AHP method for the decision-making in the choice of the investment projects

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Abstract:

The decision-making in investment project, is based, generally, on the use of the quantitative techniques (**VANA, TRI, TRE, FCF ,ECF, PER, BETA**) ([12],[13]).

We are enriching the decision-making by a qualitative approach which integrates all the criteria whatever their important level. However, we are identifying a priority factor for positioning each parameter by its degree of importance in the investment project.

Among the analysis and project evaluation methods, we opted for the AHP (Analytic Hierarchy Process) analysis method because it allows one to help in the simulation of qualitative criteria and contributes to the decision process.

Keywords: Investment project, Analytic Hierarchy Process, decision-making.

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I. Introduction

Due to globalization, opening of borders and technological developments, the contemporary business must face a significant increase in competition and a significant change in to customer behavior. All these changes have produced concerns, complications and sometimes crisis in business. These are forced to change their ways and their decision-making, innovating, being more responsive and integrated tools and smart solutions to maintain their competitive position and work for their development.

In this paper we have introduced a new approach to improve the selection of the investment project using the Analytic Hierarchy Process (AHP) [10] method. This method is a multilevel modeling
([14]) that take into account the qualitative criteria and formalize their hierarchical relationships to help decision-makers in the study of complex systems. This method can provide an intensive criteria judgment which can be used for the development of the projects studied.

In the first part, an evaluation of the investment project process is presented, and then a description of our approach is introduced in the second part, finally the results are discussed.

II. The process of evaluating an investment project

Some studies have shown that the accumulation of knowledge in the field of venture capital investment ([2], [3], [9]) is badly exploited. Indeed, we see that the players of this activity

are always based on the same practices to assess a project while successes are thin and mortality is high.

In what follows, we recall the process traditionally observed in the selection of the investment project (Figure n°1).

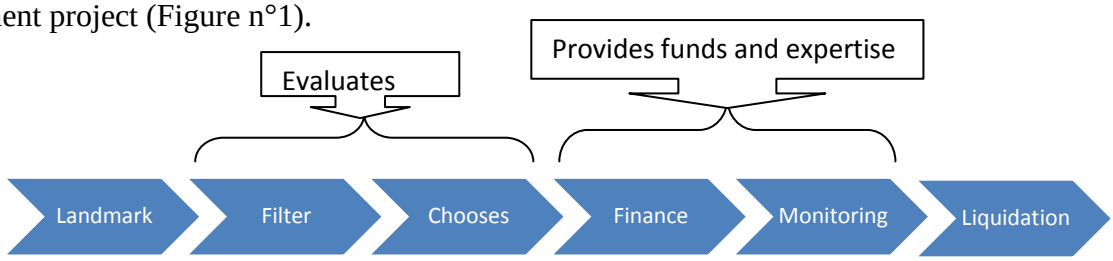

Figure 1 : evaluating process for business project creation or development

Generally, the evaluation process involves three steps namely:

a. Identification Step: this step include the initial formulation of ideas for each project and identify its objectives and their consistency with the investment fund strategy [11], its type of investment and its priorities.

b. Filtering Step: this step is an extension of the previous one it allows the classification of projects pre-selected according to quantitative and qualitative approaches. These are often quantified in an arbitrary manner without relying on a scientific approach.

c. Selection Step: after the preparation phase, which includes, substantially the economic feasibility studies, comes the stage of differentiation in which the company can choose the best projects, which guarantee the achievement of specific objectives.

In the following we present an approach which consists in evaluating a project based on an evaluation grid of the criteria identified in the study and analysis of a business plan [7].

III. Approach

So that we can establish a scientific approach to the evaluation of investment projects in an investment fund, we begin with:

- Make an identification of all the parameters of a business plan to make their classification. This phase will allow us to identify those quantitative and qualitative ones.
- We apply thereafter the AHP method based on an arbitrary and abstract quantification that simulates the one made by experts
- We give the opportunity to change these values on the basis of better cognitive reformulation of the expertise of several experts.
- We make the following corrections from a self-regulating process developed by the application of a self-learning system.

1. Identification and Classification of the parameters

The business plan [5] shows the vision of entrepreneurs on their business and gives a clear idea of the creation and development of the project. To invest in a business, investment funds are a projection of the elements identified in the business plan on a kind of grid that represents the criteria taken into account in assessing the quality of a project (Figure (1) summarizes the hierarchical classification of evaluation criteria).

We note that investment funds rely more on qualitative and quantitative criteria. Figure (2) shows the categories of criteria that are taken into account in a qualitative study for the evaluation of projects.

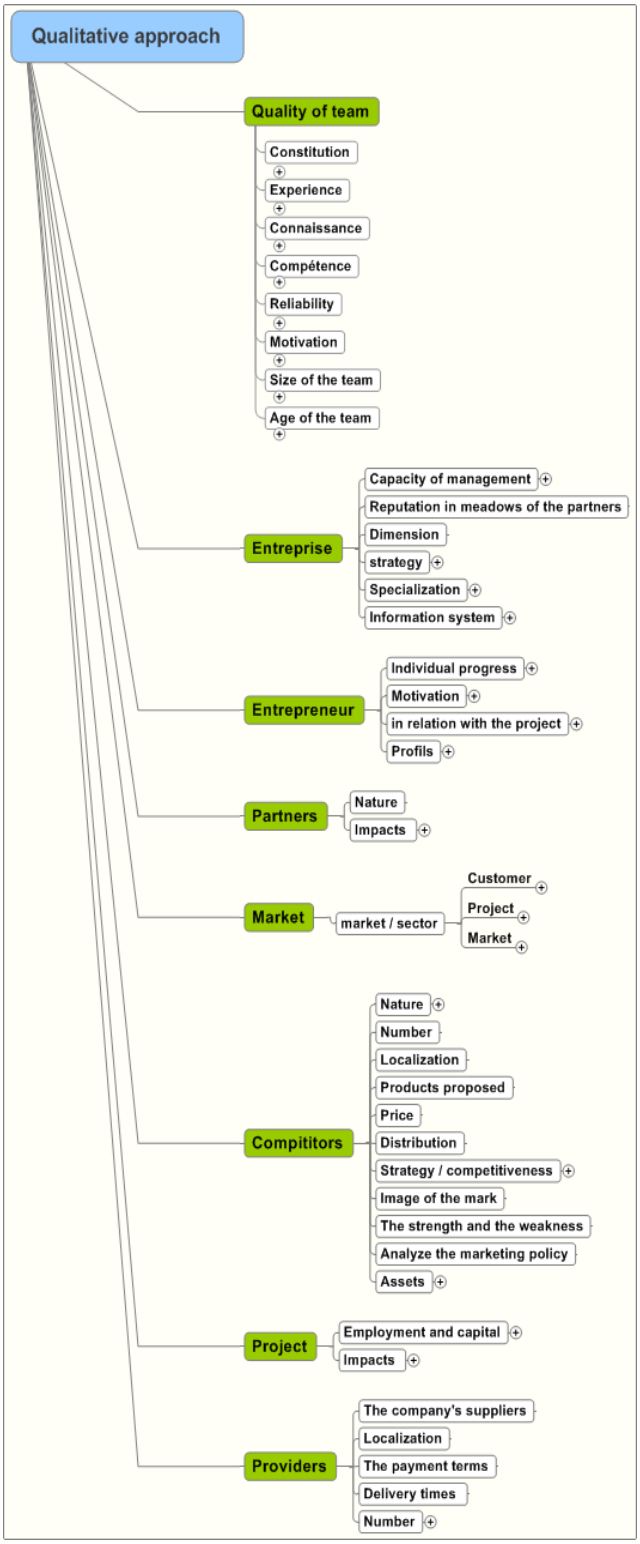

Figure N°2: Qualitative approach

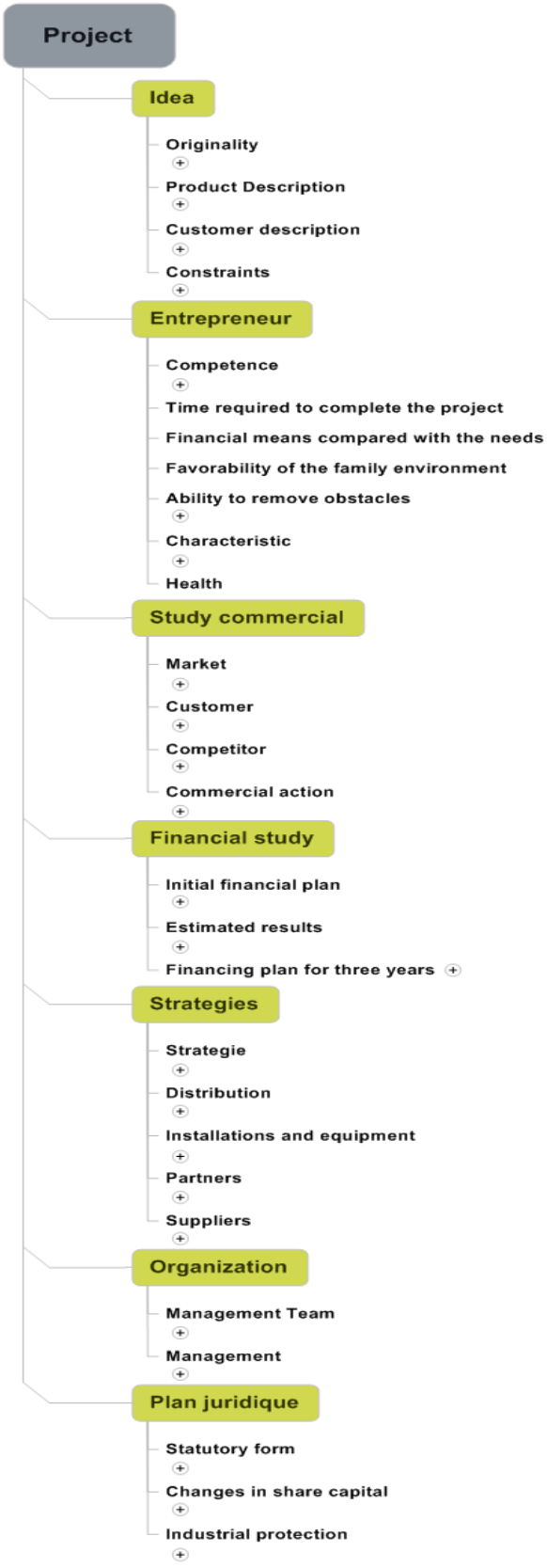

Figure N°1: Business plan

2. Proposed method

To implement a generic solution, we worked with quantified data. Also, we have assumed that cognitive analysis is result of meetings with experts. It is about respondents specialists in the field of investment and who are going to determine by their intuitions the importance of every criterion and then set the priority of each to guide the decision maker to the right choice. This method based on intuitions (often non-formal) can lead to bad decisions. It is in this context that we use the AHP method.

This method is based on comparison of button pairs of options (the alternatives) and criteria. These fundamental principles are:

1. Hierarchical structure (classes - criteria - weight)
2. Structuring priorities (sub-criteria - rows)
3. Logical consistency
4. Semiquantitative method

2.1. Simulation from the values provided by experts

To evaluate a project, some investment funds established three grids:

1. One to evaluate the criteria against each studied case by giving a rating or qualification. The evaluation at this level is often qualitative:
   a. a mention type: Excellent - Very Good - Fair - Very bad
   b. an evaluation type : ++, +, -, --
2. Another grid to the degree of importance given to a set of criteria such as "Very Important", "Important" or "Few Important".
3. One more grid which classifies the differents categories by a priority coefficient

Of course, it is not here a rule or standard but an existing practice. Note that the importance and the choice of priorities differ from one investment fund to another.

At first, we construct a hierarchical analysis of the various criteria that have been chosen, To do this, the decision maker will set the preferences he has vis-a-vis each pair of criteria. These preferences, which are expressed under verbal forms, are translated under digital forms according to the board of equivalences below, secondly we are going to build a matrix of judgment for the first one level of the criteria, then we determine it's appropriate vector, later we are going to verify the coherence between judgments made previously, and finally to build matrices for the level of the alternatives for finding its appropriate vectors.

2.3. Evaluation of project

- **Matrix of judgement**

In order to evaluate each criteria we start with the matrix of judgments given by the makers. This matrix is :

$$\begin{pmatrix} w_1/w_1 & w_1/w_2 & \ldots\ldots\ldots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \ldots\ldots\ldots & w_2/w_1 \\ w_3/w_1 & w_3/w_2 & \ldots\ldots\ldots & w_3/w1 \\ \ldots\ldots\ldots & \ldots\ldots\ldots & \ldots\ldots\ldots & \ldots\ldots\ldots \\ w_n/w_1 & w_n/w_2 & \ldots\ldots\ldots & w_n/w_n \end{pmatrix}$$

In this matrix the diagonal is obviously equal to 1 (criteria having an importance equal to itself). The decision-maker defines the preferences which he has towards every couple of criterion. These preferences, which are expressed under verbal forms, are translated under digital forms according to the table of equivalences below:

Verbal scales	Digital scales
Both criteria are equal	1
The criterion dominates moderately the other one (a little more important)	3
The criterion dominates strongly the other one (more important)	5
criterion strongly dominates the other (much more important)	7
the criterion is absolutely dominating the other (most important)	9

Table N°1 : Table of equivalences

The intermediate values (2, 4, 6, 8) between two judges can be used to refine the judgment. Therefore, we consider that the company strategy is more important than competitors, the criteria company strategy will have then the mark **8** with regard to the criteria competitors. By opposition, the criteria competitors will have a mark with regard to the criteria company strategy which will be the opposite of the mark of the criteria company strategy with regard to the same criteria, so the mark is **1/8**.

The table N°2 illustrate the comparisons between the various criteria.

Criteria	Str	Etp	Eq	M	Cp	Pr	Fr	Part
Strategy: Str	1	2	3	4	8	7	5	6
Entrepreneur:Etp	1/2	1	3	4	5	2	3	2
Team:Tm	1/3	1/3	1	2	5	4	5	6
Market:M	1/4	1/4	1/2	1	5	2	3	2
Compititors:Cc	1/8	1/5	1/5	1/5	1	2	3	2
Product:Pr	1/7	1/2	1/4	1/2	1/2	1	2	2
Provider:Fr	1/5	1/3	1/5	1/3	1/3	1/2	1	2
Partners:Part	1/6	1/2	1/6	1/2	1/2	1/2	1/2	1

Tableau N°2 : Matrix of judgement

- **Priority Vector**

To achieve this vector (Table No. 3) there are three calculations to follow:

- Add the columns of the matrix: all elements in a column are added;
- Normalize the matrix: each entry in the matrix is divided by the total columns; the normalization of the matrix allows significant comparisons between elements.
- Calculate the average of lines: All the elements of a same row of the matrix are summed and normalized then divided by the number of entries. A result of previous steps provides the percentages of global priorities.

Criteria	Str	Etp	Eq	M	Cp	Pr	Fr	Part	Sum of normalized lines	Priority
Strategy: Str	1	2	3	4	8	7	5	6	2,606	0,326
Entrepreneur:Etp	1/2	1	3	4	5	2	3	2	1,582	0,198
Team:Tm	1/3	1/3	1	2	5	4	5	6	1,359	0,170
Market:M	1/4	1/4	1/2	1	5	2	3	2	0,804	0,100
Compititors:Cc	1/8	1/5	1/5	1/5	1	2	3	2	0,490	0,061
Product:Pr	1/7	1/2	1/4	1/2	1/2	1	2	2	0,468	0,059
Provider:Fr	1/5	1/3	1/5	1/3	1/3	1/2	1	2	0,360	0,045
Partners:Part	1/6	1/2	1/6	1/2	1/2	1/2	1/2	1	0,331	0,041
Sum of columns	2,718	5,12	8,32	12,5	25,3	19	22,5	23		

Table N°3: Priority of criteria

The synthesizing criteria allowed us to establish the priority of each criteria in relation to the achievement of the objective. According to Table N°3, the company strategy, with a priority of 0.323, is the most important of the eight criteria.

➢ The coherence

To achieve at the value of the coherence we follow the following steps:

1. Multiply each value in the first column by the priority of its criteria;

2. Multiply each value in the second column by the priority of the second criterion, ...

3. Then sums the values in each row.

$$0.323\begin{bmatrix}1\\1/2\\1/3\\1/4\\1/8\\1/7\\1/5\\1/6\end{bmatrix}+0.196\begin{bmatrix}2\\1\\1/3\\1/4\\1/5\\1/2\\1/3\\1/2\end{bmatrix}+0.170\begin{bmatrix}3\\3\\1\\1/2\\1/7\\1/4\\1/5\\1/6\end{bmatrix}+0.10\begin{bmatrix}4\\4\\2\\1\\1/5\\1/2\\1/3\\1/2\end{bmatrix}+0,06\begin{bmatrix}8\\5\\5\\5\\1\\1/2\\1/3\\1/2\end{bmatrix}+0,058\begin{bmatrix}7\\2\\4\\2\\2\\1\\1/2\\1/2\end{bmatrix}+0,045\begin{bmatrix}5\\3\\5\\3\\3\\2\\2\\1\end{bmatrix}+0,041\begin{bmatrix}6\\2\\6\\2\\2\\2\\2\\1\end{bmatrix}$$

$$\begin{bmatrix}0,32\\0,16\\0,11\\0,08\\0,04\\0,05\\0,06\\0,05\end{bmatrix}+\begin{bmatrix}0,39\\0,196\\0,03\\0,08\\0,04\\0,10\\0,07\\0,10\end{bmatrix}+\begin{bmatrix}0,53\\0,53\\0,18\\0,09\\0,03\\0,04\\0,04\\0,03\end{bmatrix}+\begin{bmatrix}0,39\\0,39\\0,20\\0,10\\0,02\\0,05\\0,03\\0,05\end{bmatrix}+\begin{bmatrix}0,48\\0,30\\0,42\\0,30\\0,06\\0,03\\0,02\\0,03\end{bmatrix}+\begin{bmatrix}0,41\\0,12\\0,23\\0,12\\0,12\\0,06\\0,03\\0,03\end{bmatrix}+\begin{bmatrix}0,23\\0,14\\0,23\\0,14\\0,14\\0,09\\0,05\\0,021\end{bmatrix}+\begin{bmatrix}0,25\\0,08\\0,25\\0,08\\0,08\\0,08\\0,08\\0,04\end{bmatrix}=\begin{bmatrix}3,01\\1,91\\1,53\\0,99\\0,53\\0,50\\0,38\\0,36\end{bmatrix}$$

4. Dividing the elements of the vector by the weighted sum for each priority criteria

Strategy:	$\frac{3,01}{0.323} = 9,2274174$	Competitors:	$\frac{0,53}{0,06} = 8,658975466$
Entrepreneur:	$\frac{1,91}{0,196} = 9,6734581$	Product:	$\frac{0,50}{0,058} = 8,539524551$
Team:	$\frac{1,53}{0,177} = 8,9890702$	Providers:	$\frac{0,38}{0,045} = 8,348353202$
Market:	$\frac{0,99}{0.098} = 9,8493309$	Partners:	$\frac{0,36}{0.041} = 8,598679988$

5. Calculate the average of the values found in step 4

$$\lambda_{max} = \frac{(\sum_{1}^{8} Mi \quad)}{n} = 8,985$$

With n and Mi are concurrently the number and average of each criterion.

6. Calculate the coherence index (CI)

$$IC = \frac{\lambda_{max} - n}{n-1} = \frac{8,985-8}{8-1} = 0,1408$$

7. Calculate the ratio

$$RC = \frac{IC}{IA}$$

With IA is the index of coherence:

n	3	4	5	6	7	8
IA	0,58	0,90	1,12	1,24	1,32	1,41

So the RC obtained is: $RC = \frac{0,1408}{1,41} = 0,099$

RC < 0,10, then the degree of coherence is acceptable

➢ **The comparison between the alternatives**

To get to construct the matrix of comparison between alternatives, we will use the following table

Verbal judgment	Numerical evaluation
Extremely preferable	9 ; 8
Very strongly preferred	7 ; 6
strongly preferred	5 ; 4
Moderately preferable	3 ; 2
Indifferent	2 ; 1

Table N°4: Verbal judgment and its numerical value

- **Matrix of priorities for each alternative**

To find the values of the priorities for each alternative we follow the same principle as the priorities for the criteria and we finally get the result shown in the figure below.

	Strategy			Priority
Project1	1	4	7	0,7
Project2	0,25	1	3	4,79
Project3	0,14	0,33	1	0,09

	Entrepreneur			Priority
Project1	1	3	6	0,667
Project2	0,33	1	2	0,2222
Project3	0,17	0,5	1	0,1111

	Market			Priority
Project1	1	5	7	0,6852
Project2	0,2	1	6	0,2466
Project3	0,14	0,17	1	0,0683

	Product			Priority
Project1	1	5	8	0,72
Project2	0,2	1	4	0,21
Project3	0,13	0,25	1	0,07

	Team			Priority
Project1	1	3	8	0,6366
Project2	0,33	1	7	0,3025
Project3	0,13	0,14	1	0,0609

	Compititors			Priority
Project1	1	4	3	0,6196
Project2	0,25	1	2	0,2243
Project3	0,33	0,5	1	0,156

	Provider			Priority
Project1	1	5	6	0,65
Project2	0,2	1	8	0,28
Project3	0,17	0,13	1	0,07

	Partners			Priority
Project1	1	6	5	0,7018
Project2	0,17	1	3	0,1972
Project3	0,2	0,33	1	0,101

	Strategy			Priority
Project1	1	4	7	0,7
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Project3	0,14	0,33	1	0,09

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Project2	0,2	1	6	0,2466
Project3	0,14	0,17	1	0,0683

	Product			Priority
Project1	1	5	8	0,72
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	Team			Priority
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Project1	1	5	6	0,65
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	Partners			Priority
Project1	1	6	5	0,7018
Project2	0,17	1	3	0,1972
Project3	0,2	0,33	1	0,101

Figure N°3: Matrix of priorities for each alternative

Subsequently, we combine the priorities of alternatives with priority criteria for the overall preference of the decision maker.

For this Project: $\text{Project}_i = \sum_{j=1}^{j=8} Crj * \text{Pr}_i$ with i=1..8 ; Cr_j : Priority of criteria j and Pr_i : Priority of Project i

Calculations give us the following results:

Project $_1$	0,67108256
Project $_2$	1,71255208
Project $_3$	0,08733505

Finally, the best choice is the project n°2 because he got the best score for the overall preference is: 1.71

IV. Conclusion

With this result we were able to show how to highlight the priorities of criteria choices to judge a project. To consolidate the proposed approach, we are already working on the expansion of AHP method by integrating the fuzzy logic (FAHP :Fuzzy Analytic Hierarchy Process), also with integrating techniques which being able to lead to the improvement of expertises from methods of auto-learning, and to develop an expert system.
Our works join a wider approach which consists in developing an IT tool helping investments funds to make a reasonable decision and less risky.
The significant contribution of this technique is varied. It primarily affects the prediction, the
optimization and classification.

So, the implementation of intelligent systems can create a continuing desire to update the economic and financial data, and to encourage the operators to collect better information and classify well.
The economic enterprises are called to adopt techniques to improve the performance of their systems information. This could lead to reduce the uncertainty, manager risk and performance strategies.

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