THE ROLE OF INNOVATION FOR EFFICIENCY OF INVESTMENTS

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Abstract

The main idea of this paper is that innovation is contributing to the efficiency and sustainability of investment. The main question is how to measure and assess efficiency of investment in innovation for the project benefit. The main objectives of this paper are: a) to analyse the concept and theoretical models of innovation, and b) to establish the criteria and select model for further assessing the efficiency of investment in innovation project.

The research was based on analytical and expert methods and included theoretical analysis of literature sources, analytical, expert and comparison analysis. This paper discusses the definition of innovation of different authors, as well as the role of innovation for the efficiency of investment, and defines various criteria for measuring the efficiency of investment in innovation project. Paper suggests these criteria allocated to five groups related to product, process, finance, market and management. The comparison of three models (CBA, DEA and MCA) presented in this paper concluded that all three models in principle are suitable for assessing efficiency of investment in innovation project. However, the management aspect, which is hardly measurable but important in innovation efficiency performance analysis, suggests proceeding further modelling with MCA using it as complement to CBA.

Keywords: Innovation, economic efficiency, investment, innovation project.
JEL Codes: G11, H43.

Introduction

Most fields of activity today are concerned with innovative projects which invest for increasing production, creation of new products or services. Innovation is a part of project in order to creating benefits to customers and satisfying their needs and expectations in terms of quality of products and services. Sometimes investment project has negative economic indicators or low profitability due to inefficient use of the means of production or low innovativeness. Innovation is critical to the successful implementation of investment project at all stages.


There are many discussions about how the innovation should be measured and assessed at every project stage. Some authors as Li (2000), Elenkov and Manev (2009) suggest to measure new and improved products as direct output of innovation associated with new product development. West et al. (2003), Akgün et al. (2009) are suggesting to measure improvements in process and methods, while Czarnitzki and Kraft (2004) are speaking about the market success of innovation, suggesting “ratio of innovative products sold in the market to total sales”. Several other authors, including Barczak (1995), Linton et al. (2002), Montoya-Weiss and Calantone (1994), Cooper (1990), Cooper and Kleinschmidt (1986) and others develop the concept of output performance, including: financial, temporal, market and product related factors.

A real problem is how to measure and assess innovation efficiency for the project benefit. How to use adequate efficiency criteria for measuring innovation and how to model the efficiency of investment in innovation in a variety of scenarios. Thus investment in innovation in terms of efficiency is the main object and issue of this paper.

The aim of this paper is to analyse current concepts and models of innovation and define method for assessment of investment efficiency in innovation project. The main objectives of this paper are: a) to analyse the concept and theoretical models of innovation, and b) to establish the criteria and select model for further modelling of investment efficiency in innovation project.

Materials and Methods

The methodology of research is based on theoretical analysis of literature sources related to the role of innovation and efficiency of investment in innovation. The matrix analysis of project cycle and investment efficiency as well as benefits have been analysed using analytical methods. For the assessment of innovation efficiency a number of literature sources have been analysed. It was suggested to group the criteria into 5 typical criteria groups. The expert evaluation based on immersion method (Jordan, 2000) was used to establish the list of criteria for separate criteria groups. This method uses the experience of investigators themselves assessing the system in real context and evaluating it.
The research of available models for the analysis of innovation project efficiency was performed using the comparison analysis of different features and functions of model programmes comparing and assessing their applicability in respect of the field of application.

Innovation in Project Cycle

Innovation is a complex category, which has attracted many scientists. Austrian scientist Joseph Schumpeter in the 30s of the 20th century introduced the concept of innovation, treating it as a change in the purpose of the introduction and use of new types of consumer goods, and new production vehicles, markets, and forms of organization in the industry (Schumpeter, 1982). Definition of innovation can be found in publications of Rowe and Boise (1974), Dewar and Dutton (1986), Rogers (1995), Utterback (1994b), Afuah (1998), Fischer (2001), Garcia and Calantone (2002), McDermott and O’Connor (2002), Pedersen and Dalum (2004), Frascati Manual (2004) and others. Urabe (1988) suggested, that innovation consists of the generation of a new ideas and their implementation into a new product, process or service with attending cost reduction and increased productivity. Afuah (1998) refers to innovation as new knowledge incorporated in products, processes, and services. He classifies innovation according to technological, market, and administrative/organizational characteristics, as shown in Table 1 below.

<table>
<thead>
<tr>
<th>Technological</th>
<th>Market</th>
<th>Administrative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>Product</td>
<td>Strategy</td>
</tr>
<tr>
<td>Process</td>
<td>Price</td>
<td>Structure</td>
</tr>
<tr>
<td>Service</td>
<td>Place</td>
<td>Systems</td>
</tr>
<tr>
<td></td>
<td>Promotion</td>
<td>People</td>
</tr>
</tbody>
</table>

(Source: Afuah (1998))

After analysing the data presented in Table 1 we agree that in agriculture related activities in most cases the technological innovation is the key innovation component. It links between methods, processes and techniques that go into a product or service. It is expected that innovation would create a new product or service or would improve existing one. Speaking about market category, we agree that any product should be aiming at satisfying customer’s needs and be successfully placed on to market. In this context the link to 4P “marketing mix” including product, price, place and promotion is logical and explains how the success of innovation should be valued. Afuah (1998) is also referring to administrative innovation, which has to deal first with people, but also with components as strategy, structure and systems. We understand, it is often but not always the case.

The technological innovation is quite well defined in OECD Frascati Manual (2004) and Oslo Manual (2004). These manuals speak about the technological innovation at different stages of a project. It means that innovation is important and can be in the project cycle from idea to implementation. Some authors (Ettlie, 1983). Dewar and Dutton (1986) discuss that a theoretical model of innovation should consider different kinds of variables and represent radical or incremental innovation. According to Urabe (1988) “innovation includes both major and minor changes. Extremely major change is called a radical innovation, although it is interpreted as radical in a technological sense. It is usually the case that in the early stages of a new industry radical product innovation is the prevalent mode of innovation, but it has little if any economic impact, because product design is still in flux and the market is uncertain”. Pedersen and Dalum (2004) define radical innovation as a major change that represents a new technological paradigm. It implies that the codes developed to communicate changing technology will become inadequate. The OECD’s Oslo Manual (2004) classifies incremental innovation as other changes in products and processes like changes, which are “insignificant,” minor, or do not involve a sufficient degree of novelty. Stamm (2003) details differences between incremental and radical innovation according to nine perspectives.

To consider innovation in the context of a new or improved product we look at the production or development process as at an investment project bearing innovation in itself. We assume, that innovation is an important part of such an investment project. We assume, that at the final stage the efficiency of investment will be depending on innovation efficiency. These three dependable segments make a clear «3 target» innovation project matrix (Fig.1).

This matrix is describing the 3-target economic activity in a closed cycle, each target complementing the other. Innovativeness and innovation efficiency is a prerequisite for a successful investment project. From other side, efficient innovation contributes to the efficiency of an investment project. The main issue is to choosing the “right” innovation target to reach the investment project efficiency target.
Typical project has to go through many steps, which are starting from idea and are leading to discussions, implementation, control with a feedback to final results preceding with project evaluation (Fig. 2).

We consider that typical innovation project going through various steps has to bear innovation and innovative thinking. At every stage there should be a message about the innovative idea, innovative implementation and innovative outputs leading to overall result. The efficiency itself is not a final target of a project. A final target is benefit (Fig. 3). It means that if innovative project is efficient it is at the same time bringing different benefits, such as financial, social or economic.

Fig. 3 shows the innovation path from project idea to investment stage related to implementation, further to efficiency stage related to efficiency measurement using different criteria and indicators and, finally, to the stage of final overall result which we name as “benefit”. The value of benefit could be measured in different ways as, for example, contribution of a new product in the whole product portfolio, usually in net present value (NPV), revenue or profit.
Measuring the Investment Efficiency in Innovation Project

There are many discussions about how the investment and innovation should be measured and assessed at every project stage. Some authors as Li (2000), Elenkov and Manev (2009) suggest to measure new and improved products as direct output of innovation associated with new product development. West et al. (2003), Akgün et al. (2009) are suggesting to measure improvements in process and methods, while Czarnitzki and Kraft (2004) are speaking about the market success of innovation, suggesting “ratio of innovative product sold in the market to total sales”. Speaking about market aspects Elenkov and Manev (2009) are defining an indicator of the success of new products on a market, making a point that a rate of success of new products on a market may be very vulnerable and is never 100%. Some authors refer to patent application for innovation (Jung et al., 2008; Zahra and Nielsen, 2002), but Makri and Scandura (2010) are suggesting measuring the importance of patents in terms of patent citations. Several other useful papers can be identified, including Barczak (1995), Linton et al. (2002), Montoya-Weiss and Calantone (1994). We can mention also the papers (Cooper, 1990; Cooper and Kleinschmidt, 1996; Boston Consulting Group, 2006; Chapman et al., 2001; Cooper, 1998; Cooper and Edgett, 1996; Cooper and Kleinschmidt, 1986), which develop the concept of output performance factors, including financial, temporal, market and product related factors.

The above-presented sources refer to measurement criteria, which are in most cases related to the product, technology (process) and market. The use of a number of different measurement indicators is leading to the need for further examination of the innovation-business performance relationship. Here we should think about the investment efficiency in innovation project in terms of a wider benefit for a firm or society. All above findings have let us to distinguish 5 major groups where various measurement criteria are allocated (Fig.4). To the three groups mentioned in the above referred publications, namely: product, market and process, we allocated two additional groups, namely, finance and management. The logical explanation for this is that financing of investment in innovation is very often a limiting factor. Management of the innovation process is also considered as rather important and complex performance criteria for measuring the efficiency of innovation.

As our research is focusing on innovation projects in agriculture and forestry related sectors, we have exercised to draw up in the Table 2 the list of criteria within each of five groups listed in Fig.4, which could be used for measuring the efficiency of investment in innovation. In defining these criteria it was essential to take on consideration the particularities of a new form of innovation project which appeared in agriculture recently - innovation partnership. This is a kind of multi-actor collaborative group established and managed properly for solving a specific problem with applying a specific innovation as a part of investment project. This is the model which is used in European Innovation Partnership (EIP) for the Agriculture Sustainability and Productivity (European Commission, 2016) when the multi-actor operational groups are established to perform an innovation project for the benefit of all group members and to a wider target sector.

Taken this context described above, the criteria referred to in group “Product” (Table 2) are expected to reflect a product as a value for every member of a partnership group. “Process/technology” group relates more to the implementation of process from problem to idea and technological implementation. “Management” group criteria are to measure the performance of a partnership group taken all existing environment, including leadership, education background or national support for the EIP projects.

The criteria referred to “Finance” group are to measure investment in research, innovation, investment in total product, farm investment and other indicators. It is important that both private and public investment, including support grants, are considered there. Our research proves that companies that successfully apply a structured process to innovation project management reduce risk in the process and increase project results.
Table 2. Measurement Criteria for Innovation Efficiency by Group

<table>
<thead>
<tr>
<th>Product</th>
<th>Process/technology</th>
<th>Management</th>
<th>Finance</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of new innovative products</td>
<td>Technological readiness level</td>
<td>Collaborative partnerships for innovation</td>
<td>Innovation investment input/unit</td>
<td>Product success on a market</td>
</tr>
<tr>
<td>Product novelty level (%)</td>
<td>New/improved technology/method</td>
<td>Use of national Innovation support system</td>
<td>Innovation investment input/output unit</td>
<td>Product market share</td>
</tr>
<tr>
<td>Share of new products in a total production</td>
<td>Technical capacity performance indicators</td>
<td>Skilled leadership</td>
<td>Investment in R&amp;D/Investment input</td>
<td>Product market</td>
</tr>
<tr>
<td>Use of patents</td>
<td>Cost of production</td>
<td>Structured organization and responsibilities</td>
<td>Innovation investment input/total farm investment</td>
<td>Potential market for a product</td>
</tr>
<tr>
<td>Product functionality and adaptability to existing systems</td>
<td>Technological performance</td>
<td>Educational background for innovation</td>
<td>Public investment/Innovation investment input</td>
<td>Market readiness</td>
</tr>
</tbody>
</table>

The market related criteria are expected to measure the potential of the market for the innovation product, but also the product success on the market rate, taking on consideration a mix of marketing activities. It is important to note that all the criteria presented in Table 2 are covering rather wide spectrum of innovation process and are subject to adjusting during the modelling process.

Comparison of Models for Assessing Efficiency of Investment in Innovation Project

There are many ways to assess investment efficiency in innovation. Some papers talk about the “profitability” of innovation using its EBITDA margin based on projects implemented (Stumpf, 2000), other authors suggest indicators such as the rate of renewal on a product portfolio (measured as the % of sales corresponding to products less than 5 years in the pipeline (Montoya-Weiss and Calantone, 1994), others propose a straightforward ROI model (Pearce, 2015) considering return on investment as one way of considering profits in relation of capital invested. It is possible to simply use the traditional NPV (Net Present Value) and IRR (Internal Rate of Return) or payback period indicators for each project that is part of the innovation portfolio, as part of a Cost Benefit Analysis (CBA).

In practice the most common form of analysis in governments is cost effectiveness analysis (CEA), where the costs of alternative ways of providing similar kinds of output are compared (George et. al., 2001). Any differences in output are compared subjectively with the differences in costs. Less common, although widely used in public sector projects and planning, is CBA, in which some important non-marketed outputs are explicitly valued in money terms. Both CEA and CBA are analytical ways of comparing different forms of input or output, in these cases by giving them money values, and might themselves be regarded as examples of multi-criteria analysis.

Data Envelopment Analysis (DEA) widely used in modelling the performance of business entities. It uses a mathematical programming model to estimate the best-practice frontier without a specific functional form assumption and, permits the evaluation of firms based on simultaneous dimensions given that it allows the use of multiple inputs and outputs. DEA can be used to calculate the maximal performance measurement of each decision making unit (DMU) - firms in this case- given a certain number of inputs, relative to all DMUs in the sample (Mittal et al., 2005; Wilson, 2008).

The Multi Criteria Analysis (MCA) becomes widely recognized in governments for decision taking where quantities cannot be always valued in monetary terms (Golub, 1997). MCA is not a substitute for CBA, but it may be a complement and used in many cases, especially where multiple criteria are diverse in both the kinds of problem that they address (for example prioritization of programmes as well as single option selection) and in the techniques that they employ, ranging from decision conferencing to less resource intensive processes. However when multiple efficiency criteria of different nature: both quantitative and qualitative are involved, for comparing impacts it is not always possible to giving all of them explicit monetary values, although they may include some data from cost-effectiveness or cost-benefit analyses.

For comparing the models described above in terms of their use for assessing investment efficiency in innovation projects performed by EIP operational groups we have preceded to a comparison using the practical questioning matrix (Table 3).

The responses presented in table 3 and our recent experience with several projects provides important lessons in the area of selecting a right model for further analysis. All three models in principle are suitable for such type of exercise. The question is how to use them and what criteria to apply. The table 3 shows, that MCA seem to be more flexible, as for the modelling of the process some non-measurable qualitative criteria could be applied. They are important when we want to assess quality related project or process management performance. This management aspect is very important in partnership projects. However, it is difficult to apply a numerical measurement of management performance. The MCA can be just helpful in this respect.
Table 3. Comparison of Models for Analysis of Investment Efficiency in Innovation Projects

<table>
<thead>
<tr>
<th>Criteria for comparison</th>
<th>CBA</th>
<th>DEA</th>
<th>MCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used for decision taking</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Using multiple criteria</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>All (input and output) criteria have to be measurable</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Some qualitative criteria can be used</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Comparing alternative scenarios</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Can assess quality of management performance</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Easily available</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Usually MCA is performed to assess and compare at least two alternative scenarios and to select the better one. The question is if measuring the investment efficiency, as a part of an innovation project should be performed as analysis of alternatives? To our experience it could, taken that alternative scenario and/or alternative projects could be compared. The specific project scenario could also be compared to a standard scenario of a typical project in the same group of projects. This could be the case when assessing a group of EIP innovation partnership projects. Of course, the MCA would not replace the CBA to assess the final overall result-benefit of an innovative investment project.

Conclusions

As emphasized in the literature, innovation can bring benefit for a project with saving time, costs and introducing new product to the market. Understanding the concept of innovation and the place of innovation in a project cycle provide a basis for focusing on innovation efficiency analysis in the context of innovation project with the assumption that efficient innovation is a success key for the efficient investment.

The “three target” innovation project matrix, as suggested in this paper, is leading through different steps to bear innovation and innovative thinking into all project stages. At every stage there should be a message about the innovative idea, innovative implementation and innovative results leading to overall efficiency. We suggest the investment efficiency is not a final target. The final target is the benefit from investing in innovation, and this benefit could be financial, social or economic.

The findings of authors enabled distinguishing 5 major groups of criteria where various efficiency factors are allocated. To the three criteria groups (product, market and process) used in the literature, two additional groups were allocated: finance and management. The logical explanation for this is that financing of innovation in investment project is very often a limiting factor, also management, being non-measurable, is considered a rather important performance indicator for the efficiency of investments.

The comparison of three models (CBA, DEA and MCA) and recent experience with real projects provided valuable lessons in the area of selecting a right model for further analysis. All three above listed models in principle are suitable for assessing investment efficiency of innovation project. Taken that it is problematic to measure management performance and the qualitative assessment is helpful, this suppose that the MCA could be useful to tackle with this issue. Thus, we conclude that the MCA could be further used for assessment of investment efficiency in innovation project together with CBA.

References


INOVACIJŲ VAIDMUO INVESTICIJŲ EFEKYVYVUMUI

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Santrauka

Pagrindine išdėja šiame darbe yra tai, kad inovacijos prisideda prie inovacijų efektyvumo ir tvarumo. Pagrindiniai šio tyrimo uždaviniai yra: a) išanalizuoti inovacijų koncepcijų ir teorinius modelius, ir b) nustatyti vertinimo kriterijus ir parinkti modelį kuriuo toliau vertinti inovacijų projektų efektyvumą. Tyrimams naudojami analitinis ir ekspertinis metodai, atliekamas teorinis literatūros šaltinių tyrimas, taip pat palyginamoji veiksnys ir vertinimo kriterijų analizė. Šiais metodais straipsnyje analizuojami skirtinio autorų inovacijų apibūdinimai, taip pat inovacijų vaidmuo investicinių projektų naudai. Straipsnyje nagrinėjami įvairūs vertinimo kriterijus ir vertinimo modeliai, kurie turi įtakos vertinant inovacijų efektyvumą. Tačiau, vertinimo metodų ir modelių apibūdinimas ir tiesioginės įtakos inovacijoms ir teoriniams ir praktiškams projektams. The article has been reviewed. Received in November, 2016 Accepted in November, 2016

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