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The Comparison of Edas, Copras, and EFI Methods in the Decision-Making Process

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ABSTRACT

Individuals reach decisions at every moment of their daily lives. They become happy as long as the benefit of these decisions is above their cost. If real life worked under a complete information hypothesis, all the individuals would live happily forever. In this situation, correct decision making becomes a very important subject for the individuals. There are many decision-making methods. There is no general consensus as to which one of them gives the best solution. Instead, it is suggested to conduct sensitivity analysis in the issue of the reliability of the MCDM methods or comparison to another method. This study compares EDAS and COPRAS methods. For this, the results obtained from EDAS method have been compared to COPRAS and EFI methods. All three methods give the same performance results. The found results are statistically significant. This result supports the strong relationship existing among MCDM methods.

KEYWORDS

Burden, Business Freedom, Financial Freedom, Government Integrity, Health, Investment Freedom, Judicial Effectiveness, Monetary Freedom, Property Rights, Spending, Tax Labor Freedom, Trade Freedom

INTRODUCTION

Individuals make decisions at every moment of their daily lives, and they are happy as long as the benefit of these decisions is more than their cost. If real life functioned under a complete information hypothesis, all individuals would live happily forever. However, daily life is lived within the reality of imperfect information. As emphasized by (Zavadskas et al. 2019, p.1), today's actual world problems involve multiple datasets, some of which are precise or objective and some uncertain or subjective. In this situation, correct decision making becomes a very important subject for individuals. According to (Garg & Kaur, 2018, p.1), in complex decision-making systems, high cost and computational effort are often required to process information and evaluate it to produce accurate results. In such cases, the main purpose of the decision makers is to reduce the computational costs and to reach the desired goal in a shorter time.

Decision makers must simultaneously assess many criteria and alternatives when they solve problems or during the decision-making process. Instead of seeing decision makers as rational individuals, it is necessary to help them to solve the problem. According to (Lunenburg, 2010, p.3), the decision-making process is divided into six stages: first, identify the problem; second, generate alternatives; third, evaluate alternatives; fourth, choose an alternative; fifth, implement the decision; and sixth, evaluate the effectiveness of the decision.

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After reaching a decision, it is necessary to take action to solve the problem. Multi-Criteria Decision Making (MCDM) explains the process of choosing the best solution among many criteria and alternatives. MCDM provides the decision makers various alternatives for the solution of the problem.

Decision making problems in the real world are complex. Finding a solution depending on a single criterion is not rational, and such a procedure produces an incorrect result. The fact that decision making problems are in a complex structure stems from the fact that the decision makers create qualitative definitions depending on their subjective assessments.

There are many decision-making methods. MCDM methods are used to solve selection problems, classification problems, and sequencing problems. There is no general consensus as to which one of them gives the best solution. Instead, it is suggested that a sensitivity analysis on the issue of the reliability of the MCDM methods or comparison to another method be conducted. In this study, a comparison of the Evaluation based on Distance from Average Solution (EDAS), Complex Proportional Assessment (COPRAS), and Economic Freedom Index (EFI) methods was conducted. In other words, a relationship between the methods in the decision-making process was found.

The EDAS method enables selection or ranking among decision alternatives and calculates according to average solution distances. While evaluating, the EDAS method determines the performance of the alternative to be included in the optimal solution set with the highest positive distance and the lowest negative distance. The COPRAS method makes a proportional evaluation by calculating how much better or worse one alternative is than the other alternative. The EFI method shows the economic freedom performance of countries, and the country with a high score is predicted to have a high economic performance.

LITERATURE REVIEW

There is an EDAS method application on the basis of the study. For this reason, the studies conducted with only the EDAS method have been summarized.

Table 1. Studies Conducted with EDAS Method

No	Authors	Type of study	The aim of the study	Result
1.	(Keshavarz Ghorabaee, et.al. 2015)	Case study	Inventory classification	EDAS method could conduct this classification.
2.	(Stević, et. al., 2016)	Case study	Ordering the city logistics scenarios	AHP-EDAS method could conduct this ordering.
3.	(Ghorabaee, et. al., 2016)	Case study	Supplier selection	Extended fuzzy EDAS method could conduct this selection.
4.	(Kahraman, et. al., 2017)	Case study	Solid waste disposal field selection	Fuzzy EDAS method could conduct this selection.
5.	(Stanujkic, et. al., 2017)	Case study	Contractor selection for a construction project	EDAS method could conduct this selection.
6.	Keshavarz Ghorabaee, et. al., 2017a)	Case study	Sub-contractor selection in construction sector	EDAS method could conduct this selection.
7.	(Keshavarz Ghorabaee, et. al., 2017b)	Case study	Performance assessment of bank branches	Stochastic EDAS could make this assessment.
8.	(Keshavarz Ghorabaee, et. al., 2017c)	Case study	Supplier selection	EDAS method could conduct this selection.
9.	(Stanujkic, et. al., 2018)	Case study	Personnel selection	EDAS method could conduct this selection.

Table 1 continued on next page

Table 1 continued

No	Authors	Type of study	The aim of the study	Result
10.	(Stević, et. al., 2018)	Case study	Selection of PVC manufacturer most convenient for flat remodeling	Fuzzy EDAS method could conduct this selection.
11.	(Keshavarz Ghorabaee,et.al. 2018a)	Case study	Subcontractor selection in construction projects	Fuzzy EDAS method could conduct this selection.
12.	(Keshavarz Ghorabaee,et.al. 2018b)	Case study	Comparison of EDAS and TOPSIS methods	EDAS method is more efficient than TOPSIS method.
13.	(Karaşan & Kahraman, 2018)	Case study	Determination of sustainable development objectives	EDAS method could make this determination.
14.	(Kutlu Gündoğdu, et.al. 2018)	Case study	Hospital selection	HF-EDAS method could conduct this selection.
15.	(Chatterjee, et.al. 2018)	Case study	Material selection problem	DOE-EDAS method could solve this problem.
16.	(Feng, et.al. 2018)	Case study	Investment project selection	EDAS method could conduct this selection.
17.	(Liang, et.al. 2018)	Case study	Assessment of clean production for gold mines	ELECTRE- EDAS method could make this assessment.
18.	(Mathew & Sahu, 2018)	Case study	Selection of convenient material transportation equipment	CODAS, EDAS and WASPAS methods are in accordance with one another.
19.	(Li, et.al. 2019)	Case study	Selection of a company whose property management activities are convenient	MCGDM based EDAS method could conduct this selection.
20.	(Zhang, et.al. 2019)	Case study	Supplier selection	Fuzzy EDAS method could conduct this selection.
21.	(Kundakcı, 2019)	Case study	Determination of the best steam boiler alternative	MACBETH-EDAS method could make this determination.
22.	(Zavadskas, et.al. 2019a)	Case study	Selection of autonomous vehicle	EDAS-M method could conduct this selection.
23.	(He, et.al. 2019)	Case study	Green supplier selection	EDAS-PULTSs method could conduct this selection.
24.	(Wang, et.al. 2019)	Case study	Investment project selection	EDAS method could conduct this selection.
25.	(Fan, et.al. 2019)	Case study	Technology selection in operations	EDAS method could conduct this selection.
26.	(Qian, et.al. 2019)	Case study	New product investment selection	EDAS method could conduct this selection.
27.	(Sudha, 2019)	Case study	Selection of water management applications	EDAS method could conduct this selection.
28.	(Stević, et.al. 2019)	Case study	Supplier selection	Fuzzy EDAS method could conduct this selection.
29.	(Li, et.al. 2019)	Case study	Selection of emergency alternative	Extended EDAS method could conduct this selection.
30.	(Asante, et.al. 2020)	Case study	Determination of the barriers in front of renewable energy	MULTIMOORA-EDAS method could make this determination.
31.	(Li, et.al. 2020)	Case study	Selection of alternative refrigerator to facilitate purchasing decisions	EDAS method could conduct this selection.

Table 1 continued on next page

Table 1 continued

No	Authors	Type of study	The aim of the study	Result
32.	(Polat & Bayhan, 2020)	Case study	Supplier selection	Fuzzy EDAS method could conduct this selection.
33.	(Darko & Liang, 2020)	Case study	Mobile payment platform selection	q-ROF EDAS method could conduct this selection.
34.	(Han & Wei, 2020)	Case study	Investment project selection	Extended EDAS method could conduct this selection.
35.	(Das & Chakraborty, 2020)	Case study	Assessment of untraditional processing process	GC-EDAS method could make this assessment.
36.	(Liang, 2020)	Case study	Selection of design projects providing energy save	IF-EDAS method could conduct this selection.
37.	(Xu, et.al. 2020)	Case study	Green supplier selection	Extended EDAS method could conduct this selection
38.	(He, et.al. 2020)	Case study	Investment project selection	P2TLN-EDAS method could conduct this selection.
39.	(Yazdani, et.al. 2020)	Case study	Renewable resource selection	Shannon Entropy-EDAS method could conduct this selection.
40.	(Zhan, et.al. 2020)	Case study	Automobile selection	PROMETHEE-EDAS method could conduct this selection.
41.	(Mishra, et.al. 2020)	Case study	Selection of a convenient method for waste disposal	IF-EDAS method could conduct this selection.
42.	(Behzad, et.al. 2020)	Case study	Assessment of the performance of waste management system	BWM-EDAS method could make this assessment.
43.	(Moniri, et.al. 2020)	Case study	Assessment of return risks in petroleum processing facilities	SWARA-EDAS method could make this assessment.
44.	(Mitra, 2020)	Case study	Cotton fabric selection	EDAS method could conduct this selection.
45.	(Jauković-Jocić, et.al. 2020)	Case study	Assessment of the quality of the e-courses	EDAS method could make this assessment.
46.	(Mitra, 2020)	Case study	Selection of the most convenient jute fiber	EDAS method could conduct this selection.
47.	(Dhanalakshmi, et.al. 2020)	Case study	The biomass material selection	FAHP- TOPSIS-EDAS methods could conduct this selection.
48.	(Demirtas, et.al. 2021)	Case study	Selection of the best renewable energy consumption	Fuzzy EDAS method could conduct this selection.
49.	(Ren, et.al. 2021)	Case study	Credit assessment for micro and small companies	Extended EDAS method could make this assessment.
50.	(Chinram, et.al. 2021)	Case study	Energy power plant selection	EDAS method could conduct this selection.
51.	(Rashid, et.al. 2021)	Case study	Industrial robot selection	BW-EDAS MCDM methods could conduct this selection.
52.	(Mishra, et.al. 2021)	Case study	Selection of logistic suppliers	FF-CRITIC-EDAS method could conduct this selection.

SCOPE AND AIM OF THE STUDY

The aim of this study was to compare the EDAS, COPRAS and EFI methods. The Economic Freedom Index of 15 randomly selected countries and 12 decision components taking place in 2021 were used

at the application stage. In the study, calculations related to the EDAS method were shown in detail. Only the result matrix was given for the COPRAS method. The calculations for the EFI method were taken from the related website.

The quantitative and qualitative factors used in the EFI method were used as decision components and are as follows: Property Rights, Judicial Effectiveness, Government Integrity, Tax Burden, Government Spending, Fiscal Health, Business Freedom, Labor Freedom, Monetary Freedom, Trade Freedom, Investment Freedom, and Financial Freedom. Within this framework, equal significance degrees were given to decision components in accordance with the EFI definition. Decision components were shown in the letter range of C1-C12 in the study.

The EDAS, COPRAS, and EFI methods show the economic freedom performances of countries, and the country with the highest score has the highest performance.

METHODS

THE EDAS METHOD

The EDAS method developed by (Keshavarz Ghorabaee et.al. 2015) suggests a solution for assessing the alternatives. This method first calculates the average value and second calculates the positive and negative distances from the average. At the last stage, it calculates the difference between the two distance measures and the average value. The ease of the application of the EDAS method is the advantage of the method. (Qian et al. 2019, p.105-106) produced a mathematical demonstration of the method.

Decision making matrix is formed.

$$X = \left[x_{ij}\right]_{n\times m} \tag{1}$$

where x_{ij} value shows the performance of i^{th} decision alternative according to j^{th} criterion. Average solution is calculated according to all criteria as shown below.

$$AV = \left[AV_{ij}\right]_{1\times m} \tag{2}$$

where

$$AV_j = \frac{\sum_{i=1}^{n} x_{ij}}{n} \tag{3}$$

Positive Distance from Average (PDA) and Negative Distance from Average (NDA) are calculated according to the criterion type (benefit and cost) shown below.

$$PDA = \left[PDA_{ij}\right]_{n\times m} \tag{4}$$

$$NDA = \left[NDA_{ij} \right]_{n \times m} \tag{5}$$

If jth criterion is beneficial:

$$PDA = \frac{\max(0, (X_{ij} - AV_j))}{AV_j} \tag{6}$$

$$NDA = \frac{\max(0, (AV_{ij} - X_{ij}))}{AV_j} \tag{7}$$

If jth criterion is non-beneficial:

$$PDA_{ij} = \frac{\max(0, (AV_{ij} - X_{ij}))}{\overset{\wedge}{AV}(\otimes)_j} \tag{8}$$

$$NDA_{ij} = \frac{\max(0, (X_{ij} - AV_{ij}))}{AV_j} \tag{9}$$

Weighted PDA and NDA totals are calculated for all alternatives.

$$SP_i = \sum_{j=1}^{m} \omega_j PDA_{ij} \tag{10}$$

$$SN_i = \sum_{j=1}^{m} \omega_j NDA_{ij} \tag{11}$$

where ωj is the weight of jth criterion.
The normalized SP and SN values are determined for all alternatives.

$$NSP_i = \frac{SP_i}{\max_i(SP_0)} \tag{12}$$

$$NSN_i = 1 - \frac{SN_i}{\max_i(SN_i)} \tag{13}$$

Assessment score (AS) is determined for all alternatives.

$$AS_i = \frac{1}{2}(NSP_i + NSN_i) \tag{14}$$

Step 7. Alternatives are ordered according to AS. The alternative with the highest AS is the best choice among the candidate alternatives.

SOLUTION OF THE EDAS METHOD

Ayçin (2020, p. 104-109) incorporated the solution of the EDAS method.
Step 1. Formation of the decision matrix

Table 2. Decision Matrix

	Criteria	max	max	max	max	max	max	max	max	max	max	max	max
	Country Name	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**
1	Argentina	46,10	45,70	54,00	70,40	52,80	38,40	59,50	46,30	41,90	62,60	55,00	60,00
2	Australia	81,50	90,00	89,80	62,60	58,10	88,70	87,40	84,10	86,70	89,80	80,00	90,00
3	Brazil	55,00	45,50	47,50	70,10	56,50	5,30	58,00	50,70	77,80	64,60	60,00	50,00
4	Canada	84,50	73,30	87,90	76,00	49,80	84,20	81,40	72,40	76,10	88,80	80,00	80,00
5	China	62,20	71,50	46,40	72,60	67,60	54,80	80,20	64,90	69,80	71,20	20,00	20,00
6	Germany	78,80	69,80	81,50	60,40	40,30	92,80	82,40	53,00	77,20	84,00	80,00	70,00
7	India	59,20	55,90	48,10	78,70	78,50	18,00	76,70	41,30	72,10	69,40	40,00	40,00
8	Japan	87,80	75,50	82,00	67,80	57,80	67,50	85,90	79,00	85,10	80,40	60,00	60,00
9	Russia	54,40	42,40	41,70	93,00	66,10	99,60	84,10	55,40	67,30	74,00	30,00	30,00
10	South Africa	59,60	57,10	50,60	63,90	65,90	53,40	61,50	59,40	76,80	72,60	45,00	50,00
11	Sweden	86,60	79,10	92,50	43,60	29,50	97,60	83,20	53,90	81,50	84,00	85,00	80,00
12	Switzerland	85,40	82,20	87,90	70,40	67,60	96,90	73,60	72,50	85,40	86,00	85,00	90,00
13	Turkey	61,50	58,60	45,40	73,20	64,50	75,80	68,50	48,80	65,40	76,00	70,00	60,00
14	United Kingdom	87,60	76,70	86,50	64,90	54,80	77,30	94,40	73,20	81,00	84,00	80,00	80,00
15	United States	79,70	72,40	76,80	76,00	62,20	34,90	82,50	87,10	81,10	80,40	85,00	80,00

Step 2. Attainment of average solution matrix
It is calculated as shown in Equation (2)

Table 3. Average Solution Matrix

Criteria	max	max	max	max	max	max	max	max	max	max	max	max
Country Name	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**
Argentina	46,10	45,70	54,00	70,40	52,80	38,40	59,50	46,30	41,90	62,60	55,00	60,00
Australia	81,50	90,00	89,80	62,60	58,10	88,70	87,40	84,10	86,70	89,80	80,00	90,00
Brazil	55,00	45,50	47,50	70,10	56,50	5,30	58,00	50,70	77,80	64,60	60,00	50,00
Canada	84,50	73,30	87,90	76,00	49,80	84,20	81,40	72,40	76,10	88,80	80,00	80,00
China	62,20	71,50	46,40	72,60	67,60	54,80	80,20	64,90	69,80	71,20	20,00	20,00
Germany	78,80	69,80	81,50	60,40	40,30	92,80	82,40	53,00	77,20	84,00	80,00	70,00
India	59,20	55,90	48,10	78,70	78,50	18,00	76,70	41,30	72,10	69,40	40,00	40,00
Japan	87,80	75,50	82,00	67,80	57,80	67,50	85,90	79,00	85,10	80,40	60,00	60,00
Russia	54,40	42,40	41,70	93,00	66,10	99,60	84,10	55,40	67,30	74,00	30,00	30,00
South Africa	59,60	57,10	50,60	63,90	65,90	53,40	61,50	59,40	76,80	72,60	45,00	50,00
Sweden	86,60	79,10	92,50	43,60	29,50	97,60	83,20	53,90	81,50	84,00	85,00	80,00
Switzerland	85,40	82,20	87,90	70,40	67,60	96,90	73,60	72,50	85,40	86,00	85,00	90,00
Turkey	61,50	58,60	45,40	73,20	64,50	75,80	68,50	48,80	65,40	76,00	70,00	60,00
United Kingdom	87,60	76,70	86,50	64,90	54,80	77,30	94,40	73,20	81,00	84,00	80,00	80,00
United States	79,70	72,40	76,80	76,00	62,20	34,90	82,50	87,10	81,10	80,40	85,00	80,00
AVj	71,33	66,38	67,91	69,57	58,13	65,68	77,29	62,80	75,01	77,85	63,67	62,67

Step 3. Attainment of distance matrices from the average

Table 4. Positive Distance from Average

Country Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Argentina	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Australia	0,14	0,36	0,32	0,00	0,00	0,35	0,13	0,34	0,16	0,15	0,26	0,44
Brazil	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,04	0,00	0,00	0,00
Canada	0,18	0,10	0,29	0,09	0,00	0,28	0,05	0,15	0,01	0,14	0,26	0,28
China	0,00	0,08	0,00	0,04	0,16	0,00	0,04	0,03	0,00	0,00	0,00	0,00
Germany	0,10	0,05	0,20	0,00	0,00	0,41	0,07	0,00	0,03	0,08	0,26	0,12
India	0,00	0,00	0,00	0,13	0,35	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Japan	0,23	0,14	0,21	0,00	0,00	0,03	0,11	0,26	0,13	0,03	0,00	0,00
Russia	0,00	0,00	0,00	0,34	0,14	0,52	0,09	0,00	0,00	0,00	0,00	0,00
South Africa	0,00	0,00	0,00	0,00	0,13	0,00	0,00	0,00	0,02	0,00	0,00	0,00
Sweden	0,21	0,19	0,36	0,00	0,00	0,49	0,08	0,00	0,09	0,08	0,34	0,28
Switzerland	0,20	0,24	0,29	0,01	0,16	0,48	0,00	0,15	0,14	0,10	0,34	0,44
Turkey	0,00	0,00	0,00	0,05	0,11	0,15	0,00	0,00	0,00	0,00	0,10	0,00
United Kingdom	0,23	0,16	0,27	0,00	0,00	0,18	0,22	0,17	0,08	0,08	0,26	0,28
United States	0,12	0,09	0,13	0,09	0,07	0,00	0,07	0,39	0,08	0,03	0,34	0,28

Table 5. Negative Distance from Average

Country Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Argentina	0,35	0,31	0,20	0,00	0,09	0,42	0,23	0,26	0,44	0,20	0,14	0,04
Australia	0,00	0,00	0,00	0,10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Brazil	0,23	0,31	0,30	0,00	0,03	0,92	0,25	0,19	0,00	0,17	0,06	0,20
Canada	0,00	0,00	0,00	0,00	0,14	0,00	0,00	0,00	0,00	0,00	0,00	0,00
China	0,13	0,00	0,32	0,00	0,00	0,17	0,00	0,00	0,07	0,09	0,69	0,68
Germany	0,00	0,00	0,00	0,13	0,31	0,00	0,00	0,16	0,00	0,00	0,00	0,00
India	0,17	0,16	0,29	0,00	0,00	0,73	0,01	0,34	0,04	0,11	0,37	0,36
Japan	0,00	0,00	0,00	0,03	0,01	0,00	0,00	0,00	0,00	0,00	0,06	0,04
Russia	0,24	0,36	0,39	0,00	0,00	0,00	0,00	0,12	0,10	0,05	0,53	0,52
South Africa	0,16	0,14	0,25	0,08	0,00	0,19	0,20	0,05	0,00	0,07	0,29	0,20
Sweden	0,00	0,00	0,00	0,37	0,49	0,00	0,00	0,14	0,00	0,00	0,00	0,00
Switzerland	0,00	0,00	0,00	0,00	0,00	0,00	0,05	0,00	0,00	0,00	0,00	0,00
Turkey	0,14	0,12	0,33	0,00	0,00	0,00	0,11	0,22	0,13	0,02	0,00	0,04
United Kingdom	0,00	0,00	0,00	0,07	0,06	0,00	0,00	0,00	0,00	0,00	0,00	0,00
United States	0,00	0,00	0,00	0,00	0,00	0,47	0,00	0,00	0,00	0,00	0,00	0,00

It is calculated as shown in Equation (6) and Equation (7).

Table 6. Weights of Criteria

C	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
W	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08

Step 4. Attainment of the weighted total values

Table 7. Weighted Total Positive Values

Country Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Spi
Argentina	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Australia	0,01	0,03	0,03	0,00	0,00	0,03	0,01	0,03	0,01	0,01	0,02	0,04	0,22
Brazil	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Canada	0,02	0,01	0,02	0,01	0,00	0,02	0,00	0,01	0,00	0,01	0,02	0,02	0,15
China	0,00	0,01	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,03
Germany	0,01	0,00	0,02	0,00	0,00	0,03	0,01	0,00	0,00	0,01	0,02	0,01	0,11
India	0,00	0,00	0,00	0,01	0,03	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,04
Japan	0,02	0,01	0,02	0,00	0,00	0,00	0,01	0,02	0,01	0,00	0,00	0,00	0,10
Russia	0,00	0,00	0,00	0,03	0,01	0,04	0,01	0,00	0,00	0,00	0,00	0,00	0,09
South Africa	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
Sweden	0,02	0,02	0,03	0,00	0,00	0,04	0,01	0,00	0,01	0,01	0,03	0,02	0,18
Switzerland	0,02	0,02	0,02	0,00	0,01	0,04	0,00	0,01	0,01	0,01	0,03	0,04	0,21
Turkey	0,00	0,00	0,00	0,00	0,01	0,01	0,00	0,00	0,00	0,00	0,01	0,00	0,03
United Kingdom	0,02	0,01	0,02	0,00	0,00	0,01	0,02	0,01	0,01	0,01	0,02	0,02	0,16
United States	0,01	0,01	0,01	0,01	0,01	0,00	0,01	0,03	0,01	0,00	0,03	0,02	0,14

It is calculated as shown in Equation (10) and Equation (11).

Step 5. Normalization of the weighted total values

Table 8. Weighted Total Negative Values

Country Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	SNi
Argentina	0,03	0,03	0,02	0,00	0,01	0,03	0,02	0,02	0,04	0,02	0,01	0,00	0,22
Australia	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
Brazil	0,02	0,03	0,03	0,00	0,00	0,08	0,02	0,02	0,00	0,01	0,00	0,02	0,22
Canada	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
China	0,01	0,00	0,03	0,00	0,00	0,01	0,00	0,00	0,01	0,01	0,06	0,06	0,18
Germany	0,00	0,00	0,00	0,01	0,03	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,05
India	0,01	0,01	0,02	0,00	0,00	0,06	0,00	0,03	0,00	0,01	0,03	0,03	0,21
Japan	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
Russia	0,02	0,03	0,03	0,00	0,00	0,00	0,00	0,01	0,01	0,00	0,04	0,04	0,19
South Africa	0,01	0,01	0,02	0,01	0,00	0,02	0,02	0,00	0,00	0,01	0,02	0,02	0,14
Sweden	0,00	0,00	0,00	0,03	0,04	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,08
Switzerland	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Turkey	0,01	0,01	0,03	0,00	0,00	0,00	0,01	0,02	0,01	0,00	0,00	0,00	0,09
United Kingdom	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
United States	0,00	0,00	0,00	0,00	0,00	0,04	0,00	0,00	0,00	0,00	0,00	0,00	0,04

Table 9. Normalization of the Weighted Total Positive Values

Country Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Spi	N-SPi
Argentina	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
Australia	0,01	0,03	0,03	0,00	0,00	0,03	0,01	0,03	0,01	0,01	0,02	0,04	0,22	**1,00**
Brazil	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,02**
Canada	0,02	0,01	0,02	0,01	0,00	0,02	0,00	0,01	0,00	0,01	0,02	0,02	0,15	**0,70**
China	0,00	0,01	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,03	**0,13**
Germany	0,01	0,00	0,02	0,00	0,00	0,03	0,01	0,00	0,00	0,01	0,02	0,01	0,11	**0,50**
India	0,00	0,00	0,00	0,01	0,03	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,04	**0,18**
Japan	0,02	0,01	0,02	0,00	0,00	0,00	0,01	0,02	0,01	0,00	0,00	0,00	0,10	**0,43**
Russia	0,00	0,00	0,00	0,03	0,01	0,04	0,01	0,00	0,00	0,00	0,00	0,00	0,09	**0,41**
South Africa	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	**0,06**
Sweden	0,02	0,02	0,03	0,00	0,00	0,04	0,01	0,00	0,01	0,01	0,03	0,02	0,18	**0,80**
Switzerland	0,02	0,02	0,02	0,00	0,01	0,04	0,00	0,01	0,01	0,01	0,03	0,04	0,21	**0,96**
Turkey	0,00	0,00	0,00	0,00	0,01	0,01	0,00	0,00	0,00	0,00	0,01	0,00	0,03	**0,16**
United Kingdom	0,02	0,01	0,02	0,00	0,00	0,01	0,02	0,01	0,01	0,01	0,02	0,02	0,16	**0,72**
United States	0,01	0,01	0,01	0,01	0,01	0,00	0,01	0,03	0,01	0,00	0,03	0,02	0,14	**0,64**

Table 10. Normalization of the Weighted Total Negative Values

Country Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	SNi	N-SNi
Argentina	0,03	0,03	0,02	0,00	0,01	0,03	0,02	0,02	0,04	0,02	0,01	0,00	0,22	**0,00**
Australia	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	**0,96**
Brazil	0,02	0,03	0,03	0,00	0,00	0,08	0,02	0,02	0,00	0,01	0,00	0,02	0,22	**0,01**
Canada	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	**0,95**
China	0,01	0,00	0,03	0,00	0,00	0,01	0,00	0,00	0,01	0,01	0,06	0,06	0,18	**0,21**
Germany	0,00	0,00	0,00	0,01	0,03	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,05	**0,78**
India	0,01	0,01	0,02	0,00	0,00	0,06	0,00	0,03	0,00	0,01	0,03	0,03	0,21	**0,04**
Japan	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	**0,95**
Russia	0,02	0,03	0,03	0,00	0,00	0,00	0,00	0,01	0,01	0,00	0,04	0,04	0,19	**0,14**
South Africa	0,01	0,01	0,02	0,01	0,00	0,02	0,02	0,00	0,00	0,01	0,02	0,02	0,14	**0,39**
Sweden	0,00	0,00	0,00	0,03	0,04	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,08	**0,62**
Switzerland	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,98**
Turkey	0,01	0,01	0,03	0,00	0,00	0,00	0,01	0,02	0,01	0,00	0,00	0,00	0,09	**0,58**
United Kingdom	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	**0,95**
United States	0,00	0,00	0,00	0,00	0,00	0,04	0,00	0,00	0,00	0,00	0,00	0,00	0,04	**0,83**

It is calculated as shown in Equation (12).

Step 6. Calculation of the assessment scores

Table 11. Assessment Scores and Rankings of the Countries

Country Name	ASi	Rank
Argentina	0,00	**15**
Australia	0,98	**1**
Brazil	0,01	**14**
Canada	0,82	**4**
China	0,17	**12**
Germany	0,64	**8**
India	0,11	**13**
Japan	0,69	**7**
Russia	0,27	**10**
South Africa	0,22	**11**
Sweden	0,71	**6**
Switzerland	0,97	**2**
Turkey	0,37	**9**
United Kingdom	0,84	**3**
United States	0,73	**5**

It is calculated as shown in Equation (14).

The results of the application in which the performances of the economic freedoms of the countries were assessed with the EDAS method are shown in Table 11, and the countries with the highest economic freedom performance, in the same order as the IFE results, are Australia, Switzerland, United Kingdom, Canada, United States, Sweden, Japan, Germany, Turkey, Russia, South Africa, China, India, Brazil, and Argentina.

SOLUTION OF THE COPRAS METHOD

The aim of the COPRAS method developed by Zavadskas et al. (1994) is to assist decision makers with the issue of the selection of alternatives. The COPRAS method was evaluated as an agreeable method, and it determines a solution according to a positive ideal solution and a negative ideal solution. The COPRAS method uses the benefit approach in the issue of rational selection, calculating the difference between each alternative and the optimal value via the benefit degrees. It is used with a wide scope in the solution of strategic decisions.

The COPRAS method calculation consists of six stages (Ayçin, 2020, p. 67-71): first, the formation of a decision matrix; second, the normalization and weighting of the decision matrix; third, the weighting of the normalized decision matrix; fourth, the addition of weighted normalized indexes; fifth, finding the relative significance levels of the alternatives; and sixth, the calculation of the performance indexes for each alternative. The results attained from the COPRAS method are shown in Table 12.

Table 12. P_i Values and Their Rankings

Country Name	S+i	S-i	S-min	ΣS-i	S-min/ S-i	ΣS-min/ S-i	Qi	Pi	Rank
Argentina	0,052	0,000	0,00	0,00	0,00	0,00	0,052	0,64	**15**
Australia	0,081	0,000					0,081	1,00	**1**
Brazil	0,052	0,000					0,052	0,65	**14**
Canada	0,076	0,000					0,076	0,94	**4**
China	0,057	0,000					0,057	0,70	**12**
Germany	0,071	0,000					0,071	0,87	**8**
India	0,055	0,000					0,055	0,68	**13**
Japan	0,072	0,000					0,072	0,89	**7**
Russia	0,060	0,000					0,060	0,74	**10**
South Africa	0,058	0,000					0,058	0,72	**11**
Sweden	0,073	0,000					0,073	0,90	**6**
Switzerland	0,081	0,000					0,081	1,00	**2**
Turkey	0,063	0,000					0,063	0,78	**9**
United Kingdom	0,077	0,000					0,077	0,95	**3**
United States	0,073	0,000					0,073	0,91	**5**

The results of the application in which the performances of the economic freedoms of the countries were assessed with the COPRAS method are shown in Table 12 where it may be seen that

the countries with the highest economic freedom performance are as follows in the order of their IFE results: Australia, Switzerland, United Kingdom, Canada, United States, Sweden, Japan, Germany, Turkey, Russia, South Africa, China, India, Brazil, and Argentina.

COMPARATIVE ANALYSIS

The performance scores and rankings obtained from the three methods used in the study are given in Table 13. All three methods give the same economic freedom performance ranking.

Table 13. Assessment Scores

Country Name	EDAS (AS_i)	Rank	Country Name	EFI	Rank	Country Name	COPRAS (P_i)	Rank
Argentina	0,00	15	Argentina	52,7	15	Argentina	0,64	15
Australia	0,98	1	Australia	82,4	1	Australia	1,00	1
Brazil	0,01	14	Brazil	53,4	14	Brazil	0,65	14
Canada	0,82	4	Canada	77,9	4	Canada	0,94	4
China	0,17	12	China	58,4	12	China	0,70	12
Germany	0,64	8	Germany	72,5	8	Germany	0,87	8
India	0,11	13	India	56,5	13	India	0,68	13
Japan	0,69	7	Japan	74,1	7	Japan	0,89	7
Russia	0,27	10	Russia	61,5	10	Russia	0,74	10
South Africa	0,22	11	South Africa	59,7	11	South Africa	0,72	11
Sweden	0,71	6	Sweden	74,7	6	Sweden	0,90	6
Switzerland	0,97	2	Switzerland	81,9	2	Switzerland	1,00	2
Turkey	0,37	9	Turkey	64,0	9	Turkey	0,78	9
United Kingdom	0,84	3	United Kingdom	78,4	3	United Kingdom	0,95	3
United States	0,73	5	United States	74,8	5	United States	0,91	5

SENSITIVITY ANALYSIS

The sensitivity relationship among the scores was examined in this part of the study. For this, Kendall's tau-b and Spearman's rho as the nonparametric correlation scales were used. According to Table 14, there is a positive and complete relationship among the three performance scores attained from the three methods. The found results are statistically significant.

Table 14. Nonparametric Correlations

			EDAS	EFI	COPRAS
Kendall's tau_b	EDAS	Correlation Coefficient	1.000	1.000**	1.000**
		Sig. (2-tailed)	.	.	.
		N	15	15	15
	EFI	Correlation Coefficient	1.000**	1.000	1.000**
		Sig. (2-tailed)	.	.	.
		N	15	15	15
	COPRAS	Correlation Coefficient	1.000**	1.000**	1.000
		Sig. (2-tailed)	.	.	.
		N	15	15	15
Spearman's rho	EDAS	Correlation Coefficient	1.000	1.000**	1.000**
		Sig. (2-tailed)	.	.	.
		N	15	15	15
	EFI	Correlation Coefficient	1.000**	1.000	1.000**
		Sig. (2-tailed)	.	.	.
		N	15	15	15
	COPRAS	Correlation Coefficient	1.000**	1.000**	1.000
		Sig. (2-tailed)	.	.	.
		N	15	15	15

**. Correlation is significant at the 0.01 level (2-tailed).

CONCLUSION

There are many MCDM methods, and there is no single optimal solution among them. However, they play an important role in decision making that minimizes possible damage and losses. MCDM methods are used over a wide area for the solution of choice, ranking, and sorting problems. In addition, it is suggested that sensitivity analysis or a comparison to another method on the issue of the reliability of their results be conducted.

EDAS, COPRAS, and EFI methods were compared in this study. In this respect, the three methods give the same performance ranking results. Moreover, there is a positive and complete relationship among the performance scores. Results are statistically significant. This result supports the studies of 2020a, 2020b, and 2020c previously conducted with different MCDM methods.

As in other MCDM methods, EDAS and COPRAS methods were seen to be used in limited numbers in the area of basic economy and finance. The use of more multi-criteria decision-making methods in the future will ensure new working opportunities in these areas.

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