

# Multi criteria method for the selection of an innovative project of SME / SMI

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**Abstract**— this study is dedicated to the construction of a rational approach to project selection. Indeed, by relying on the Multi criteria decision support methods, we elaborated the various stages leading to the final choice. Thus, we will successfully discuss the choice of the evaluation team, the conditions that must check the projects as well as the judging criteria in order to be actionable. We compile a list of common criteria for the selection of projects, and then we will discuss the balance of these criteria and different methods of aggregation of judgments by project. The study focused on one of the criteria in particular, namely that of 'innovativeness of SMEs.

**Keywords**— Multi criteria methods of decision, innovative project, SMEs support

## I. INTRODUCTION

In a context of globalization, constant evolution of the markets, and therefore increased competition, innovation is at the heart of the concerns of businesses. It tends to become an indispensable condition for their survival as well as their development. Innovation helps to ensure a meaningful and sustainable competitive advantage for the company, but is, however, a complex process.

Businesses seek to innovate, but still, to recognize innovative ideas to develop them into projects.

The selection of projects occupies an important place in the tasks of decision-makers, and this regardless of the type of business concerned. Policy makers or managers who must evaluate and select projects will face the same problem: there are more potential projects than resources to be allocated for repairs, so they must make a choice.

Besides, the vital character represents innovation for SMEs, financing difficulties posed for them another decisive factor making the selection of projects. a primordial and essential step in the process of innovation. Also, we

develop. An approach for selection and evaluation of innovation projects and we take an approach of measuring innovation in SMEs.

Also, during the implementation of our methodology, we compile a list of criteria for the evaluation of projects. We focus particularly our attention on the criterion of innovativeness of SMEs, which will be developed in this present work.

## II. APPROACH OF MULTI-CRITERIA EVALUATION AND SELECTION OF PROJECTS

We will present the various stages of selection of innovative projects

### A. Selection of the Group's judgment.

The judgment group consists of the following elements:

- ✓ **The leader of the SME:** owner of SMEs and SMIs will play the role of coordinator of the debates within the group.
- ✓ **A project manager:** It is the guarantor of compliance with the specifications
- ✓ **The engineers and technicians of the SMEs:** will take care of the technical and technological feasibility of the innovation at the level of SMEs and SMIs.
- ✓ **A several commercial:** assessing the impact of innovation at the level of the market and commercial relevance.
- ✓ **A technical assistant:** control and use of software necessary for the conduct of some analyses multi-criteria. He must be able to formulate the results in an understandable way for all.

- ✓ **An accountant:** Control of the financial resources of SMEs and SMIs, it can consider solutions credits.

*B. Definition of objectives.*

A selection of projects has meaning only in relation to objectives and specific aims. This step is necessary because the choice of the criteria and their weighting stems directly from the objectives. These will of course be in line with the overall strategy of the company. [35]

The different objectives of the SMEs can be translated as follows:

- Minimization of costs;
- Minimization of the time;
- Increase quality;
- Increase in eco-efficiency;
- Promotion of the image of the company.

*C. ESTABLISHMENT OF THE LIST OF PROJECTS IN COMPETITION*

To assess projects in a rational way, several criteria must be used taking into account several constraints and objectives. Nevertheless, these projects must meet a number of conditions in order to be subject to assessment. :

- ✓ Projects concerned with the selection must be homogeneous in order to be able to be compared and a choice.
- ✓ It is important that projects are independent of each other, to avoid the duplication of measures.

*D. Choice of evaluation criteria.*

The criteria for selection of projects selected must obey certain rules in order to ensure the smooth running of the evaluation:

- ✓ The following criteria must be common to all the projects involved in the selection. It is a common sense rule.
- ✓ Another precaution should not be omitted: the verification of the independence of criteria. Even that should not a draft appears under several different labels and is subject to redundant judgments, should also avoid multiple judgments which always express the same thing. This would implicitly favor one type of test [35].

**List of criteria:**

«Checklists» (ACLs) all exist in the literature: criteria for research, economic, strategic, etc. are grouped into inventories, often very long. It should be however that it would be dangerous to abruptly apply these 'aides-mémoires', also very useful, to all problems with no adaptation [35]. In-

deed, the nature of the projects, the type and the sector in which the enterprise operates, the nature of the environment... are all factors that influence the types of selected criteria. The list of criteria that we selected should be subject to modifications during its use.

**Criterion 1: Strategic relevance of innovative projects (adequacy of the project with the company's strategy) [33].** The company may adopt a strategy of products or processes with two distinct characters of innovation: offensive or defensive

TABLE 1  
 INNOVATIVE DEPENDING ON THE STRATEGIC CHOICES

The company's strategy		Innovative project
Offensive	Defensive	
	Differentiation	Improvement of a product or of an existing service
Diversification		Design and launch of a product or a radically new service
	Focus campaign	Improvement of a process or an existing organization
Domination by the costs		Implementation of a process or a radically new organization

**Criterion 2: The financial evaluation**

A profitable investment provides more resources that it absorbed. But the company can invest only if the operation does not put its cash difficulties. This is why the evaluation is also done on the movement of financial flows and not only on expenditure and revenue.

TABLE 2  
 MAIN ADVANTAGES/DISADVANTAGES OF THE FINANCIAL CRITERIA

	Benefits	Disadvantages
VAN	- Integrates the time value of money; - Is a good indicator of performance.	- The problem of the choice of the discount rate; - Does not compare projects of different sizes or whose life is different.
TRI	- Represents an absolute rate of return; - Incorporates the time value of money.	- Ignores the difference in size between projects.
Payback period (criterion necessary but not sufficient)	- Simple method; - Incorporates the concept of risk linked to the time factor.	- Ignores what happens after the recovery period (myopic criterion).

To enable comparable assessments between devices whose life is not the same, the flows are updated. The choice of the discount rate is crucial in this operation, because he played decisively on results [1]. Financial profitability is carried out according to the following criteria: return on investment, VAN, sorting, discount rate. We propose the following table, which summarizes the main benefits/disadvantages of these three criteria.

**Criterion 3: Assessment industrial [1]**

Only costs of production management are never fully adapted to the strategic management of new technologies. Experience shows that if the calculation of production costs remains essential, it has significant limitations:

- ✓ Standard costs established on the basis of homogeneous sections and the distribution keys are dependent on a certain vision of the structure of the company and the allocation rules set by managers. They are conventional and have no value in itself. However, the application of a major innovation will always deeply transform the General Organization of the company and will require revision of these conventions.
- ✓ The nature of costs evolves as a result of the organizational changes, including in the qualification, and the duties of operators. Direct, decisive costs in mass production, are now reduced, wholesale, matter and dedicated investment. Labor, is in contrast a growing share of indirect costs and is in addition to the depreciation of other investments, the cost of non-quality, management, storage, maintenance.

The traditional calculation of costs does not incorporate some elements that still weigh heavy on the outcome of the exercise. Legal accounting takes into account of the visible costs, appointed, monitored. It neglects all those that result from non-encrypted dysfunction, as well as those who are deliberately accepted for better performance, such as the hidden costs and opportunity costs.

**Hidden costs** escape them as usual information systems. Some are diluted in the visible costs without explicit link with the objective to be achieved (for example, the remuneration of intermediaries who occupy posts absentees), others represent a loss of value. This is the case of working time which are paid without having given rise to a production (for example, the salary of an absent owner)

**Opportunity costs** for example, result from the maintenance of idle machinery to not load stocks, the equipment to ensure its preventive maintenance, or stop the slowdown of production to ensure quality...The search for total quality, total productive maintenance, just-in-time, involves a different assessment of these generators costs of efficiency. We have thus referred most of the elements that reveal the real price to pay for the new objectives. Taken into account

in a comprehensive approach, they indicate not the cost of a production, but the cost of a decision.

**Criterion 4: Assessment of the impact of projects**

Evaluation indicators shall be adapted to the objective. For example, a company that purchased a packaging robot with aims to satisfy an important client, at the same time sought to: increase the speed of deliveries; reducing the rate of returns damaged; reduce staff costs; or even blow a bottleneck [1].

In most cases, the initial objectives are enriched other objectives. Here, the establishment of the machine originally answered requests or requirements of a client. The target is complex and scalable. That is why the final target is never the innovation itself, it is only a means. The effects of craze for 'high tech' push to focus too much attention on innovation itself [2].

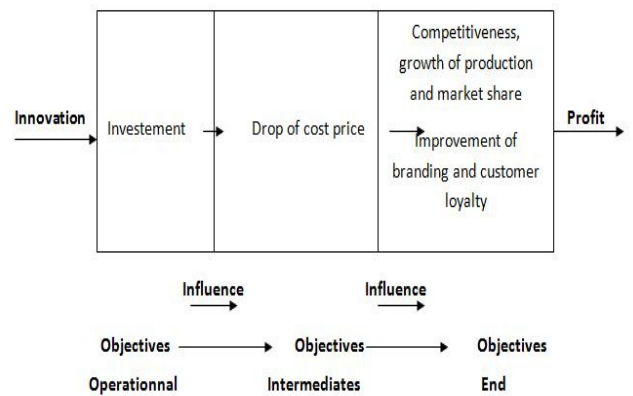


Fig 1: Example of different levels of evaluation [2]

The following table gives an evaluation grid for innovative projects based on the typology of innovative projects (innovative intensity and purpose of the project) and the criterion above.

**Criterion 5: Innovativeness of SMEs**

When the choice of selecting a project of innovation happens at a higher level (investors in the presence of several innovations from several small projects), the criterion "character innovative SMEs' or 'Degree of innovation of the SMEs' appears. Indeed, investors must measure this criterion to make the choice of project.

TABLE 3  
 EVALUATION GRID FOR INNOVATIVE PROJECTS [33]

Type of innovative projects	Potential impact on the company
Improvement of a product or of an existing service	Limited to a product or service
	Embeddable in a repetitive activity
Design and launch of a new product or service radically	Limited to a service project
	Embeddable in a repetitive activity
Improvement of a process or an existing organization	Limited to an activity
	Generalizable across the enterprise
Implementation of a process or a radically new organization	Limited to an activity
	Generalizable across the enterprise

E. *Weighting of criteria.*

For various reasons, including his personal preferences, the decision-maker may consider that a criterion is more or less important than another. Following the expected objective, a test would be privileged over others. For example, if the SMEs primarily pursue an objective of eco-efficiency, highest cited environmental impact criterion will be favored over others. Remember that the list is not exhaustive and that it must always be subject to adjustments following the undertaking and the context.

This quantitative aspect is especially supported by the Multi criteria optimization methods. In the simplest case, may be asked to the evaluation group to place on a cardinal scale criteria by setting, for example, coefficients (ex: each criterion is given a coefficient between 1 and 5 that reflects its weight). The allocation of a total amount of points to be allocated by each actor, among the various criteria (ex: 20 total points to place the choice on 6 criteria) is also a simple solution.

TABLE 4  
 WEIGHTING OF JUDGMENT CRITERIA

	Actor A	Actor B	Actor C	Weighted average	level of consensus per criterion
Criterion 1	8	6	10	8	Medium
Criterion 2	3	2	1	2	Good
Criterion 3	2	6	1	3	Weak
Criterion 4	1	1	1	1	Strong
Criterion 5	5	4	3	4	Good
Criterion 6	1	1	4	2	Weak
TOTAL	20	20	20		

This table shows how actors can allocate their points on criteria, from a maximum of 20. The right column of the table shows the level of consensus or opposition that there

may be between the players around a criterion. For example, criteria 2 and 6 have the same average weight. Nevertheless, the opinion of stakeholders on the weighting of criteria 6 are more scattered than those in criterion 2, which explains the difference in the level of consensus.

Regarding criterion 4, the average weight is 1. The level of consensus is considered "Strong" because all the players offer the same weighting.

Some criteria may have importance such that they cannot be treated in the same way as the others. This is the case of the criteria to apply the concept of veto threshold. They can be absolute or relative worth, intervene alone or in series, etc., depending on the choices made by the group.

F. *Selection of the method of selection*

Once judgment criteria laid down and weighted, then choose the method of project selection.

In the previous chapter, we have cited the different methods of Multicriteria decision aid classified according to 3 operational approaches of aggregation of judgments.

A question then arises: what is the method of multi-criteria decision to use support? To answer this question, we conducted a comparative study between the various methods that is presented in the following table:

TABLE 5  
 COMPARISON BETWEEN METHODS OF MULTI CRITERION DECISION SUPPORT [8]

Criteria	Multicriteria decision aid methods <sup>1</sup>				
	MAVT	MAUT	SMART	UTA	AHP
Easy to apply			X	X	X
Taking into account qualitative criteria	X	X	X		X
Taking account of quantitative criteria	X	X	X	X	X
Decomposition of a problem in several levels					X
Verification of the consistency of the assessment at each level of decomposition of the problem					X

On this basis, we propose to retain the AHP method for the following reasons:

- ✓ One of the major advantages of the AHP is located in the construction of a hierarchical diagram which forces the decision makers to structure their problem. Define the objectives, the criteria to retain and assign numeric values require compro-

mises. In other words, the AHP model has an intrinsic value regardless of the final result.

- ✓ The AHP method takes into consideration qualitative and quantitative criteria.
- ✓ It also allows measuring the consistency of the judgments used to determine priorities and possibly re-assess mismatch.
- ✓ The AHP has flexible enough levels because the addition of criteria for a good hierarchical structure does not interfere with its overall performance.
- ✓ The AHP method is considered to be flexible because also that some authors have converted the scale of 1-9 of SAATY in a scale of 5 or 100 levels.
- ✓ The identification of priorities to consider the relative priority of each criterion to obtain the best alternative according to the identified objectives.
- ✓ Flexibility, that allows its use, in a diverse range of unstructured problems.
- ✓ Its implementation is facilitated by the use of Expert Choice or Super Decisions (trial 9 month version) software.

#### G. Judgment per criterion

Once the criteria have been established, it should be for each actor to judge each share compared with regard to each of the criteria. In the context of the ex ante evaluation, this study is prospective. It can be based on opinions of experts, statistics, or depending on the complexity of the subject on pre-established models. Thus, attempts at this stage, to give values to the impact of each action under the criterion.

The interest of this step is to arrive in the end to provide each share a note by criterion. This notation allows you to compare both the shares between them and notices between actors, for the same action. To facilitate calculations, if there is no use of software allowing all possibilities of multi-criteria analysis, the transformation of the qualitative value notice to facilitate the continuation of the analysis, even if this operation sometimes leads to an impoverishment of the quality of the information.

Preference and indifference thresholds also deserve to be defined, especially in long and complex analyses. It can happen that actors with no common repository on these subjects do not apply the rules in the same way, which can sometimes lead to bias. So for example, if these thresholds are not clearly defined in advance, two actors with very close opinions may classify two actions one at the same level and the other at different levels, because preference

and indifference thresholds will not be well enough defined. These thresholds must be clear criterion for each actor. These thresholds are generally established on the basis of the degree of accuracy of the data that measure the criterion.

#### H. Aggregation of judgments

Once the projects rated by criterion, the temptation is great to apply simple mathematical operations to compare actions. However, it is necessary to master the methods used, otherwise the risk is high of lead to inconsistencies and results little or no credible. The weighted sum applies perfectly to measures of actual, comparable values between them. On the other hand, this full aggregation method becomes quickly uncertain when she has values of a different nature.

In the case of partial aggregation, it is done by comparing the possible responses between them taken two by two, and that following each criterion. After all criteria being reviewed, it will therefore be seen if a response is better than another, or whether one is indifferent to the two answers, or whether they are too dissimilar to be compared [36].

### III. ASSESSMENT OF CRITERION INNOVATIVENESS OF SMES

Overall, the innovative company is one that has developed of the new 'products' or significantly improved.

According to a recent *Green Paper on innovation* [5] of the European Commission: The innovative company has a number of features which can be grouped into two broad categories of skills:

#### 1) Strategic skills

They include the following points:

- ✓ **Long term vision:** Experience shows that it is very difficult to communicate and cooperate permanently with a firm without strategy. For this purpose, the company must have a *long-term strategy* that allows us to register its innovations and investments along a "path" technological and commercial. [7].
- ✓ **Willingness and ability to collect, process and integrate technological and economic information :** The success of an innovation process requires to be mobilized, where and when necessary, all the necessary resources (finance, technology, information of any kind on the markets, competition, etc.). The best interest of innovative companies is to find a way to mobilize these resources [7]. Also, the company should aim to 'learning' of new behaviors or know-how. She must learn to take advantage of the expertise offered to him by its environment and develop its absorption capacity [7]. Identity learning is characterized by the right to the error, enhancement of

the creation and sharing of knowledge, the incentive to mutual learning and relationships of trust [3].

- ✓ **Ability to identify, or even anticipate market trends:** It translates the absorption capacity, which joins a strong ability to listen to the will to take advantage of environmental externalities and integrate new knowledge and skills.

## 2) *Organizational skills*

Translate into:

- ✓ **The taste and control of risks:** To engage in innovation, it must have a sense of the risk. But we still need, to succeed, namely control this risk. The risk management takes all its importance. Also, the company must be aware of the importance of integrating a venture capital.
- ✓ **Internal cooperation between the various departments functional, and externally, with public research, the consulting firms, customers and suppliers:** Policy innovation within a company included several elements (actors, actions, knowledge) and depends on the density and speed of interaction between these elements (interface and service transfer, interdisciplinary programs, support for the partnership, coupling of the company and the financial sphere through venture capital,...). The innovative company will bring attention to these mechanisms of interaction. [7]
- ✓ **The involvement of the whole of the enterprise in the process of change and investment in human resources:** Innovative Company must integrate human resources management practices favoring the production and accumulation of skills necessary for innovation. The climate of immobility that makes difficult any interactivity should be banned [7]. Innovation flourishes within a highly interactive system. Innovation policy will push the company to renew its products and processes.

The criteria above define innovative SMEs. However, some characteristics allow the measure of innovation within a company.

### A. *Percentage of sales generated by new or improved products [4]*

The impact of innovation can be measured by the percentage of sales generated by new or improved products.

Thus, it focuses on the percentage shares to:

- Innovations of rupture for products marketed;
- Incremental innovations on products marketed;
- Unchanged products, but whose production methods have changed.

However, the results obtained through this question raise problems of interpretation. Indeed, for companies that

come to boot, all products are in principle new and the percentage of sales resulting from new or improved products is 100 percent by definition. They should be treated separately. On the other hand, firms that have started their activities as a result of mergers, spin-offs and other kinds of reorganizations should not be treated as firms recently created if they are previously merged similar activities.

Of course, these percentage shares will be related to specific periods. In the Oslo manual, this period is set at three years [4], Crépon. B. fixed it this time in the last five years [6]. Attributable to new products sales (rupture innovation) and products improved (incremental innovation) could be, in addition, broken down depending on whether:

- Sales from products that is new or improved for the market on which the SME operates;
- Sales from products that is new or improved for only the SMEs.

In the absence of these figures at the level of the enterprise, should consider the percentages estimated closest to reality. These indicators are directly influenced by the **life cycle of products**. Therefore, a large proportion of sales of new or significantly modified products is not necessarily indicative of a high rate of innovation.

In order to take account of the effects of the **life cycle of the product** on this indicator, it is suggested to ask the company to provide an estimate of the average length of the lifecycle of its products. This information will be used for weighting suggested higher percentage shares.

Other factors should also be considered when interpreting the data obtained using these indicators:

- ✓ SMEs making custom production will often have a higher proportion of new or significantly improved products than SMEs which make batch production or series, or falling within processing industries;
- ✓ Younger SMEs will have a higher proportion of new products than older SMEs;
- ✓ SMEs aiming to replace products that are deleted will also record's highest proportions of products technologically new SMEs whose purpose is to expand their range of products.

### B. *Environment for the SMEs*

The capacity for innovation of an enterprise is strongly influenced by its environment. It is important to look at the impact of the structure of the surrounding territory, the quality of direct and indirect reports the SME's relationship with the various actors who are there as well as its relationship with big business.

Scientific knowledge and technical skills provide a vital support of innovation in the company. In most countries, they reside in the scientific and technological public sector institutions working to enrich them. **The scientific and technological base** is the accumulated sum of knowledge

as well as scientific and technological institutions that underlie innovation by providing technological training and scientific knowledge [4].

These institutions contribute to provide qualified personnel to fill key posts in innovation. They are also a wealth of expert advice, they offer a framework of collaboration and fruitful interactions, and they are a source of substantial technological advances.

The components of the *scientific and technological basis* are as follows:

- The system of **technical training**;
- The **University** system;
- Support of **basic research** (excluding radical breakthroughs and long-term benefits, basic scientific research sometimes appears as with little direct benefits for innovation in the business) [4].

We therefore deduce a number of settings for measuring innovation reports maintained by the SMEs with its environment:

- ✓ Relations with laboratories: for scientific research, to develop new products. Nevertheless, it is important to underline the fact that this type of report is not systematic in the case of SMEs.
- ✓ Relations with University research centers: this is an excellent way to keep abreast of new techniques in production or marketing.
- ✓ Relations with large companies or other SMEs in innovation projects, such collaborations are aimed at:
  - Reduce the need for internal investment by sharing activities with others;
  - Allocate costs, mainly those specific to an innovation project and which can hardly be absorbed by other projects fail;
  - Complete the range of expertise needed and to keep abreast of everything that is happening outdoors [39].
- ✓ Participation in exhibitions or membership, in professional associations: This parameter can be considered as being of highest degree less than other cities, but it can still give an assessment of the policy of the company or its global culture more generally. Participation in this type of manifestation, falling within the scope of technology watch, will help to assess the degree of attention of the SMEs in its environment.

#### C. Skills and number of qualified personnel

The ability of a company to innovate depends in part on its staff. Have competent employees is a major asset for an innovative company. A firm that lacks skilled workers is unable to innovate. The company needs engineers capable of managing production operations, sellers understand the

technology that they offer for sale (it comes at a time for them to sell and communicate suggestions from buyers in return), as well as managers aware of the issues of innovation.

We propose to calculate the proportion of engineers within the SMEs, as well as managers and technicians. It will be natural to benefit an investment in an SME with the best human competencies.

Another parameter to measure can be considered in the same logic, namely the degree of renewal of the skills of the staff through training. A company that invests in the training of its employees and specifically in the field of innovation will significantly increases its chances to achieve concrete and successful innovations.

#### D. Industrial property

Questions regarding the filing of patents are essential for a better understanding of the innovation process.

The parameter usually selected with this in mind to measure innovation is the number of deposits and grants of patents of the SMEs. This information may be obtained from various national and international data banks. In Algeria, it is the national Algerian industrial Protection (INAPI) agency that is listed this information.

Nevertheless, data on patents, be it applications or grants, are not indicators of the output of innovation, but indicators of inventions, do not necessarily lead to innovations. This indicator will therefore be considered with caution. Furthermore, it is noted that most SMEs are reluctant to file patents, firstly because in some cases, the use of the secret for innovation protection is more favorable, and on the other hand because of the costs of the procedure for filing of patents, although they provide an excellent protection against imitations and are seriously beneficial to SMEs income.

The number of acquired licenses can also be a good indicator of the degree of interest of SMEs in innovation. The acquisition of new technologies and techniques can only encourage the spirit of innovation and development. Of course, this tool is also very insufficient, insofar as skills technology does drive not systematically of innovations.

The following table lists the various tools of measurement of innovation in the SMEs, which we have developed above.

TABLE 6  
 INNOVATION IN SME MEASUREMENT PARAMETERS

Measurement tools	Parameters
Percentage of sales generated by corporate innovations	Percentage of sales generated by products, services, and new processes or improved over a period of time.
Environment for the SMEs	Relations with scientific research laboratories; Relations with University research centers; Reports and partnerships with other SMEs or large companies; Participation in fairs; Membership in professional associations.
Skills and number of qualified personnel	Number of engineers; Number of frames; Number of technicians; Investment in specialized trainings and their frequency.
Industrial protection	The number of patents filed; Number of licenses acquired

#### IV. CONCLUSION

The selection of projects of innovation requires studies and evaluations following multiple and conflicting criteria. Such operations require the implementation of a clear and rational approach that we tried to expose through this work. The selection criteria shall include all components of a strategy of economic development of the company. Their prioritization should also reflect the objectives that the company wants to achieve.

Also, we tarried on a criterion in particular (innovative nature of the SMEs) on which it was necessary to lift the veil. Indeed, innovation is widely recognized as the engine of economic growth. These are the new products and services and new methods of production which give added value to companies and enable them to gain new market shares or to maintain them.

Also recognize and evaluate innovation becomes essential. On the other hand, SMEs with limited resources, it will be necessary that they have means to choose innovation projects on which to invest. Our work fits into the development of this issue.

It was to identify promising projects of innovation, to make a selection among several innovative projects and then to introduce criteria for the measurement of innovation in SMEs.

Most of our intake is located at the following levels:

- ✓ Identification of the characteristics of innovative projects;
- ✓ Construction of an approach based on these characteristics and leading to the identification of an

- innovative project or validation of a project as a bearer of an innovation;
- ✓ Proposal of an approach to evaluation and selection of innovative projects based on multi-criteria selection methods;
- ✓ Proposal of statements concerning the Multi criteria method to use in the context of our approach; Proposal of criteria: to measure innovation in SMEs.

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<sup>1</sup> *MAVT*: multiple attribute value theory,  
*MAUT*: multiple attribute utility theory,  
*SMART*: simple multiple- attribute rating technique,  
*UTA*: utility theory additive,  
*AHP*: analytic hierarchy process.