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The Application of VIKOR Model on the Measurement and Ranking of Geo-morph Sites in the Geo-tourism Areas of Damavand

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Abstract The researchers examine the application of VIKOR model on the measurement and rank of geo-morph sites in the tourism areas of Damavand. Thus, the main objective of the study is: to determine the best geo-morph site with the help of criteria's and indicators. The researchers selected VIKOR models and relevant analytical methods in order to rank 30 studied geo-morph site in tourism areas. 12 geo-morph sites were selected based on restrictions that the researchers determined According to these models, the value of Q represented the final ranking of each site from the total 6 main indicators and 41 sub indicators. This value is between zero and one. If the value is near one, it is desirable and if it is near zero, it is undesirable. The findings of the study reveal Lar plain, Mosha plain, and Damavand volcano have the highest value of Q and Shebli tower, Ski result, and Central mosque have the lowest value of Q among sites. According to the highest and the lowest value of Q, the area can be ranked and divided in to 4 groups; poor, fair, good, and great.

Keywords: *Geo-tourism area, VIKOR model, Geo-morph site, Damavand*

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1. Introduction

Geo-tourism is a form of tourism that focuses mainly on the geology and landscape. Geo-tourism extends the tourism industry to notice the geo-sites and protected geological diversity as well as understand Earth Sciences (Through recognition of the value and learn from them). tourism is a central knowledge that the interdisciplinary integration of the tourism industry by preserving and interpreting the attractions Still life - along with the cultural issues associated with them geo sites occur in public [5]. The protection of geology and interpretation geology are two basic factors that they are crucial ways in order to access stable geotorism, geosites and geommorphosites (Hose, 2012). Geo tourism is a new concept related to tourism that as a growing form of fast of the tourism industry has emerged [3].

The geo morphosite (geomorphologic site) is a geomorphologic system (type of relief) that received a special value due to human perception and exploiting (Panizza, Piacente, 1993 [8] as cited in COMĂNESCU, 2009).

Vlsekriterijumska Optimizacija KOmpromisno Resenje method (the Serbian name of VIKOR) means multi criteria optimization and compromise solution. It is a multi-criteria decision making method developed in 1990 by Serafim Opricovic to solve decision problems with conflicting criteria. This method ranks alternatives and determines the compromise solution that is the closest to the "ideal". Regarding the rapid growth of use of VIKOR among practitioners, more than 200 scholarly papers and conference proceedings have subjected VIKOR as one of the brilliant technique and/or combined with other MCDM methods (Opricovic, 2011 [6]; Kang, 2014 [4] as cited [11]). Vikor method one of the most widely used models in decision-making and is the preferred option.

Damavand is located in the East of Tehran and the southern province of Mazandaran. This area is between length 5135 5 E 354237 N, and length 53 6 19 E and 35 42 7N. Because of geographical location and strategic that is caused to annually millions of passengers pass from the region (Cultural Heritage Administration Handicrafts and Tourism Damavand city, 2015). Damavand is the vicinity of three provinces such as Mazandan, Samnan, and Tehran. Tehran has high potentially such as politics, culture, facilities and transportation system in the west caused up to create numerous capabilities for the region. As the matter of fact this area is also corridor north to the south of the country.

Fattahi & et al, [2] in a study to assess and prioritize social stability in rural areas Delfan city using VIKOR's decision and came to the conclusion that in order to improve the level of social stability in Delfan city should measures like equitable distribution of resources and opportunities provide adequate social services for community members, especially in the sections of education

and health, social and gender discrimination, promoting political accountability and community participation in social development was the focus of planning.

The present research intended to analyze the application of VIKOR model on the measurement and ranking of geo morphosites in the geo tourism areas of Damavand. Determiners have much more freedom to evaluate indicators but in this study, the researchers applied VIKOR model from among other model because this model is more effective to determine the valid ranking. Hence the mater this study was the application of VIKOR model on the measurement and ranking of geo- morph sites in the geo-tourism areas.

One question is going to be address to what extend VIKOR model is more effective on the measurement and ranking of geo morphosites in the tourist areas of Damavand. The purpose of this study is applying VIKOR model in order to identify and rank geo morpho site in the tourist of Damavand. It is hoped that the result of this study will be effective on the improvement, measurement and ranking of the geo morphosite in tourisms areas.

2. Methodology

The present study set out to investigate the application of VIKOR model on the measurement and ranking of geo-morph sites in the geo-tourism areas of Damavand. The general approach of research is quantitative and data collection method based on the determination of the top of geo- tourist areas as well as theoretical explanation and defines the main criteria and effective choice and development activities of geotourism based data library and field survey. The method is used in this research is a combination of analytical and descriptive methods by using Library and field systems to carry out. In this research the following steps were taken.

The first step was to identify 30geomorphosites. This study examined which geomorphosite is suitable and the value of geotourisme. Secondly the restrictions were applied for the right choice. In this study, it was used topography maps and visit geomorphosite to determine indicators and assesse the sites. The researchers applied some models like (Reynard [10], Prolong [9], Paniza [8]) and assessors determine appropriate indicators regarding to the religious culture and political situation this research study intend to rank indicators between zero – one. As a result, the researchers prepare an average among advantages and through Ant ropy Shannon method determine the value of indicators.

3. Data Analysis

In order to the answer the question, to what extent VIKOR model is more effective on the measurement and ranking of geomorphosites in the tourist areas of Damavand. The researchers divided limitations into to five parts. The first one is during the course of the visitor center is less than or equal to 10 kilometors.2-The number of people employed in every site at least 4 people 3-Number of infrastructure is at least 2. 4- The number of visitors is greater than or equal to 10000 a year. 5-Number of qualified workers (specialist) in not less than 3 people.

The third step: In the flowing table the researchers select the appropriate geomorphosite after restriction.

Fourth step is determining the 6 main criteria and 41 sub-indicators as flows Table 2. The researchers chose other criteria in order to determine these criteria.

Table 1. Geo morphosite presented in the study area.

No	Geomorphosite name and Label	Height (m)	Lithology/ Origin
1	Polor waterfall GS_1	2500	Quaternary/Alluvial fan
2	Lar lake GS_2	2531	limestone/Jurassic/ Karst
3	Ask Spring GS_3	2300	Dark shale, Sandston/ Jurassic /Karst
4	Damavand volcano GS_4	5671	Trachyandesitic/ Quaternary
5	Larijan spring GS_5	2700	Cherty limestone/ Jurassic/ Karst
6	Vararo Plain GS_6	4098	limestone/Jurassic/ Karst
7	Alla spring GS_7	1980	Paleocene/ Conglomerates, marl limestone
8	Mosha Plain GS_8	2250	Cenozoic/Green tuff
9	Central Mosque GS_9	1960	Alluvial fan / Man-made/ 812 AH
10	Ski resort GS_{10}	2800	Quaternary/Alluvial fan
11	Tower Shibli GS_{11}	1800	Quaternary/Alluvial fan/ Man-made/ 5th century
12	Shrine GS_{12}	2750	Cenozoic/Green tuff/ Man-made/7 th century AH

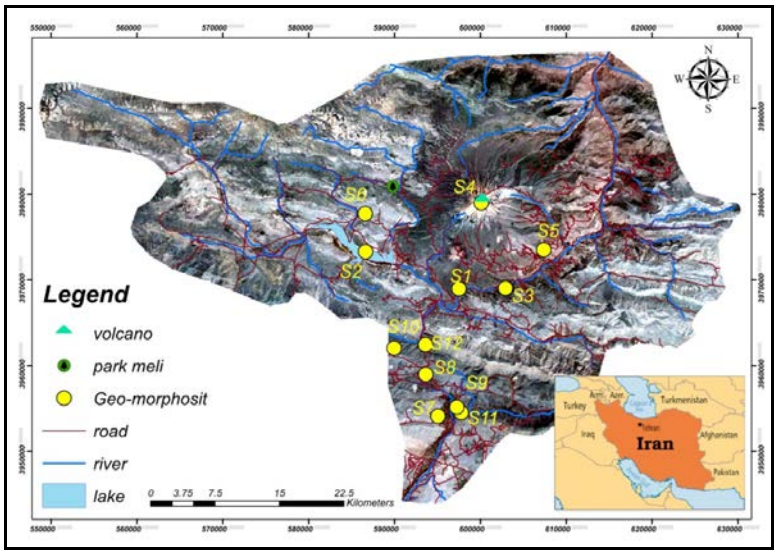

Figure 1. Location of the geomorphosites in Damavand

Table 2. determining the main criteria and sub-indices

No	Index	No	Index
I	**Geo mophotourism**	**II**	**management**
1	surface (km^2)	22	Coordination with related organizations
2	Age	23	accessibility
3	Paleo geographical value	24	***financial support***
4	Rarity	25	***The role of women***
5	Geodiversity	26	Number of infrastructure
6	Aesthetics	27	Neighborhood service centers
7	Environmental attractiveness	28	The number of people employed
8	Biogeography	29	path length
9	***Therapeutic value***		
III	**Communications**	**IV**	**Protection**
10	The possibility of exchanging information	30	Threats
11	Initiatives and documentation	31	Protection laws
12	Promote communication site	32	level of deterioration
13	Conferences	33	The number of visitors
14	Identify the type of site	34	seasonal occupancy
		35	***Security***
VI	**Cultural and economic**		**Teaching and Learning**
15	Historical and Religious value	36	Cognitive Ability
16	***Sociology***	**37**	The scientific knowledge
17	Handicrafts	38	Museum
18	Crops	39	Interpretation centers
19	Customs	40	***Local innovative entrepreneurship***
20	Economic value	41	Training local people
21	Artistic value		

Fifth step is using the model to analyze the data collection according to the VIKOR model, the researcher's masseur and rank the geomorphosites in Damavand region.

In order to implement VIKOR model, the researchers applied multi criteria making decision **n** and **m** criteria. The steps of implementing VIKOR model is as follows the first one is making matrix.

$$X_{ij} = \begin{bmatrix} X_{11} & \cdots & X_{1m} \\ \vdots & \cdots & \cdots \\ X_{m1} & \cdots & X_{mn} \end{bmatrix}$$

where in X_{ij} performance options i (i=1,2,…,m) in relation to criterion j (j= 1,2,…,n) (Table 3).

Table 3. Making matrix

شاخ	GS1	GS2	GS3	GS4	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12
1	0.001	675	0.09	400	0.007	3	0.03	12	0.0004	0.04	0.0001	0.04
2	100000	38500	208000	100000	100000	2080000	6500000	320000	1400	120	1000	1080
3	0.75	0.75	1	1	0.75	1	0.75	1	0	0.5	0	0.5
4	0.5	0.5	0.5	1	0.75	0.5	1	0.5	0.5	0.25	1	1
5	0.25	0.25	0.5	1	0.5	0.75	0.5	0.5	0	0.25	0	0.25
6	0.5	1	0.5	1	0.25	1	0.75	0.5	0.75	0.5	1	0.5
7	1	1	1	1	0.75	1	1	1	0	0.75	0	0.5
8	0.5	1	1	1	0.5	1	0.75	0.5	0	0	0	0
9	1	0.5	1	0.5	1	0.25	1	0.25	0	0.25	0	0
10	0.5	1	1	1	1	0.75	1	1	1	1	1	1
11	0.5	1	0.5	1	1	0.5	1	0.75	1	0.5	0.5	0.5
12	1	1	1	1	1	0.25	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1	0.75	1
14	0.5	0.5	0.25	1	0.25	0.25	0.5	0.5	0.5	0.25	0.5	0.5
15	0.5	0.25	0.5	1	0.25	0	0	0.5	1	0	1	1
16	0	0	0.5	0.25	0	0.25	0.25	0.5	1	0	0.5	1
17	0.5	0	1	0.25	0.5	1	0.5	0.75	1	0.5	1	0.5
18	0.5	1	0.75	1	0.25	1	1	1	0	0.5	0.25	0.25
19	0.5	0	1	1	1	0.5	1	1	1	1	0.5	1
20	1	1	0.5	0.5	1	0.75	1	1	0.25	1	0.5	1
21	1	0.75	1	1	0.5	1	0.5	0.5	1	0.5	1	0.75
22	1	1	0.75	1	1	0.5	1	1	1	1	1	1
23	1	0.5	1	0.25	0.75	0.25	1	1	1	1	1	1
24	1	1	0.5	0.75	0.75	0.5	1	1	1	1	0.5	1
25	15	20	5	10	4	7	10	5	10	10	4	15
26	8	5	4	4	6	3	10	10	10	8	10	10
27	1	0.5	1	0.25	1	0.5	1	1	1	1	1	1
28	20	20	50	50	200	5	100	200	20	100	15	100
29	0	5	2	10	3	10	4	5	1	8	1	5
30	0.5	0.5	0.5	0.75	0.5	0.25	0.75	0.75	0.5	0.5	0.5	0.5
31	0.5	0.25	0.5	0.5	0.5	0.75	0.5	1	0.25	0.5	0.5	0.5
32	0.5	0.5	0.75	0.5	0.25	0.75	0.25	0.25	0.75	0.5	0.75	0.5
33	100000	15000	10000	10000	30000	10000	150000	100000	50000	10000	15000	10000
34	365	120	240	30	200	150	365	365	365	365	365	365
35	1	0.25	1	1	1	0.75	1	1	0.5	1	0.75	0.75
36	0.75	0.5	0.25	1	0.5	0.75	0.5	0.75	0.5	1	0.75	0.25
37	0.5	1	1	1	0.5	0.75	1	0.5	0.75	0.25	0.25	0.5
38	0.5	1	1	1	0.5	0.5	0.75	1	1	0.25	0.5	1
39	1	1	0.5	1	0.5	0.25	0.75	0.25	1	0.5	1	1
40	0.75	1	0.5	1	0.5	0.5	0.75	0.5	0.5	0.5	0.25	0.5
41	1	1	1	1	1	0.75	1	0.5	0.75	1	0.5	1

The second step is no scale design matrix

$$n_{ij} = \frac{a_{ij} - a_i^{Min}}{a_{ij}^{Max} - a_i^{Min}}.$$

At this stage, the criteria with different dimensions to become dimensionless criteria and a matrix defined in Table 4.

Table 4. No scale design matrix

	GS1	GS2	GS3	GS4	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12
1	0.5	0.5	0.5	1	0.75	0.5	1	0.5	0.5	0.25	1	1
2	0.0031	0.00	0.65	0.0031	0.0031	0.6499	0.20	1	4E-06	0	2.75E-	3E-06
3	0.25	0.25	0.5	1	0.5	0.75	0.5	0.5	0	0.25	0	0.25
4	0.5	1	0.5	1	0.25	1	0.75	0.5	0.75	0.5	1	0.5
5	0.5	0.5	0.5	0.75	0.5	0.25	0.75	0.75	0.5	0.5	0.5	0.5
6	1.48E-	1	0.0001	0.5925	1.04E-	0.0044	4.44	0.0177	5.9111	5.93E-	0	5.93E-05
7	1	0.5	1	0.25	1	0.5	1	1	1	1	1	1
8	0.7142	0.28	0.1428	0.1428	0.4285	0	1	1	1	0.7142	1	1
9	1	0.26	0.6268	0	0.5074	0.3582	1	1	1	1	1	1
10	1	0.25	1	1	1	0.75	1	1	0.5	1	0.75	0.75
11	0.5	0.5	0.75	0.5	0.25	0.75	0.25	0.25	0.75	0.5	0.75	0.5
12	0.5	0.25	0.5	0.5	0.5	0.75	0.5	1	0.25	0.5	0.5	0.5
13	0	0	0.5	0.25	0	0.25	0.25	0.5	1	0	0.5	1
14	0.5	1	1	1	0.5	0.75	1	0.5	0.75	0.25	0.25	0.5
15	0.75	0.5	0.25	1	0.5	0.75	0.5	0.75	0.5	1	0.75	0.25
16	0.5	0.25	0.5	1	0.25	0	0	0.5	1	0	1	1
17	1	0.5	1	0.25	0.75	0.25	1	1	1	1	1	1
18	1	1	0.5	0.5	1	0.75	1	1	0.25	1	0.5	1
19	0.5	1	1	1	0.5	1	0.75	0.5	0	0	0	0
20	0.5	0	1	1	1	0.5	1	1	1	1	0.5	1
21	1	1	1	1	0.75	1	1	1	0	0.75	0	0.5
22	0.5	1	0.75	1	0.25	1	1	1	0	0.5	0.25	0.25
23	0.75	0.75	1	1	0.75	1	0.75	1	0	0.5	0	0.5
24	1	0.5	1	0.5	1	0.25	1	0.25	0	0.25	0	0
25	1	1	0.5	1	0.5	0.25	0.75	0.25	1	0.5	1	1
26	1	1	1	1	1	0.75	1	0.5	0.75	1	0.5	1
27	0.5	1	1	1	0.5	0.5	0.75	1	1	0.25	0.5	1
28	0.75	1	0.5	1	0.5	0.5	0.75	0.5	0.5	0.5	0.25	0.5
29	0.5	0	1	0.25	0.5	1	0.5	0.75	1	0.5	1	0.5
30	1	1	0.75	1	1	0.5	1	1	1	1	1	1
31	0.5	1	1	1	1	0.75	1	1	1	1	1	1
32	1	1	1	1	1	0.25	1	1	1	1	1	1
33	0.5	1	0.5	1	1	0.5	1	0.75	1	0.5	0.5	0.5
34	1	1	0.5	0.75	0.75	0.5	1	1	1	1	0.5	1
35	1	0.75	1	1	0.5	1	0.5	0.5	1	0.5	1	0.75
36	1	1	1	1	1	1	1	1	1	1	0.75	1
37	0	0.5	0.2	1	0.3	1	0.4	0.5	0.1	0.8	0.1	0.5
38	0.68	1	0.0625	0.375	0	0.1875	0.37	0.06	0.375	0.375	0	0.6875
39	1	0.005	0	0	0.020	0	0.14	0.09	0.0404	0.0909	0.0050	1
40	0.07	0.0769	0.2307	0.2307	1	0	0.48	1	0.0769	0.4871	0.0512	0.487179
41	0.5	0.5	0.25	1	0.25	0.25	0.5	0.5	0.5	0.25	0.5	0.5

In most MADM issues to know the relative importance of needed indicators So that their sum is equal to one unit. The relative importance, degree preferred of every indicator than others to make decision on the measures.

The third step is determining the weighting of criteria. In order to determine the weight of indicators, the researchers used Entropy method. As can be seen Entropy method in the following Table 5.

Table 5. The weight of each indicator based on entropy

Evaluation Site					
No	**Index**	**Weigh**	**No**	**Index**	**Weigh**
I	**Geo mophotourism**	**0.6**	**II**	**management**	**0.2**
1	surface (km^2)	0.199131	22	Coordination with related organizations	0.000837
2	Age	0.135209	23	accessibility	0.008982
3	Paleo geographical value	0.023988	24	***financial support***	***0.00402***
4	Rarity	0.00857	25	***The role of women***	***0.047821***
5	Geodiversity	0.033838	26	Number of infrastructure	0.027625
6	Aesthetics	0.006009	27	Neighborhood service centers	0.006405

7	Environmental attractiveness	0.011442	28	The number of people employed	0.052370
8	Biogeography	0.051314	29	path length	0.03334
9	***Therapeutic value***	***0.024685***			
III	**Communications**	**0.01**	**IV**	**Protection**	**0.05**
10	The possibility of exchanging information	0.000837	30	Threats	0.003844
11	Initiatives and documentation	0.003052	31	Protection laws	0.005408
12	Promote communication site	0.003853	32	level of deterioration	0.008045
13	Conferences	0.000326	33	The number of visitors	0.001369
14	Identify the type of site	0.007431	34	seasonal occupancy	0.018153
			35	***Security***	***0.005506***
VI	**Cultural and economic**	**0.1**		**Teaching and Learning**	**0.04**
15	Historical and Religious value	0.031182	36	Cognitive Ability	0.008846
16	***Sociology***	***0.002411***	**37**	The scientific knowledge	0.005214
17	Handicrafts	0.009326	38	Museum	0.004053
18	Crops	0.011951	39	Interpretation centers	0.010605
19	Customs	0.010597	40	***Local innovative entrepreneurship***	***0.005295***
20	Economic value	0.005553	41	Training local people	0.003023
21	Artistic value	0.022981			

The fourth step is to determine the best F_j^* and the worth (F_j^-) value of positive and negative criteria as follows:

$$F_j^* = \text{Max} F_{ij} \quad F_j^- = \text{Min} F_{ij}.$$

(F_j^*) is the best value of criteria **j** and (F_j^-) is the worth value of criteria j from among alternatives. Table 6 shows this F_j .

Table 6. The highest and lowest value criteria

No	F_j^*	F_j^-	No	F_j^*	F_j^-	No	F_j^*	F_j^-
1	1	0.25	15	1	0.25	29	1	0
2	1	0	16	1	0	30	1	0.5
3	1	0	17	1	0.25	31	1	0.5
4	1	0.25	18	1	0.25	32	1	0.25
5	0/75	0.25	19	1	0	33	1	0.5
6	1	0	20	1	0	34	1	0.5
7	1	0.25	21	1	0	35	1	0.5
8	1	0	22	1	0	36	1	0.75
9	1	0	23	1	0	37	1	0
10	1	0.25	24	1	0	38	1	0
11	0/75	0.25	25	1	0.25	39	1	0
12	1	0.25	26	1	0.5	40	1	0
13	1	0	27	1	0.25	41	1	0.25
14	1	0.25	28	1	0.25			

The fifth step is: measure utility value(S) and dissatisfaction (R) in the following part.

$$S_i = \sum_{j=1}^{n} W_j \frac{F_{j-}^* F_{ij}}{F_j^* - F_j^-}$$

$$R_i = \text{Max}\left\{ \text{w}_\text{j} \frac{\text{F}_{\text{j}-}^* \text{F}_{\text{ij}}}{\text{F}_\text{j}^* - \text{F}_\text{j}^-} \right\}.$$

The measure of W_j is the weight of criteria

Table 7. Multiplication Weights factor in the decision matrix and calculation Ri and Si

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
1	0.0033097	0.0033	0.00992	0.00992	0.00331	0.00331	0.00331	0.00992	0.0033097	0.00662	0	0.00992
2	0.1018284	0.1566	0.00074	0.00049	0.00049	0.00058	0.10182	0.03182	0.00761	0.00049	0	0.00734
3	0.0294044	0.0196	0	0.03920	0.00980	0.00980	0.01960	0.01960	0	0.01960	0.00980	0.00980
4	0.0069623	0.0023	0.00696	0.00696	0.00232	0.00696	0.00232	0.00464	0.0046415	0	0.00232	0.00232
5	0	0.0044	0.00222	0.00445	0.00222	0.00222	0.00222	0.00445	0.0022270	0.00222	0.00222	0.00222
6	0.0010254	0.0041	0	0.00136	0.00374	0.23072	0.0001	0.00015	0.0007	0.00026	0.00032	0.0035
7	0.0024738	0.0074	0.00742	0	0.00742	0.00247	0.00742	0.00742	0.0074215	0.00742	0.00742	0.00742
8	0	0.0320	0.03200	0.00457	0.02286	0.00914	0.00457	0.03200	0.0320080	0.01371	0.02286	0.03200
9	0.0075342	0.0210	0.02103	0	0.02103	0.00565	0.01318	0.02103	0.0210332	0.01067	0.02103	0.02103
10	0.0042530	0.0063	0.00425	0.00638	0.00638	0	0.00638	0.00638	0.0021265	0.00638	0.00638	0.00425
11	0.0093212	0	0.00932	0.00466	0.00466	0.00466	0.00932	0	0.0093212	0	0.00466	0.00466
12	0.0041776	0.0062	0.00208	0.00208	0.00208	0	0.00208	0.00208	0	0.00208	0.00208	0.00208
13	0.0090322	0.0180	0.01806	0.00903	0	0	0.01806	0.00903	0.0361290	0	0	0.03612
14	0.0040273	0.0020	0	0.00604	0.00201	0.00604	0.00604	0.00604	0.0040273	0.00201	0	0.00201
15	0.0068327	0.0068	0.00683	0.01024	0.00683	0.00341	0	0.00341	0.0034163	0.00341	0.01024	0

16	0	0.0133	0.02662	0.02662	0.01331	0.00665	0.01331	0	0.0266262	0.00665	0	0.02662
17	0	0.0104	0.01040	0	0.01040	0.00346	0.01040	0.01040	0.0104070	0.00693	0.01040	0.01040
18	0.0042889	0.0064	0.00214	0.00214	0.00643	0.00643	0.00214	0.00643	0	0.00643	0.00643	0.00643
19	0.0594544	0.0297	0	0.05945	0.02972	0.05945	0.05945	0.04459	0	0.02972	0	0
20	0.0061388	0.0122	0.00613	0.01227	0.00613	0	0.01227	0.01227	0.0122777	0.01227	0.01227	0.01227
21	0.0132571	0.0132	0	0.01325	0.01325	0.01325	0.01325	0.01325	0	0.00994	0.00994	0.00662
22	0.0138469	0.0138	0.00346	0.01384	0.00692	0.01384	0.01038	0.01384	0	0.00346	0.00692	0.00346
23	0.0277931	0.0277	0	0.02779	0.02084	0.02084	0.02779	0.02084	0	0.02084	0.01389	0.01389
24	0.0071502	0.0071	0	0.01430	0.02860	0.01430	0.02860	0.02860	0	0.02860	0.00715	0
25	0	0	0.01228	0.01228	0.01228	0.01228	0.00409	0.00819	0.0122870	0.00409	0.00409	0.01228
26	0.0017510	0	0	0.00350	0.00350	0.00350	0.00350	0.00350	0.0017510	0.00350	0.00350	0.00350
27	0.0015654	0.0046	0.00156	0.00469	0.00156	0.00469	0.00469	0.00313	0.0046964	0.00156	0	0.00469
28	0.0020451	0.0020	0	0.00613	0.00409	0.00613	0.00204	0.00409	0.0020451	0.00204	0.00204	0.00204

The rest of the Table 7. Multiplication Weights factor in the decision matrix and calculation Ri and Si

29	0.0108052	0.0081	0.01080	0.00270	0.00540	0	0.01080	0.00540	0.0108052	0.00540	0.00540	0.00540
30	0	0.0009	0.00097	0.00097	0.00097	0.00097	0.00048	0.00097	0.0009699	0.00097	0.00097	0.00097
31	0.0004849	0.0009	0.00097	0.00097	0	0.00097	0.00097	0.00097	0.0009699	0.00097	0.00097	0.00097
32	0	0.0044	0.00446	0.00446	0.00446	0.00446	0.00446	0.00446	0.0044646	0.00446	0.00446	0.00446
33	0	0.0017	0	0.00353	0	0.00353	0	0.00353	0.0035364	0.00353	0	0
34	0	0.0046	0	0.00232	0.00465	0.00465	0	0.00465	0.0046575	0.00232	0.00465	0.00465
35	0.0027940	0	0.00279	0.00279	0.00279	0.00139	0.00279	0	0.0027940	0	0	0.00139
36	0.0003782	0.0003	0	0.00037	0.00037	0.00037	0.00037	0.00037	0.0003782	0.00037	0.00037	0.00037
37	0.0386296	0.0193	0.00386	0.03863	0	0.01931	0.00772	0.01545	0.0038629	0.01158	0.03090	0.01931
38	0.0103889	0.0034	0	0.02077	0.03809	0.05540	0.00346	0.02077	0.0207779	0	0.02077	0.03809
39	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0.0606	0.00311	0.01400	0.00466	0.00466	0.01400	0.02956	0.0046675	0.06067	0.02956	0.02956
41	0	0.0028	0.00287	0.00860	0.00287	0.00287	0	0.00287	0.0028696	0	0	0.00287
Si	0.390	0.539	0.212	0.537	0.312	0.547	0.433	0.416	0.256	0.301	0.263	0.344
Ri	0.101	0.156	0.032	0.136	0.038	0.230	0.101	0.044	0.036	0.060	0.030	0.038

The last step is VIKOR index (Q)

$$Q_i = V\left[\frac{S_{i-}S^-}{S^* - S^-}\right] + (1-\mathrm{V})\left[\frac{R_{i-}R^-}{R^* - R^-}\right]$$

$$S^- = \mathrm{Min}S_i \quad S^* = \mathrm{Max}S_i \quad R^- = \mathrm{Min}R_i \quad R^* = \mathrm{Max}R_i$$

Max S	0.547946253
Min S	0.212621341
Max R	0.230721582
Min R	0.030903752

Parameter V is chosen according to the agreed decision in the group. In this case the value of V is half according to the unanimous agreement.

Table 8. Ranking of geo morphosites based on index VIKOR (Q) and score

Value	Gs1	Gs2	Gs3	Gs4	Gs5	Gs6	Gs7	Gs8	Gs9	Gs10	Gs11	GS12
Q	0/1674	1	0/5067	0/7488	0/2063	0/4433	0/3376	0/8014	0/07851	0/0763	0/0027	0/2142
The final rating	9	1	4	3	8	5	6	2	10	11	12	7
Grouping	4	1	2	2	4	3	3	1	4	4	4	4

4. Discussion

The study was an attempt to examine the application of VIKOR model on the measurement and ranking of geo morphosites in the geotourism areas of Damavand. Thus the main objective of the study is: to determine the best geomorphosite with the help of criteria and indicators. In this study the researchers arranged alternatives according to the measure of Q, R, and S.

In this step, regarding to the measure of Q, R, S, the alternatives can be categorized into three groups from low to high. Afterwards, the alternative is selected as a best alternative from among three groups. In Q group, the alternative is the best that have two conditions.

The first one is: If the alternative Gs2 and Gs8 are the first and the second and n indicates the number of alternatives as follows:

$$\mathrm{Q}\,(\mathrm{Gs2}) - \mathrm{Q}(\mathrm{Gs8}) > \frac{1}{n-1} \quad \mathrm{n} = 12$$

$$\rightarrow 1 - 0/8014 > \frac{1}{12-1} \rightarrow 0/1986 > 0/09$$

The second one is: alternative Gs2 have to be at least the best rank between R and S groups. If the first condition does not hold, we can accesses the best alternatives as the following formula

$$\mathrm{Q}(G_m) - \mathrm{Q}(Gs2) < \frac{1}{n-1}.$$

In this study the first condition is approved.

5. Conclusion

This study attempts to investigate the application of VIKOR model on the measure and ranking of geomorphosites in the geotourism areas of Damavand. The finding of the study reveals that are statistically significant between groups. According to the highest and lowest of the value of Q, the area can be divided into four groups: weak, medium, good, prefect. According to table (8) geomorphosites are ranked.

1- If the point of geomorphosites is between 0/002-0/25 the area gain the weak condition.

Table 9. Categorization based on Q

No	Group	Q Value
1	weak	0.002- 0.25
2	medium	0.25- 0.50
3	good	0.50- 0.75
4	prefect	0.75-1

2- If the point of geomorphosites is between 0/25- 0/50 the area gain the medium condition.

3- If the point of geomorphosites is between 0/50- 0/75 the area gain the good condition.

4- If the point of geomorphosites are between 0/75- 1 the area gain the perfect condition.

According to the VIKOR model LAR and Damavand volcano are the best and Shebli Tower is the lowest geomorphosites from among geomorphosites regarding to the value of Q. The finding of this study leads to the assessment of geomorphosites and preparing a map for the area (Figure 2).

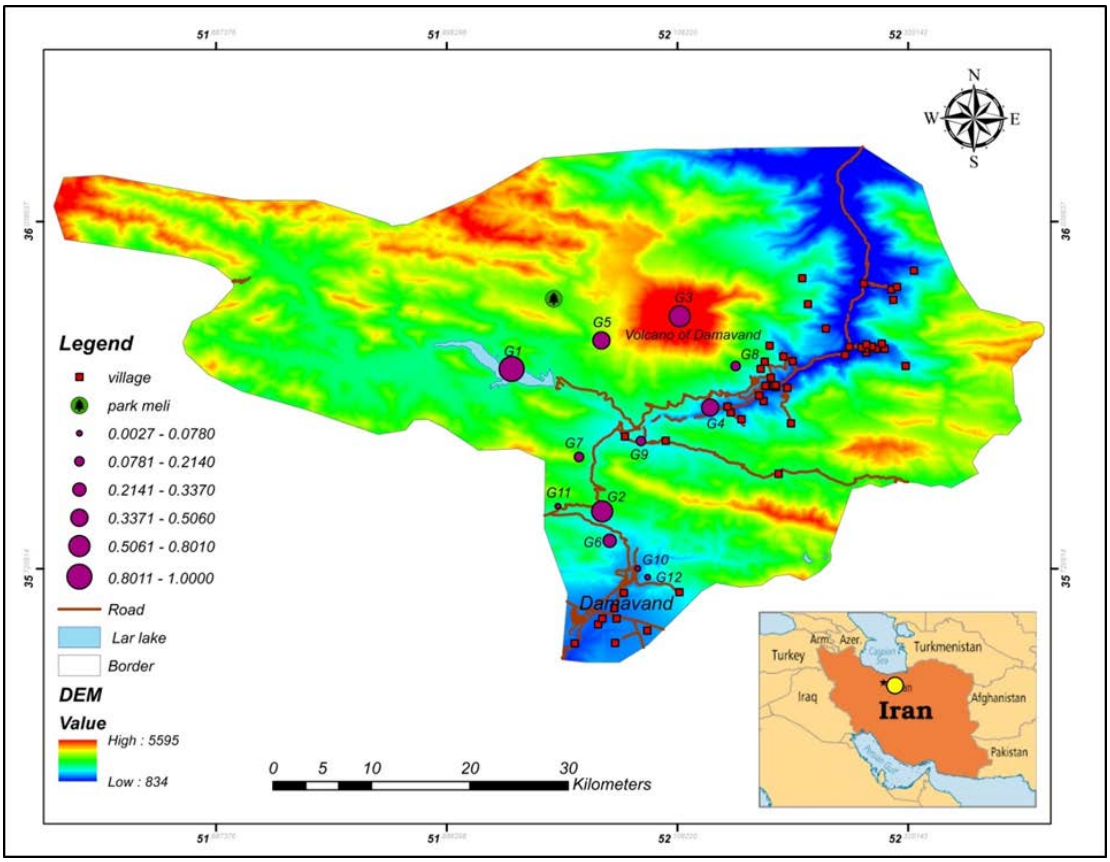

Figure 2. The map of geomorphosite according to the VIKOR Model

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