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ARTICLE

Ranking the quality of life indexes by years in Asian countries using multi-criteria decision-making methods

Pınar Çelebi Demirarslan[1] · Fatma Sönmez Çakır[2] · Ilkben Akansel[3]

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Abstract

The objective weighting methods recently introduced in the literature include method based on the removal effects of criteria (MEREC), logarithmic percentage change-driven objective weighting (LOPCOW), and modified preference selection index method (MPSI). The aim of this study was to analyze the effects of the above methods on criteria weights and rank in decision problems involving over 20 alternatives. Based on the quality of life index (QLI), the ranking of Asian countries was carried out by combining the above weighting methods with the multi-attributive ideal-real comparative analysis (MAIRCA). Combination of these methods has not been used before in this research area. Capitals of Asian countries were selected and evaluated with eight different criteria. MEREC, LOPCOW, and MPSI methods were used to weight the criteria. The MAIRCA method was used to rank the alternatives. These results were compared with Numbeo rankings. The MPSI method showed the closest ranking to the Numbeo ranking, exhibiting the highest Spearman rank correlation and lowest Euclidean distance. Given its straightforward applicability, the MPSI method is preferred among the aforementioned objective weighting methods, followed by the MEREC and then the LOPCOW methods. In addition, we also examined the applicability of the preference selection index (PSI) method to the data sets. The results indicate the PSI method may not calculate the criteria weights in decision-making problems where the number of alternatives is high.

Keywords LOPCOW · MAIRCA · MCDM · MEREC · MPSI · Quality of life index · Ranking

1 Introduction

Determination of the weights of the criteria in the multi-criteria decision-making (MCDM) problems is incredibly significant since it remarkably affects the results. In decision problems, failure to obtain reliable criterion weights can create uncertainty about the accuracy of the solution of the decision problem (Jessop 2004). In cases

Extended author information available on the last page of the article

of uncertainty, subjective methods can be used by taking opinions of decision makers. However, there is also the possibility of error in human judgment. Due to such possible errors, it is difficult to ensure accurate evaluation of criterion weights (Pala 2023). For this reason, using objective weighting methods and determining criterion weights reliably in decision problems is particularly important. Depending on this situation, new MCDM methods are developed to be used in the solution of decision problems. Three of them are the method based on the removal effects of criteria (MEREC) method introduced by Keshavarz-Ghorabaee et al. (2021), the logarithmic percentage change-driven objective weighting (LOPCOW) Method proposed by Ecer and Pamucar (2022), and modified preference selection index (MPSI) Method suggested by Gligori´c et al. (2022). Since they are newly introduced to the literature and being objective methods, the difference between them has been a matter of curiosity for researchers. Therefore, it is aimed to examine the impact of MEREC, LOPCOW, and MPSI weighting methods to criteria weights and the ranking results in this study. In addition, the applicability of PSI method instead of MPSI method has been questioned, since MPSI is a modified version of PSI method. In this context, the quality of life index (QLI) values are used as data set. For this purpose, MEREC, LOPCOW, MPSI and multi-attributive ideal-real comparative analysis (MAIRCA) methods are used as a combined method. The criteria weights for the QLI were calculated with the MEREC, LOPCOW and MPSI methods, and the capitals of 30 Asian countries were ranked according to the QLI using the MAIRCA method.

The QLI values to be used in the study are published by Numbeo every 6 months and the general QLI of the cities is estimated based on eight different indexes (Numbeo 2022). By calculating the QLI for selected cities around the world, these cities are ranked by the effects of certain criteria. Since the Numbeo database contains both the data of the criteria and the ranking results of the cities, it allows testing the developed MCDM methods.

The indexes in the QLI can be considered as criteria in MCDM problems. Among these criteria, purchasing power, safety, health services, and climate indexes are the benefit criteria (maximization oriented); pollution, property price/income ratio, cost of living and traffic indices are cost criteria (minimization oriented). It is preferred that the criteria with the maximization direction be large, and the criteria with the minimization direction be small. The eight indexes used in this study are explained in Numbeo web site (Numbeo 2022).

The aim of this study is to determine criteria weights with MEREC, LOPCOW, and MPSI weighting methods, which are new and objective methods in the literature, to compare them and to reveal their effects on ranking. The competence of these methods in decision models with a large number of alternatives was also evaluated. The results that will solve the problems that other scientists who will use the method may encounter have been reached. In the application part of the study, MAIRCA was combined for the first time with the weighting methods mentioned. The novelty of the study is explained below.

1.1 Highlights

- It is aimed to examine the effects of MEREC, LOPCOW, and MPSI weighting methods, which are new and objective methods in the literature, on criteria weights and ranking results.
- A new usage area for the MEREC method has been added to the literature.
- The applicability of the Preference Selection Index (PSI) method, which is a modified version of this method instead of the MPSI method, was investigated and it was found that the PSI method was inadequate in calculating the criteria weights in decision-making problems with a large number of alternatives. This result is an important problem solver for other studies. Therefore, MPSI method was preferred instead of PSI method.
- MEREC, LOPCOW, MPSI, and MAIRCA methods were used as a combined method. With the MPSI method, methods that have not been encountered in the literature have been added to the combined MCDM methods and have been guiding the way for new areas of use by comparing them.
- The usage of MAIRCA method with the mentioned weighting methods was encountered only in this study. The rest of the article consists of the literature review in the second section, methods in the third section, results in the fourth section, discussion in the fifth section, and conclusion in the final section.

2 Literature review

Although MEREC and LOPCOW methods have recently been added to the literature as weighting methods, they have been used in various studies alone or integrating with other methods.

Table 1 shows the studies in which MEREC, LOPCOW, and MAIRCA methods are preferred for weighting and ranking the criteria in various decision-making problems.

Unlike MEREC and LOPCOW methods, MPSI method has been appeared in very few studies which are the support system selection in an underground mine (Gligori´c et al. 2022), the anti-fatigue lightweight design of heavy tractor frame (Zhang et al. 2022) and the bank selection problem (Yılmaz 2023).

While there are studies in the literature where MEREC and LOPCOW methods are used together (Bektaş, 2022; Yalman et al. 2023; Yaşar and Ünlü, 2023; Yürüyen et al. 2023), only one study was found in which MEREC, LOPCOW, and PSI methods were used (Ulutaş et al. 2023). However, no study comparing MEREC, LOPCOW, and MPSI methods has yet been found.

In the literature, it is seen that the studies in which MEREC and MAIRCA methods are used together are few and mostly in mechanical engineering (Trung and Thinh 2021; Nguyen et al. 2022; Sapkota et al. 2022). The literature examples of studies which uses MEREC and MAIRCA methods in social sciences were mostly based on financial performance of BIST insurance index (Çilek 2022) and

Table 1 MEREC, LOPCOW, and MAIRCA methods areas of use

Method	Author/s and year	Areas of use
MEREC	Ghorabaee, 2021	Location of logistics distribution centers
	Goswami et al. 2021	Selection of renewable energy sources
	Sabaghian et al. 2021	Document classification
	Trung and Thinh 2021	Turning operations
	Goswami et al. 2022	Selection of a green renewable energy source
	Hadi and Abdullah 2022	Hospital location selection
	Mishra et al. 2022	Low-carbon tourism strategy evaluation
	Rani et al. 2022	Treatment technology selection for food wastes
	Sapkota et al. 2022	Production process
	Toslak et al. 2022	Firm performance evaluation
	Keleş, 2023a, b	Forklift selection problem
	Puška et al. 2023	Ranking electric cars
	Mastilo et al. 2024	Analysis of financial indicators
	Wang et al. 2024	Underground mine safety and health
LOPCOW	Bektaş, 2022	Evaluation of performance
	Ecer and Pamucar 2022	Evaluation of performance
	Biswas and Joshi 2023	Evaluation of a list of initial public offering
	Biswas et al. 2023	Comparison of countries
	Ecer et al. 2023a, b	Sustainability performance
	Ecer et al. 2023b	Assess the role of unmanned aerial vehicles
	Ersoy 2023	Evaluation of the performance
	Keleş 2023a, b	Comparison of countries
	Nila and Roy 2023	Selection of the most suitable third-party logistics
	Ulutaş et al. 2023	Material selection
	Rong et al. 2024	Risk assessment
	Ulutaş et al. 2024	Evaluation of third-party logistics
MAIRCA	Gigović et al. 2016	Warehouse location selection
	Badi and Ballem 2018	Supplier selection
	Chatterjee et al. 2018	Supplier performance evaluation
	Pamucar et al. 2018	Logistics center selection
	Ayçin and Orçun 2019	Financial performance evaluation
	Ayçin and Güçlü, 2020	Financial performance evaluation
	Kehribar et al. 2021	Financial performance evaluation
	Ecer 2022	Vaccine selection
	Hadian et al. 2022	Evaluating flood susceptibility
	Chen et al. 2023	Emergency decision-making process
	Haq et al. 2023	Sustainable material selection
	Tešić et al. 2023	Strategy selection in the system of defense
	Wu et al. 2023	Risk evaluation

on banking sector (Özcan 2022). Few studies have been found in which MCDM methods are used for the ranking of the QLI. Some studies using MCDM methods for QLI ranking are given in Table 2.

De Vicente Oliva and Romero-Ania (2022) aimed to develop a multidimensional QLI which can replace the current methodology designed by Eurostat and implemented by the national statistical institutes of the European Union member states using ELECTRE III method.

As a result of the literature review, any study comparing the difference of MEREC, LOPCOW, and MPSI methods or considering MAIRCA, LOPCOW, MPSI, and MEREC methods together has not been found. Furthermore, the studies which the mentioned weighting methods and MAIRCA method are used have never been focused on the field of QLI. With this study, the use of weight determination in the ranking of countries according to QoL is also added to the used areas of the MEREC, LOPCOW, MPSI, and MAIRCA methods. The studies containing QLI-MCDM have not focused on the Asian countries. Based on the literature review, no studies have been conducted to measure and analyze the impact of using different weighting methods in ranking and prioritizing Asian countries according to QLI. Therefore, the research in question will contribute significantly to the literature. In addition to all these, it is thought that examining the applicability of the PSI method in decision problems with a large number of alternatives will contribute significantly to the literature. For this purpose, first, the application steps of MEREC, LOPCOW, MPSI, PSI, and MAIRCA methods will be introduced. Then the weights of the criteria (quality of life indicators) will be calculated with the MEREC, LOPCOW, and MPSI methods. According to these weights, the Asian countries will be ranked with the MAIRCA method. Finally, the ranking results will be compared with the ranking on the Numbeo website.

3 Method

In this study, rankings were carried out for Asian countries using QLI between 2020 and 2023. While the indices were weighted by the MEREC, LOPCOW, and MPSI methods, rankings are computed by the MAIRCA method, and these methods were combined in the study. Eight index values, including purchasing power (including rent) index, pollution index, property prices to income ratio index, cost of living index, safety index, climate index, health care index, and traffic index were chosen as criteria and the values for the capitals of Asian countries were used. The data were pulled from numbeo.com for the years 2020, 2021, 2022, and 2023. Since 2023 data have not yet been completed, mid-year data were used as index values in the analysis. Concerning a convenient comparison with the other years, mid-year index values were also used for each year. The ranking results for quality of life by years are also available on this site. The ranking results obtained in this study were compared with the Numbeo ranking results by calculating correlation coefficients and Euclidean distances. During the analysis, EXCEL and SPSS programs were used.

The QLI available in the Numbeo website content (in Java) is calculated as (URL1):

Table 2 Some studies using MCDM methods for QLI ranking

Author/s and year	Areas of use	Method
Kaklauskas et al. 2018	Ranking of the quality of life of European cities between 2012 and 2016	INVAR, COPRAS
Altın, (2020)	Compare the results of the QLI of 86 European cities	WASPAS, VIKOR, CRITIC
Altın, 2021	Ranked Western European cities	COPRAS
Çınaroğlu 2021	Ranked the EU member states	CRITIC, CODAS, and ROV
Akram et al. 2022	Rank the cities	2-tuple linguistic Fermatean fuzzy set extension of MULTIMOORA
Şeker (2015)	Ranked the districts of Istanbul	WAM
Kara (2019)	Quality of life in Istanbul	AHP
Coronicova Hurajova and Hajduova (2021	Ranked 8 regions of Slovakia	Scoring method, average, entropy, TOPSIS and WSA
Ayyıldız and Demirci (2018)	81 provinces in Turkey	SWARA and TOPSIS
Küçükal et al. (2021)		GIA, PROMETHEE, and MOORA

index.main = Math.max (0,100 + purchasingPowerInclRentIndex/2.5-(housePriceToIncomeRatio × 1.0) − costOfLivingIndex/10 + safetyIndex/2.0 + healthIndex/2.5 − trafficTimeIndex/2.0 – pollutionIndex × 2.0/3.0 + climateIndex/3.0).

Since the index data of some Asian countries or their capitals could not be reached, the evaluation was made over 29, 28, 28, and 25 countries for years 2020, 2021, 2022, and 2023, respectively. The data sets are given at Tables 9, 10, 11 and 12 in Appendix A.

3.1 Method based on the removal effects of criteria (MEREC)

This method is added to MCDM techniques in 2021 by Keshavarz-Ghorabaee et al. The method called MEREC is used to determine the weights of the criteria and has been tested by its developers and found to give consistent and reliable results with other criteria weight calculation methods. For the criteria weights, subjective weighting methods, objective weighting methods, and hybrid weighting methods are used (Keshavarz-Ghorabaee et al 2021). There are places where each method is superior to the others. MEREC stands as one of the objective weighting methods.

In the MEREC method, the effects of each criterion on the overall performance of the alternatives are examined for criterion weights. The effect of removing a criterion on the overall performance of the alternatives is examined. If the total performance is more affected by the removal of which criterion, that criterion should have a greater weight. Thus, both the weights can be given to the criteria and the criteria deemed unnecessary by the expert can be removed. To obtain objective criteria weights, MEREC uses the perspective of subtraction rather than inclusion, which is the basis of other objective weighting methods (Keshavarz-Ghorabaee 2021). In this method, criteria and alternatives are evaluated simultaneously. The method is based on maximizing the overall performance of alternatives with variation within and between criteria, measured using standard deviation and correlation (Sabaghian et al. 2021). The application steps of the method are as follows (Keshavarz-Ghorabaee 2021; Keshavarz-Ghorabaee et al 2021):

Step 1. Creating decision matrix: a decision matrix is created showing the ratings of each alternative or the values of each alternative according to each criterion. The elements of this matrix are denoted by x_{ij}, and these elements must be greater than zero. If there is negative data, it should be converted to positive using appropriate methods. A decision matrix $X = [x_{ij}]$ of size $m \times n$ can be represented as follows, where m represents the number of alternatives and n the number of criteria:

$$X = \begin{bmatrix} x_{11} x_{12} \cdots x_{1j} \cdots x_{1n} \\ x_{21} x_{22} \cdots x_{2j} \cdots x_{2n} \\ \vdots \vdots \ddots \vdots \ddots \vdots \\ x_{i1} x_{i2} \cdots x_{ij} \cdots x_{in} \\ \vdots \vdots \ddots \vdots \ddots \vdots \\ x_{m1} x_{m2} \cdots x_{mj} \cdots x_{mn} \end{bmatrix}$$

Step 2. The normalized matrix $M^x = \left[m_{ij}^x\right]$ is obtained using the following appropriate equations.

$$m_{ij}^x = \frac{\min_i x_{ij}}{x_{ij}} \text{ if the j. criterion is maximization oriented (When high is preferred)} \tag{1}$$

$$m_{ij}^x = \frac{x_{ij}}{\max_i x_{ij}} \text{ if the j. criterion is minimization oriented (When low is preferred)} \tag{2}$$

Step 3. In this step, the performances of the alternatives are calculated with the help of a logarithmic measure with equal criterion weights.

$$S_i = \ln\left[1 + \left(\frac{1}{n}\sum_j \left|\ln\left(m_{ij}^x\right)\right|\right)\right] \tag{3}$$

Step 4. In this step, the logarithmic measure is used similarly to the previous step. The difference from Step 3 is that the performances of the alternatives are determined based on the removal of each criterion separately. By removing each criterion one by one, the performances of the alternatives are calculated. Let S_{ij}' be the overall performance of the i^{th} alternative computed with the removal of the j^{th} criterion, then the value for each alternative is calculated as below:

$$S_{ij}' = \ln\left[1 + \left(\frac{1}{n}\sum_{k,k\neq j} \left|\ln\left(m_{ik}^x\right)\right|\right)\right] \tag{4}$$

Step 5. The effect of removing the criterion is calculated. For this, the results of Step 3 and Step 4 are used. Thus, the sum of the absolute deviations is found and the effect of removing the criterion is computed. Let E_j be the removal effect. E_j is found with the help of the following equation:

$$E_j = \sum_i \left|S_{ij}' - S_i\right| \tag{5}$$

Step 6. The final weights of the criteria are determined. In this step, the objective weight of each criterion is calculated using the removal effects (E_j) calculated in Step 5. Let w_j represent the weight of the j^{th} criterion:

$$w_j = \frac{E_j}{\sum_k E_k} \tag{6}$$

Here the sum of the weights of the criteria is equal to 1 ($\sum_j w_j = 1$).

3.2 LOgarithmic percentage change-driven objective weighting (LOPCOW)

The LOPCOW method was introduced by Ecer and Pamucar in 2022 as an objective weighting method. The distinguishing features of the LOPCOW method are that it eliminates the difference (gap) caused by the size of the data by expressing it as a percentage of the standard deviations of the mean square values of the series and it provides the opportunity to work with negative values in the data set (Bektaş, 2022). Therefore, the distribution of criterion weights is less affected by changes in the performance values of the alternatives and provides a reasonably accurate result (Biswas et al. 2022). In addition, it is not affected by the influence of a large number of alternatives and criteria (Bektaş, 2022; Biswas et al. 2022). The steps of the LOPCOW method are as follows (Ecer and Pamucar 2022):

Step 1. A decision matrix is created with the ratings of each alternative or the values of each alternative according to each criterion. The elements of this matrix are denoted by x_{ij}, and these elements can be negative unlike the MEREC method. A decision matrix $X = \left[x_{ij}\right]$ of size $m \times n$ can be formed as in MEREC method, where m represents the number of alternatives and n the number of criteria.

Step 2. The normalized decision matrix $M^x = \left[m_{ij}^x\right]$ can be computed by Eqs. 7 and 8 in accordance with the characteristics of the criterion.

$$m_{ij}^x = \frac{x_{ij} - x_i^-}{x_i^+ - x_i^-} \text{if the j. criterion is maximization oriented (When low is preferred)} \tag{7}$$

$$m_{ij}^x = \frac{x_i^+ - x_{ij}}{x_i^+ - x_i^-} \text{if the j. criterion is minimization oriented (When low is preferred)} \tag{8}$$

In equalities above, x_{ij} is the value of the ith alternative at jth criterion, x_i^- denotes the lowest value of the criterion gets from the alternative, and x_i^+ denotes the highest value of criterion takes from the alternative.

Step 3. Calculating the percentage values (PV) of the criteria: in this step, to eliminate the difference (gap) caused by the data size, the mean square value as a percentage of the standard deviations of each criterion is obtained with the help of Eq. 9.

$$PV_{ij} = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{m} (m_{ij}^x)^2}{m}}}{\sigma} \right) .100 \right| \tag{9}$$

where σ is the standard deviation and m represents the number of alternatives.

Step 4. Objective weights for each criterion are computed by Eq. 10.

$$w_j = \frac{PV_{ij}}{\sum_{i=1}^{n} PV_{ij}} \tag{10}$$

where the sum of the weights of the criteria is 1 ($\sum_j w_j = 1$).

3.3 Modified preference selection index (MPSI)

Preference selection index (PSI) method introduced by Mania and Bhatt (2010) eliminates the need to determine the relative importance of the criteria and is used both for finding criterion weights and for ranking purposes (Mufazzal and Muzakkir 2017), which makes it preferred in the literature. However, in decision problems with several alternatives as in this study, it is not possible to use the PSI method since the addition of numerous normalized values between 0 and 1 can be greater than 2 and as a result, overall preference value becomes negative. In addition, Zhang et al. (2022) argued in their study that the PSI method "prefers" certain criteria, and this leads to injustice in making decisions. Due to such disadvantages, different normalization techniques have been tried for the PSI method in the literature (Do and Nguyen 2023) or the PSI method has been modified (Gligorić et al. 2022; Zhang et al. 2022). The MPSI method is a modification of the traditional PSI method, achieved only by eliminating a certain step from the original PSI method. This small change increases the final values of the weighting coefficients, bringing them closer to the values obtained with other objective weighting methods. MPSI method is one of them and the application steps are explained below (Gligorić et al. 2022):

Step 1. A decision matrix is formed with the ratings of each alternative or the values of each alternative according to each criterion same as LOPCOW and MEREC. A decision matrix $X = \left[x_{ij}\right]$ of size $m \times n$ is formed, where m represents the number of alternatives and n the number of criteria.

Step 2. The normalized matrix $M^x = \left[m_{ij}^x\right]$ is obtained using Eqs. 1 and 2.

Step 3. Calculate the preference variation value p_j as follows:

$$p_j = \sum_{i=1}^{m} \left(m_{ij}^x - \overline{m}_j\right)^2 \tag{11}$$

where $\overline{m}_j$ is the mean normalized value given in Eq. 12.

$$\overline{m}_j = \frac{1}{n} \sum_{i=1}^{n} m_{ij}^x \tag{12}$$

Step 4. The weights of criteria w_j are computed by Eq. 13.

$$w_j = \frac{p_j}{\sum_{j=1}^{n} p_j} \tag{13}$$

where the sum of the weights of the criteria is 1 ($\sum_j w_j = 1$). PSI method involves an extra step that computes PSI by $q_j = 1 - p_j$ and then calculate the weights according to $w_j = \frac{q_j}{\sum_{j=1}^{n} q_j}$.

3.4 Multi-attributive ideal-real comparative analysis (MAIRCA)

Pamucar et al. introduced the MAIRCA method, which was developed at the Center for Defense Logistics Studies at the University of Belgrade, at a conference in 2014 (Pamucar et al. 2014). The method is based on the logic of defining the difference between theoretical and real results. Thanks to the linear normalization algorithm used, very reliable results can be attained (Ecer 2022). It can also be used easily with other MCDM or alternative solution methods. There have been many studies for ranking aim where it is used alone or with other solution methods. The advantages of this method have been considered in choosing the MAIRCA method. These advantages are (Ecer 2022) listed below:

- It can be used in problems with many evaluation criteria and alternatives.
- It can solve decision problems with both qualitative and quantitative evaluation criteria.
- It is easy to understand and apply.
- It produces consistent solutions thanks to its own algorithm.

The method consists of six steps (Pamucar et al. 2014):

Step 1. Creating the decision matrix: in this step, an initial matrix with alternatives and criteria is built. A decision matrix $X = \left[x_{ij}\right]$ is formed with $m \times n$ dimension, where m represents the number of alternatives and n the number of criteria.

Step 2: determination of preference according to alternatives: at this stage, there is no priority calculation for the decision maker to choose between alternatives. The decision maker gives equal priority to alternatives. Since there will be equal priority among m alternatives, the preference ratio (P_{A_i}) among the alternatives is calculated as follows:

$$P_{A_i} = \frac{1}{m}; \sum_{i=1}^{m} P_{A_i} = 1, i = 1, 2, \dots, m \tag{14}$$

Step 3: determination of theoretically considered matrix elements: this matrix is denoted by (T_p), and the elements of the matrix are determined as the product of the preference ratio of the preferred alternatives (P_{A_i}) and the criterion weighting coefficients (w_n). Let n be the number of criteria:

$$w_1 w_2 \dots w_n$$

$$T_p = P_{A_i}\left[P_{A_i} * w_1 P_{A_i} * w_2 \dots P_{A_i} * w_n\right] \tag{15}$$

Step 4: calculation of real rating matrix (T_r) elements: here, n is the number of criteria and m is the total number of alternatives:

$$C_1 C_2 \dots C_n$$

$$T_r = \begin{matrix} A_1 \\ A_2 \\ \cdots \\ A_m \end{matrix} \begin{bmatrix} t_{r11} & t_{r12} & \cdots & t_{r1n} \\ t_{r21} & t_{r22} & \cdots & t_{r2n} \\ \cdots & \cdots & \cdots & \cdots \\ t_{rm1} & t_{rm2} & \cdots & t_{rmn} \end{bmatrix}$$

The real grading matrix (T_r) is made by multiplying the elements of the theoretically considered (T_p) matrix with the elements of the initial decision matrix (X) according to the formulas given below:

a) If the criterion is the benefit criterion, that is, if it is preferred to be maximum:

$$t_{rij} = t_{pij} * \left(\frac{x_{ij} - x_i^-}{x_i^+ - x_i^-} \right) \tag{16}$$

b) If the criterion is the cost criterion, that is, if it is preferred to be minimum:

$$t_{rij} = t_{pij} * \left(\frac{x_{ij} - x_i^+}{x_i^- - x_i^+} \right) \tag{17}$$

In equalities above, x_{ij} is the value of the ith alternative at jth criterion, x_i^- denotes the lowest value of the criterion gets from the alternative, and x_i^+ denotes the highest value of criterion takes from the alternative.

Step 5: creating the total gap matrix. The elements of the total gap matrix (G) are obtained by calculating the difference between the theoretical considered matrix (T_p) and the actual grading matrix (T_r) created in Step 3.

Step 6: calculation of final values (Q_i) of criterion functions according to alternatives: at this stage, the final values are obtained by summing the rows of the gap matrix (G) for each alternative.

4 Results

The descriptive statistics of data sets for the years are given at Table 3 where C1 is purchasing power index, C2 is safety index, C3 is health care index, C4 is cost of living index, C5 is property prices to income ratio index, C6 is traffic index, C7 is pollution index, and C8 is climate index.

Sd standard deviation, *Min* minimum, *Max* maximum, *K* kurtosis, *S* skewness

Table 1 shows the descriptive statistical values of the data sets used for the analyses. Mean, standard deviation, minimum, maximum, skewness, and kurtosis values are presented, and it is observed that the data set does not have extreme values. The following sub-sections include weighting method results and applicability results of PSI method, then ranking results using MAIRCA method.

Table 3 Descriptive statistics of criteria for mid points of 2020, 2021, 2022, and 2023

2020	*C1*	C2	C3	C4	C5	C6	C7	C8
Mean	49.7	64.7	63.6	49.3	17.2	38.8	68.0	66.9
Sd	24.9	15.4	10.8	17.7	10.3	9.9	18.7	20.2
Min	18.1	34.7	41.1	22.5	3.4	20.8	33.3	20.2
Max	95.5	88.5	87	89.7	41.6	60.1	95.9	94.7
K(S)	− 1.2(0.5)	− 0.4(− 0.6)	0.0(0.1)	− 0.4(0.6)	0.2(0.9)	− 0.2(0.5)	− 1.18(− 0.2)	0.1(− 0.7)
2021	C1	C2	C3	C4	C5	C6	C7	C8
Mean	45.2	65.1	64.0	47.7	17.5	38.7	66.8	65.9
Sd	23.7	15.7	10.8	17.2	12.2	9.9	18.2	19.9
Min	12.4	35.1	39.9	24.3	2.7	21.1	33.1	20.2
Max	90.4	88.1	87.3	85.3	52.7	59	95.7	92.6
K(S)	− 1.2(0.5)	− 0.3(− 0.7)	0.3(0.0)	− 0.3(0.8)	1.5(1.2)	− 0.5(0.5)	− 1.0(− 0.2)	0.2(− 0.7)
2022	C1	C2	C3	C4	C5	C6	C7	C8
Mean	50.3	64.8	64.1	47.4	18.3	38.9	68.2	68.5
Sd	28.3	15.6	10.6	18.0	12.8	9.9	18.6	18.6
Min	11.7	35.3	39.7	18.7	3	20.7	33	20.2
Max	98.3	88.3	86.7	95.7	56.9	59.6	95.7	94.7
K(S)	− 1.4(0.4)	− 0.6(− 0.6)	0.3(0.1)	0.6(0.9)	1.4(1.1)	− 0.3(0.4)	− 0.9(− 0.3)	0.2(− 0.6)
2023	C1	C2	C3	C4	C5	C6	C7	C8
Mean	53.9	64.5	64.6	45.2	18.3	40.0	67.6	67.0
Sd	31.0	16.3	10.7	15.7	11.3	9.7	18.6	18.6
Min	12.3	35.1	39.9	18.3	3.2	20.5	33	20.2
Max	110.5	88	86.1	85.9	41.8	61	93.7	94.7
K(S)	− 1.5(0.3)	− 0.9(− 0.5)	0.2(− 0.1)	0.8(0.7)	− 0.5(0.7)	0.0(0.4)	− 0.9(− 0.3)	0.2(− 0.6)

4.1 Criteria weights with MEREC, LOPCOW, and MPSI methods

The steps of the MEREC, LOPCOW, and MPSI methods were applied to the four decision matrices given in Appendix A. The criteria C1, C2, C3, and C8 are maximum oriented criteria and C4, C5, C6, and C7 are minimum oriented criteria in the analysis. The removal effect (E_j) values in MEREC method, the percentage values (PV_j) in LOPCOW method, and preference variation values (p_j) in MPSI method were calculated for each criterion and results are given in Table 4.

When the results for MPSI method are examined, it is seen that the preference variation values for a few criteria is higher than 1; namely, criterion C1, C5, and C8 in 2020 and 2022; C1, C4, C5, and C8 in 2021; C1, C5 in 2023. This situation caused to get negative values at the PSI values ($q_j = 1 - p_j$) calculation step of PSI method. This occurs because as the number of alternatives increases, the sum of preference variation values increases and exceeds 1. For this reason, the PSI method becomes

Table 4 Analysis results for MEREC, LOPCOW, and MPSI

2020	C1	C2	C3	C4	C5	C6	C7	C8
E_j	1.90	1.26	0.91	1.49	2.31	0.98	0.80	2.58
PV_j	47.16	78.00	83.46	90.78	94.31	86.11	57.90	92.04
p_j	1.91	0.85	0.43	0.96	1.19	0.61	0.84	1.28
2021	C1	C2	C3	C4	C5	C6	C7	C8
E_j	2.32	1.15	0.92	1.35	2.70	0.88	0.77	2.37
PV_j	52.90	76.76	89.50	87.27	111.60	81.75	62.22	91.74
p_j	1.85	0.85	0.41	1.02	1.17	0.62	0.82	1.24
2022	C1	C2	C3	C4	C5	C6	C7	C8
E_j	2.55	1.11	0.92	1.57	2.73	0.87	0.71	2.42
PV_j	51.85	75.50	91.55	104.76	115.21	83.95	57.17	102.40
p_j	2.24	0.85	0.40	0.82	1.47	0.61	0.85	1.04
2023	C1	C2	C3	C4	C5	C6	C7	C8
E_j	2.37	1.02	0.85	1.32	1.85	0.79	0.63	2.19
PV_j	50.74	71.87	91.64	102.15	83.12	86.62	53.74	99.24
p_j	1.89	0.83	0.37	0.72	1.27	0.49	0.80	0.93

E_j removal effect at MEREC method, PV_j percentage value at LOPCOW method, p_j preference variation value at MPSI method

dysfunctional when the number of alternatives is large. Therefore, PSI method could not be applied in this study, MPSI method was preferred instead. The criteria weights attained by MEREC, LOPCOW, and MPSI methods are illustrated with Fig. 1.

According to Fig. 1, while MEREC and MPSI methods gave the close and high values, LOPCOW gave very low value for criteria C1. The opposite situation was observed for the criteria C3 and C6. The highest weighted criterion was C8 in 2020, C5 in 2021 and 2022, and C4 in 2023 by MEREC method. The lowest weighted criterion was C7 in each year. In the results of LOPCOW method, the highest weighted criterion was found as C5 for 2020, 2021, and 2022, but C4 for 2023. The lowest weighted criterion was C8 at each year. The highest weighted criterion was found as C8 and lowest weighted criterion was C3 by MPSI method at each year.

4.2 Ranking by MAIRCA method

In this section, Asian countries are ranked according to eight criteria weighted by the MEREC, LOPCOW, and MPSI methods for each year. The decision matrices are same as the matrices used for weighting and are given in Appendix A. In the next step, since there will be equal priority among the alternatives, the preference rate (P_{A_i}) is calculated as in Table 5 using Eq. 14.

After second step, all calculations are made using the weight values determined by the MEREC, LOPCOW, and MPSI methods, separately. The ranking results by years and methods are summarized at the following Table 6.

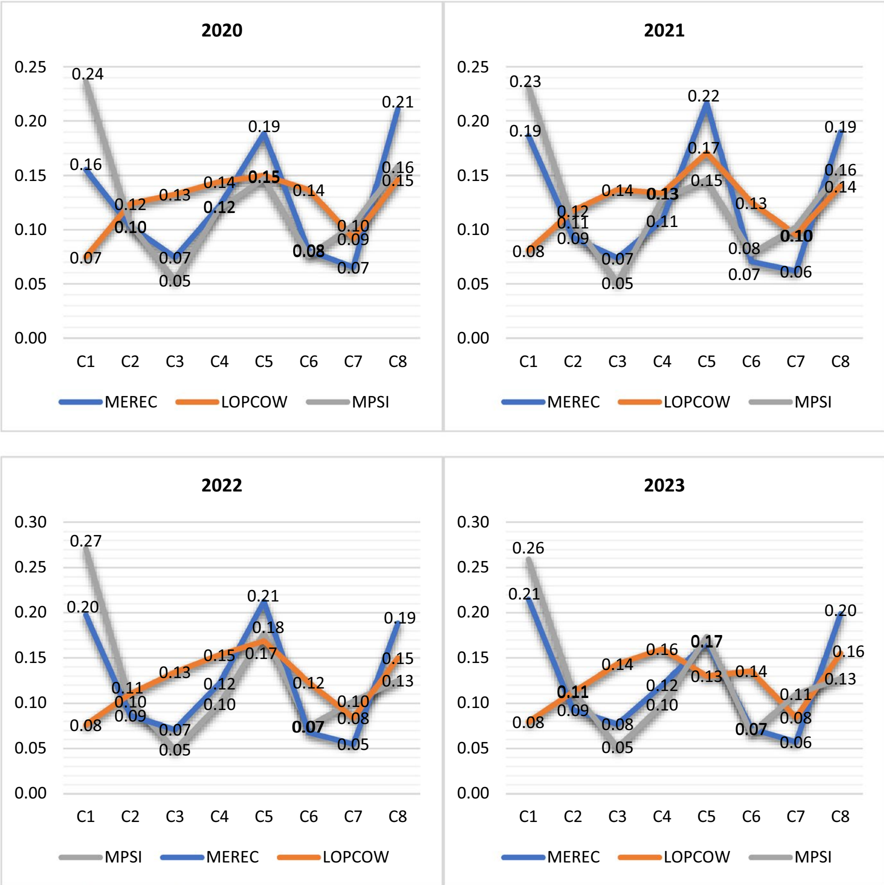

Fig. 1 Criteria weights according to MEREC, LOPCOW, and MPSI methods by years

Table 5 Preference rates

	2020	2021	2022	2023
M	29	28	28	25
$P_{(Ai)} = 1/m$	0.034	0.036	0.036	0.040

The results were tested by comparing the ranking results with the current ranking status on the Numbeo website. In the rankings, Oman is generally in the best condition among Asian countries according to the QLIs, while Philippines took the last place mostly. According to the results, there was no statistically significant difference between the rankings.

Spearman rank correlation results were analyzed to determine the correlations between the ranking scores. The Spearman correlation coefficient enables the comparison of rankings and the determination of the degree of relatedness between the

Table 6 Summarized ranking results by MAIRCA method

	Country	NUMBEO	MEREC + MAIRCA		LOPCOW + MAIRCA		MPSI + MAIRCA	
		Ranking	Q_i	Ranking	Q_i	Ranking	Q_i	Ranking
2020	Oman	1	0.0078	1	0.0085	1	0.0068	1
	Un. Arab Emirates	2	0.0100	2	0.0097	2	0.0088	2
	Japan	3	0.0115	7	0.0124	8	0.0115	5
	Qatar	4	0.0115	5	0.0116	6	0.0102	3
	Saudi Arabia	5	0.0113	4	0.0119	7	0.0106	4
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	Bangladesh	27	0.0209	27	0.0230	27	0.0228	27
	Iran	28	0.0237	29	0.0235	28	0.0249	28
	Philippines	29	0.0237	28	0.0236	29	0.0252	29
		NUMBEO	MEREC + MAIRCA		LOPCOW + MAIRCA		MPSI + MAIRCA	
	Country	Ranking	Q_i	Ranking	Q_i	Ranking	Q_i	Ranking
2021	Oman	1	0.0076	1	0.0083	1	0.0072	1
	Un. Arab Emirates	2	0.0087	2	0.0092	2	0.0082	2
	Japan	3	0.0104	3	0.0118	6	0.0111	4
	Qatar	4	0.0116	7	0.0118	7	0.0116	5
	Singapore	5	0.0135	12	0.0145	14	0.0131	10
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	Bangladesh	26	0.0218	26	0.0237	26	0.0236	26
	Philippines	27	0.0245	27	0.0242	27	0.0256	27
	Iran	28	0.0257	28	0.0248	28	0.0257	28
		NUMBEO	MEREC + MAIRCA		LOPCOW + MAIRCA		MPSI + MAIRCA	
	Country	Ranking	Q_i	Ranking	Q_i	Ranking	Q_i	Ranking

Table 6 (continued)

	Country	NUMBEO	MEREC + MAIRCA		LOPCOW + MAIRCA		MPSI + MAIRCA	
		Ranking	Q_i	Ranking	Q_i	Ranking	Q_i	Ranking
2022	Oman	1	0.0081	1	0.0086	1	0.0071	2
	Un. Arab Emirates	2	0.0087	2	0.0092	2	0.0069	1
	Japan	3	0.0096	3	0.0107	4	0.0094	4
	Singapore	4	0.0120	10	0.0137	13	0.0101	6
	Qatar	5	0.0110	7	0.0118	9	0.0094	5
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	Iran	26	0.0218	26	0.0213	26	0.0241	26
	Bangladesh	27	0.0206	24	0.0223	27	0.0233	25
	Philippines	28	0.0230	28	0.0225	28	0.0252	28
		NUMBEO	MEREC + MAIRCA		LOPCOW + MAIRCA		MPSI + MAIRCA	
	Country	Ranking	Q_i	Ranking	Q_i	Ranking	Q_i	Ranking
2023	Oman	1	0.0102	1	0.0104	1	0.0089	2
	Un. Arab Emirates	2	0.0111	3	0.0126	4	0.0087	1
	Japan	3	0.0104	2	0.0116	2	0.0103	3
	Qatar	4	0.0130	4	0.0139	7	0.0111	4
	Singapore	5	0.0164	9	0.0176	14	0.0143	7
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	Iran	23	0.0259	24	0.0248	23	0.0281	23
	Bangladesh	24	0.0245	22	0.0261	24	0.0267	22
	Philippines	25	0.0290	25	0.0277	25	0.0313	25

Table 7 Correlation coefficients of ranking results

2020	NU	M+M	L+M	MPSI+M	2021	NU	M+M	L+M	MPSI+M
NU	1				NU	1			
M+M	0.92**	1			M+M	0.92**	1		
L+M	0.91**	0.97**	1		L+M	0.92**	0.95**	1	
MPSI+M	0.97**	0.96**	0.94**	1	MPSI+M	0.97**	0.96**	0.95**	1
2022	NU	M+M	L+M	MPSI+M	2023	NU	M+M	L+M	MPSI+M
NU	1				NU	1			
M+M	0.96**	1			M+M	0.95**	1		
L+M	0.91**	0.94**	1		L+M	0.87**	0.95**	1	
MPSI+M	0.98**	0.96**	0.88**	1	MPSI+M	0.99**	0.97**	0.89**	1

NU Numbeo ranking results, *M+M* MEREC and MAIRCA ranking results, *L+M* LOPCOW and MAIRCA ranking results, *MPSI+M* MPSI and MAIRCA ranking results

**p value < 0.01

results. The Spearman correlation coefficient approaching 1 indicates an increasing relationship between the two rankings. According to the results at Table 7, high correlation was observed between all multi-criteria method rankings at 0.01 level of significance. Among them, the results of MPSI and MAIRCA methods have the highest correlation coefficient with Numbeo ranking results, which means that MPSI weights give the most successful criteria weights compared to MEREC and LOPCOW methods.

Euclidean distance shows the distance between two points, and with these distances, it can be determined how far the sets of rankings are from each other. A small distance value indicates that the two compared clusters are closer to each other. The Euclidean distance between the ranking results and Numbeo ranking was computed and presented at Table 8, and the results implied that the closest ranking was MPSI + MAIRCA.

Table 8 Euclidean distances between the ranking results

2020	NU	M+M	L+M	MPSI+M	2021	NU	M+M	L+M	MPSI+M
NU	0.00				NU	0.00			
M+M	18.06	0.00			M+M	17.38	0.00		
L+M	19.34	11.40	0.00		L+M	17.38	13.93	0.00	
MPSI+M	10.68	13.04	15.75	0.00	MPSI+M	10.58	11.92	13.57	0.00
2022	NU	M+M	L+M	MPSI+M	2023	NU	M+M	L+M	MPSI+M
NU	0.00				NU	0.00			
M+M	12.81	0.00			M+M	11.14	0.00		
L+M	17.78	15.17	0.00		L+M	18.06	11.66	0.00	
MPSI+M	9.06	11.83	20.93	0.00	MPSI+M	6.16	8.37	17.03	0.00

NU Numbeo ranking results, *M+M* MEREC and MAIRCA ranking results, *L+M* LOPCOW and MAIRCA ranking results, *MPSI+M* MPSI and MAIRCA ranking results

5 Discussion

The aim of the study was to compare the MEREC, LOPCOW, and MPSI methods and their effects to criteria weights and ranking results in the decision problems involving over 20 alternatives. From the mathematical point of view, MEREC method is based on logarithmic function and measure the removal effects of the criteria. LOPCOW method is based on a percentage of the standard deviations of the mean square values and allows negative numbers in the data sets, unlike MEREC and MPSI methods. MPSI method considers relative importance of the criteria.

In the normalization step, a simple linear normalization is used, and all the criteria are transformed to the minimization type criteria in MEREC method. LOPCOW uses Weitendorf's Linear Normalization technique, and MPSI method involves 0–1 interval normalization using Max–Min values (Aytekin 2021). In terms of ease of application, it has been seen that the MPSI method is the most easily applicable method at normalization and calculation steps.

Based on the criteria weighting results given with Fig. 1, it can be said that the MPSI method gives more stable criteria weights and is not affected by small changes in the data set. Comparing MPSI, MEREC, and LOPCOW weighting values, it can be said that MEREC and MPSI gives close results, in contrast to the LOPCOW method. The weight results could not be criticized with the literature, since there has been no study that compared the MEREC and MPSI or LOPCOW and MPSI methods as far as known. However, MEREC and LOPCOW results can be compared to literature. It is seen in the literature that the LOPCOW method gives exactly the opposite weights compared to the MEREC method. Bektaş (2022), Yalman et al. (2023), Ulutaş et al. (2023), and Yaşar and Ünlü (2023) state in their study that since the criteria with higher weights in the MEREC method receive lower weights in the LOPCOW method, the results obtained from both objective criterion weighting methods are combined for a more stable weighting.

Upon examination of the change in criterion weights over time, it becomes evident that C1, C5, and C8 receive the most weight in the MEREC and MPSI methods. While the criteria that receive the highest weight as a result of the LOPCOW method vary from year to year, they include criteria C1, C5, and C8. The purchasing power index (C1) indicates the relative purchasing power of goods and services in a given city in comparison to the average net salary. The property price-to-income ratio (C5) is defined as the ratio of average apartment prices to the average disposable family income. In the climate index (C8), settlements with high quality of life have moderate temperatures and low humidity. The criteria weights imply that countries seeking to enhance the quality of life should prioritize indexes pertaining to purchasing power, property price-to-income ratio, and climate. In other words, the increase of the purchasing power and climate index values, in conjunction with a reduction in the property price-to-income ratio, significantly influences the ranking of countries. Consequently, while these countries endeavor to enhance climatic conditions, they should implement political measures to regulate purchasing power and property price-to-income ratios. Given their geographical location, countries are unable to alter air temperature and humidity, yet they can implement environmental policies that improve these conditions within the constraints of their own climatic conditions.

Additional to the above inferences, the usability of the PSI method is also discussed in this study. In Table 2, the preference variation values of criteria such as C1, C5, and C8 are higher than 1. This situation caused to get negative values while computing the PSI values ($q_j = 1 - p_j$) for PSI method. This occurs because as the number of alternatives increases, the sum of preference variation values increases, so that it exceeds 1. For this reason, the PSI method gives incorrect criteria weights, and it becomes useless as happened in this study, especially when the number of alternatives is large. Therefore, MPSI method was preferred instead of PSI method. This result will be an important guide when choosing the right MCDM method for other studies. Accordingly, when the results of the study are examined in terms of the number of alternatives, although PSI method is preferable, objective, and easy to apply, this study indicates that the PSI method is sensitive to the number of alternatives. However, the MEREC, LOPCOW, and MPSI methods are not affected by the number of alternatives.

When the ranking results were compared to Numbeo, there was no statistically significant difference between the rankings. Furthermore, it can be concluded that the MPSI method is more preferable compared to the MEREC and LOPCOW methods because the correlation between the MPSI + MAIRCA and Numbeo rankings is between 0.97 and 0.99, the closest ranking is again MPSI + MAIRCA with values between 6.16 and 10.68 based on the ranking distances, and the ease of application of MPSI.

6 Conclusion

In MCDM, subjective, objective, and combined methods can be used to determine the criteria weights. These combined methods can be created by hybridizing different subjective and objective weighting methods. The reason for using the combination method is that it is thought that more consistent results are obtained. In this study, the data reached at Numbeo website were analyzed by MEREC, LOPCOW, MPSI, and MAIRCA methods. The Numbeo QLI determines and calculates the quality of life of the world countries with eight different criteria. These data are shared in the database mentioned in certain periods of the year. This study presents the ranking of Asian countries in this database on the basis of selected QLIs by years with MCDM methods. Eight criteria and over twenty-five alternative countries were used to calculate the index values. MEREC, LOPCOW, and MPSI methods were used to determine the weights of the criteria, and MAIRCA method was used to find the rankings of the alternatives. MEREC + MAIRCA, LOPCOW + MAIRCA, and MPSI + MAIRCA values were compared with the results in Numbeo database.

The following results were obtained from the study:

- MEREC, LOPCOW, and MPSI methods are newly added to the literature and have been compared for the first time and have been used for the first time to rank countries according to their QLIs and make significant contributions to the domestic and foreign literature. Among these weighting methods, MPSI weights gave the closest ranking results to Numbeo.
- By combining the MPSI method with the MAIRCA method, methods that have not been encountered before in the literature have been added to the MCDM methods, thus this study has guided new areas of use.
- This study also examines the applicability of PSI method to the decision problems containing more than 20 alternatives, which indicated that PSI method cannot be applicable at problems with high number of alternatives. This result is an important problem solver while choosing the right MCDM method for other studies. Thus, MPSI method was preferred instead of PSI method.
- The MAIRCA method was used together with the mentioned weighting methods in only this study. Therefore, this study contributes to the field.

In future studies, the weighting methods can be combined to a single weight, hybridized with different MCDM techniques and expanded according to different fuzzy set bases. A method can be developed to obtain a single weight by integrating these objective weighting results. Analyses can be performed for different countries and different year intervals and thus the generalizability of the method used can be examined. In addition, possible reasons for changes in country rankings during the study period, such as economic or social changes, and how these factors may have affected quality of life indices can be discussed in future studies.

6.1 Limitations of study

In the research, QLI data in Asian countries taken from the Numbeo website were used. The limitation of this study is that data for every country could not be accessed for every year. For this reason, the number of alternatives in the data sets between 2020 and 2023 included in the study is different. For this reason, analysis results may vary depending on different countries and different years. This situation also makes it difficult to interpret the change in the quality of life in countries over the years. To overcome these limitations in future studies, the data for other continents can be used or the countries with missing data for some years may not be included in the study.

Appendix A

See Tables 9, 10, 11 and 12.

Table 9 Decision matrix for QoL index in 2020

Country	Purchasing power index	Safety index	Health care index	Cost of living index	Property price to income ratio	Traffic commute time index	Pollution index	Climate index
Oman	91.9	78	58.8	52.8	6.5	20.8	37.7	67.2
United Arab Emirates	90	88.4	71.3	61.9	5.8	26.5	45.8	43.9
Japan	75.1	76.6	80.1	89.7	15.9	40.5	42.2	85.3
Qatar	95.5	88.5	73	67.4	6.2	30.7	60.7	36
Saudi Arabia	87.3	72.6	64.6	49.6	3.4	30	65.7	44.4
Singapore	82.6	68.5	71	81.1	21.7	41.2	33.3	57.5
Taiwan	64	86.2	87	64.1	33.5	33.7	49.4	84.4
Cyprus	55.6	68.5	50.9	65.5	6.3	26.2	61	86
Bahrain	50.6	77	64.8	59.4	8.6	29.8	58.1	64.3
Pakistan	28.9	70.8	64.5	22.5	12.2	35	43.5	76.9
Turkey	42	60.3	68.7	32.3	7	36.5	67.4	91.5
South Korea	76.5	73.2	81.9	81.6	24.6	41.9	58.2	68.4
Kazakhstan	45.3	66.3	67.1	33.5	7.4	32	45.7	21.3
Armenia	26.4	76.9	53.4	34	18.5	32.1	56.4	63.4
Jordan	32.9	61.2	65.8	56.2	9	43	76	89
Georgia	25.7	79.2	52.2	30.2	15.7	37.6	74.5	84.2
Kuwait	67.3	67.5	57.9	50.6	16.2	32.6	67.7	20.2
Malaysia	61.4	34.7	66.5	40.5	11	42	67.6	56.6
Azerbaijan	28.1	69.2	44.4	32.2	16.3	37.8	78	91.4
Vietnam	29.1	61.8	54.8	38.4	18.7	29.2	90.6	79
Lebanon	30.9	55.6	65.8	68.5	16.7	39.6	93.3	94.7
Thailand	31.7	58.5	77.8	55.8	28.1	45	76.6	58.4
Nepal	19.1	64.6	56.1	30.3	24.5	37.2	95.9	92.6
India	51.3	41.3	67.1	27.4	14.1	57	91	58.9

Table 9 (continued)

Country	Purchasing power index	Safety index	Health care index	Cost of living index	Property price to income ratio	Traffic commute time index	Pollution index	Climate index
China	59.2	65.5	64.9	44.2	41.6	45.3	86.1	57.6
Indonesia	24.8	46.5	56.8	44.3	21.1	53.1	84.3	63.8
Bangladesh	27.2	35.6	41.1	35.9	15.6	60.1	93.4	71.3
Iran	18.1	46.6	52.6	38.7	40.4	52.9	82.1	71
Philippines	22.4	35.4	63	41.3	31.5	56	90	61.2

Table 10 Decision matrix for QoL index in 2021

Country	Purchasing power index	Safety index	Health care index	Cost of living index	Property price to income ratio	Traffic commute time index	Pollution index	Climate index
Oman	80.2	78.6	59.7	51	5.3	21.1	36.3	67.2
United Arab Emirates	90.4	87.9	71.7	59.6	4.5	26.3	44.5	43.9
Japan	74.9	76.6	80	85.3	13.8	41.1	43	85.3
Qatar	79.1	88.1	73.1	62.2	6.4	30.6	60.4	36
Singapore	78.5	72	71.2	82.6	17.6	41.1	33.1	57.5
Saudi Arabia	82.5	73.2	65	52.6	2.7	30	64.3	44.4
Taiwan	52.5	86.5	87.3	66.5	30.8	33.7	49.1	84.4
Cyprus	51.4	69.1	54.6	67	5.8	25.7	62.1	86
Pakistan	26.8	70.9	64.2	24.3	11.1	35.1	42.2	76.9
Bahrain	50.8	78	66.8	56.1	8	31	61.2	64.3
Turkey	36.1	60	69.1	31.8	6.5	36.4	65.7	91.5
Kazakhstan	38.4	66.4	66.8	31.2	7.4	31.9	48	21.3
South Korea	64.7	73.8	82.2	80.3	29.7	42.1	58.7	68.4
Armenia	24.9	77.3	55.4	33.6	17.9	32.3	57.4	63.4
Georgia	27.1	75.9	53.9	29.1	13.8	37.6	74.5	84.2
Jordan	26.2	62.1	65.5	53.4	9.2	42.9	75.8	89
Malaysia	59.3	35.4	67.8	40.1	9.1	41.7	66.8	56.6
Kuwait	60.4	69.3	59	48.5	16.2	31.9	65.8	20.2
Azerbaijan	23.4	69.2	44.3	31.5	17.9	37.9	75.7	91.4
Vietnam	25.2	62.4	56.7	36.4	18.8	28.7	89.4	79
Nepal	19.7	64.3	56.8	30.1	19.3	37.3	95.7	92.6
Thailand	28.8	58.7	77	51	26.2	46.2	77	58.4
China	51.2	65.7	64.1	46	42.5	45.2	84.9	57.6
India	38	40.5	67.2	27.7	20.6	57.2	90.7	58.9

Table 10 (continued)

Country	Purchasing power index	Safety index	Health care index	Cost of living index	Property price to income ratio	Traffic commute time index	Pollution index	Climate index
Indonesia	23.9	46.6	56.9	41.8	21.6	52.9	84.3	63.8
Bangladesh	20	35.1	39.9	35.3	18.9	59	93.1	71.3
Philippines	17.5	35.2	63.1	42.8	36.9	54.4	90	61.2
Iran	12.4	45.3	52.8	37.5	52.7	52.9	81.5	71

Table 11 Decision matrix for QoL index in 2022

Country	Purchasing power index	Safety index	Health care index	Cost of living index	Property price to income ratio	Traffic commute time index	Pollution index	Climate index
Oman	80.3	79.5	59.4	51.1	4.7	20.7	35.8	67.2
United Arab Emirates	94.6	88.3	72.6	56.1	4.7	26.3	43.6	43.9
Japan	81.1	76.2	80.4	72.6	14.2	42.2	42.5	85.3
Singapore	94.6	72.8	71.1	79.1	16.8	41.2	33	57.5
Qatar	93.3	86	73.6	60.9	7.6	30.1	59.9	36
Saudi Arabia	98.3	73.7	64.8	53.9	3	30.7	63.6	44.4
Bahrain	68.1	78.9	65.8	53.9	3.9	30.8	61.2	64.3
Cyprus	58.7	70.1	54.2	53.2	6.8	25.2	61.1	86
Pakistan	28.5	70.5	64.2	18.7	11.9	34.9	41.7	76.9
Taiwan	59.5	84.9	86.7	60.6	35.5	34	49.1	84.4
Turkey	31.9	60.6	68.5	28.5	9	36.4	66	91.5
South Korea	77.3	74.6	82.8	77.4	30.5	42.1	58.8	68.4
Armenia	26.5	78.3	57	40	16.5	31.5	57	63.4
Malaysia	74.1	36.6	67.9	38.1	7	41.8	66.8	56.6
Kuwait	76.8	69.5	59	46.5	12.5	32.2	68.8	20.2
Jordan	32.8	61.2	65	49.4	8.5	42.4	75.6	89
Georgia	24.3	74.8	54.1	36.5	13.6	37.6	72.8	84.2
Azerbaijan	30.3	69.6	46.4	30.5	14.8	37.8	75.2	91.4
Vietnam	28.9	61.9	57.6	34.8	20.6	28.7	89.5	79
Thailand	26.7	59	76.9	46.7	31.8	46.2	76.7	58.4
Nepal	18.7	62.7	56.4	28.7	29.1	36.9	95.7	92.6
India	51.8	40.9	65.6	27.2	18	57.4	90.5	58.9
Indonesia	30.9	46.7	56.9	36	19.1	52.9	84.7	63.8
Lebanon	11.7	53.3	65.2	95.7	30.4	39.8	93.9	94.7

Table 11 (continued)

Country	Purchasing power index	Safety index	Health care index	Cost of living index	Property price to income ratio	Traffic commute time index	Pollution index	Climate index
China	46	67.6	66	50.2	56.9	43.8	82.5	57.6
Iran	15.4	44.3	52.6	32.7	33.2	52.3	81.1	71
Bangladesh	24	36.3	39.7	32.2	15.6	59.6	93.8	71.3
Philippines	23.6	35.3	63.4	36.7	36.4	53.6	89.9	61.2

Table 12 Decision matrix for QoL index in 2023

Country	Purchasing power index	Safety index	Health care index	Cost of living index	Property price to income ratio	Traffic commute time index	Pollution index	Climate index
Oman	82.5	79.9	60.2	50.4	4.1	20.5	35	67.2
United Arab Emirates	110.5	88	70.2	59.8	5.3	31.1	46.6	43.9
Japan	88.7	76	79.5	57.3	12.4	41.2	42.6	85.3
Qatar	102.1	86	73.5	59.4	6	29.7	59.8	36
Singapore	85.9	76.9	70.9	85.9	15.7	41.4	33	57.5
Taiwan	73.2	85.1	86.1	57.2	28.7	34.4	49.5	84.4
Saudi Arabia	93.2	73.8	64.6	52.3	3.2	32	63.4	44.4
Pakistan	24.7	68.7	64.5	18.3	16.3	35.5	41.3	76.9
South Korea	81.2	75.2	82.7	76.3	27.7	42.2	58.9	68.4
Turkey	34	61	69.3	27.6	10.4	36.1	65	91.5
Malaysia	71.3	37.3	68.1	35.9	8.2	41.6	65.7	56.6
Kuwait	81.3	69.8	57.9	47	12.9	34.7	69	20.2
Armenia	24.6	78.4	56.8	44.2	17.8	30.2	59.1	63.4
Jordan	32.9	61.5	65.2	47.3	8.3	41.6	75.6	89
Georgia	24.1	74.2	54.2	42.5	13.9	37.4	71.9	84.2
Azerbaijan	28.9	69.5	47.3	33.1	14.6	37.1	74.5	91.4
Vietnam	36.5	62.8	57.6	35	18.4	28.4	89.1	79
China	73.8	72.2	68.4	41.5	35.6	43.4	79.9	57.6
India	60.1	40.7	65.1	25.5	13.9	57.4	90.7	58.9
Thailand	30.1	59.9	77.1	44.9	31.3	45.5	77.1	58.4
Indonesia	27	47.4	56.6	35.2	22.5	52.1	85	63.8
Lebanon	12.3	53.3	64.2	54	41.8	39.5	93.7	94.7
Iran	18.1	44	52.6	30.8	32	52.4	80.8	71
Bangladesh	26	36.8	39.9	28.4	15	61	93.6	71.3
Philippines	24	35.1	62.9	40.4	40.8	53.6	89.9	61.2

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Authors and Affiliations

Pınar Çelebi Demirarslan[1] · Fatma Sönmez Çakır[2] · Ilkben Akansel[3]

✉ Fatma Sönmez Çakır
fsonmez@bartin.edu.tr

Pınar Çelebi Demirarslan
pdemirarslan@bartin.edu.tr

Ilkben Akansel
iakansel@bartin.edu.tr

1 Department of Business Bartın, Faculty of Economics and Administrative Sciences, Bartin University, Bartın, Türkiye

2 Department of Management Information Systems, Faculty of Economics and Administrative Sciences, Bartin University, Bartın, Türkiye

3 Department of Economics, Faculty of Economics and Administrative Sciences, Bartin University, Bartın, Türkiye