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Optimal infrastructure selection to boost regional sustainable economy

Abstract

It is widely recognized the role of infrastructures in boosting the economic growth of the regions. In many cases, an infrastructure is selected by subjective reasons. Selection of the optimal infrastructure for sustainable economic development of a region should be based on objective and founded reasons, not only economical, also environmental and social. In this paper is developed such selection through a hybrid method based on Delphi, AHP and VIKOR. To do this, a panel of experts assesses both the infrastructures and the drivers for their selection. The method lets us to verify the consistency of answers from experts. In our case, AHP obtains preference values for each infrastructure using the eigenvector method. Meanwhile, the VIKOR method evaluates whether the proposed is the one that best fits the prevailing view, minimizing the regret to the most separate opinions. Thus, for La Costera (Spain), the region under study, this research work concludes that the Thematic Route is the optimal infrastructure.

Keywords: infrastructure planning; sustainable economy; regional economic boost; Delphi method; Analytical Hierarchy Process; VIKOR technique.

1. Introduction.

In the Leader’s Declaration of the Seoul Summit 2010, one of the main G20's goals is to ‘boost and sustain global demand, foster job creation, contribute to rebalancing and increase our potential growth through investment in infrastructure’ (G20 2010).Two years later, in the Los Cabos Summit, all G20 members ask Finance Ministers and Central Bank Governors to consider ways in which the G20 can foster investment in infrastructure and ensure availability of sufficient funding for infrastructure projects (G20 2012). In 2013, the Leader’s Declaration of St. Petersburg Summit includes a consideration of the work underway by the World Bank and Regional Development Banks to mobilize and catalyze additional financing for infrastructure investment, particularly in emerging markets and developing countries (G20 2013). As Haider et al.

(2013) asserts, the most widespread opinion among policymakers and economists is that investment in infrastructure development serve both as a tool for job creation and as a stimulus form the economy as a whole.

Investing in infrastructure to develop a territory involves a selection procedure tailored to particular needs. Moreover, policymakers should cope with both the rational and the intuitive to select the best project. Castells and Solé-Ollé (2005) have analyzed the decision making of infrastructure's localization reaching the conclusion that governments invest more in infrastructure in the regions where the electoral productivity is higher, regardless of criteria such as equity or efficiency. While municipalities governed by a given political party (Solé-Ollé and Sorribas-Navarro 2008), receive more grants if the government belongs the same political party.

Making the optimal decision constitutes a highly complex synergistic problem. As Xiang (2011) exposed, the three pillars of sustainability are economy, environment and equity, and the balance between the three components highly depends on the social factor in selecting infrastructures (Hunt et al 2012; Hunt et al 2013; Mladenovic et al. 2014). In addition, Snieska and Simkunaite (2009) have shown that the evaluation model of economic effect of infrastructure must involve determinants tailored to regional peculiarities. Basically, these regional peculiarities are economic and business reality, landscape, geography, urban planning, social aspects, the development potential of the region, etc. And moreover, the decision should be as objective as possible, free from constraints alien to the investment efficiency and sustainability (Curiel-Esparza et al. 2004). This paper shows that the issue can be successfully addressed by applying a multi-criteria decision expert system to La Costera, Spanish region of Valencia. The proposed expert system for selecting a specific infrastructure for sustainable economic boost will consider not only the economic aspects but also criteria such as environmental impact, employment created, the effect on the sustainability of every municipality in the region and the additional social function or social impact. Moreover, it should be noted that, as pointed Curiel-Esparza and Canto-Perello (2012) people relates a location attractive with the quality of a determinate place.

Multicriteria decision methods have been applied to study the best location of an infrastructure or activity (Zolfani et al. 2013), sustainable energy planning (Tsoutsos et al. 2009) or to select the best strategy for business management (Zavadskas et al. 2011). Among them, Analytical Hierarchy Process (AHP) developed by Saaty (1980) has been used to study issues such as planning of urban infrastructure (Canto-Perello et al. 2013; Curiel-Esparza and Canto-Perello 2013), site selection solar farms (Uyan 2013), assessment of alternatives for preservation of historic buildings (Kutut et al. 2014), planning of sustainable energy systems (Pisani and Villacci 2011) and to study the land-use suitability evaluation (Cengiz and Cengiz 2009) or urban growth (Vaz et al. 2012). While VIKOR technique introduced by Opricovic (1979), has been applied for parameters selection problem in rotor spinning (Fallahpour and Moghassem 2012) or analysis satisfaction in mobile service (Kang and Park 2014). Moreover, the integrated methodology combining AHP and VIKOR has been used for location selection in renewable energy planning (Kaya and Kahraman 2010) or plant location selection (Tavakkoli-Moghaddam et al. 2011). Unlike previous research works, the aim of this paper is not selecting the optimal location for a given infrastructure, but selecting the optimal infrastructure to develop in a given region.

The method developed in this paper is a hybrid expert system combining Delphi, AHP and VIKOR techniques, in order to select the most desirable infrastructure according to drivers that present complex synergies. The Delphi method let us to collect the point of views from a panel of experts anonymously. Afterwards, there is a feedback process to reach consensus, and a series of judgments are obtained about the weight of the drivers and an assessment of facilities for each driver. The AHP will structure the experts' knowledge and let us to perform a consistency analysis. Finally, the VIKOR method finds a compromise solution and assesses its stability in our infrastructure selection.

2. AHP. Hierarchical structure for optimal infrastructure selection.

In AHP is used a graphical hierarchical structure to visualize the alternatives and criteria and relations between them and the goal, and facilitates comparisons. The lower level of the hierarchy consists of the infrastructure to be possible for the common good must be preselected between the proposals of both experts and citizens and representative groups. Saaty (1980) proposes brainstorming to identify the most important elements which shall form the hierarchical structure, to be submitted inhomogeneous groups composed of five to nine elements. Other researchers have shown the utility of increasing agreement among stakeholders and experts in the decision making process (Chow and Sadler 2010; Arciniegas and Janssen 2012).

The first step is to select a group of anonymous policy makers, government officials and urban planners (Chen et al. 1992; Chang et al. 2008; Taskin 2009). Afterwards, the experts complete a first survey requesting drivers and proposals for infrastructure that can serve as a regional sustainable economic boost. In our case, the first questionnaire has highlighted those related to cultural and leisure tourism. It is noteworthy that the tourism industry contributes to sustainability, as has been shown by Deng et al. (2011). Ibret et al. (2013) place emphasis on sustainability of development in relation to the existing tourism potential in a given region. Therefore, the following five alternatives have been obtained based on the characteristics they have as generators of economic development:

- **Cableway (CW):** Cable cars represent an environmentally friendly way of transportation allowing access to remote and environmentally sensitive areas, such as the Alpine (Brida et al. 2014). In addition, the scenery (territory, landscape) that passengers can see from a cable is itself an important resource in the field of tourism economy in many countries such as Slovenia (Tezak et al. 2011), and included in many plans of enhancement tourism, as in Turkey (Yürüdür and Dicle 2011)

- **Ethnological Museum (EM)**: Bryan et al. (2012) outline the important contribution of museums to economic development. Moreover, the effects and implications of cultural assets in general are increasingly present in the policies of socio-economic development of the territories (Fonseca and Rebelo 2010). Nowadays it is considered to be a valuable resource for the development of specific geographical areas (European Commission 2006).

- **Golf Resort (GR):** Neo (2001) outlines that golf courses are opposed to the ideal of urban sustainability. However, Tanner and Gange (2005) conclude that the diversity of indicator groups as bumblebees, birds and ground beetles can be improved in golf courses relative to neighbor farmland and pasture. Regardless its ecological impact, the positive aspects of golf tourism including job increase and local economy enhance have been key drivers for the panel of experts to consider this alternative in a first survey. Golf tourism has been a boost for the development of the regional economy in China (Shen and Kou 2013), New Zealand (Gazley 2010), Portugal (Pestana et al. 2010) or Cyprus (Boukas 2011).

- **Multipurpose Reservoir (MR):** As well as their public water supply function, reservoirs can also provide a valuable recreation resource and substantial economic benefits to the surrounding community (Nickolds 2004). Moreover, recreation-based jobs can typically be maintained for a long period of time (Douglas and Harpman 1995). A suitable management policy may result in the benefit of all interests related to the operation of a multipurpose reservoir (Efsdtratiadis and Hadjibiros 2011). An artificial lake is considered a highly desirable amenity for many resident owners (Larson and Perrings 2013) and Debnath et al. (2013) highlights the great economic importance of the recreational factor in the management models of a multipurpose reservoir.

- **Thematic Route (TR)**: This concept means a route that connects natural or cultural attractions, on the basis of a certain theme. Considering sustainability, thematic routes provide education and leisure at the same time. Nagy (2012) outlines the main aims of such routes: raising interest, education, development of cooperation, new markets, protection, packaging, decrease expenditures, development, fitting the trends. The benefits of thematic route creation (Csapó 2012) include the regional economic boost, enhance of the enterprises among local residents, improve of investments, the development of new infrastructure and the increase of tourism flow.

These five infrastructures are innovative alternatives for the region, so that the decision of their selection does not have contrasting experiences, but adds the attraction of novelty for the initial phase of economic boost.

For infrastructure selection, the following drivers have been chosen:

- **Amount of investment (AOI):** The amount of investment required for the implementation of infrastructure is an inexcusable criterion because all else equal, it is preferable that require less investment.

- **Grant or Financing terms (GFT):** By their nature of general interest, certain actions can be subsidized, funded specifically or be subsidized in their interest rate by different levels of government (national or supranational), and the possibility must be considered by experts.
- **Economic growth (ECG):** The results of expected economic growth and its cost effectiveness are evaluated by this criterion.
- **Environmental impact (ENI):** This controller evaluates the effects of an infrastructure on the landscape and environmental sustainability, both in its execution and exploitation.
- **Municipalities' sustainability (MUS):** Although economic boost is evaluated for the whole region, infrastructures positively affecting a larger number of municipalities in the area are preferred because they increase equity and regional sustainability.
- **Job & Social equity (JSE):** Direct and indirect employment generated by infrastructure's implementation must be considered a driver regardless of the direct economic results.
- **Social Impact (SOI):** Among social criteria, this controller measures the complementary use an infrastructure provides to society regardless of their economic stimulus features, such as a regional hospital or university.

These drivers to be applied in selecting the optimal infrastructure are common to all regions, and will be valued according to their importance in relation to the region under study, in our case, La Costera. Accordingly, the multilevel hierarchical structure is shown in Figure 1.

3. Assessment of drivers and infrastructures

The Delphi technique is well suited as a means and method for consensus-building by using a series of questionnaires or strategically designed surveys to collect reliable data from a panel of selected experts. Its implementation provides an efficient dynamic process.

The AHP method is very suitable for complex social issues in which intangible factors cannot be neglected (Curiel-Esparza and Canto-Perello 2013; Kutut et al. 2014), because this process allows the utilization of linguistic variables. The opinion of experts is transformed in numerical data by assigning a number to each judgment by means of the fundamental scale of the AHP for pairwise comparisons. This scale is shown as Table 1. For this purpose, a questionnaire is sent to the panel of experts to assess the degree of importance among drivers (see Table 2).

In the square matrix, the first element compares a driver himself, and the assigned value is 1 (the same goes for the entire main diagonal). In the following row's components, numeric value indicated in the questionnaire is placed if it belongs to the right half of Table 2; while if it belongs to the left half, its reciprocal value is placed. All questionnaire values are transferred to the corresponding matrix's row from the value 1 of the diagonal, and their reciprocals are placed in symmetrical positions ($a_{ij} = 1/a_{ji}$)

$$\begin{bmatrix} 1 & 1/2 & 1/5 & 1 & 3 & 1 & 1/3 \\ 2 & 1 & 1/3 & 1/3 & 1 & 1 & 1 \\ 5 & 3 & 1 & 1/3 & 2 & 5 & 3 \\ 1 & 3 & 3 & 1 & 3 & 9 & 5 \\ 1/3 & 1 & 1/2 & 1/3 & 1 & 3 & 2 \\ 1 & 1 & 1/5 & 1/9 & 1/3 & 1 & 1/2 \\ 3 & 1 & 1/3 & 1/5 & 1/2 & 2 & 1 \end{bmatrix} \tag{1}$$

The expert's preferences or judgments expressed in the questionnaires are individual opinions that must be synthesized into one that represents all reliably. To group this information there are several possible ways to aggregate, although the method of aggregation not influence directly in the result (Wu et al. 2008). The Aggregation of Individual Judgments (AIJ) for each set of pairwise comparisons is the method we will use in this paper, because individuals must relinquish their own preferences (values, objectives) for achieving the goal. For AIJ (Forman & Peniwati 1998; Dong et al. 2010), the geometric mean must be used

$$a_{ij} = \prod_{k=1}^{m} \left(a_{ij}^{(k)}\right)^{1/k} \qquad (2)$$

The aggregated values are shown in assessment drivers' square matrix (A), in which $a_{ji} = 1/a_{ij}$:

$$A = \begin{bmatrix} 1.000 & 1.039 & 0.489 & 0.962 & 2.961 & 0.212 & 1.039 \\ 0.962 & 1.000 & 0.324 & 1.000 & 1.000 & 0.333 & 0.962 \\ 2.046 & 3.086 & 1.000 & 1.994 & 4.898 & 0.349 & 2.998 \\ 1.039 & 1.000 & 0.501 & 1.000 & 2.885 & 0.324 & 1.852 \\ 0.330 & 1.000 & 0.204 & 0.347 & 1.000 & 0.113 & 0.520 \\ 4.717 & 3.003 & 2.865 & 3.086 & 8.883 & 1.000 & 4.970 \\ 0.962 & 1.039 & 0.334 & 0.540 & 1.924 & 0.201 & 1.000 \end{bmatrix} \qquad (3)$$

AHP allows assessing the consistency of the opinions of experts, so that a maximum tolerable value of human inconsistency is ensured. The consistency index, CI, is given by the formula:

$$CI = \frac{\lambda_{max} - n}{n-1} \qquad (4)$$

Where λ_{max} is the maximum eigenvalue and n is the order of the matrix or number of drivers. This values is compared with the random consistency index RCI by Saaty (2012) to get CR, Consistency Ratio:

$$CR = \frac{CI}{RCI} \qquad (5)$$

There is consistency in the experts' opinions if CR is smaller than a given value depending of n. In our case (n=7), the maximum CR = 0.100.

$$\mathrm{CR} = 0.023 \ < 0.100 \qquad (6)$$

That is to say, the assessment of experts' panel is consistent.

The priority of each driver is obtained using the eigenvector method. Hence, the resulting priority vector (see Figure 2) is:

$$\boldsymbol{\omega} = [0.0949 \quad 0.0833 \quad 0.2030 \quad 0.1100 \quad 0.0450 \quad 0.3878 \quad 0.0760] \qquad (7)$$

which is shown graphically in Figure 3.

The experts have evaluated the relative importance of infrastructures for each driver, as shown as an example in Table 3 for AOI driver. Repeating the procedure for all the drivers, we have seven questionnaires by expert in this round. Similarly to the calculation of the weight of the drivers, with the aggregates judgments of questionnaires we form the comparing infrastructures tables for each driver and the corresponding matrices; and with a similar mathematical treatment, we get the priorities and consistency indexes. E.g., for the first criterion (AOI) weighting preferences of the alternatives is shown at matrix (A)

$$\mathbf{A} = \begin{bmatrix} 1.000 & 0.941 & 0.905 & 8.091 & 1.063 \\ 1.063 & 1.000 & 0.962 & 8.817 & 1.039 \\ 1.105 & 1.080 & 1.000 & 7.105 & 2.933 \\ 0.124 & 0.113 & 0.141 & 1.000 & 0.144 \\ 0.941 & 0.962 & 0.341 & 6.940 & 1.000 \end{bmatrix} \qquad (8)$$

whose mathematical treatment give us the rate of consistency value of 2.8% < 10%, and the eigenvector or ranking of the alternatives with respect to criterion AOI is show in Table 4.

Similarly for the set of drivers, we obtain the matrix (DA) of priorities of the infrastructures:

$$\boldsymbol{DA} = \begin{bmatrix} 0.2312 & 0.1759 & 0.0637 & 0.0864 & 0.0974 & 0.1192 & 0.0508 \\ 0.2416 & 0.0374 & 0.0716 & 0.0876 & 0.3445 & 0.0423 & 0.4367 \\ 0.3103 & 0.1836 & 0.1527 & 0.1916 & 0.1291 & 0.1068 & 0.0478 \\ 0.0307 & 0.4781 & 0.6024 & 0.0392 & 0.0334 & 0.1600 & 0.1287 \\ 0.1862 & 0.1251 & 0.1097 & 0.5952 & 0.3956 & 0.5716 & 0.3359 \end{bmatrix} \tag{9}$$

which, when multiplied by the weight vector of criteria (7) gives us the alternatives or global priority vector (see Table 5, lower row) where the chosen alternative Thematic Route (TR) has been highlighted. This results are shown in Figure 4.

4. Analyzing consensus and stability condition with VIKOR method.

The VIKOR method is efficient to rank the infrastructures (Tavakkoli-Moghaddam and Mousave 2011), and in our research work, their results complement and contrast the AHP analysis. Used in multiple criteria decision analysis, its purpose is to solve decision problems with conflicting and noncommensurable factors, with three assumptions: that for the conflict resolution is acceptable compromise, which, through mutual concessions provides maximum utility of the majority group, and minimum individual regret (Liou et al. 2011); that the decision maker prefers the closest to the ideal facility; and that the infrastructures are evaluated according to all drivers.

The VIKOR starts from a metric function or distance function based on the infrastructure’s evaluation for each driver (driver functions, f_{ij}) and the weights of each driver; the compromise facility is determined between the set of feasible infrastructures evaluated according to set drivers (Opricovic and Tzeng 2007). The VIKOR procedure has the following steps:

- Let us consider the Table of drivers functions f_{ij}, for the i driver (n drivers) and the j alternative (J alternatives), which corresponding to the drivers function matrix, transpose of the corresponding matrix in AHP. We select the best f_i (*) and worst f_i (∇) values of all drivers functions; i = 1,2, ... n; j = 1,2,… J (see Table 6).

- The values S_j and R_j, j =1,2, ..., J, are calculated by the relations:

$$S_j = \sum_{i=1}^{n} w_i \frac{f_i^* - f_{ij}}{f_i^* - f_i^\nabla} \tag{10}$$

$$R_j = \max_i w_i \frac{f_i^* - x_{ij}}{f_i^* - f_i^\nabla} \tag{11}$$

where w_i are the weights of the criteria. Values

$$S^* = \min_j S_j \tag{12}$$

$$S^* = \min_j S_j \tag{13}$$

$$R^* = \min_j R_j \tag{14}$$

$$R^\nabla = \max_j R_j \tag{15}$$

are obtained to calculating values Q_j, (j =1,2, ..., J), according the relationship

$$Q_j = \nu \frac{S_j - S^*}{S^{\nabla-} - S^*} + (1 - \nu)\frac{R_j - R^*}{R^\nabla - R^*} \tag{16}$$

Where it is introduced $\boldsymbol{\nu}$ as a weight for the strategy of maximum group utility, while (1-$\boldsymbol{\nu}$) is the weight of the individual regret. This strategy is by consensus for $\boldsymbol{\nu}$ = 0.5, with results showed in Table 7. Infrastructures are ranked and sorted by the S, R and Q values from the minimum value. The results are shown in the three ranked lists of Table 8.

- The best classified infrastructure by the Q value, named Q(1), is the compromise solution (minimum) if two conditions a and b are accomplished:
    a. Condition of Advantage Acceptable: The difference in values of the two best infrastructures Q(1) and Q(2) classified according to Q, Thematic Route and Ethnological Museum, must satisfy

$$\mathrm{Q(2)} - \mathrm{Q(1)} \geq \mathrm{DQ} \tag{17}$$

where

$$\mathrm{DQ} = 1 / (\mathrm{J} - 1) \tag{18}$$

In our case,

$$\mathrm{DQ} = 0.250 \tag{19}$$

$$\mathrm{Q(EM)} - \mathrm{Q(TR)} = 0.574 \tag{20}$$

and the condition is achieved.

    b. Condition of Acceptable stability in decision: The best rated infrastructure by Q must also be the best rated by S and/or R. In our case, this condition is also accomplished. Therefore, the compromise infrastructure, Thematic Route, is stable in the decision process.

The VIKOR results are shown graphically in Figure 5 (Q values) and Figure 6 (Preferences).

5. Conclusions.

A widely proven recommendation for the economic boost of a given region is the allocation of the appropriate infrastructure considering their local singularity and potential development. Faced with the choice of an infrastructure based on intangible criteria, this paper shows how to apply a decision method based on the multicriteria comparison of the judgments of a panel of experts. The method proposed in this paper for optimal infrastructure selection to regional economic boost is an expert system based on the Delphi, AHP and VIKOR techniques. Boosting the economy cannot be dissociated from sustainability, and therefore the evaluation drivers have taken into account not only economic factors but also those related to the environment and social equity.

Drivers most valued by experts have been JSE (38.78%) and ECG (20.30%), which are factors of economic growth and social equity. The remaining 40.92% is distributed among the other five criteria, with a value from 4.50% to 11.00%. In evaluating infrastructures, AHP highlighted with 38.09% the selected infrastructure (Thematic Route) and the other four alternatives are staggered between 11.35% and 24.26%. Also the VIKOR analysis, under consensus hypothesis, highlighted as best choice the Thematic Route, with a significant acceptable advantage over the infrastructure valued secondly. These results highlight the usefulness of Delphi-AHP-VIKOR hybrid method as a tool for decision making in selecting the most appropriate infrastructure to boost economic and sustainable development in a given region, such as La Costera (Spain). Moreover, selecting the best type of sustainable infrastructure allows ruling out erroneous proposals and focusing efforts on defining their specific characteristics and the best location, which contributes to the efficient management of time and resources.

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Figure 1. Hierarchical structure to determine optimal infrastructure to boost regional sustainable economy

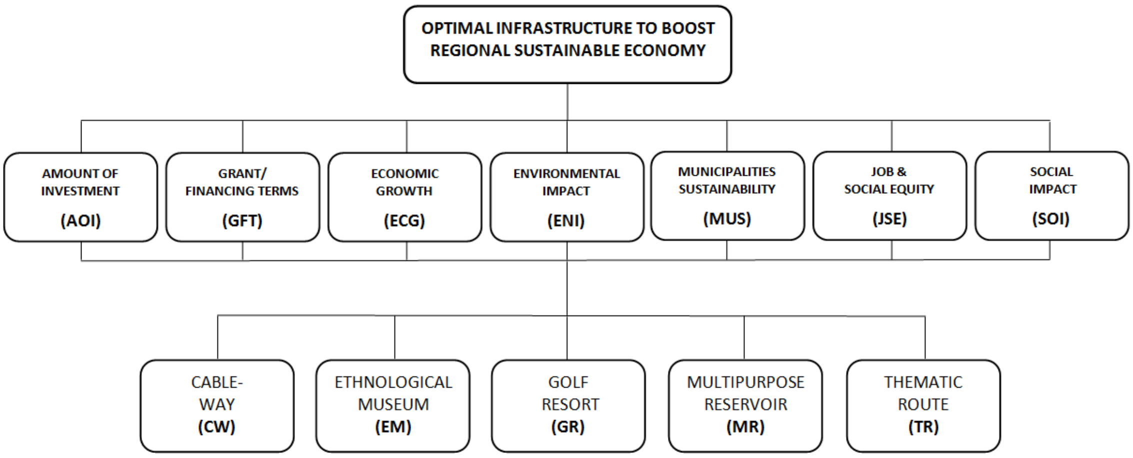

Figure 2. Contribution of each driver to the optimal infrastructure selection

(Consistency Ratio = 2.1 %)

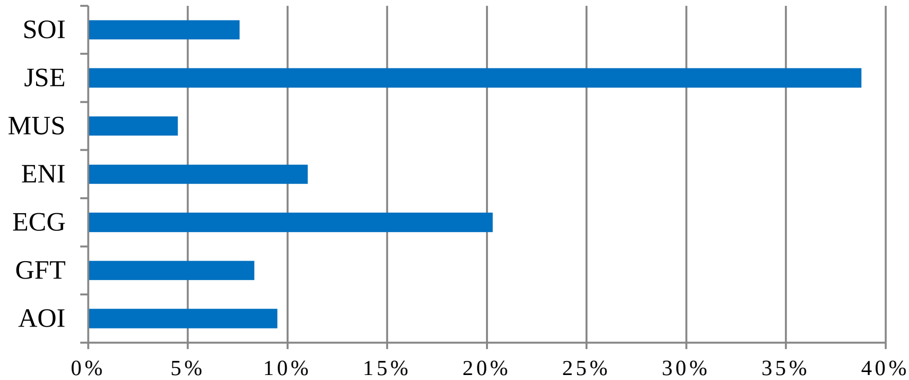

Figure 3. Priority results for the infrastructure according to the drivers (all consistency ratios are less than 3.8 %)

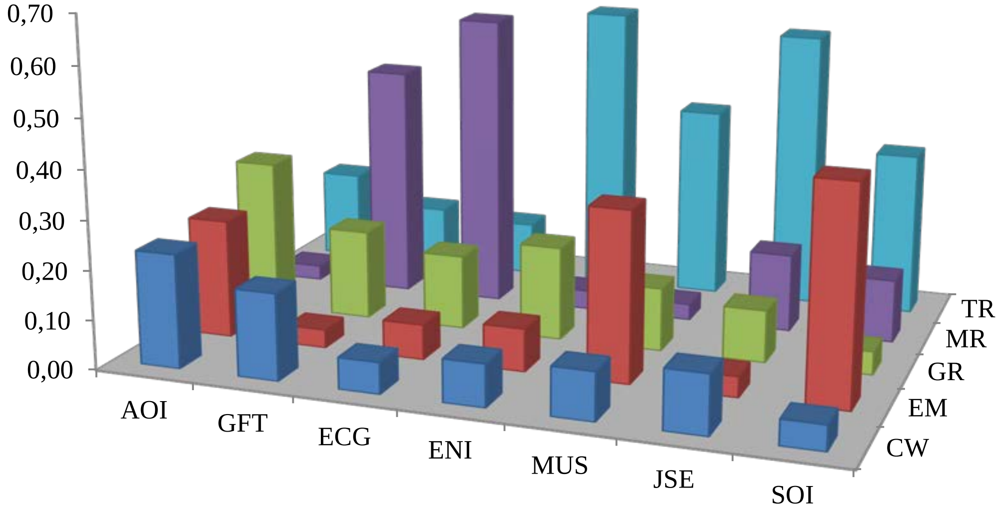

Figure 4. Final priority results for selecting infrastructure in AHP

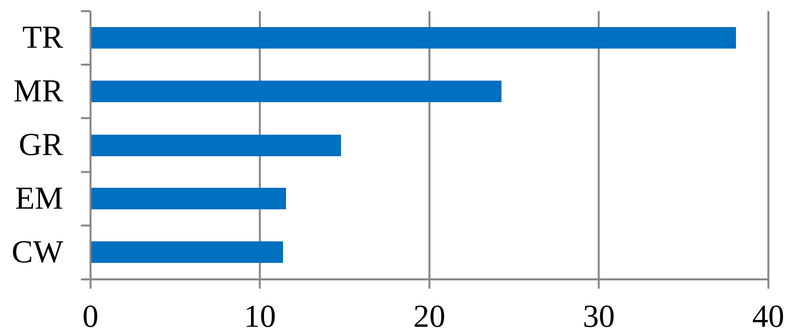

Figure 5. Relative preferences for selecting infrastructure in VIKOR

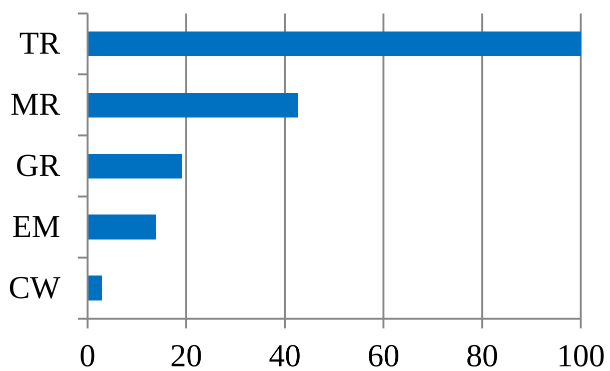

Table 1. Saaty's fundamental scale for pairwise comparisons

Degree of Importance	**Definition**	**Explanation**
1	Equal importance	Two options contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one option over another
5	Strong importance	Experience and judgment strongly favor one option over another
7	Very strong or demonstrated	An option is favored very strongly over another. Its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one option over another (the highest possible order of affirmation).
Intermediate values can be used in the case that it is deemed necessary		

Table 2. Questionnaire for drivers assessment

If this driver is the most important of two in the row, indicate the degree of importance:																		If this driver is the most important of two in the row, indicate the degree of importance:
Among of Investm. (AOI)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Grants/Financ. Terms(GFT)**
Among of Investm. (AOI)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Economic Growth (ECG)**
Among of Investm. (AOI)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Environmental Impact (ENI)**
Among of Investm. (AOI)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Munic. Sustainability (MUS)**
Among of Investm. (AOI)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Job & Social Equity (JSE)**
Among of Investm. (AOI)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Social Impact (SOI)**
Grants/Financ. Terms (GFT)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Economic Growth (ECG)**
Grants/Financ. Terms (GFT)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Environmental Impact (ENI)**
Grants/Financ. Terms (GFT)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Munic. Sustainability (MUS)**
Grants/Financ. Terms (GFT)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Job & Social Equity (JSE)**
Grants/Financ. Terms (GFT)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Social Impact (SOI)**
Economic Growth (ECG)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Environmental Impact (ENI)**
Economic Growth (ECG)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Munic. Sustainability (MUS)**
Economic Growth (ECG)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Job & Social Equity (JSE)**
Economic Growth (ECG)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Social Impact (SOI)**
Environmental Impact (ENI)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Munic. Sustainability (MUS)**
Environmental Impact (ENI)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Job & Social Equity (JSE)**
Environmental Impact (ENI)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Social Impact (SOI)**
Munic. Sustainability (MUS)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Job & Social Equity (JSE)**
Munic. Sustainability (MUS)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Social Impact (SOI)**
Job & Social Equity (JSE)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Social Impact (SOI)**

Table 3. Assessment alternatives questionnaire for AOI driver

With respect driver **Amount of investment (AOI)** required for the implementation of infrastructure

If this infrastructure is the preferred of two in row, indicate the degree of preference:																		If this infrastructure is the preferred of two in row, indicate the degree of preference:
Cableway (CW)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Ethnological Museum (EM)**
Cableway (CW)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Golf Resort (GR)**
Cableway (CW)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Multipurpose Reservoir (MR)**
Cableway (CW))	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Thematic Route (TR)**
Ethnological Museum (EM)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Golf Resort (GR)**
Ethnological Museum (EM)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Multipurpose Reservoir (MR)**
Ethnological Museum (EM)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Thematic Route (TR)**
Golf Resort (GR)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Multipurpose Reservoir(MR)**
Golf Resort (GR)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Thematic Route (TR)**
Multipurpose Reservoir(MR)	**9**	8	**7**	6	**5**	4	**3**	2	**1**	2	**3**	4	**5**	6	**7**	8	**9**	**Thematic Route (TR)**

Table 4. Priority of infrastructures with respect to AOI driver

Infrastructure	CW	EM	GR	MR	TR
Priority	0.2312	0.2416	0.3103	0.0307	0.1862

Table 5. Final priority results for each proposed infrastructure

Infrastructure	CW	EM	GR	MR	**TR**
Global Priority	0.1135	0.1153	0.1477	0.2426	**0.3809**

Table 6. Criterion function. Best and worst values f_i

	CW	**EM**	**GR**	**MR**	**TR**	**f^***	**f^{∇}**
AOI	0,2312	0,2416	0,3103	0,0307	0,1862	0,3103	0,0307
GFT	0,1759	0,0374	0,1836	0,4781	0,1251	0,4781	0,0374
ECG	0,0637	0,0716	0,1527	0,6024	0,1097	0,6024	0,0637
ENI	0,0864	0,0876	0,1916	0,0392	0,5952	0,5952	0,0392
MUS	0,0974	0,3445	0,1291	0,0334	0,3956	0,3956	0,0334
JSE	0,1192	0,0423	0,1068	0,1600	0,5716	0,5716	0,0423
SOI	0,0508	0,4367	0,0478	0,1287	0,3359	0,4367	0,0478

Table 7. S, R, Q values for the infrastructure selection

	f^*	**f^{∇}**	**Wc**	**CW**	**EM**	**GR**	**MR**	**TR**
AOI	0,3103	0,0307	0,0948	0,0268	0,0233	0,0000	0,0949	0,0421
GFT	0,4781	0,0374	0,0833	0,0571	0,0833	0,0556	0,0000	0,0667
ECG	0,6024	0,0637	0,2029	0,2030	0,2000	0,1695	0,0000	0,1857
ENI	0,5952	0,0392	0,3879	0,1007	0,1005	0,0799	0,1100	0,0000
MUS	0,3956	0,0334	0,1100	0,0371	0,0064	0,0331	0,0450	0,0000
JSE	0,5716	0,0423	0,0450	0,3315	0,3878	0,3406	0,3016	0,0000
SOI	0,4367	0,0478	0,0760	0,0754	0,0000	0,0760	0,0602	0,0197
			S_j	0,8316	0,8012	0,7547	0,6117	0,3141
			R_j	0,3315	0,3878	0,3406	0,3016	0,1857
			Q_j	0,8607	0,9707	0,8088	0,5744	0,0000

S^* =	0,3141	S^{∇}=	0,8316
R^* =	0,1857	R^{∇}=	0,3878

Table 8. Ranking of infrastructures according to R, S, Q

Position	1	2	3	4	5
According to S	**TR**	MR	GR	EM	CW
According to R	**TR**	MR	CW	GR	EM
According to Q	**TR**	MR	GR	CW	EM