weights [CRITIC] and aggregated weights are presented in Table 9.

Table 8. Final Weights

Criteria	DLO	ILO	BF	DR
σ_J	0.1876	0.1650	0.2229	0.1902
C_J	0.1847	0.1571	0.2681	0.1629
W_J	0.2390	0.2033	0.3469	0.2108

Table 9. Results of Criteria Weights

Criteria	Subjective (SWARA)	Objective (CRITIC)	Aggregated Weighting Method
BF	0.3080	0.3469	0.3274
ILO	0.2878	0.2033	0.2455
DR	0.2197	0.2108	0.2152
DLO	0.1846	0.2390	0.2118

Business Fundamentals [BF] is the most important criterion according to both the SWARA and CRITIC methods. It is noticeable that the weights and ranks of the other criteria given by these two methods are different. Additionally, the aggregated weighting method demonstrates that BF is the most important criterion, just like the SWARA and CRITIC methods. Moreover, the weights of international logistics opportunities [ILO], digital readiness [DR] and domestic logistics opportunities [DLO] are in the same rank order as was generated using the SWARA method. However, the weights and ranks of the other criteria of the CRITIC method are not the same. Therefore, for better accuracy and reliability, aggregated weights were used in this study. The comparison of the three different weighting approaches is shown in Figure 1.

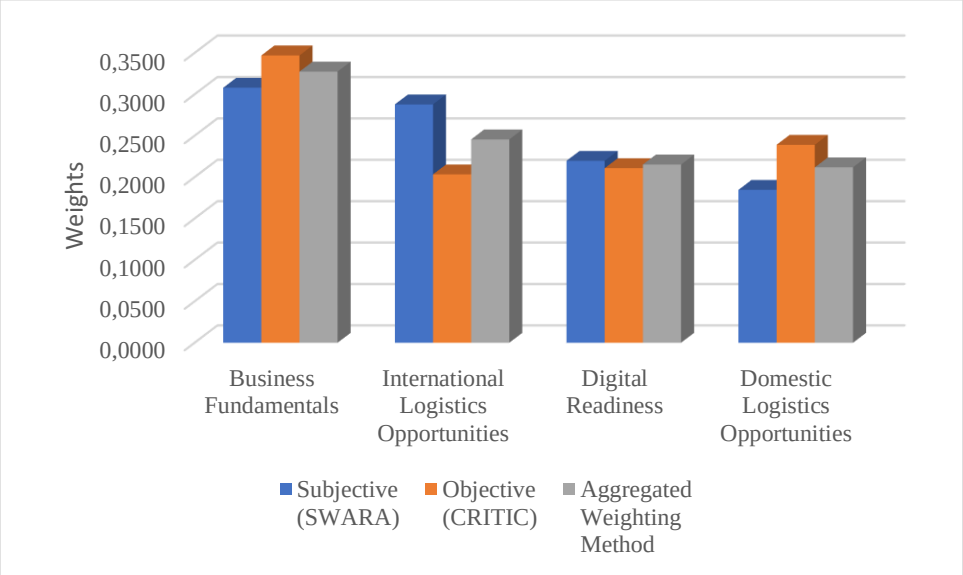

Figure 1. Results of Criteria Weights Based on Three Different Methods

According to the results obtained by the aggregated weighting method, BF and DLO are the most important and least important of the four criteria, respectively.

Results Obtained from The Ranking Method [CoCoSo]

A step-by-step calculation was conducted to obtain the rank of alternatives. First, the initial decision matrix was formed. It is shown in Table 10.

Table 10. The Initial Matrix

Weights	**0.2118**	**0.2455**	**0.3274**	**0.2152**	**Weights**	**0.2118**	**0.2455**	**0.3274**	**0.2152**
Optimal Value	*Max*	*Max*	*Max*	*Max*	**Optimal Value**	*Max*	*Max*	*Max*	*Max*
Country	**DLO**	**ILO**	**BF**	**DR**	**Country**	**DLO**	**ILO**	**BF**	**DR**
China	8.47	9.75	7.11	6.63	Pakistan	5.16	4.63	4.13	5.06
India	8.04	7.45	5.94	7.61	Peru	4.72	5.12	4.48	4.58
UAE	5.60	5.89	9.10	7.37	Colombia	4.67	5.08	4.55	4.53
Malaysia	5.29	5.88	7.85	6.72	Ghana	4.61	4.44	5.00	5.14
Indonesia	6.34	5.89	5.77	6.21	Sri Lanka	4.49	4.73	4.32	5.12
Saudi Arabia	5.38	5.74	7.89	6.30	Argentina	4.87	4.63	4.24	4.68
Qatar	5.91	4.96	7.92	6.38	Tunisia	4.61	4.48	5.06	4.39
Thailand	5.11	5.98	5.77	6.04	Lebanon	4.81	4.61	3.79	4.8
Mexico	5.37	6.32	4.93	5.11	Nigeria	5.15	4.39	3.62	4.61
Vietnam	5.02	6.03	5.61	5.43	Bangladesh	5.02	4.48	3.53	4.63
Turkey	5.14	5.70	5.80	5.50	Iran	4.57	4.11	4.38	5.15
Oman	4.95	4.88	7.24	5.81	Tanzania	4.62	4.14	4.70	4.58
Chile	4.83	5.18	7.01	5.55	Cambodia	4.45	4.48	4.16	4.73
Bahrain	4.99	4.70	7.15	5.34	Ecuador	4.50	4.65	4.49	4.03
Kuwait	5.07	4.64	6.23	5.76	Paraguay	4.45	4.38	4.30	4.72
Jordan	4.88	4.75	6.72	5.14	Algeria	4.88	4.24	4.61	3.91
Russia	5.01	5.41	5.13	5.14	Ukraine	4.34	4.38	3.95	4.91
Philippines	5.02	5.28	4.31	5.99	Uganda	4.41	4.38	3.91	4.24
Brazil	5.42	5.42	4.13	5.19	Bolivia	4.44	4.46	3.74	3.45
Morocco	4.64	5.09	6.45	4.69	Ethiopia	4.42	4.40	3.21	3.64
Egypt	5.15	4.72	5.62	5.00	Mozambique	4.25	4.39	2.17	3.22
Kazakhstan	4.66	4.66	6.19	5.10	Venezuela	4.48	3.96	1.56	3.99
Uruguay	4.78	4.45	6.14	5.22	Angola	4.37	4.30	1.90	3.11
South Africa	4.81	5.00	4.99	5.01	Myanmar	4.44	4.27	2.04	2.79
Kenya	4.60	4.65	4.97	5.56	Libya	4.48	3.81	1.96	1.84

The normalized values of the decision matrix were computed based on Eq. [12] and are presented in Table 11.

The total of the weighted comparability sequence, the whole of the power weight of comparability sequences for each alternative sum of the weighted comparability sequence, and the power weight of comparability sequences for each alternative, S_i and P_i, were calculated using Eqs. [14] and [15], and are shown in Table 12 and 13, respectively.

Table 11. The Normalized Matrix

Country	DLO	ILO	BF	DR	Country	DLO	ILO	BF	DR
China	1.0000	1.0000	0.7361	0.8302	Pakistan	0.2156	0.1380	0.3408	0.5581
India	0.8981	0.6128	0.5809	1.0000	Peru	0.1114	0.2205	0.3873	0.4749
UAE	0.3199	0.3502	1.0000	0.9584	Colombia	0.0995	0.2138	0.3966	0.4662
Malaysia	0.2464	0.3485	0.8342	0.8458	Ghana	0.0853	0.1061	0.4562	0.5719
Indonesia	0.4953	0.3502	0.5584	0.7574	Sri Lanka	0.0569	0.1549	0.3660	0.5685
Saudi Arabia	0.2678	0.3249	0.8395	0.7730	Argentina	0.1469	0.1380	0.3554	0.4922
Qatar	0.3934	0.1936	0.8435	0.7868	Tunisia	0.0853	0.1128	0.4642	0.4419
Thailand	0.2038	0.3653	0.5584	0.7279	Lebanon	0.1327	0.1347	0.2958	0.5130
Mexico	0.2654	0.4226	0.4469	0.5667	Nigeria	0.2133	0.0976	0.2732	0.4801
Vietnam	0.1825	0.3737	0.5371	0.6222	Bangladesh	0.1825	0.1128	0.2613	0.4835
Turkey	0.2109	0.3182	0.5623	0.6343	Iran	0.0758	0.0505	0.3740	0.5737
Oman	0.1659	0.1801	0.7533	0.6880	Tanzania	0.0877	0.0556	0.4164	0.4749
Chile	0.1374	0.2306	0.7228	0.6430	Cambodia	0.0474	0.1128	0.3448	0.5009
Bahrain	0.1754	0.1498	0.7414	0.6066	Ecuador	0.0592	0.1414	0.3886	0.3795
Kuwait	0.1943	0.1397	0.6194	0.6794	Paraguay	0.0474	0.0960	0.3634	0.4991
Jordan	0.1493	0.1582	0.6844	0.5719	Algeria	0.1493	0.0724	0.4045	0.3588
Russia	0.1801	0.2694	0.4735	0.5719	Ukraine	0.0213	0.0960	0.3170	0.5321
Philippines	0.1825	0.2475	0.3647	0.7192	Uganda	0.0379	0.0960	0.3117	0.4159
Brazil	0.2773	0.2710	0.3408	0.5806	Bolivia	0.0450	0.1094	0.2891	0.2790
Morocco	0.0924	0.2155	0.6485	0.4939	Ethiopia	0.0403	0.0993	0.2188	0.3120
Egypt	0.2133	0.1532	0.5385	0.5477	Mozambique	0.0000	0.0976	0.0809	0.2392
Kazakhstan	0.0972	0.1431	0.6141	0.5650	Venezuela	0.0545	0.0253	0.0000	0.3726
Uruguay	0.1256	0.1077	0.6074	0.5858	Angola	0.0284	0.0825	0.0451	0.2201
South Africa	0.1327	0.2003	0.4549	0.5494	Myanmar	0.0450	0.0774	0.0637	0.1646
Kenya	0.0829	0.1414	0.4523	0.6447	Libya	0.0545	0.0000	0.0531	0.0000

Table 12. Weighted Comparability Sequence and S_i

Country	DLO	ILO	BF	DR	S_i	Country	DLO	ILO	BF	DR	S_i
China	0.2118	0.2455	0.2410	0.1787	0.8770	Pakistan	0.0457	0.0339	0.1116	0.1201	0.3113
India	0.1902	0.1505	0.1902	0.2152	0.7461	Peru	0.0236	0.0541	0.1268	0.1022	0.3068
UAE	0.0678	0.0860	0.3274	0.2063	0.6875	Colombia	0.0211	0.0525	0.1298	0.1003	0.3038
Malaysia	0.0522	0.0856	0.2732	0.1820	0.5929	Ghana	0.0181	0.0260	0.1494	0.1231	0.3166
Indonesia	0.1049	0.0860	0.1828	0.1630	0.5367	Sri Lanka	0.0120	0.0380	0.1199	0.1223	0.2923
Saudi Arabia	0.0567	0.0798	0.2749	0.1664	0.5778	Argentina	0.0311	0.0339	0.1164	0.1059	0.2873
Qatar	0.0833	0.0475	0.2762	0.1693	0.5764	Tunisia	0.0181	0.0277	0.1520	0.0951	0.2929
Thailand	0.0432	0.0897	0.1828	0.1567	0.4724	Lebanon	0.0281	0.0331	0.0968	0.1104	0.2684
Mexico	0.0562	0.1037	0.1464	0.1220	0.4283	Nigeria	0.0452	0.0240	0.0895	0.1033	0.2619
Vietnam	0.0386	0.0918	0.1759	0.1339	0.4402	Bangladesh	0.0386	0.0277	0.0856	0.1041	0.2560
Turkey	0.0447	0.0781	0.1841	0.1365	0.4434	Iran	0.0161	0.0124	0.1225	0.1235	0.2744
Oman	0.0351	0.0442	0.2467	0.1481	0.4741	Tanzania	0.0186	0.0136	0.1364	0.1022	0.2708
Chile	0.0291	0.0566	0.2367	0.1384	0.4608	Cambodia	0.0100	0.0277	0.1129	0.1078	0.2584
Bahrain	0.0371	0.0368	0.2428	0.1306	0.4472	Ecuador	0.0125	0.0347	0.1272	0.0817	0.2562

Kuwait	0.0412	0.0343	0.2028	0.1462	0.4245	Paraguay	0.0100	0.0236	0.1190	0.1074	0.2600
Jordan	0.0316	0.0389	0.2241	0.1231	0.4177	Algeria	0.0316	0.0178	0.1325	0.0772	0.2591
Russia	0.0381	0.0661	0.1550	0.1231	0.3824	Ukraine	0.0045	0.0236	0.1038	0.1145	0.2464
Philippines	0.0386	0.0608	0.1194	0.1548	0.3736	Uganda	0.0080	0.0236	0.1021	0.0895	0.2232
Brazil	0.0587	0.0665	0.1116	0.1250	0.3618	Bolivia	0.0095	0.0269	0.0947	0.0601	0.1911
Morocco	0.0196	0.0529	0.2124	0.1063	0.3912	Ethiopia	0.0085	0.0244	0.0717	0.0671	0.1717
Egypt	0.0452	0.0376	0.1763	0.1179	0.3770	Mozambique	0.0000	0.0240	0.0265	0.0515	0.1019
Kazakhstan	0.0206	0.0351	0.2011	0.1216	0.3784	Venezuela	0.0115	0.0062	0.0000	0.0802	0.0979
Uruguay	0.0266	0.0265	0.1989	0.1261	0.3780	Angola	0.0060	0.0203	0.0148	0.0474	0.0884
South Africa	0.0281	0.0492	0.1490	0.1182	0.3445	Myanmar	0.0095	0.0190	0.0208	0.0354	0.0848
Kenya	0.0176	0.0347	0.1481	0.1388	0.3391	Libya	0.0115	0.0000	0.0174	0.0000	0.0289

Table 13. Exponentially Weighted Comparability Sequence and P_i

Country	**DLO**	**ILO**	**BF**	**DR**	P_i	**Country**	**DLO**	**ILO**	**BF**	**DR**	P_i
China	1.0000	1.0000	0.9045	0.9607	3.8653	Pakistan	0.7226	0.6150	0.7030	0.8820	2.9225
India	0.9775	0.8867	0.8371	1.0000	3.7013	Peru	0.6282	0.6899	0.7330	0.8519	2.9030
UAE	0.7855	0.7729	1.0000	0.9909	3.5493	Colombia	0.6134	0.6847	0.7387	0.8485	2.8854
Malaysia	0.7433	0.7720	0.9424	0.9646	3.4222	Ghana	0.5937	0.5764	0.7734	0.8867	2.8302
Indonesia	0.8617	0.7729	0.8263	0.9419	3.4028	Sri Lanka	0.5449	0.6326	0.7196	0.8855	2.7826
Saudi Arabia	0.7565	0.7588	0.9443	0.9461	3.4057	Argentina	0.6662	0.6150	0.7127	0.8585	2.8523
Qatar	0.8207	0.6682	0.9458	0.9497	3.3844	Tunisia	0.5937	0.5852	0.7778	0.8388	2.7955
Thailand	0.7140	0.7810	0.8263	0.9339	3.2551	Lebanon	0.6520	0.6113	0.6711	0.8662	2.8005
Mexico	0.7551	0.8094	0.7682	0.8849	3.2176	Nigeria	0.7209	0.5648	0.6539	0.8539	2.7935
Vietnam	0.6975	0.7853	0.8159	0.9029	3.2016	Bangladesh	0.6975	0.5852	0.6444	0.8552	2.7823
Turkey	0.7192	0.7549	0.8282	0.9067	3.2090	Iran	0.5791	0.4804	0.7247	0.8873	2.6715
Oman	0.6835	0.6565	0.9114	0.9227	3.1741	Tanzania	0.5972	0.4918	0.7506	0.8519	2.6915
Chile	0.6568	0.6976	0.8992	0.9093	3.1629	Cambodia	0.5242	0.5852	0.7057	0.8617	2.6768
Bahrain	0.6916	0.6275	0.9067	0.8980	3.1237	Ecuador	0.5496	0.6186	0.7338	0.8118	2.7138
Kuwait	0.7068	0.6168	0.8548	0.9202	3.0986	Paraguay	0.5242	0.5624	0.7179	0.8611	2.6656
Jordan	0.6684	0.6359	0.8832	0.8867	3.0743	Algeria	0.6684	0.5248	0.7435	0.8020	2.7388
Russia	0.6955	0.7247	0.7828	0.8867	3.0897	Ukraine	0.4427	0.5624	0.6865	0.8730	2.5646
Philippines	0.6975	0.7097	0.7187	0.9315	3.0574	Uganda	0.5000	0.5624	0.6827	0.8280	2.5731
Brazil	0.7621	0.7258	0.7030	0.8896	3.0804	Bolivia	0.5186	0.5809	0.6661	0.7598	2.5253
Morocco	0.6039	0.6860	0.8678	0.8591	3.0168	Ethiopia	0.5065	0.5672	0.6080	0.7782	2.4600
Egypt	0.7209	0.6309	0.8165	0.8785	3.0468	Mozambique	0.0000	0.5648	0.4390	0.7350	1.7388
Kazakhstan	0.6103	0.6204	0.8524	0.8844	2.9675	Venezuela	0.5400	0.4053	0.0000	0.8086	1.7538
Uruguay	0.6444	0.5787	0.8494	0.8913	2.9637	Angola	0.4705	0.5419	0.3625	0.7220	2.0969
South Africa	0.6520	0.6739	0.7727	0.8791	2.9775	Myanmar	0.5186	0.5336	0.4058	0.6782	2.1362
Kenya	0.5902	0.6186	0.7712	0.9099	2.8898	Libya	0.5400	0.0000	0.3823	0.0000	0.9223

The relative weights of the alternatives were computed with three appraisal score strategies using Eqs. [16]-[18], respectively. The final ranking of alternatives (based on k_i values) was determined using Eq. [19] and is presented in Table 14.

Table 14. Final Aggregation and CoCoSo Ranking

Country	k_{ia}	Ranks	k_{ib}	Ranks	k_{ic}	Ranks	k_i	Final Ranks
China	0.0294	1	34.5224	1	1.0000	1	12.8557	1
India	0.0276	2	29.8173	2	0.9378	2	11.1780	2
UAE	0.0263	3	27.6236	3	0.8934	3	10.3800	3
Malaysia	0.0249	4	24.2175	4	0.8467	4	9.1623	4
Indonesia	0.0244	7	22.2514	7	0.8307	7	8.4694	7
Saudi Arabia	0.0247	5	23.6739	5	0.8400	5	8.9686	5
Qatar	0.0246	6	23.6040	6	0.8352	6	8.9399	6
Thailand	0.0231	8	19.8656	8	0.7860	8	7.6036	8
Mexico	0.0226	11	18.3009	14	0.7688	11	7.0467	14
Vietnam	0.0226	12	18.6955	13	0.7679	12	7.1823	13
Turkey	0.0227	9	18.8158	12	0.7702	9	7.2260	11
Oman	0.0226	10	19.8387	9	0.7693	10	7.5784	9
Chile	0.0225	13	19.3662	10	0.7641	13	7.4104	10
Bahrain	0.0221	14	18.8547	11	0.7530	14	7.2232	12
Kuwait	0.0218	15	18.0406	15	0.7429	15	6.9325	15
Jordan	0.0217	16	17.7777	16	0.7363	16	6.8355	16
Russia	0.0215	17	16.5756	18	0.7322	17	6.4157	18
Philippines	0.0213	19	16.2371	22	0.7235	19	6.2905	22
Brazil	0.0213	18	15.8540	23	0.7259	18	6.1600	23
Morocco	0.0211	21	16.7989	17	0.7186	21	6.4805	17
Egypt	0.0212	20	16.3410	19	0.7220	20	6.3251	19
Kazakhstan	0.0207	22	16.3038	20	0.7055	22	6.2970	20
Uruguay	0.0207	23	16.2875	21	0.7047	23	6.2906	21
South Africa	0.0206	24	15.1427	24	0.7005	24	5.8903	24
Kenya	0.0200	26	14.8622	25	0.6809	26	5.7751	25
Pakistan	0.0201	25	13.9345	27	0.6819	25	5.4543	27
Peru	0.0199	27	13.7565	28	0.6768	27	5.3879	28
Colombia	0.0198	28	13.6340	29	0.6725	28	5.3414	29
Ghana	0.0195	29	14.0180	26	0.6636	29	5.4666	26
Sri Lanka	0.0191	32	13.1255	31	0.6484	32	5.1431	31
Argentina	0.0195	30	13.0300	32	0.6621	30	5.1223	32
Tunisia	0.0192	31	13.1602	30	0.6513	31	5.1577	30
Lebanon	0.0190	33	12.3200	34	0.6471	33	4.8621	33
Nigeria	0.0189	34	12.0877	36	0.6443	34	4.7787	36
Bangladesh	0.0188	35	11.8691	39	0.6407	35	4.6995	38
Iran	0.0183	39	12.3864	33	0.6212	39	4.8619	34
Tanzania	0.0184	38	12.2831	35	0.6247	38	4.8291	35
Cambodia	0.0182	40	11.8406	40	0.6190	40	4.6702	40
Ecuador	0.0184	37	11.8031	41	0.6263	37	4.6637	41
Paraguay	0.0181	41	11.8829	38	0.6169	41	4.6831	39
Algeria	0.0186	36	11.9291	37	0.6322	36	4.7128	37
Ukraine	0.0174	42	11.3018	42	0.5927	42	4.4594	42
Uganda	0.0173	43	10.5081	43	0.5896	43	4.1804	43

Bolivia	0.0168	44	9.3483	44	0.5728	44	3.7611	44
Ethiopia	0.0163	45	8.6061	45	0.5549	45	3.4863	45
Mozambique	0.0114	49	5.4109	46	0.3882	49	2.2252	48
Venezuela	0.0115	48	5.2889	48	0.3905	48	2.1843	49
Angola	0.0136	47	5.3314	47	0.4608	47	2.2569	46
Myanmar	0.0138	46	5.2501	49	0.4683	46	2.2343	47
Libya	0.0059	50	2.0000	50	0.2006	50	0.8687	50

According to the results, China, India, the UAE, Malaysia, and Saudi Arabia have the best logistics market performance, while Angola, Myanmar, Mozambique, Venezuela, and Libya have the worst logistics market performance.

Sensitivity Analysis

The results of this study were validated by sensitivity analysis. The sensitivity analysis was conducted by modifying the λ value. Namely, the sensitivity of the alternatives was tested to understand which alternatives are most sensitive to a change in the λ value. Table 15 illustrates the various scenarios with different λ values.

Table 15. Results of the Sensitivity Analysis

Country	**λ=0.00**	**λ=0.10**	**λ=0.20**	**λ=0.30**	**λ=0.40**	**λ=0.50**	**λ=0.60**	**λ=0.70**	**λ=0.80**	**λ=0.90**	**λ=1.00**
China	1	1	1	1	1	1	1	1	1	1	1
India	2	2	2	2	2	2	2	2	2	2	2
UAE	3	3	3	3	3	3	3	3	3	3	3
Malaysia	4	4	4	4	4	4	4	4	4	4	4
Indonesia	7	7	7	7	7	7	7	7	7	7	7
Saudi Arabia	5	5	5	5	5	5	5	5	5	5	5
Qatar	6	6	6	6	6	6	6	6	6	6	6
Thailand	8	8	8	8	8	8	8	8	8	8	8
Mexico	14	14	14	14	14	14	14	14	14	14	14
Vietnam	13	13	13	13	13	13	13	13	13	13	13
Turkey	11	11	11	11	11	11	11	11	12	12	12
Oman	9	9	9	9	9	9	9	9	9	9	9
Chile	10	10	10	10	10	10	10	10	10	10	10
Bahrain	12	12	12	12	12	12	12	12	11	11	11
Kuwait	15	15	15	15	15	15	15	15	15	15	15
Jordan	16	16	16	16	16	16	16	16	16	16	16
Russia	18	18	18	18	18	18	18	18	18	18	18
Philippines	λ21	21	21	21	21	22	22	22	22	22	22
Brazil	23	23	23	23	23	23	23	23	23	23	23
Morocco	17	17	17	17	17	17	17	17	17	17	17
Egypt	19	19	19	19	19	19	19	19	19	19	19
Kazakhstan	20	20	20	20	20	20	20	20	20	20	20
Uruguay	22	22	22	22	22	21	21	21	21	21	21
South Africa	24	24	24	24	24	24	24	24	24	24	24
Kenya	25	25	25	25	25	25	25	25	25	25	25

Pakistan	27	27	27	27	27	27	27	27	27	27	27
Peru	28	28	28	28	28	28	28	28	28	28	28
Colombia	29	29	29	29	29	29	29	29	29	29	29
Ghana	26	26	26	26	26	26	26	26	26	26	26
Sri Lanka	31	31	31	31	31	31	31	31	31	31	31
Argentina	32	32	32	32	32	32	32	32	32	32	32
Tunisia	30	30	30	30	30	30	30	30	30	30	30
Lebanon	33	33	33	33	33	33	34	34	34	34	34
Nigeria	36	36	36	36	36	36	36	36	36	36	36
Bangladesh	38	38	38	38	38	38	38	38	38	38	39
Iran	34	34	34	34	34	34	33	33	33	33	33
Tanzania	35	35	35	35	35	35	35	35	35	35	35
Cambodia	40	40	40	40	40	40	40	40	40	40	40
Ecuador	41	41	41	41	41	41	41	41	41	41	41
Paraguay	39	39	39	39	39	39	39	39	39	39	38
Algeria	37	37	37	37	37	37	37	37	37	37	37
Ukraine	42	42	42	42	42	42	42	42	42	42	42
Uganda	43	43	43	43	43	43	43	43	43	43	43
Bolivia	44	44	44	44	44	44	44	44	44	44	44
Ethiopia	45	45	45	45	45	45	45	45	45	45	45
Mozambique	48	48	48	48	48	48	48	47	47	47	46
Venezuela	49	49	49	49	49	49	49	49	49	49	48
Angola	46	46	46	46	46	46	46	46	46	46	47
Myanmar	47	47	47	47	47	47	47	48	48	48	49
Libya	50	50	50	50	50	50	50	50	50	50	50

According to the sensitivity results, the top 10 ranking order of the logistics market performance of developing countries remains unchanged under all scenarios. However, the rest of the ranking order was changed by changes in the value of λ. It is remarkable that the top 10 results for logistics market performance are so robust. Additionally, the results obtained in this study were compared with the results published in the AEMLI 2023 report. The comparison of the proposed model and the AEMLI 2023 report on the basis of the top 10 countries in terms of logistics market performance is shown in Figure 2. Furthermore, all the results of comparisons between the proposed model and the AEMLI 2023 report are presented in Appendix 1.

According to the results, China, India, the UAE, and Malaysia rank in the top 4 both in the proposed model and in the AEMLI 2023 report. However, the ranking order was changed for the countries ranked fifth, sixth, seventh, ninth, and tenth. For instance, Saudi Arabia and Qatar are in fifth and sixth place in the proposed model, while Indonesia and Saudi Arabia are in fifth and sixth place in the AEMLI 2023 report. Moreover, Oman and Chile are in ninth and tenth place in the proposed model, whereas Mexico and Vietnam are in ninth and tenth place in the AEMLI 2023 report.

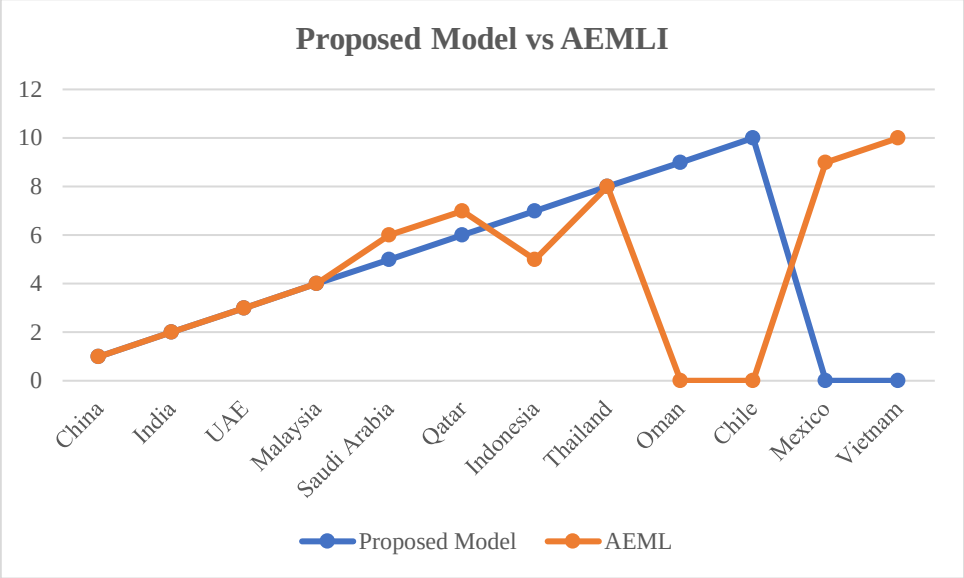

Figure 2. Comparison of the Proposed Model and the AEMLI 2023 Report

CONCLUSION

Logistics performance has become one of the most important indicators to measure the level of efficiency in international trade activity. Additionally, the growth of the logistics industry has been significant around the world due to its positive effect on the economic and social development of countries [Mešić et al., 2022]. As stated by Ozmen [2019], the evaluation of the logistics competitiveness of countries has a potential impact on the development of current policies as well as building projects for future improvement. Parallel to this, many scientists have been investigating the logistics performance of countries using different MCDM approaches. As mentioned in the literature review, most studies that evaluate logistics performance have employed LPI indicators. However, a limited number of studies have examined the logistics market performance of countries using MCDM methods. Accordingly, the main goal of this study was to assess the logistics market performance of developing countries using integrated MCDM methods. In this context, the indicators in the AEMLI report were used to assess the logistics market performance of developing countries. This index examines four key areas, namely domestic logistics opportunities [DLO], international logistics opportunities [ILO], business fundamentals [BF] and digital readiness [DR].

In the current study, a new integrated approach based on the combination of subjective [SWARA] and objective [CRITIC] weighting methods with CoCoSo has been proposed for the assessment of the logistics market performance of fifty developing countries. Two types of weighting methods were used to determine which criterion is most important for logistics market performance. For more accurate and reliable results, the aggregated weight method, which involves both objective and subjective information, was used to identify the importance of the criteria. According to the results obtained by the SWARA method, the relative importance of the criteria was as follows: BF > ILO > DR > DLO. Based on the SWARA method, the most and least important criteria were Business Fundamentals [BF] and Domestic Logistics Opportunities [DLO], respectively. According to the results obtained by the CRITIC method, the relative importance of the criteria was as follows: BF > DLO > DR > ILO. Based on the CRITIC method, the most and least important criteria were Business Fundamentals [BF] and International Logistics Opportunities [ILO], respectively. According to the results obtained by the Aggregated Weighting method, the relative importance of the criteria was as follows: BF > ILO > DR > DLO. Based on the Aggregated Weighting method, the most and least important criteria were Business Fundamentals [BF] and Domestic Logistics Opportunities [DLO], respectively.

The logistics market performance of developing countries was ranked using the CoCoSo method. According to the results obtained by the CoCoSo method, the top five developing countries in terms of logistics market performance are: China, India, the UAE, Malaysia, and Saudi Arabia. China has the best logistics market performance, followed by India and the UAE. On the other hand, the bottom five developing countries in terms of logistics market performance are: Angola, Myanmar, Mozambique, Venezuela, and Libya. Libya has the worst logistics market performance, followed by Venezuela and Mozambique.

The present findings seem to be inconsistent with those of another study [Kara et al., 2022], which found the top five countries to be the UAE, China, Malaysia, Saudi Arabia, and Qatar. There were also some differences in the bottom five countries, as that study found that Mozambique, Angola, Venezuela, Myanmar, and Libya had the worst logistics market performance. Although the results reported here differ from those of the study conducted by Kara et al. [2022], the findings are consistent with the original AEMLI 2023 report. For instance, China, India, the UAE, and Malaysia are ranked the same in both the proposed model and the AEMLI report. However, significant changes were observed in the bottom five rankings. All comparisons between the proposed model and the AEMLI report are presented in Appendix I.

In this research, a sensitivity analysis with different λ values was conducted. According to the results of the sensitivity analysis, the proposed model gives stable ranking results for logistics market performance. In other words, no significant changes in ranking were observed after modifying the λ values. Thus, it can be concluded that the proposed model is efficient and convenient for the assessment of logistics market performance by MCDM methods.

With this research, the following contributions have been made to the existing literature: [1] A new model has been proposed to evaluate the logistics market performance of countries. [2] To the best of author's knowledge, this is the first study to examine logistics market performance through the combination of two weighting methods. [3] The empirical results indicate that the proposed model has been validated by the sensitivity analysis. Therefore, it can be applied to other decision-making problems in the logistics industry.

In addition to its aforementioned contributions, the current study also has some limitations. For instance, it has only examined one time period [2022]. Therefore, the current study could be replicated over more than one time period, and the results from each period could be compared. Afterwards, more detailed research could be conducted by increasing the number of criteria and countries. Additionally, further research could be carried out with other MCDM methods, including fuzzy and gray approaches.

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Appendix 1.

Country	Proposed Model	Country	AEMLI Report	Rank Change	Country	Proposed Model	Country	AEMLI Report	Rank Change
China	1	China	1	=	Pakistan	27	Pakistan	26	▼
India	2	India	2	=	Peru	28	Peru	27	▼
UAE	3	UAE	3	=	Colombia	29	Colombia	28	▼
Malaysia	4	Malaysia	4	=	Ghana	26	Ghana	29	▲
Indonesia	7	Indonesia	5	▼	Sri Lanka	31	Sri Lanka	30	▼
Saudi Arabia	5	Saudi Arabia	6	▲	Argentina	32	Argentina	31	▼
Qatar	6	Qatar	7	▲	Tunisia	30	Tunisia	32	▲
Thailand	8	Thailand	8	=	Lebanon	33	Lebanon	33	=
Mexico	14	Mexico	9	▼	Nigeria	36	Nigeria	34	▼
Vietnam	13	Vietnam	10	▼	Bangladesh	38	Bangladesh	35	▼
Turkey	11	Turkey	11	=	Iran	34	Iran	36	▲
Oman	9	Oman	12	▲	Tanzania	35	Tanzania	37	▲
Chile	10	Chile	13	▲	Cambodia	40	Cambodia	38	▼
Bahrain	12	Bahrain	14	▲	Ecuador	41	Ecuador	39	▼
Kuwait	15	Kuwait	15	=	Paraguay	39	Paraguay	40	▲
Jordan	16	Jordan	16	=	Algeria	37	Algeria	41	▲
Russia	18	Russia	17	▼	Ukraine	42	Ukraine	42	=
Philippines	22	Philippines	18	▼	Uganda	43	Uganda	43	=
Brazil	23	Brazil	19	▼	Bolivia	44	Bolivia	44	=
Morocco	17	Morocco	20	▲	Ethiopia	45	Ethiopia	45	=
Egypt	19	Egypt	21	▲	Mozambique	48	Mozambique	46	▼
Kazakhstan	20	Kazakhstan	22	▲	Venezuela	49	Venezuela	47	▼
Uruguay	21	Uruguay	23	▲	Angola	46	Angola	48	▲
South Africa	24	South Africa	24	=	Myanmar	47	Myanmar	49	▲
Kenya	25	Kenya	25	=	Libya	50	Libya	50	=