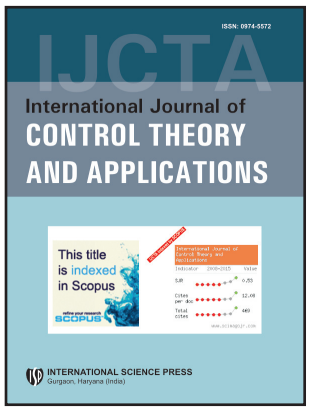

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An Integrated AHP-VIKOR Approach for Market Selection Process

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Abstract: Market selection is an important process for prospective companies due to its influence on firm performance and market penetration. Yet, as in different fields, since there are different factors to be considered in the business creation process, selecting a suitable Multi-criteria Decision Making (MCDM) framework has become a crucial step for early-stage entrepreneurs and experts. Therefore, this paper presents the application of AHP-VIKOR technique to support market selection process. First, the decision hierarchy was designed based on experts' considerations and pertinent scientific literature. Then, AHP (Analytic Hierarchy Process) was applied to calculate the criteria weights. Finally, VIKOR ranked the alternatives and the most suitable market was selected. To do these, a case study of a prospective electronic company is presented to validate the proposed approach.

Keyword: AHP, VIKOR, Market Selection, Entrepreneurship.

1. INTRODUCTION

In the business creation process, considerable attention has been given to the market selection decision [1]-[3]. In this respect, selecting the right markets to enter is considered to be one of the most relevant strategic decisions for prospective companies [4]. Particularly, an inappropriate market selection may result in low sales, difficulties in the market penetration process and subsequently, unsatisfactory returns on investment [5]-[7]. In addition, other decisions (e.g. market mix, procurement and distribution channels) are strongly affected [11] Therefore, it is necessary to find a method choosing the most suitable market alternative for any prospective firm.

Some authors have worked on designing different methodologies for market selection, considering several factors or criteria that may affect the market performance and potential sales volume. In [8], a case-based reasoning (CBR-INT) supporting tool was presented to support market selection decisions based on the experience of competitors in international markets. This model predicted the potential profitability of international projects with a precision of approximately 90%. On the other hand, in [9] a model was proposed for international market selection. This framework indicated how a particular firm may choose prospective international markets by quantifying nontrade barriers. Additionally, the model considered three level of analysis in order to prioritize markets: penetration of the company's product line, use of company's web-site and internationalization of main buyers. The results evidenced that France was the best market alternative for the prospective firm under study.

Another approach was developed in [10], a model with four consecutive filters was proposed. In this regard, the model considered relevant information on markets (e.g. country risk indicators, macroeconomic data, and imports per product group) and provided a list of categorized opportunities for a prospective South African firm. Additionally, in [13], the Data Envelopment Analysis was used to select international markets. Particularly, the model simultaneously considered dual-role factors, weight restrictions, and imprecise data. Another proposed framework was the Fuzzy Attractiveness of Market Entry (FAME) which was applied to address the decision-making problem of product introduction into alternative markets [14].

In literature, very few MCDM-related approaches were found to solve the market selection problem. The search string used in the literature survey was "*market selection*" AND "*Multi-criteria Decision-making*" The string was defined considering the standards of Scopus database. In this regard, a hybrid MCDM method including AHP and TOPSIS was developed to elicit a suitable target market. More precisely, AHP was used to calculate the criteria contributions and TOPSIS was applied to rank the market target alternatives from the best to the worst ones [11]. On the other hand, in [12], an AHP-SWOT analysis was performed to evaluate the market attractiveness of 44 sub-Saharan countries while prioritizing on social cultural issues. The model considered social/cultural/dynamism factors that are not usually taken into account by entrepreneurs in market selection analysis. In light of these, the conducted literature review practice showed that studies concentrating on market selection with the use of MCDM methods are largely limited. Furthermore, there are no applications combined with VIKOR method. Therefore, we implemented an AHP-VIKOR hybrid approach for the market selection problem.

The remainder of this paper is organized as follows: In Section II, AHP and VIKOR methods are presented. In Section III, a case study of a prospective electronic company is described. Finally, Section IV presents conclusions.

2. AHP (ANALYTIC HIERARCHY PROCESS) AND VIKOR METHODS

AHP is a theory of measurement consisting of calculating dominance priorities from pairwise comparisons of several elements with respect to common criteria [15]. It is a comprehensive focus designed to cope with the rational and irrational when decision-makers face multi-objective, multicriteria and multi-factor decisions with a number of decision alternatives [16]. Since its origins, AHP has been widely used. In banking sector [17]-[18], industry [19]-[20], evaluation of human resources [21], evaluation of software performance [22]-[23], strategic planning [24]-[25], supplier selection [26]-[27], competence evaluation [28], organizational performance evaluation [29], HR recruitment [30], technology evaluation [31], project selection [32], energy selection [33]; and other applications. AHP provides decision makers a better framework on specific criteria and subcriteria when determining weights [34]. Its structure is comprised of three levels [35]: goal, criteria, and sub-criteria.

On the other hand, VIKOR is an MCDM method focusing on ranking and selecting from a set of alternatives in the presence of conflicting factors [36]. This technique is based on the closeness to the ideal solution. In this respect, each alternative is assessed by considering each factor function and then, the compromised ranking is performed by measuring the closeness to the ideal alternative [37]. Being aware of its importance, VIKOR method has been applied also in different fields: In project selection [38], supplier selection [39], quality improvement [40], material selection [41], risk evaluation [42]; and other applications.

To implement AHP-VIKOR, it is necessary to follow these steps:

Step 1: Design the decision model structure

The problem has to be clearly established and decomposed into a rational system. This structure is obtained by decision makers through research, pertinent scientific literature, and brainstorming.

Step 2: Obtain the criteria weights

The team of experts is asked to make the comparisons according to Saaty´s scale [15] where two criteria are compared in terms of importance (refer to Table 1). Let A represent an n x n comparison matrix as stated in Eq. 1. The values on the diagonal have equal relevance (1) due to the self-comparison. Then, normalize matrix A and obtain factor weights by applying Eq. 2. W_i is the importance degree for the ith factor.

Table 1
Saaty´s scale for AHP

Intensity of importance	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Definition	Equal	Weak	Moderate	Moderate plus	Strong	Strong plus	Very strong	Very, very strong	Extreme

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & 1 \end{bmatrix} \tag{1}$$

$$W_i = \frac{\left(\prod_{j=1}^{n} a_{ij}\right)^{1/n}}{\sum_{i=1}^{n}\left(\prod_{j=1}^{n} a_{ij}\right)^{1/n}}, \quad i, j = 1, 2, \dots, n \tag{2}$$

Step 3: Calculate the consistency ratios

To ensure that criteria weights derived from the pairwise comparison matrix A are acceptable, the consistency indexes must be calculated via applying Eq. 3-4. Here, $\lambda_{máx}$ is the maximum eigenvalue and n represents the matrix size. Besides, CV represents the consistency values for factors and is defined as CV = $[cv_i]_{1xn}$ where $cv_i = c_i/w_i (i = 1, 2, \dots, n)$. On the other hand, matrix C denotes an n-dimensional column vector representing the total of the weighted values for the importance intensity of criteria (refer to Eq. 5). Then, CR (Consistency ratio) is computed via using Eq. 6 where RI denotes the random consistency index. If CR is equal/below 10%, the decision matrix is concluded to be consistent.

$$\lambda_{max} = \frac{\sum_{i=1}^{n} cv_i}{n} \tag{3}$$

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{4}$$

$$C = [c_i]_{nx1}, \quad i = 1, 2, \dots, n \tag{5}$$

$$CR = \frac{CI}{RI} \tag{6}$$

Step 4: Rank the market alternatives by using VIKOR

To conduct VIKOR, identify the ideal f_i^* and the anti-ideal f_i^- values of all factor functions ($i = 1, 2, \ldots, n$). If the *ith* function represents a benefit, apply Eq. 7; otherwise, use Eq. 8.

$$f_i^* = \max_i f_{ij}, \quad f_i^- = \min_i f_{ij} \tag{7}$$

$$f_i^* = \min_i f_{ij}, \quad f_i^- = \max_i f_{ij} \tag{8}$$

Then, calculate S_j and R_j ($j = 1, 2, \ldots, J$) values via using Eq. 9 and Eq. 10 respectively. The W_i values are provided by the AHP method.

$$S_j = \sum_{i=1}^{n} w_i \frac{(f_i^* - f_{ij})}{(f_i^* - f_i^-)} \tag{9}$$

$$R_j = \max_i \left[w_i \frac{(f_i^* - f_{ij})}{(f_i^* - f_i^-)} \right] \tag{10}$$

After this, calculate Q_j by applying Eq. 11-13. Here, v is a parameter that is introduced due to the maximum group utility. A value of 0.5 is usually recommended for this variable [43].

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

$$S^* = \min_i S_j, \quad S^- = \max_i S_j \tag{2}$$

$$R^* = \min_i R_j, \quad R^- = \max_i R_j \tag{3}$$

The next step involves ranking the market alternatives based on S, R and Q values. Finally, select the suitable markets for the prospective firm according to [38]-[43]

3. CASE STUDY

In this section, a case study is presented to validate the proposed approach and enable decision makers, involved in entrepreneurship and business creation processes, to select the best market alternative for a prospective company. This research was implemented in a Colombian entrepreneurship department. This department provides consulting services on business creation and innovation to early-stage entrepreneurs. In this case, a potential electronic company with a new wireless device was considered.

Initially, five market alternatives (*Banks (B)*, *Schools (S)*, *Healthcare providers (HP)*, *Movie theatres (MT)* and *Internet Cafes (IC)*) and five criteria (*Market size (C1), Aesthetic need (C2), Wiring Amount (C3), Potential frequency of use (C4) and Purchasing power (C5)*) were identified based on pertinent scientific literature and the personal experience of a *decision-making team*. With this information, a decision hierarchy was design to select the most suitable market for the company under study (refer to Figure 1). The experts' team was comprised of four professional with wide expertise in entrepreneurship, electronic engineering, and innovation.

Then, the decision makers were asked to make the pairwise comparisons according to the Saaty's scale (refer to Table 2). After this, the normalized matrix was calculated by using Eq. 2 (refer to Table 3). Finally, the criterion weights were computed via applying Eq. 2 (refer to Table 4). On the other hand, the consistency ratio was equal to 0.1; therefore, the decision matrix is consistent and the factor contributions can be considered as acceptable.

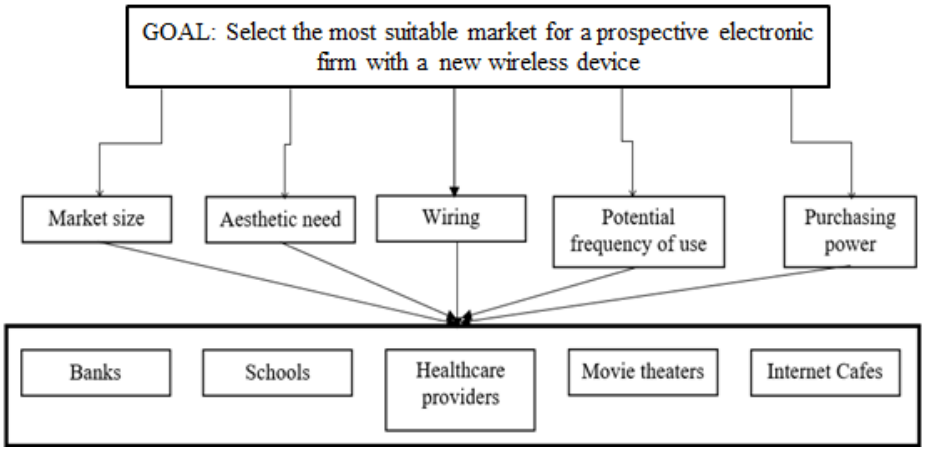

Figure 1: Multi-criteria decision model to select the most suitable market for a prospective electronic company with a new wireless device

Table 2
Pairwise comparison matrix for AHP

Criterion	*Wiring Amount*	*Aesthetic Need*	*Market size*	*Potential frequency of use*	*Purchasing power*
Wiring Amount	1,00	2,67	0,27	1,08	0,16
Aesthetic Need	1,60	1,00	0,13	0,63	0,13
Market size	4,00	7,50	1,00	6,00	0,22
Potential frequency of use	3,25	2,50	0,17	1,00	0,16
Purchasing power	7,00	8,00	6,00	7,00	1,00
Sum	16,85	21,67	7,57	15,71	1,66

Table 3
Normalized decision matrix for AHP

Criterion	*Wiring Amount*	*Aesthetic Need*	*Market size*	*Potential frequency of use*	*Purchasing power*
Wiring Amount	0,06	0,12	0,04	0,07	0,09
Aesthetic Need	0,09	0,05	0,02	0,04	0,08
Market size	0,24	0,35	0,13	0,38	0,13
Potential frequency of use	0,19	0,12	0,02	0,06	0,09
Purchasing power	0,42	0,37	0,79	0,45	0,60

Table 4
Final criterion weights derived from AHP method

Criterion	*Wiring Amount*	*Aesthetic Need*	*Market size*	*Potential frequency of use*	*Purchasing power*	*Weight*
Wiring Amount	0,06	0,12	0,04	0,07	0,09	0,08
Aesthetic Need	0,09	0,05	0,02	0,04	0,08	0,06
Market size	0,24	0,35	0,13	0,38	0,13	0,25
Potential frequency of use	0,19	0,12	0,02	0,06	0,09	0,10
Purchasing power	0,42	0,37	0,79	0,45	0,60	0,53

Considering the results from Table 4, the most important criterion is *Purchasing Power* with 53% and the second is *Market Size* with 25%. This demonstrates that the financial measures continue to be more relevant than operational indexes as stated in previous studies [8]-[10] and [44]-[46]. In addition, there is a significant gap (43%) between *Purchasing Power* and the operational factor with the highest score (*Potential frequency of use* – 10%). Therefore, market alternatives with high financial and market performance will be strongly considered to be selected as suitable for the prospective electronic company under study. To validate this, VIKOR method was implemented. First, a key performance index (KPI) was established for each factor. In this respect, *Purchasing power* factor was measured with the *average liquidity (COP)*. On the other hand, the *Potential frequency of use* was evaluated with *device usage (Daily (6), weekly (5), monthly (4), trimonthly (3), per semester (2) and annually (1))*. The *Market size* criterion was assessed with the *number of companies in the sector*. Another established KPI was *average wire length (measured in meters)* and it was defined to measure *wiring amount* criterion. Regarding *aesthetic need*, a binary variable was defined (assign "1" if the companies from a particular sector need to reduce the number of hard-wired connections to improve their aesthetic appearance; otherwise, 0).

After defining the indicators, an initial matrix is computed (refer to Table V). Here, W_i values were provided by AHP method. Then, S_j, R_j and Q_j values were calculated and the market alternatives were ranked (refer to Table 6). Based on these outcomes, *Banks* ($Q_1 = 0.041$) and *Healthcare providers* ($Q_3 = 0.064$) are the best market alternatives for the prospective electronic firm. *Healthcare providers* were also accepted to be part of the set of suitable markets due to $Q_3 - Q_1 < 0.25$. When analysing these results deeper, it can be noted that *Banks* and *Healthcare providers* showed the best financial performance (refer to C5) which is coherent with the AHP conclusions.

Table 5
Initial VIKOR matrix

Market/Criterion	*C1*	*C2*	*C3*	*C4*	*C5*
B	78	1	126	6	$1.729.451.386,00
S	531	1	85	5	$430.000.000,00
HP	34	1	3456	5	$1.905.469.502,00
MT	9	1	57	5	$456.000.000,00
IC	256	1	37	4	$23.000.500,00
W_i	25,0%	6,0%	9,0%	10,0%	53,0%
f_i^*	256	1	3456	6	$1.905.469.502,00
f_i^-	9	1	37	4	$23.000.500,00

Table 6
Market ranking according to AHP-VIKOR technique

Markets	S_j	*Rank*	R_j	*Rank*	$Q_j(v = 0,5)$	*Rank*
B	0,317	3	0,180	1	0,041	1
S	0,276	2	0,415	4	0,337	2
HP	0,275	1	0,225	2	0,064	3
MT	0,798	5	0,408	3	0,826	4
IC	0,72	4	0,53	5	0,926	5

4. CONCLUSION

The market selection is a key process to reduce the failure risk when entering into new markets. However, in literature, very few models can help to address this arduous task. To cover this gap, the present research

proposed an AHP-VIKOR method to select the most suitable markets for prospective companies. This approach can be extended and replicated with a high level of effectiveness in entrepreneurship and innovation processes. To do this, it will be necessary to design decision hierarchies containing the pertinent criteria and sub-criteria to adequately select the right market for any prospective firm. This specific issue is even more relevant when potential companies face with a large set of market alternatives. Regarding the scenario under study, the results demonstrated that *Banks* and *Healthcare providers* are the most suitable markets for a prospective electronic company with a new wireless device. On the other hand, it was proved that financial measures continue to be considered as the most relevant when making this decision.

In future research, it is recommended to add more criteria and sub-criteria to the hierarchy. Additionally, it is proposed to use new hybrid methods considering interdependencies between factors to compare the results provided by AHP-VIKOR technique.

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