

Interreg Greece-Bulgaria



GR-BG BUSINESS PASSPORT

European Regional Development Fund

Deliverables 4.3.3

"Evaluation of Proposals of Cross Border Innovation Competition"

In the framework of the project "Greek Bulgarian Business Partnership by Assistance, Services, Solutions to Promote Open Regions Team" with the acronym "GR BG BUSINESS PASSPORT"

INTERREG VA COOPERATION PROGRAMME
GREECE – BULGARIA 2014 – 2020

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Interreg VA "Greece-Bulgaria 2014-2020" Cooperation Program

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The project is co-funded by the European Union and National Resources of the participating countries under the "INTERREG VA GREECE - BULGARIA 2014-2020" Cooperation Program



Introduction

As businesses seek ways to differentiate themselves from the competition, they develop and/or adopt new products, processes, techniques and processes.

"Innovation" is the most effective way to achieve a strong competitive advantage for a business [1].

By "innovation" here we mean: A new idea and its implementation into a new product, process or service that results in economic growth, increased employment and net profits for the business that developed it.

We focused here on innovations related to the use of robots by small (see family businesses) along the Greek-Bulgarian border.

Innovation is not simply a discovery or an invention, but is the commercial exploitation of knowledge and techniques in new ways for new purposes. An innovation involves the radical restructuring of a business in the following ways:

1. Managing change in a way that encourages the development of new ideas, new technologies and new opportunities.
2. Improving the application of new technologies, capabilities, processes and services with the aim of creating competitive advantages.
3. Acceptance of the "principle" that regardless of size and industry, any business can innovate to increase sales.
4. Changing the mindset of the business so that the business becomes receptive to new ideas and invests in them.

Innovation is not invention, but rather the process by which an idea is leveraged with a measurable result in the marketplace. Innovation is not about one part of the business, but about the whole business. All innovation scholars agree that the innovation process consists of distinct stages, one of which is the evaluation stage, however they disagree as to the exact number of distinct stages.

The stage of evaluating innovative ideas is critical because it is where the decision to accept or reject an innovation development proposal is made. It has been estimated that 7 out of 8 new ideas never reach the research and development stage.

The effectiveness of an innovation evaluation process is critical to developing a business with innovation commercialization. Specifically, on the one hand, a "lax" evaluation process fails to identify weak ideas, resulting in wasted resources. On the other hand, a "strict" evaluation process leads to rejection of useful innovations.

Many works have been published in the literature on the evaluation of innovations. However, most of them are mainly of academic interest rather than practical interest mainly for two reasons: First, they require the values of many variables, which are not available in business, and second, they require specialized technical knowledge that business executives dealing with the innovation evaluation process.

In practice, companies evaluate innovations based on evaluation criteria according to the company's goals.



The object of this study is to present innovation evaluation criteria for small (often family) businesses along the Greek-Bulgarian border with an emphasis on the introduction of robots in their operations. It should be noted that many regions on the aforementioned border are experiencing problems such as continuous population decline as well as *terminally low* incomes in the European Union. The development of businesses based on innovation, and indeed innovation based on the use of various robots, could contribute to solving the aforementioned problems. Partners PB3 (Greece) and PB4 (Bulgaria), with their expertise in robotics and European Union funding,

1. Innovation evaluation criteria

The innovation selection process is a process in which a series of continuous changes are made to the implemented and proposed projects. The process includes generating alternatives, determining the time needed to make a decision, gathering data, setting constraints and criteria. The evaluation and comparison of innovation projects is complicated by the use of multiple criteria that do not have a common basis and whose relative importance changes over time.

The innovation evaluation process as well as the implementation process should be linked to the project objectives, where in this particular case it is innovation ideas for small (often family) businesses along the Greek-Bulgarian border with an emphasis on the introduction of robots in their work. The project objectives define the space and the factors that will be assessed during the evaluation process.

Interest is focused on:

- 1) In the commercial section: Product and market characteristics
- 2) In the environment: Government, society, workers
- 3) In the technical department: Research and development activities
- 4) Finance and accounting: Investment costs, cash flows, profitability, etc

The purpose of the evaluation process is to select from a large list of ideas, the few that are judged to need to be analyzed in more detail. The proposed approach for evaluation is to apply a multi-step process (Hamilton)[3]. Hamilton[3] distinguishes three stages in the evaluation process: the initial evaluation objective, the classification stage and the scoring stage with probability phases in each stage. The key point of the staged approach is to subject ideas to cheaper and more general evaluations at first, and then to have the few ideas that pass the first stage of evaluation undergo more rigorous evaluation.

The first step in the evaluation process is to define the criteria that will be used to score the ideas. These criteria must have been formed before the ideas were born based on the objectives, limitations of the evaluation, the objectives of the business and factors related to the success of the innovation which at this point is identified with the successful implementation of the idea. The first criteria to which a new idea should be submitted in the initial evaluation phase may be for example whether the new idea fits the business strategy and whether the idea is viable. At this stage the concept should fit with the introduction of robots into small business operations.



It should also be noted that a number of normative approaches to the evaluation of innovations have been proposed. These include:

- 1) Portfolio models (see portfolios) based on linear or dynamic programming
- 2) Benefit contribution methods such as questionnaires
- 3) Scoring models and combined correlations
- 4) Deterministic and probabilistic econometric models
- 5) Market research approaches

But of all these approaches only those of benefit contribution methods and mainly questionnaires and rating models are regularly used by executives.

According to research, three evaluation criteria describe the size of the innovation opportunity [2].

- 1) The perceived advantage of innovation
- 2) Assessment of financial possibilities
- 3) Estimated life span

The first includes the innovation advantage over the rest of the market due to the technology used and the solutions it offers. The second concerns the assessment of sales and revenue that the innovation will bring to the business. The third and final criterion describes the estimated lifetime and stability of the innovation.

In addition, three other criteria illustrate the opportunities that exist in the market for innovation which are: First, the size of the market, where it has a large turnover and a large geographic scope so it has a long life. The second is market logic where customers use objective selection criteria, have a comprehensive understanding of the products and businesses operating in the market. Finally the third is the domestic market where customers and competitors are domestic. These three criteria describe the degree of cooperation of the innovation with the existing resources of the enterprise and state the extent to which the development of the innovation can be undertaken by the enterprise. The first synergy criterion is operational synergy. This refers to synergy with existing distribution channels, sales personnel, customers, distribution and promotion resources, management capabilities. The second is technological and productive synergy. That is, the synergy with the resources and capabilities of the production process and the technical skills. Finally the third is financing the development of the innovation, it describes the financing requirements of the innovation, whether it will be entirely undertaken by the company or whether there should be other ways of financing.

The last two evaluation dimensions are related to strategy. They describe the role of innovation. In essence, these firstly include differentiation, i.e. innovation is decisive for operating in a new market for the development of a new product, and secondly, market retention. More specifically, innovation is crucial for defending a market, for sustainability in a market and for business renewal.

Another factor of particular importance in evaluating innovations is the innovation's potential for differentiation. Innovations that lead to the creation of new or differentiated products receive a high score. The fact that innovations that help differentiate the firm from the competition are preferred over other innovations.

At the same time, factors that contribute to the rejection of an innovation depend on its possible economic results, its synergy with the existing resources of the company and its ability to contribute to the differentiation of the company from the competition.



According to the work of RCCooper[6] it should be pointed out that in a corresponding research, the following factors that will be presented correctly assess the success or failure of innovations in businesses. The factors for this are:

- Technical capabilities (the know-how and technology needed to innovate existed)
- Market and customer knowledge (knowledge of market conditions and customer requirements and needs)
- Degree of modernization (The innovation is something new to the business, the market and potential customers of the economy are new to the business)
- Technological superiority/uniqueness (The innovation has technological superiority, offers technological superiority and will lead to the production of new or high technology)
- Degree of market competitiveness and degree of customer satisfaction (Highly competitive market, level of competition, number of competitors, degree of satisfaction with competing businesses)
- Cooperation with the administrative and commercial organization of the company (adequacy of financial-administrative resources, adequate distribution and promotion network)
- Degree of technical difficulty/complexity. (the technology is expensive, complex and presents technical difficulties)
- Market need (size and degree of maturity)
- Possibility of commercial exploitation of the innovation (adequacy of distribution and distribution network, sufficient promotion resources)
- Market data (market is defined by customers or technological capabilities)
- Production capabilities (production process efficiency, production capacity)
- Uniqueness (degree of innovation-uniqueness of innovation)
- Existence of serious/large competitors in the market, target, degree of satisfaction with competing products)
- Market dynamism (degree of appearance of innovations, degree of change in customer needs and requirements)
- Cost of innovation
- Supporting procedures applied by the market research company (evaluation of technical possibilities, economic analysis of results, business planning)
- Standardization of the innovation (can the innovation be standardized and absorbed by the market)
- Source of innovation (where does the innovation come from, from within the business, from third parties, from customers)

The order in which the above factors are presented also reflects their importance for the success or failure of the innovation. In addition, it should be noted that many times the evaluation and selection process can be characterized by the existence of several criteria but without any measure of comparison.

2. Innovation evaluation methods and techniques

Many innovation development projects never reach the implementation stage. This is because there are not enough resources to implement all the ideas that exist. Also, the majority of ideas are not suitable for commercialization. The necessary high degree of



attrition of innovation development projects combined with the desire to maximize the revenue of research and development programs emphasizes the careful evaluation of innovation development projects.

The evaluation stage is a decision to accept or reject an innovation development project. That is, it is the point at which the management decides on the commitment of resources for the development of innovation. The effectiveness of the evaluation decision is critical to the success of the company's research program. From a strategic point of view, the evaluation stage largely determines the character and direction of the company's development program and its technology portfolio (see portfolio). In addition, at this initial stage management can take the necessary steps to maximize the revenue that will result from commercialization of the innovation. A weak evaluation process fails to identify weak ideas resulting in wasted valuable resources and time.

According to studies it has been shown that management is more likely to consider an idea and reward its creator if the idea is characterized by management as "relevant". An idea is considered relevant if:

- It satisfies an existing need or solves an existing problem.
- It can be developed into a new project, compatible with the general purposes and objectives of the enterprise.
- It can be investigated with existing laboratory resources and infrastructure.

There are several methods for evaluating ideas. Initially, according to studies by Baker, Siegman and Rubenstein[8] as well as Baker, Siegman and Larson[7] ideas are evaluated based on three factors: In time pressure where the degree of immediacy of the need, problem or opportunity addressed by the idea . In predictability where is the degree of certainty about the methods and procedures used. In the time horizon where it is essentially the expected for the start to completion time of the research activity in case the idea is accepted.

On the other hand, Baker's colleagues [4] with him concluded that on the part of researchers and technicians, the dominant factors that influence subjective assessments are not the same as those that influence the tendency to accept ideas from management. Moreover, with the findings of Baker, Siegman and Larson [7], Martin also agrees, who discovered some positive correlations between an idea and its acceptance by an idea evaluator. These correlations are: Lower perceived probability of failure of a given idea, financial cost of implementing it, and finally, quick resolution of the problem at hand. The more feasible these associations are, the more likely it is to be accepted.

Moore and Baker[4] , [5] suggest classifying the models in the following categories:

- Scoring Models which calculate overall performance based on the project's score against pre-selected criteria given for project success.
- Financial models that include calculations such as net present value, IRR or financial equations
- Constrained optimization models where they optimize the object's economic objective function within specified resource constraints
- Risk analysis models where as input they have the simulation of the analysis of the data in the form of distribution and as output they have the form of distribution of utility factors. Some examples are market share or ROR.



Souder [4], [5] for assessing the value of scientific management models uses 5 categories of models which are Linear models, non-linear models, 0-1 models, Scoring models [9] (as proposed and by Moore and Baker) and efficiency models. More generally, evaluation techniques or models vary quite a bit in terms of complexity.

3. Scoring Models

The method involves identifying a small number of criteria that are critical to the success of a project. Such criteria can be the total cost of the research and development, the time to complete the research and development, the probability of success, etc. Competing ideas are then evaluated on the extent to which they satisfy the critical criteria. The points awarded for each criterion are then combined to calculate the project score. The higher the score, the more desirable the idea. Scoring models are most applicable to research, exploratory development, and advanced levels of research and development. Moore and Baker[4], in an analysis of their scoring models they found that the construction method can significantly affect the results produced. They point out that when a scoring model includes at least seven intervals for estimating the degree of "compliance" with each selected criterion, and the scores are added rather than multiplied to give an overall project score, the resulting project scores from the scoring models are significantly positively correlated with scores derived from constrained optimization models and economic models.

3.1 Economic Models

Economic models or efficiency indicators bring complexity. Early models were simple equations or formulas designed to give a score or index relative to the attractiveness of a project.

3.2 Optimization Models

Constrained optimization models are generally the most complex and require the use of a computer to select the optimum. Specific models may include nonlinear, linear, or integer programming. The linear programming approach was generally supported as it provided the developer with more useful information.

More generally, much has been written about the evaluation and selection of research and development projects. But according to the literature, only a small number of the proposed techniques and methods are used in practice. This is because most techniques involve models that require many quantitative inputs that are not readily available in the business or, in many cases, the methods are based on techniques too specialized for R&D executives.

Rubenstein argues that mathematical models require data that do not exist in organizations. Also, many of these techniques require complex calculations from the first phase of developing the new idea. The problem is that the quality and quantity of data in the early stages of innovation development requires time and valuable resources to be committed to extensive research, while there are high rates of uncertainty. There is a lack of balance between the large amounts of resources required to prepare the evaluation process and the small chances of project success due to the extensive risk involved.



Taking into account all the above, we propose the following "competition criteria" which specifically concern the use of robots in businesses.

- 1) The use of robots to suit the operations of the business. The more it matches the business, the higher score it will receive.**
- 2) The use of robots will increase productivity due to an increase in working time (eg working beyond eight hours, also on holidays, etc.).**
- 3) What is the estimated working speed of the robot (relative to a human)?**
- 4) The use of robots will increase the accuracy of the work provided, i.e. the work provided will be more accurate.**
- 5) Using a robot will improve decision-making "strictly", i.e. based on its sensor data - without (human) biases.**
- 6) The use of robots will reduce staff in the business (see job loss).**
- 7) The use of robots will increase the staff in the business (see job growth).**
- 8) The proposed bot is "friendly" (see interactive) to the user.**
- 9) The use of robots is decisive for the viability of the business.**
- 10) What is the expected payback time (in months) of acquiring the robot?**
- 11) What is the estimated maintenance and operation cost of the robot (in euros per year)?**
- 12) What is the estimated profit from using the robot (in euros per year)?**



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ANNEX

QUESTIONNAIRE

Part 1: Identification of innovation evaluation criteria

	Very low	low	Average	High	Very high
How would you describe the degree of competition in your industry?					
To what extent are innovations of interest to your business?					

	Rarely	Somewh at often	Often	Often enough	Very often
Where and to what extent does most innovation occur in your business?					
Improvement / development of new products					
Improving / developing a process / method (eg transfer process, training method)					
Improvement / development of new technology					

	Not important	Minimally important	important	Quite important	Very important
How important is innovation in the following areas of your business?					
Product improvement					
Entry into new markets					
Offer differentiated benefits to customers					
Exploiting rights from patenting new technology					
Boosting business sustainability					
Replacement of existing products					
Other (fill in)					

How important do you consider the use of robots in the following areas of your business?

Not important
Minimally important
important
Quite important
Very important

The business image of the company					
The use of existing production resources					
The use of existing staff					
The existing quality assurance system					
Other (fill in)					

How important do you consider the contribution of robots to the following results of your business?

Not important
Minimally important
important
Quite important
Very important

High return on investment					
Sales increase					
Increasing the market size of the business					
Geographical development of the company's market					
Other (fill in)					

What is the way of financing innovations adopted by your company?

Self financing	
Subsidies from development programs (National - European)	
Venture capital	
Bank loan	
Pumping drinks from the capital market	
Other (fill in)	

Part 2: Evaluation of the weight of innovation criteria

	0	1-2	3-5	6-10	> 10
In the last 5 (five) years, how many times did your business implement an innovation?					

	0	1-2	3-5	6-10	> 10
In the last 5 (five) years, how many times did your business develop an innovation?					

The last time you implemented or developed an innovation, which of the following contributed to your decision and to what extent?	Not at all	Minimum	A little bit	Enough	Very
Diversification of business strategy					
Compatibility with business strategy					
Differentiation of the manufactured product					
Compatibility with existing technology					
Method of financing					
Economic benefit					
Retention of existing market share					
Increase existing market share					

The last time you rejected an innovation, which of the following contributed to your decision and to what extent?	Not at all	Minimum	A little bit	Enough	Very
Limited ability to diversify business strategy					
Incompatibility with business strategy					
Limited ability to differentiate the product produced					
Incompatibility with existing technology					
Method of financing					
Economic benefit					
Limited ability to retain and/or increase existing market share					
The life cycle / duration of the innovation					