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Design metaheuristic technique in order to locate airport construction and comparison with multi-criteria decision making methods

H. Pourabbas[1] , R. Bagheri[2,*], M. Sabzeh parvar[3]

The false location of airports is one of the most important issues and challenges that we face on some airports, finding scientific solutions to optimize airports, to achieve travelers, including these challenges. The main purpose of this research is to provide a metaheuristic technique for locating the construction of airport and compared with the results of the seca model and the Copras Method. The metaheuristic technique is based on new multi-criteria decision making techniques, aimed at prioritizing research alternatives and its difference with the rest of the methods is to use statistical methods and now it is possible to understand and simply process its process. The statistical population of this research is (experts and management in Iran airport and air Navigation Company). After research, alternatives were selected based on the opinions of experts who included five provinces of the country, as well as 10 standard indicators, including the average income per year, the population of the province and ... who were extracted from the questionnaire as input. Finally, the provinces were prioritized according to different ways, all results based on choosing Isfahan province as the right province and Najaf Abad city as the final alternative.

***Keywords**: metaheuristic technique design, Airport location, multi-criteria decision making*

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1. Introduction

In 2007, Ruiz et al. recognized location, considering social, financial, and environmental affects, as a key aspect in nearby planning [1]. locating tries to help decision makers and planners in selecting the proper places to carry out activities by way of regulating the indicators and influential elements in selection making and imparting logical solutions [2]. Airport area studies is one of the most crucial problems in distinct regions, which due to its role and overall performance, has a sizeable impact at the movement of human beings and goods, so the wrong region of airports is one of the most essential problems. Which we are facing in some airports, in order that, because of this error, many human and financial losses occur [3-5]. as an example, we will mention the

* Corresponding Author.
[1] PhD Student, Faculty of Economics and Management, Central Tehran Branch, Islamic Azad University, Tehran, Iran. Email: hamed_pourabbas@yahoo.com
[2] Department of Management, Faculty of Administrative and Economic Sciences, Ferdowsi University of Mashhad, Mashhad, Iran. Email: Rbagheri@um.ac.ir
[3] Department of Industrial Engineering, Faculty of Technical and Engineering, Karaj Branch, Islamic Azad University, Karaj, Iran. Email: msabzeh@gmail.com

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development of the brand new Chabahar airport, which gets rid of the 10th hunting base of Konarak from the variety of use. there are various mission and education activities and they arrive at Chabahar Airport a minute later, because of this that the looking base is nearly in problem and the Konarak looking base have to be moved to the new airport, which also has its very own costs and issues (Airport company And Air Navigation of Iran, the first quarter of 1400). The study to decide the appropriate place of the airport requires recognizing the importance of its location in the area, the degree and level of the predicted airport and conducting all specialized studies including wind analysis, geological structure of the area, accurate determination of altitude, temperature and slope [6]. space science is a realm of analytic studies that determine the location or place suitable for activities or services. The time of its creation dates back to the beginning of the 17th century and the issue raised by Fermat. The content of his problem was that there are 3 points in space and the fourth place is to be located in such a way that the sum of the distances is minimal with these three points [7]. various decision-making methods have been used to solve airport location problems. Mirkovic et al. In 2019, the importance of an airport that is close to the border between two (or extra) countries and is supposed to attract passengers from all border countries, and finally the concept of a cross-border airport as a suitable solution for Co-investment of neighboring countries is visible, they noted [8]. In 2010, Broshki et al., For the spatial decision analysis section, identified two sections: individual decisions and group decisions. In such a way that each decision maker first solves the problem individually and then the answers of all decision makers are merged into a final opinion. using the capabilities of web 2.0, these researchers proposed a multi-criteria participatory spatial decision making tool based totally on Geographic information system (GIS) to solve the problem of selecting the appropriate place [9]. Airport-based development is a new concept in city and regional development, while airports are experiencing a fundamental trade in the services they provide to users, relying on non-aviation potentials, in addition to traditional aviation services, to provide an opportunity for provide business suppliers and support agents to increase their profits and guarantee their working life [10]. today, looking at the importance of airports and the aviation industry and its significant advances around the world, as well as the achievements of this technology, and considering the statistics of flights and passenger movement and the increasing size of the air operations field, the number and type of aircraft and increasing speed. They, aviation-related services, involvement in economic, social issues, etc. can be realized in its importance [11]. therefore, the choice of airport location is important both economically, socially, and in terms of environmental impacts, etc. [12]. Airports are a vital component of modern-day infrastructure and have increasingly proven to be influential in shaping urban form and structure, and cities have also influenced the scale and performance of airports [13]. the main questions in this research are (which are effective factors for the construction of the airport), and (how effective factors for determining the airport location are weighed). the main purpose of this study is to prevent designers and airport planners, according to operational constraints, with the use of new techniques of exploitation of adverse effects and ultimately, the selection of the airport's false location and, on the other hand, due to the multiplicity of decision-making methods in choosing the decision making method, it is possible that we can ensure the right level alternative with the progress of the metaheuristic method.

2. Theoretical Foundations

today, with the growth of urban population, the use of public and private transportation is rapidly increasing, which leads to air pollution and noise pollution and excessive fuel consumption [14].

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studies have shown that public transportation is more cost-effective compared to personal vehicles and causes less pollution [15-17].increasing air travel and rapid transformation of aircraft has created issues in locating airports, which resolves it requires planning and the use of airport knowledge and decision making methods [18]. The airport construction project is one of the major projects among air transport studies that require a significant environment in the location of a city and requires special investment in the implementation of economic, social, political and environmental functions [19].

2.1. Multi-Criteria Decision Making

If decisions are based on several criteria, it can be desirable and satisfied decision maker [20]. To achieve a particular goal, it is necessary to assess the decision maker in addition to several criteria and measure different alternatives according to the criteria. such a process is called several criteria decisions [21]. Multi-criteria decision making methods are divided into categories of multi-attribute decision making and multi-objective decision making. Many models are used for design and multi-indicator models for choosing the appropriate alternative [22-24].most managers decisions are influenced by way of various quantitative and qualitative factors, most of which are in conflict with each other, and they try to choose the best alternative between several available alternatives. mistakes and inaccuracies in decision making require payment for the error. The greater the power and authority of management, the higher the cost of wrong decisions [25]. Multi-attribute decision methods based totally on mathematical arguments determine the best decision alternative among the available alternatives by ranking them [26].

2.2. Effective criteria in airport location

In detailed airports, selecting the right location for them is one of the important parts [27]. the selection of a appropriate place for the airport depends on the study classification of the study [28]. The person or group that is responsible for selecting the right place for new airports must first determine the main indicators [29]. based on which the proper location of the dimensions and specifications should be selected, according to the results of studies conducted in the airport location, by the international Civil Aviation organization (ICAO), the impact on the airport location can be 4 general categories Divided into the description of table 1 [30].

Table 1. Effective criteria in locating the airport

Main criteria	Indicators	Referenec
Physical factors	Access to the transportation system- Earth 's existence for future development- to use the airport (military, business) and…	ICAO
Aviation and geographical factors	climatic conditions - the position of airports around - the location of the barriers surrounding it - topography and…	The International Transport Forum
Factors economic	evaluating profit and cost - analysis of administrative costs, maintenance, fuel , etc.	IJAER
Environmental factors	environmental impacts and sound pollution - compliance with wide area planning and …	Procedia Computer Science

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3. Literature Review

In 2007, Yang et al. In 2007, the knowledge of scientific and modernization isn't more than a hundred years old. so far, from various perspectives to the location of attention, each one sometimes has been another evolution. In terms of the location and selection of the best places for different purposes, and the optimum location of the location, as well as the use of location models such as hierarchical analysis process models and Boolean and its integration with the geographic information system, so far, comparable research and research on the level international and Iran are accepted and studies that we refer to several examples [31]. Mohammad Mirabi et al. Then, airborne hubs and design of the country of transportation hub were set at 15 international and major airports, and eventually Shiraz and Imam Khomeini airports were the largest number of hubs and in the next rank of Mehrabad and Mashhad airport. Alireza Eidi et al in 2018 in an article titled 'presenting heuristic methods to solve the capacity-Capital location problem: To include serving the farthest points of demand at the lowest service, for a desired issue, a minimal mathematical model The maximum presentation, given the fact that the issue under investigation is a small sentence, to solve the problem in large sizes, heuristic algorithms including a simulated annealing algorithm and an algorithm of the anti-community, development They were given, the results of dissolved examples indicate that developed algorithms can produce good quality solutions by spending very low performance times. Mahnaz Afshari in 2020, in the research as investigating Imam Khomeini Airport, according to climate studies based totally on the hierarchical analytical process. The results of the mean temperature showed that 79.21% of the location of the place has completely desirable conditions for the construction of the airport. these areas that cover the western and southern south of the region also include Imam Khomeini airport. in this way, the airport is in terms of temperature in perfect condition.Issa Ebrahimzadeh et al. In 2009 in a study to locate the Shahid Beheshti international Airport in Isfahan using the strategic model SWOT, this study was a research-development-applied research and these researchers found that considering the location of the airport, choose the necessary routes in the final development of the airport, free of any obstacles or if there's an obstacle can be removed. around Isfahan airport, you can only see small altitudes such as Sanbandi and Marshanan mountains, and also around the airport, air barracks and numerous industrial factories, which can be said that Isfahan airport is located in a low area where the lack of high altitudes causes risks have been reduced in it.in other research conducted by Jafar Fatahali et al. (2008) with topsis, semnan province's location using topsis method, which was named entropy method for weighting to indices, then via using the topsis method, the studied cities were ranked. as a result, the airport was located about 16 km west of Damghan city.

4. Methodology

The research method used in this research is descriptive survey and is a Delphi survey research in terms of the type of survey method used. The purpose of Delphi's method is to access the most secure group agreement for a discussion that uses a questionnaire and disintegration of the experts to repeatedly occurring according to their return. finally, using the questionnaire, we reached the 10 indicators of the statistical society perspective that are average household income (thousand rials) [32]. population [33]. The future expansion, distance from the nearest airport, air traffic, used airport (commercial, military ...), safety and compliance with standards, topography, economic value, passenger attraction (number of internal passengers per 12 months) [34].

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4.1. Alternatives desired

it is natural to consider the number of provinces in the country, which is 31 provinces, and to know conditions such as provinces such as Tehran, Fars, Golestan, Khuzestan, Mazandaran, etc. due to the number of airports in these provinces or proximity to neighboring provinces, other components alternatives aren't considered. finally, according to the above conditions and scoring of relevant experts in the provinces, whose number was 62 and of course the effective indicators, by selecting 5 provinces, Yazd, South Khorasan, Ardabil, Hamedan and Isfahan, respectively, was completed.

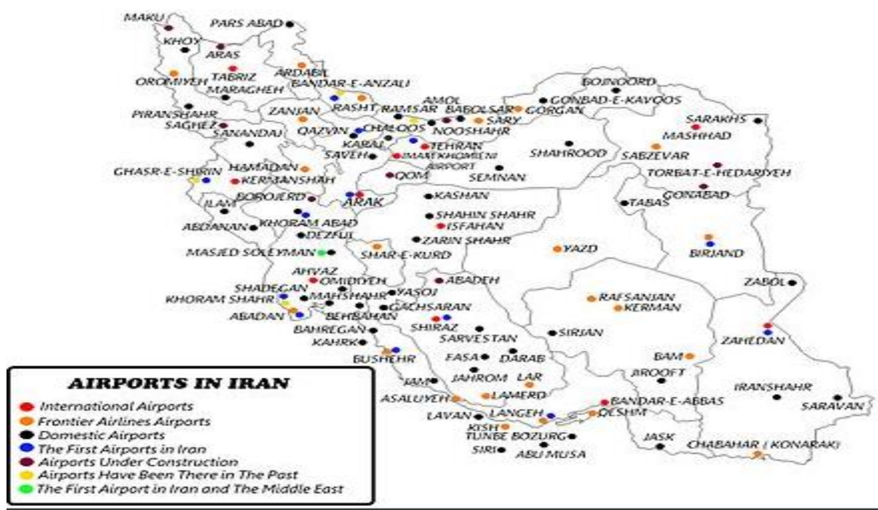

Figure1.Airports of the country (1:2500000cm)

4.2. Metaheuristic technique

The metaheuristic method is a part of the compensatory methods and belongs to the compromise subgroup. The technique is based on the mean, this technique does not require complex calculations. If the level of confidence is added to the technique, a unified procedure will be created between the decision makers. suppose we have M alternatives and N indicators. The various alternatives i are marked as xi. also, the various indices of j are specified as xj. xij is the value and value of the rank i'm and the index j am. by calculating the weights of the indicators, this technique can be easily used.

Steps of metaheuristic technique

4.2.1. Formation of decision matrix

according to the number of alternatives and criteria and evaluation of all alternatives, for different criteria, the decision matrix is formed as follows.

Table 2. Decision making matrix

$$X = \begin{bmatrix} x11 & \cdots & x1n \\ \vdots & \ddots & \vdots \\ xm1 & \cdots & xmn \end{bmatrix}$$

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4.2.2. Scale measurement of indicators and measuring a quantitative quantity index (Pairwise comparison)

An alternative (AI) in several signs decision may be described by types of indexes (XJ): quantitative indicators (such as cost, capacity, etc.) and qualitative indicators (such as comfort, beauty, and ...) (Use of Likert 5 spectrum).

4.2.3. Entropy technique and evaluation of index weights

Entropy method is one of the multi-criteria decision making methods to calculate the weight of the criteria. in this way, the matrix is a benchmark alternative.

$$Ej=-k\sum_{i=1}^{m}[pij\ ln\ pij]\ (j=1,2,n) \quad k=\frac{1}{ln\ m}\ dj=1-Ej,\forall j \quad Wj=\frac{dj}{\sum_{j=1}^{n}dj}\ ,\forall j \quad Pij=\frac{Xij}{\sum_{i=1}^{m}xij}\ ,\forall i,j \tag{1-4}$$

4.2.4. Normalization the decision matrix

There are several methods for unavailable, but usually a few indicators are used in the following (norm) method.

$$Rij=xij/\sqrt{\sum_{i=1}^{m}xij2} \tag{5}$$

4.2.5. Determination of normal weighted decision matrix

in this step, the weight of the criteria obtained from the entropy technique is multiplied in the normal matrix to obtain the weighted matrix.

$$V=R*W \tag{6}$$

4.2.6. Calculate the sum of the squares of the alternatives and the mean of the squares of the alternatives

We use Equations 7 and 8 to calculate the sum and mean squares of the alternatives (according to the weightless unmeasured matrix).

$$SSA=\sum_{i=1}^{m}\frac{vi.^2}{n}-\frac{v..^2}{mn} \tag{7}$$

$$MSA=\frac{SSA}{2mn^4} \tag{8}$$

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Table 3. Technique variables

Alternative	m
Indicator	n
The sum of each alternative	vi.
Total data of normalized weighted decision matrix	v..
The Sum squares of alternatives	SSA
The Mean squares of alternatives	MSA
The mean of each alternative	$\bar{v}$ i.
The importance of each alternative	Ci

4.2.7. The importance of each alternative

Using the mean squares of the alternatives and the mean of each level of the normalized weighted decision matrix, we arrive at the significance of each level. Given that the sum of Ci is one, whichever is greater is the criterion for our selection.

$$Ci=\frac{\bar{VI},^{MSA}}{M} \tag{9}$$

$$\sum_{i=1}^{m} ci=1 \tag{10}$$

4.3. Seca

The Seca model is a new multi-criteria decision-making technique that aims to rank research alternatives. The difference with other methods is that, in similar methods that rank the alternatives, the weight of the criteria is first calculated by another secondary method and then given as input to these methods, but in the Seca model. , both the standard weight and the ranking of the alternatives are done together [35].

4.3.1. Forming a decision matrix

The decision matrix is a row-column matrix in which columns, decision criteria, and rows are problem alternatives.

4.3.2. Normalization

In relation 11, BC includes criteria that have a profit (or positive) aspect, and in relation 12, NC includes criteria that have a cost (or negative) aspect.

$$X_{ij}^{N}=\begin{cases}\frac{X_{ij}}{max_k X_{kj}} & if \quad j \in BC,\\ \frac{min_k X_{kj}}{X_{ij}} & if \quad j \in NC,\end{cases} \tag{11-12}$$

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4.3.3. Formation of optimization model

The standard deviation of the elements of each vector can obtain the information of the internal variable of the standard. To obtain the variable information between criteria from the decision matrix, we must calculate the correlation between each pair of criteria vectors. Then the following relation can show the degree of difference between the jm criterion and other criteria.

$$\pi j=\sum_{l=1}^{m}(1-r_{jl}) \tag{13}$$

increasing the variability in the vector of a criterion (σj), as well as increasing the degree of difference between the criterion j and other criteria (πj), increases the importance (weight) of the criterion. accordingly, the normalized values (σj) and (πj) are defined as reference points for the criteria weights. these values can be calculated as 14 and 15 relations.

$$\sigma j^{N}=\frac{\sigma_j}{\sum_{l=1}^{m}\sigma_l} \qquad \pi j^{N}=\frac{\pi_j}{\sum_{l=1}^{m}\pi_l} \tag{14-15}$$

based on the above explanations, a nonlinear multi-objective planning model is obtained, which is given below.

$$\text{Max } Si=\sum_{j=1}^{m} WjXij^{N} \qquad \forall_i \in \{1,2,\ldots n\} \tag{16}$$

$$\text{Min}\lambda_b= \sum_{j=1}^{m}(W_j-\sigma_j^N)^2 \tag{17}$$

$$\text{Min}\lambda_c= \sum_{j=1}^{m}(W_j-\pi_j^N)^2 \tag{18}$$

$$\text{s.t. } \sum_{j=1}^{m} W_j=1 \tag{19}$$

$$W_j \le 1 \ , \forall_j \in \{1,2,\ldots,m\} \tag{20}$$

$$W_j \ge \varepsilon \ , \forall_j \in \{1,2,\ldots,m\} \tag{21}$$

In Equation (16), it increases the overall performance of each alternative, and Equations 17 and 18 minimize the deviation of the weight criteria from the reference points for each criterion. Equation (19) ensures that the sum of the weights is equal to 1. Equations (20) and (21) determine the weight of the criteria for some values in the interval [1,ε]. It should be noted that ε is a small positive parameter considered as a low criterion for the standard weight. in this model, the value of this parameter is set to 0.001. To optimize the relation (16), we can use the objective-to-constraint function technique. And create a one-objective relationship as stated in Equation 22.

$$\text{Max } Z = \lambda_a - \beta(\lambda_b + \lambda_c) \tag{22}$$

$$\text{s.t. } \lambda a \le S_i \qquad \forall_i \in \{1,2,\ldots n\} \tag{23}$$

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$$Si=\sum_{j=1}^{m} WjXij^{N} \quad \forall_i \quad \epsilon \{1,2,\ldots n\} \tag{24}$$

$$\lambda b=\sum_{J=1}^{M} (W_j- \sigma_j^N)^2 \tag{25}$$

$$\lambda c= \sum_{j=1}^{m} (W_j- \pi_j^N)^2 \tag{26}$$

$$\sum_{j=1}^{m} W_j =1 \tag{27}$$

$$W_j \leq 1 \;, \forall_j \;\epsilon\; \{1,2,\ldots,m\} \tag{28}$$

$$W_j \geq \varepsilon \;, \forall_j \;\epsilon\; \{1,2,\ldots,m\} \tag{29}$$

The above multi-objective model can be converted into a single-objective model. according to the objective performance of the model based on Equation 22, the minimum overall performance score of the alternatives is maximized. since the deviation from the reference points must be minimal, they are subtracted from the target performance by a factor of.. This coefficient affects the importance of achieving the reference points of the weight criteria. Equation 23 specifies a minimum value of the overall performance score of each alternative (Si). Equation 24 calculates the total weight multiplication of each criterion in the normal matrix. Equations 25 and 26 obtain the total deviation of the weight criteria from the reference points (standard deviation and correlation) for each criterion. Equation 27 indicates that the sum of the weights is equal to 1. And relations 28 and 29 indicate that the weight obtained must be between 0 and 1.

4.4. Complex Proportional Assessment (Copras)

Copras is one of the decision-making methods and is used to prioritize or rank different alternatives and uses the weight of criteria to do so. This method was first developed to determine the priority and degree of effectiveness of alternatives. This method is used to evaluate the value of both minimum and maximum criteria and the effect of minimum and maximum criteria on the evaluation of results is considered separately. also, this method, while simple, does not require complex mathematical operations to calculate it [36].

Steps of the Copers method

4.4.1. Formation of Copras decision matrix

the first step in this technique is to form a decision matrix. The decision matrix is a matrix for evaluating a number of alternatives based on a number of criteria. that is, a matrix in which each alternative is scored based on a number of criteria.

4.4.2. Calculating the weight of criteria

To determine the importance of each criterion compared to other criteria, criteria should be weighed. in this step, the weight of the criteria must be obtained by one of the weight calculation methods, including the entropy method.

4.4.3. Determining positive and negative criteria

positive criteria are criteria whose increase improves the situation, and negative criteria are criteria whose decrease improves the situation.

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4.4.4. Normalization of the decision matrix

in this step, using the following equation, we normalize the decision matrix of the problem to eliminate the dimension and scale of the decision matrix values.

$$dij = \frac{qi\, xij}{\sum_{j=1}^{n} xij} \tag{30}$$

4.4.5. Calculate the sum of normalized values

in this step, the sum of the normal values of the positive criteria should be separated and the negative criteria should be calculated separately for each alternative.

$$sj^{+} = \sum zi{=}{+}dij \tag{31}$$

$$sj^{-} = \sum zi{=}{-}dij \tag{32}$$

4.4.6. final ranking of alternatives

in this step, we rank the alternatives according to the following relation, which is the calculation of the Copras index. The higher the Qj value, the better the ranking of that alternative in the prioritization. the choice with the best value is the ideal alternative.

$$Qj = sj^{+} + \frac{s^{-}\, min \sum_{j}^{n} = 1 s_j^{-} x}{s_j^{-} \sum_{j}^{n} = 1 s^{-} min / s_j^{-}} \tag{33}$$

4.4.7. The degree of importance

The final step is to identify the choice that has the best status among the alternatives, the alternatives that have the best status in terms of criteria are identified with the highest degree of importance Nj. The importance of each Nj of the Aj alternative is calculated based on the following formula.

$$Nj = \frac{Qj}{Qmax} \times 100 \tag{35}$$

in this regard, Q max is the largest value of relative importance and the usefulness of the alternatives is always between 0 and 100%.

5. Research Findings

in this section, the information and data collected are reviewed using data analysis methods. therefore, for this purpose, tables, results of methods or diagrams are mentioned and each of them is carefully reviewed and analyzed.

5.1. Metaheuristic technique

in this study, the result is the design of a meta-heuristic technique for use in multi-criteria decision making methods. evaluation of this issue is stated in this part of the research.

5.1.1. Formation of decision matrix

The decision matrix is a matrix for evaluating a number of alternatives based on a number of criteria. revenue, population and number of passengers indicators are quantitative and the other seven indicators are qualitative, which are converted into small values according to the Likert

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spectrum. Topographic and air traffic indicators are negative indicators and the other 8 indicators are positive.

Table 4. decision matrix

Attribute / Alternative	1	2	3	4	5	6	7	8	9	10
Yazd	735888	1668602	Very low	Very much	Very low	Very much	Very much	much	low	17
South Khorasan	411955	874223	low	much	low	Very much	Very much	medium	Very low	148
Ardebil	505008	1292350	Very much	low	medium	Very much	Very much	low	medium	292
Hamedan	722484	1718226	much	low	much	Very much	Very much	low	much	61
Isfahan	599678	5362388	medium	Very low	Very much	Very much	Very much	much	Very much	2621

5.1.2. Determination of normalized weighted decision matrix

in this step of the metaheuristic technique, the created normal decision matrix must be balanced. For this purpose, the weight of each criterion is multiplied by all the devices below the same criterion. the weight of the criteria must be determined in advance. For this purpose, entropy technique has been used in this technique to calculate the weight of the criteria.

Table 5. Normalized weighted decision matrix

Attribute / alternative	1	2	3	4	5	6	7	8	9	10
Yazd	0.009	0.035	0.009	0.056	0.045	0.009	0.009	0.007	0.018	0.003
South Khorasan	0.005	0.018	0.018	0.044	0.036	0.009	0.009	0.011	0.009	0.030
Ardebil	0.006	0.027	0.045	0.022	0.027	0.009	0.009	0.015	0.027	0.059
Hamedan	0.008	0.036	0.036	0.022	0.018	0.009	0.009	0.015	0.036	0.012
Isfahan	0.007	0.112	0.027	0.011	0.009	0.009	0.009	0.007	0.045	0.535

5.1.3. Calculate the sum squares of alternatives and the mean squares of alternatives

according to relations 7 and 8, we get the sum of the squares of the alternatives and the mean of the squares of the alternatives, as referred to earlier than, the basis of the referred to technique is

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primarily based on the mean of the alternatives. thus, the sum of the squares of the alternatives is equal to 2.55×10^{-2} and the mean squares of the alternatives is equal to 2.55×10^{-7}.

$$\mathrm{SSA}=\sum_{i=1}^{m}\frac{vj.^2}{n}-\frac{v..^2}{mn}=0.0255$$

$$\mathrm{MSA}=\frac{\mathrm{SSA}}{2mn^4}=0.000000255$$

;

5.1.4. The importance of each alternative

in this step, according to Equation 9, we reach the importance of each alternative based on the weighted unmeasured matrix. The sum of all the importance of the alternatives is equal to 1, and any alternative that has a larger value is our selection criterion.

C1=0/1999997970 C2=0/199999794

C3=0/199999808 C4=0/1999997976

C5=0199999868

therefore, Isfahan province in the first priority, Ardabil province in the second priority, Hamedan province in the third priority, Yazd province in the fourth priority and finally South Khorasan province in the fifth priority, so it can be concluded that .C5> C3> C4> C1> C2

5.2. Seca model

5.2.1. Formation of decision matrix

The decision matrix of this model is a row-column matrix that consists of 5 rows of rows and 10 criteria of columns, and each cell of this matrix is the evaluation of each project against each criterion. criteria C5 and C8 are negative in nature. the two criteria C6 and C7 are omitted due to the same numbers relative to the alternatives because the alternatives in these criteria do not compete with each other.

5.2.2. Determine the normal values of σj and πj

in this section, the normal values of σj and πj are calculated using relations 14 and 15. To normalize, each πj must be divided by the sum of the total πj, for the normal value σj, the value σj, which is the standard deviation, must first be calculated. To normalize, each σj must be divided by the sum of the total σj. The results are given in table 6.

Table 6. Normal values σj and π_j

σj	πj	inicators
0.076	0.122	*C1*
0.135	0.111	*C2*
0.126	0.115	*C3*
0.131	0.148	*C4*
0.130	0.148	*C5*
0.101	0.125	*C6*
0.126	0.112	*C7*
0.171	0.115	*C8*

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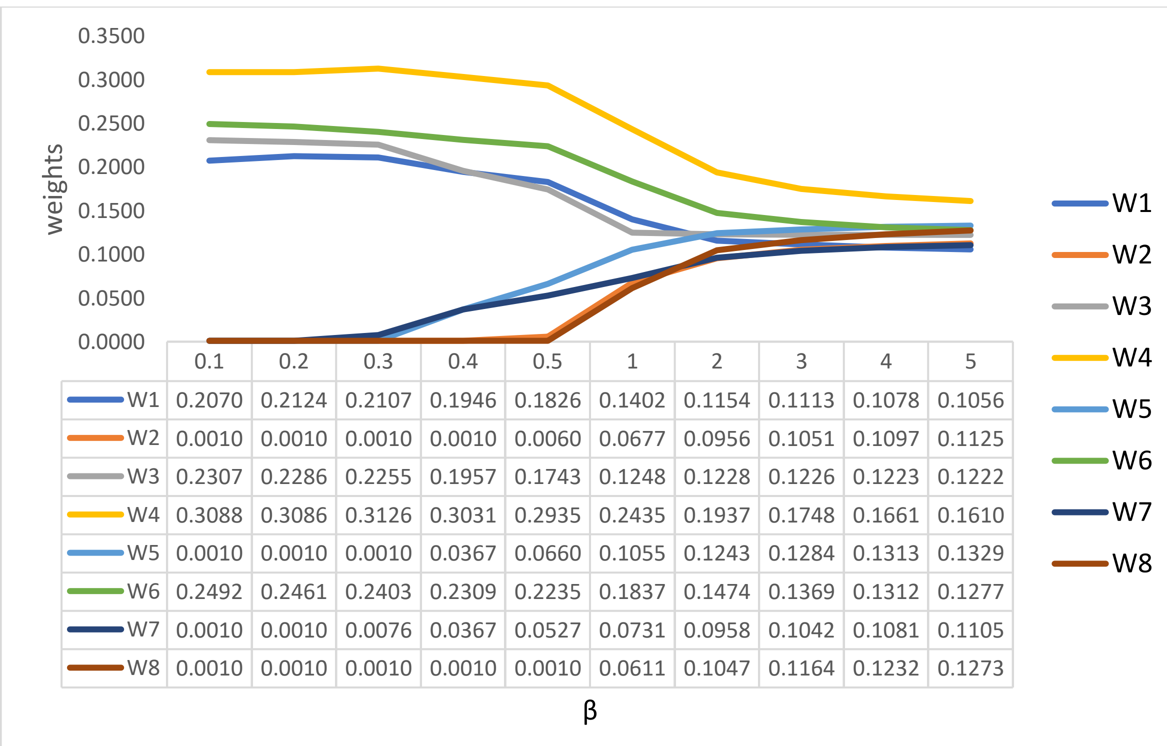
5.2.3. Forming an optimization model and solving it

in this section, using relationships 22 to 29, a nonlinear optimization model is actually formed and solved by Lingo software. in this model, for the values of "β" from 0.1 to 5 models have been implemented and, in each implementation, the weight of the criteria and the score of the alternatives have been obtained. the weight values of the criteria (W) and alternative score (A) are given in Tables 7 and 8, respectively, for the different values of "β". Schematically in Figures 2 and 3, the weight of the criteria and the score of the alternatives are given. As both the tables and the graphs show, for the weight of the criteria they converge from the values of "β"> 3, and for the alternatives from "β"> 0.5 convergence, so we can use as a subscription "β" = 4 is considered the convergent value that the weight of the criteria and the score of the alternatives in this value are constant for the problem. according to the convergence of β >3, it can be concluded that the fifth alternative, ie Isfahan province with a score of 0.7981 in the first priority, Yazd province with a score of 0.5340 in the second priority, Hamadan province with a score of 0.5295 in the priority rank, Ardabil province with a score 0.4771 is in the fourth priority and South Khorasan province is in the last priority with a score of 0.4090, so it can be concluded that A5> A1> A4> A3> A2. also, according to the "β" = 4 subscription, we can say that the fourth index (distance from the nearest airport) with a rating of 0.166 is in the first priority... and the first or seventh indices with a score of 0.108 are in the last priority.



	0.1	0.2	0.3	0.4	0.5	1	2	3	4	5
W1	0.2070	0.2124	0.2107	0.1946	0.1826	0.1402	0.1154	0.1113	0.1078	0.1056
W2	0.0010	0.0010	0.0010	0.0010	0.0060	0.0677	0.0956	0.1051	0.1097	0.1125
W3	0.2307	0.2286	0.2255	0.1957	0.1743	0.1248	0.1228	0.1226	0.1223	0.1222
W4	0.3088	0.3086	0.3126	0.3031	0.2935	0.2435	0.1937	0.1748	0.1661	0.1610
W5	0.0010	0.0010	0.0010	0.0367	0.0660	0.1055	0.1243	0.1284	0.1313	0.1329
W6	0.2492	0.2461	0.2403	0.2309	0.2235	0.1837	0.1474	0.1369	0.1312	0.1277
W7	0.0010	0.0010	0.0076	0.0367	0.0527	0.0731	0.0958	0.1042	0.1081	0.1105
W8	0.0010	0.0010	0.0010	0.0010	0.0010	0.0611	0.1047	0.1164	0.1232	0.1273

Figure 2. Changes in the weight of the criteria for different values of β.

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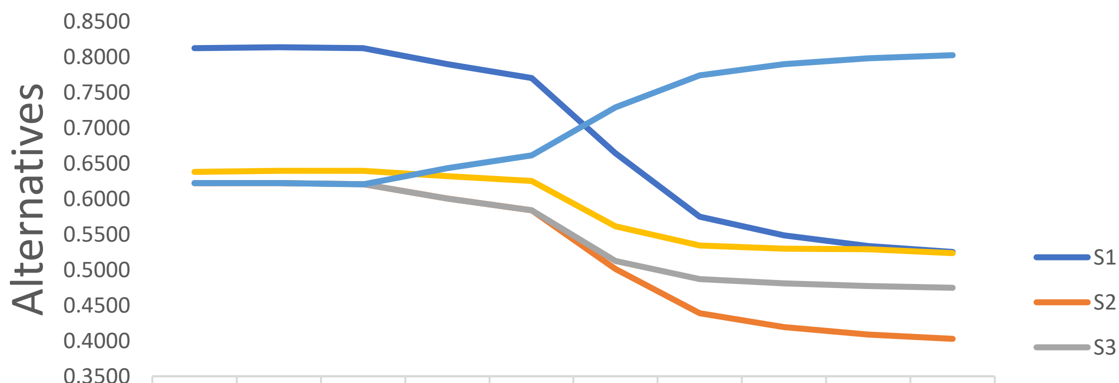

	0.1	0.2	0.3	0.4	0.5	1	2	3	4	5
S1	0.8123	0.8139	0.8124	0.7903	0.7708	0.6643	0.5747	0.5484	0.5340	0.5253
S2	0.6223	0.6222	0.6206	0.6006	0.5840	0.5013	0.4388	0.4192	0.4090	0.4028
S3	0.6223	0.6222	0.6206	0.6006	0.5840	0.5124	0.4868	0.4809	0.4771	0.4748
S4	0.6378	0.6397	0.6396	0.6325	0.6252	0.5612	0.5347	0.5297	0.5295	0.5236
S5	0.6223	0.6222	0.6206	0.6431	0.6616	0.7292	0.7745	0.7904	0.7981	0.8027

β

Figure 3. Changes in the score of alternatives for different values of β.

5.2.3. summary of Seca results

As shown in the Seca model, at "β" = 4, the weight of the criteria and the scores of the alternatives are converged, so at this value "β", the criteria are prioritized based on the weight and also the final scores of the alternatives are determined. The importance of the indicators according to figure 2 is as follows: air traffic, distance from the nearest airport, future expansion, average income, topography, economic value, population and number of passengers. also, according to figure 3, it can be concluded that the fifth alternative, ie Isfahan province in the first priority, Yazd province in the second priority, Hamedan province in the third priority, Ardabil province in the fourth priority and finally South Khorasan province in the fifth priority , So it can be concluded that A5> A1> A4> A3> A2.

5.3. Copras method

5.3.1. Weight and determination of positive and negative criteria

in this step, the weight of the criteria should be obtained the use of the entropy method. Topographic and air traffic indices are negative indicators, meaning that their reduction improves the situation, and the rest of the indicators are positive indicators, meaning that their increase improves the situation.

5.3.2. priotity and degree of importance of alternatives

in this step, we rank the alternatives according to Equation 34, which is the calculation of the Copras index. The higher the Qj value, the better the score of that alternative in the prioritization, and the smaller the Qj value indicates the lower the score of that alternative in the prioritization. The alternatives that have the best status in terms of criteria are identified with the highest degree of Nj importance.

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Table 7. priority and importance of alternatives in the Copras method

Q5=0.597	Q4=0.101	Q3=0.131	Q2=0.088	Q1=0.081	Qj (priority alternatives)
N5=1	N4=0.170	N3=0.219	N2=0.147	N1=0135	Nj (degree of importance of alternatives)

5.3.3. Final prioritization of alternatives

according to table 7, it can be concluded that the fifth alternative is Isfahan province in the first priority, Ardabil province in the second priority, Hamedan province in the third priority, South Khorasan province in the fourth priority and finally Yazd province in the fifth priority. it can be concluded that N5> N3> N4> N2> N1.

5.4. Comparison of research methods

according to the obtained results, it was found that all 3 methods indicated that Isfahan province is a suitable alternative in the first priority. There also are differences in the order of prioritization between the proposed technique and the Copras method and the Seca model, which can be seen in table 8.

Table 8. Comparison of methods

Seca	Copras	Technique	priority
Isfahan	Isfahan	Isfahan	1
Yazd	Ardabil	Ardabil	2
Hamadan	Hamadan	Hamadan	3
Ardabil	South Khorasan	Yazd	4
South Khorasan	Yazd	South Khorasan	5

5.5. Isfahan Province

Isfahan province is one of the central provinces of Iran, the center of which is the city of Isfahan and the geographical point of the center of the country is placed in this province. Isfahan province is the sixth largest province, the third most populous province of Iran and the first rank of urbanization in the country. The most important cities of this province are: Isfahan, Kashan and Najafabad. The province, with an area of about 10,676 square kilometers, is located between 30 degrees and 43 minutes to 34 degrees and 27 minutes north latitude of the equator and 49 degrees and 36 minutes to 55 degrees and 31 minutes east longitude of the Greenwich meridian. among the provinces of the country, Isfahan province has the most neighboring provinces. it is limited to Yazd and South Khorasan provinces from the east, to Semnan, Qom and Markazi provinces from the north, to Lorestan and Chaharmahal and Bakhtiari provinces from the west, to Kohgiluyeh, Boyer-Ahmad and Fars provinces from the south. naturally, the province is limited to the desert plain in the east and north, the Zagros Mountains in the west and south, which this natural situation, on the one hand, has provided limitations and on the other hand, potentials and advantages for the province.

5.5.1. Division of Isfahan province

Now we divide Isfahan province into 3 parts: northeast, northwest and southwest (the city of Isfahan was removed due to the active airport, and Kashan was included in the calculations due to the inactivity of the airport).

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North east cities. Ardestan-Nain and Khorobiabank
North weste cities. Golpayegan-Aran and Bidgol-Natanz-Shahinshahr and Meimeh-Khansar-Fereydoon-Buin and Miandasht-Fereydoonshahr-Chadegan-Borkhar-Khomeini Shahr-Najafabad-Tiran and Kron-Kashan
South west cities. Lenjan-Falavarjan-Mobarakeh-Dehaghan-Shahreza and Semirom

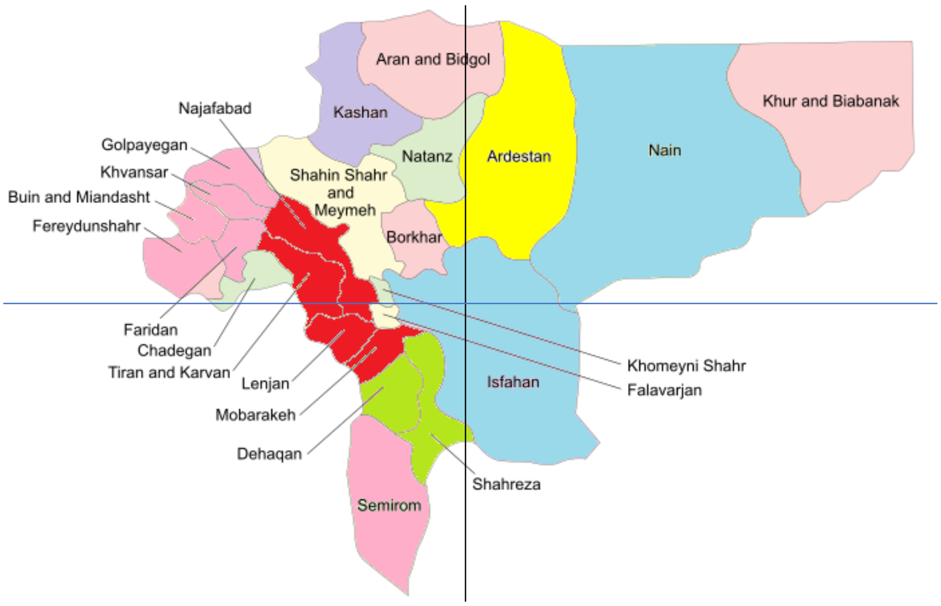

Figure 4. Map of Isfahan province

5.5.2. Formation of decision matrix

To form a decision matrix, the following steps must be implemented: identifying alternatives - identifying indicators - determining the type of indicators (positive and negative) - evaluating each alternative based on each indicator - converting qualitative and linguistic checks into quantitative - completing and finalizing decision matrix.

Table 9. Decision matrix

Attribute / alternative	1	2	3	4	5	6	7	8	9	10
North east	599678	88163	Very much	Very much	Very low	Very much	Very much	low	Very low	42
North west	599678	1532970	Very low	medium	low	Very much	Very much	medium	much	904
South west	599678	949168	much	low	low	Very much	Very much	low	low	452

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5.5.3. The final values of the three methods used in the research

At this stage, according to the methods used in the research, the degree of importance of each alternative is calculated and the result of each method is summarized in table 10.

Table 10. The degree of importance of the alternatives

Seca	Copras	Technique
A1=0.636	N1=0.71	C1=0.33333311
A2=0.752	N2=1	C2=0.33333313
A3=0.652	N3=0.86	C3=0.33333312

5.5.4. Comparison of research methods

according to the results, it was found that all three methods indicated that the northwest of Isfahan as a suitable alternative in the first priority. Also, in the order of prioritization between the proposed technique, Copras method and Seca model was not seen, the results are shown in table 11.

Table 11. Prioritize alternatives

Seca	Copras	Technique	priority
North west	North west	North west	1
South west	South west	South west	2
North east	North east	North east	3

5.6. Northwest of Isfahan province

At this stage, considering that the northwest of Isfahan province is the first priority, we must determine in which city, the location of the airport will be done. At this stage, the cities: Golpayegan-Khansar-Fereydoun-Buin and Miandasht-Fereydun shahr-Chadegan-Najafabad-Tiran and Kron have been included in the calculations and the rest of the cities have been removed due to their border and very short distance to Isfahan and Kashan.

5.6.1. Formation of decision matrix

according to the number of criteria, the number of alternatives and the evaluation of all alternatives for different criteria, the decision matrix is formed and is in the form of table 12.

5.6.2. The final values of the three methods used in the research

At this stage, according to the methods used in the research, the degree of importance of each alternative is calculated and the result of each method is shown in table 13.

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Table 12. Decision matrix

Attribute / alternative	1	2	3	4	5	6	7	8	9	10
Najafabad	599678	335884	Very much	Very low	Very low	Very much	Very much	much	Very much	160
Tiran and Kron	599678	72211	low	low	low	Very much	Very much	low	medium	34
Fereydun shahr	599678	33518	Very low	Very much	low	Very much	Very much	much	medium	16
Khansar	599678	30523	Very low	medium	Very low	Very much	Very much	much	medium	14
Golpayegan	599678	92763	low	low	Very low	Very much	Very much	much	much	44
Fereydoun	599678	46522	Very low	much	low	Very much	Very much	much	medium	22
Chadegan	599678	30514	Very low	much	low	Very much	Very much	much	medium	14
Buin and Miandasht	599678	20257	Very low	much	low	Very much	Very much	much	medium	10

Table 13. The degree of importance of the alternatives

Seca	Copras	Technique
A1=0.838	N1=1	C1=0.1249999270
A2=0.479	N2=0.26	C2=0.1249998909
A3=0.580	N3=0.164	C3=0.1249998782
A4=0.480	N4=0.141	C4=0.1249998738
A5=0.552	N5=0.318	C5=0.1249998951
A6=0.559	N6=0.190	C6=0.1249998814
A7=0.545	N7=0.148	C7=0.1249998753
A8=0.537	N8=0.126	C8=0.1249998712

5.6.3. Comparison of research methods

according to the results, it was found that all three methods indicated that Najafabad is a suitable alternative in the first priority. also, there is no difference in the order of prioritization between the proposed technique and the Copras method, and there are differences with the Seca model. The results are shown in table 14.

Table 14. Prioritize alternatives

Seca	Copras	Technique	priority
Najafabad	Najafabad	Najafabad	1
Fereydun shahr	Golpayegan	Golpayegan	2
Fereydoun	Tiran and Kron	Tiran and Kron	3
Golpayegan	Fereydoun	Fereydoun	4
Chadegan	Fereydun shahr	Fereydun shahr	5
Buin and Miandasht	Chadegan	Chadegan	6
Khansar	Khansar	Khansar	7
Tiran and Kron	Buin and Miandasht	Buin and Miandasht	8

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5.7. The final alternative

Najafabad, with an area of about 4163 square kilometers, is located 37 kilometers west of Isfahan and is surrounded by a wide plain among medium-height mountains. Najafabad, which is the fourth most populous city in Isfahan province, is located in the center of the province and has 6 cities: Najafabad, Goldasht, Jozdan, Alavijeh, Dehq and Kahrizsang. The population of this city in the year 1400 was 335884 people. Najafabad is located in a plain with a temperate and relatively dry climate. The average annual rainfall is 120 mm, which is mostly done in the cold seasons. The atmosphere has an absolute maximum temperature of 38 degrees and an absolute minimum of 9.5 degrees and an average annual temperature of 15.8 degrees. The altitude of this city is 1600 meters above sea level.

6. Conclusion

The purpose of this research is to design the technique for priority available alternatives and comparisons with designated and, on the other hand, identification of locating criteria. To select the location of the airport, first, based on aviation, physical, economic and environmental criteria, a number of alternatives that have primary conditions are studied, then effective indicators are compared to alternatives. by comparing the results of the heuristic technique and priority in other methods, the strengths of this technique were turned on. one of the strengths of this technique can be simply, accurately in calculations, non-limitation in alternatives and indicators, generalization to other locations, and its low cost. according to comparisons, the use of the technique provided in this research will be very successful if used for organizations and companies in making more correct decisions. also, considering the performance of the technique in the location of the airports, this technique has the ability to select the right alternative and location in various projects. The results of the survey indicate that there is no difference between the methods of research in selecting the appropriate alternative. And all three methods suggest that the city of Najaf Abad is the best alternative, according to the indicators of the raised, in prioritization of the provinces with 3 strategies, the differences in the order are located and in the province of Isfahan province to three parts, no observation disagreement. it will not be seen in the final stage in the order of the metaheuristic technique with the Copras method, but they differed with the cache model. In fact, these differences are the main point that requires the use of a metaheuristic technique, and ultimately, with its development through the level of confidence, we can ensure the appropriate percentile alternative. if you give the confidence level, we will see more of the metaheuristic technique.

According to the results of this study, research is proposed to investigate the research of Najaf abad county and that in which part of the county, the exact location of the airport is selected. it is suggested to use the presentation of metaheuristic technique in different issues and to compare it with other methods in order to be more reliable. due to the use of statistical topics, it is recommended that researchers, to select the appropriate alternative, use the level of confidence for the final selection of the desired alternative. in addition, it is suggested that other multi-criteria spatial analysis be used to validate the results.

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