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THEORETICAL ASSUMPTIONS OF METHODOLOGY FOR INVESTIGATION OF RISK MANAGEMENT IN INNOVATION ACTIVITY ACCORDING TO THE INNOVATION MANAGEMENT APPROACH

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Abstract. The main purpose of this article is to demonstrate theoretical assumptions of methodology for studying the risk management in the innovation activity of enterprises according to the approaches for innovation management they use. First, we identify the risks in innovation activity and the methods for their assessment in the current literature. Second, we identify approaches for innovation management and seek a link between them and possible risks. The literature review shows a literature gap on specific risks associated with a particular approach to innovation management. In order to overcome these limitations, the authors propose a structure and content of questionnaire for empirical expert survey.

Keywords: innovation risks, risk management, innovation management approaches, risk assessment methodology.

JEL Classification: L20, O30, D80.

Introduction

For today's companies innovation becomes more and more the source of strategic differentiation or cost leadership (Dillerup & Kapple, 2015). In addition, nowadays in the era of digitalization, the need to rethink and completely change activities, processes, competencies and models, the so-called process of digital transformation, pushes the innovation process in companies (Nedyalkov et al., 2020). On the other hand, innovation projects belong to the categories with the highest investment risk (Pavlov, 2008). Furthermore, challenging competition, frequent changes in companies' environments increases the complexity of innovation management significantly (Dillerup & Kapple, 2015).

The different approaches to innovation management that are used in practice can be pointed in different directions, in the field of production and / or in the field of sales of innovation. These three possible directions determine the structure of the innovation process. At the same time, the origins of the risks associated with the innovation process also differ depending on its stages and the field of application of the innovation. In today's dynamic changes in the economic environment, risk management is especially important for the market success of products. Therefore, it is necessary to study the sources and causes of risk situations, as well as to introduce approaches and manage them under specific conditions.

The purposes of this paper are to theoretically justify the creation of a methodology for studying the risk management in the innovation activity of enterprises according to the approaches for innovation management they use and to propose a questionnaire for empirical expert survey. Achieving the defined goals is subordinated to the main research thesis that risk management in innovation activities is essential to increase company competitiveness and organizational efficiency, and it should be specialized according to the chosen innovation management approach. The object of the study are companies with innovation activities. The subject of the research is practices of risk management in innovation activity.

The paper is arranged as follows. In the first section, we describe how the risk management in the innovation activities in literature has advanced and particularly what types of innovation risks have been identified by the authors in the various studies. Then we explain in detail the main approaches to innovation management and how we can group them according to the direction of the innovation process. At the end of this section, we review the existing relations in the literature between

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the approaches to innovation management, innovation strategy and risks. At section 2, we discuss our research questions; which then leads to the selection of our sampling frame and our methodology. In the last section, we discuss the key links and relationships that can be obtained using the described structure and content of the questionnaire for empirical expert research. Finally, we provide conclusions as well as offer potential for future research as a result of this study.

1. Literature review

1.1. Risk management in innovation activities

Risks in business cannot be considered only as losses, they are an opportunity to deviate from the goal to achieve strategic goals (Polinkevych et al., 2021). Biloshkurska and Biloshkurskyi (2019, p. 469) define the term innovation risk as "a characteristic of innovation activity of an industrial enterprise, which reflects the probability of achieving its positive or negative target result in the process of creation and commercialization of innovations". Innovation risk differs from other risks in some specific features: high degree of uncertainty and return; it is not a result of a specific harmful phenomenon, but a result of the creative and intellectual work; the risk symptoms appear late – at the end of the implementation of the innovation and the production tests, when the costs for it have already been incurred; the risk is related to direct and indirect economic effects; it is avoidable only by a transfer of innovation to an external source (Panteleeva, 2013).

According the ISO 31000 the risk management process contains the following steps: establishing the context, risk identification, risk analysis, risk evaluation, risk treatment, monitoring and review, communication and consultation (International Organization for Standardization [ISO], 2009).

In the risk identification phrase, all possible risks should be pointed out. There have been numerous studies (more than 34) to identify innovation risks, some focusing on the creation of innovation in general, others on new product development and single on new processes, new technologies, and reengineering. Comparing the number of identified risks by different authors, Luoma, Paasi, and Nordlund (2008) and Nechaev and Prokopyeva (2014) pointed out the largest number of specific risks (50) in innovation activities in general and Keizer, Halman, and Songb (2002) and Thangamani (2016) – respectively 142 and 52 specific risks in new product development process. The different objectives of research studies in the field logically define different criteria for classifying innovation risks (Lambovska & Todorova, 2021). For instance, Panteleeva (2013) divides the risks according to the subject-functional areas of innovation, as the risks are grouped into four sets – management, products, personnel and production. On the other hand, Bogdanova and Parashkevova (2013) focus on risks associated with uncertainty or threats of disturbance of relations with: suppliers, partners, customers, competitors, institutions, other external contractors and entities. Analyzing the similarity between the risk categories used by different authors, we can make the following summaries of the most frequently mentioned categories of innovation risks. The most common risk categories are the following: financial risks, organizational risks, market risks, technological risks and managerial risks (including project management). These risks are common both among authors who study the innovation process as a whole and with those authors who specialize in the study of new product development processes. The authors often use the following risk groups: social risks, production risks, technical risks and legal risks. On the other hand, the categories of risks related to design, supply and procurement, intellectual property, quality and planning are distinctive mainly of the new product development process. A few authors mark the categories of natural risks, risks from the business environment, resource risks and partnership risks. From what has been said so far, we can conclude that the most common risk categories combine risks that are important for companies, for the success of innovations and are often found in practice.

On the other hand, there are a number of authors (Floricel & St-Pierre, 2003; Pavlov, 2008; Luoma et al., 2008; Choi et al., 2009; Park et al., 2011; Škec et al., 2012; Brophey et al., 2013; Dewi et al., 2015; Batkovskiy et al., 2015), who systematized the risks of innovation, considering the sequence of stages of the innovation process. Analyzing the number of authors and the number of risks mentioned in the individual phases, we can conclude that most authors and most specific risks are listed in the phase "Marketing activities / Commercialization". Luoma, Paasi, and Nordlund (2008) focus their research on this phase of the process and note a large number of risks. Next in number are the phases "Design" and "Production Ramp-up". The following details, give us the opportunity to conclude that 1) there is relationship between likelihood and impact of the innovation risks and the phases of the innovation process 2) innovation risks are more likely to occur in the last stages of the innovation process. Therefore, the innovation risks should be identified and analyzed, and the most appropriate approach for their management should be chosen from the very beginning of the innovation process. In addition, this process should be constant and continuous throughout the whole innovation process.

The next step in the risk management process – the risk analysis consist of evaluation of the risk consequences and the probability that those consequences can occur. Methods for analyzing risks can be qualitative, semi-quantitative, or quantitative (ISO, 2009). Qualitative assessment methods determine likelihood, effects and level of risk ("high", "medium" and "low") and in most cases they are based on experience and descriptions. Semi-quantitative methods are deterministic and use numerical rating scales for consequence and probability and by

formula create a level of risk. Quantitative analysis methods are probabilistic and based on mathematical formulas (ISO, 2009; Lyubenova & Kirova, 2020). All three types of risk analysis and risk assessment methods are used by authors who study the risks in the innovation process. Some researchers use quantitative methods such as: Risk assessment based on expert evaluations (Keizer et al., 2002; Floricel & St-Pierre, 2003; Škec et al., 2012), Risk Matrix Chart (Susterova et al., 2012), Failure Mode and Effect Analysis (Mehrjerdi & Dehghanbaghi, 2013; Dewi et al., 2015), others use semi-quantitative methods such as: mathematical coefficients (Nechaev & Prokopyeva, 2013), Analytic Hierarchic Process (Choi et al., 2009; Park et al., 2011) and correlation analysis (Kuznetsova, 2021). A few researchers use quantitative methods like Monte Carlo Simulation (Thangamani, 2016) and System Dynamics (Mehrjerdi & Dehghanbaghi, 2013; Dillerup & Kapple, 2015).

The literature review shows that many authors utilize risk assessment questionnaires as a starting point for further more complex analyzes. For instance, Keizer, Halman, and Songb (2002) presented the Risk Diagnosing Methodology (RDM), which aims to identify and evaluate technological, organizational and business risks in product innovation. In their questionnaire respondents were asked individually to score risk statements on three five-point scales. Similarly, Floricel and St-Pierre (2003) privileged an "expert system" approach, which relies on hundreds of simple YES/NO questions and sub-questions arranged in a logical sequence function of the answer to the main question. Moreover, Zaynullina (2021) conducts an expert survey for qualitative and quantitative risk assessment of a group of innovative projects and for measurement of the potential impact of risks on the management strategies formation in context of sustainable development.

Once the risk assessment has been completed, the impact on the risk includes selecting and agreeing on one or more applicable options to change the likelihood of the risk occurring, the consequences of the risks, or both (ISO, 2009). The manager should implement one or more risk management strategies (techniques), which are:

- risk avoidance – involves eliminating a particular threat. This can be either by eliminating the source of risk within a project, or by avoiding projects or business organizations that are at risk (Molenaar et al., 2010);
- risk acceptance – the company decides not to do anything about the risk, accepts the risk and its consequences (Bowers & Khorakian, 2014). However, this response is passive, but it is planned as the ability to do anything about some risks may be limited or the costs of limiting the risk may be significantly greater than the potential losses in the event of a risk. Event (HM Treasury, 2004; Bogdanova et al., 2012);
- risk transfer – a way for organizations to protect themselves from external negative events and the responsibilities for risk can be redistributed in a more appropriate way. A company may realize that it does not have enough experience with vital technology and decide to subcontract part of the development or even sell a partially developed product to another organization (Bogdanova et al., 2012; Bowers & Khorakian (2014);
- risk mitigation – the aim of this technique (strategy) is to reduce the risk by taking initiatives to, on the one hand, reduce the damage caused by the risk, and on the other hand to reduce the likelihood of the occurrence of the risk event (Pavlov, 2012).

1.2. Innovation management approaches

Innovation management is defined as active and conscious organization, control and implementation of activities that lead to innovation (Hajikarimi et al., 2013). Its focus is to allow the organization to respond to external (customers, suppliers, competitors, consultants, media, globalization, etc.) or internal (technical departments, marketing and sales, logistics, manufacturing, etc.) opportunities and use her creative efforts to introduce new ideas, processes or products (Şimşita et al., 2014). Innovation management is a set of principles, methods and forms of management of innovation processes, activities, structures and personnel in the industrial enterprise (Kirova, 2011; Panteleeva, 2013).

The different approaches to innovation management, which are used in practice, can be oriented in different directions, in the field of production and / or in the field of sales of the innovation. Innovation management approaches can be divided into the following groups (Kirova, 2011):

- Approaches that affect only the production of innovations;
- Approaches affecting the production, implementation, distribution and diffusion of innovations;
- Approaches affecting only the implementation, distribution and diffusion of innovations.

The first group of approaches aims to create new products or technologies with high quality parameters. This group includes benchmarking and marketing techniques for impact – marketing research and marketing planning of innovations.

The essence of benchmarking is a continuous process of studying and comparing the strategy, products, processes of the company with those of world leaders and the best industry organizations (Dragolea & Cotîrlea, 2009) and transferring the leading experience of good practices into the company practice (Petrova, 2020). The concept of benchmarking as an approach to innovation management is associated with the study of the business of prominent competitors in the industry in order to derive fundamental characteristics for the development of company's own innovation (Kirova, 2011). Depending on the direction in which benchmarking is oriented in the analysis of good practices, several main types of benchmarking can be distinguished – strategic, performance,

process, functional (basic) and general (Dragolea & Cotîrlea, 2009).

The role of marketing research is to assess the needs and desires of consumers and to provide information to support the design of the marketing program of the business form. This means that marketing research tries to identify and define marketing problems and opportunities, as well as to generate and evaluate marketing impacts (Valchev, 2011). Market research, as an approach to innovation management, should support the creation of innovation, in two respects:

- in identification of sufficient and the most useful input information for the creation of product and process innovations in existing or undeveloped areas of application;
- in reduction of the risks associated with innovation, especially the marketing risks at the last steps of innovation process (Herstatt, 2004).

The second group of approaches affects the whole innovation process and includes the following approaches: innovation engineering, innovation reengineering and innovation brand strategies.

Innovation engineering is defined as a method of solving technological and business problems for organizations that want to innovate, adapt and / or enter new markets using experience in emerging technology business models, innovation culture and high-performance networks (Sidhu, 2019). In essence, it is a complex of activities and services for the creation of an innovation project, including the creation, implementation and diffusion of a particular innovation (Kirova, 2011).

Hammer and Champy (2001) define reengineering (business process reengineering) as a fundamental rethinking and redesign of business processes to achieve dramatic improvements in terms of cost, quality, service and speed. In other words, the innovation reengineering is engineering consulting services related to the rethinking and reorientation of entrepreneurial activity based on the production and implementation of innovations. Satisfying the current and strategic needs of customers is the main goal in managing innovation through reengineering (Kirova, 2011). The main philosophy of reengineering is that the rapid redesign of the company's critical core processes will generate significant improvements in the company's productivity and will generate a competitive advantage in the global market (Joshi & Dangwal, 2012).

Brand of innovation is the system of characteristic properties of the new product or operation, which: forms the consciousness of consumers and positions the innovation, its manufacturers and traders on the market; provide strategic focus and guidance to innovations; support the introduction and adoption of innovations (Bevilacqua et al., 2020). In innovation management, brand strategy means managing the processes of market diffusion of new products based on the development of the innovation brand. The properties of the brand include all the functional and emotional associations that consumers relate with the new product and give it some individuality (Kirova, 2011).

The third group of approaches includes pricing management methods, conquering new markets, acquisitions and mergers. The main goal in this case is to accelerate the sales of the innovation with maximum benefit and efficiency at the moment and for as long as possible in the future.

Pricing approach to innovation management is a tool for influencing prices in order to successfully implement the innovation. It includes two main elements:

- the pricing factors acting during the production of the innovation;
- the pricing policy applied in the realization, distribution and diffusion of innovation.

1.3. Risk management in innovation activities according to the innovation management approach

The main goals of innovation risk management are stability of the financial position of the corporation, achieving efficiency in the implementation of innovations and ensuring strategic sustainability of development (Shalneva et al., 2021). In order to support decision-making in organizations on issues related to risks in innovation, as indicated by Berglund (2007), the relationship between risk and innovation needs to be invested in more specific situations. Several studies, for instance Floricel and St-Pierre (2003); Berglund (2007); Škec, Štorga, and Marjanović (2012) study how risk is primarily related to innovation as process and not as output and its phrases.

The management of the innovation process in the company is carried out through the innovation management. Furthermore, the innovation process is unthinkable without a well-formulated innovation policy and a well-justified innovation strategy. Therefore, we can make a direct link between the innovation strategy and the innovation management approach and from there to identify the risks associated with the chosen approach. According to the position of the company on the market, the innovation strategies can be defined as: pioneer strategy, fast follower strategy, imitative strategy, dependent strategy, low cost strategy and specialization (DeSai, 2013).

The pioneer is the first, who introduce new offers – products or services on the market. This means that the company plans to build the appropriate competence to build innovation before all other companies (DeSai, 2013). The need to create a new product to stay ahead of the competition and lead to rapid market entry, implies the use of innovation engineering as a basic approach to innovation management. In this situation, it is appropriate to apply also the brand of innovation approach, as an adjunct to the overall vision of innovation. The strategy is difficult to implement because it requires the company to decide to enter the market before it is clear whether the product will be sold successfully by the leading

company (Varamezov, 2013). In addition, this strategy, as well as innovation engineering, requires large investments and high risk.

The fast follower strategy means waiting for the offensive leader to introduce the product first, monitoring the elements of his business model, identifying shortcomings, and then introducing a better product that corrects the mistakes made by the pioneer (DeSai, 2013). An appropriate approach to this strategy is benchmarking, which would help to analyze competitors, their advantages and disadvantages that can be corrected. In order for a company to deal with the need to react quickly and launch a new, better product, it should have a production system that can respond quickly enough. For this reason, it is good to plan and implement also the innovation reengineering approach. This strategy is safer than the previous one, as the consumer's response to innovation is already known. However, it is still risky because competitors can take away market share.

In an imitation strategy, companies prefer to produce a clone of the pioneers' products. These players have unique performance skills, such as low labor costs, cheap raw materials or low value production (DeSai, 2013). In this strategy, the main approach to innovation management is benchmarking, which aims to completely copy the competitor's product. With this strategy, the company saves research costs and uses ready-made scientific and technical results. Low prices of raw materials and labor make the profit from the product higher (Varamezov, 2013). Therefore, some pricing approaches may be used in order to gain a price advantage over competitors. As a result, the risks are considered and minimized.

Both dependent strategy (the company is very satisfied with the status quo and will change the functions of its proposals only at the request of their best customers) and specialization strategy (the company is looking for a unique niche in the market that is not fulfilled) are not innovation-oriented and do not require large investments (DeSai, 2013). Possibly marketing research methods can be used.

In the low price strategy, the company's goal is to stay focused on short-term profitability, limiting changes in offers and striving to offer the lowest possible prices. There pricing approach to innovation management is used as the risks are minimal.

Considering the risks through the prism of the innovation strategy and on the basis of the nature of the innovation management approaches in the literature, we can theoretically say that:

- Approaches affecting the production, implementation, distribution and diffusion of innovations such as innovation engineering, innovation reengineering and innovation brand strategy require the largest investments, and therefore consists of a large number of risks of failure;
- Approaches affecting only the production of innovations – like benchmarking, marketing research and marketing planning of innovations – are less risky, because comparison with competitors and market research allow to determine the consumer response to innovation;
- Approaches affecting only the implementation, distribution and diffusion of innovations – pricing management methods are with minimum investments and risks.

Unfortunately, what specific risks are associated with a particular approach to innovation management in the literature are not found. To cover this gap, a methodology for empirical expert survey is developed.

2. Methodology

The goals of this paper are to: 1) theoretically justify the creation of a methodology for investigating the risk management in the innovation activity according to the innovation management approaches companies use and 2) propose a structure of questionnaire for empirical expert survey. Our first objective of methodology is to provide a rich description and create new knowledge about the most used innovation management approaches in a certain sample of companies. The second objective is to obtain expert assessments of risks in the innovation activity and based on them to determine the most probable risks and the risks with the greatest impact according to the chosen approach.

The questionnaire developed by the authors, the structure and content of which will be presented in the following lines, should be used for empirical expert survey. In the survey should participate companies with innovation activities from predefined target group, involving micro, small, medium and large enterprises. Expert answers and assessments should be made by the following company representatives: Owner, Director / Manager, Head of department directly involved in the innovation activity, Head of another department or Administrative officer.

In order to fulfill all objectives, the questionnaire is designed in 3 sections: Section 1: Innovation activity, Section 2: Risk management in innovation, Section 3: Company profile.

Analyzing the innovation activity, in addition to the innovation management approach used in the companies, information about the innovations as a result of the innovation activity is also useful. Therefore, in Section 1 of the questionnaire the representatives were asked about the types of innovations created in their companies: in the last 3 years, most often and what are planned for the next 2 years. The following types of innovations are indicated in the questionnaire: Product innovations, Process innovations, Organizational and managerial innovations, Technological innovations, Market / marketing innovations, New business models. Most of the types of innovations have subtypes for greater clarity of processes and needs, for instance: as subtypes of Organizational and managerial innovations are: New organizational structures of management, Improved organizational

structures of management, New schemes for staff incentives, New methods of construction of corporate culture, New methods of supplying materials. An important question in this section is "What approach to innovation management is used in the company?" indicating the 6 approaches described in section 1.2. – Innovation Engineering, Innovation Reengineering, Benchmarking, Innovation Brand Strategy, Innovation Marketing, Pricing Approach to Innovation Management.

At the beginning of Section 2 are included general questions about risk management in the enterprise – whether and how they are documented, assessed and what methods are used for assessment. Some questions from fist part of Section 2 "Risk management in innovation" are: ....

.....

2.1. Are the risks in the company's innovation projects managed?

A) Yes, they are managed ☐

B) Efforts are being made in this direction ☐

C) There is no risk management capacity ☐

.....

2.2. Are the risks in the company's innovation projects assessed?

A) Yes, a certain quantitative method (s) is used for assessment ☐

B) Yes, a certain qualitative method (s) is used for assessment ☐

C) Intuitive assessments of risk levels are made ☐

D) Risks are not assessed

….

After a detailed literature review of the risks in innovation activities, a list of 24 risks, divided into 18 groups, are set down in the questionnaire. The risks are defined as internal and external to the company, whereas that external risks are difficult, even impossible to manage. Internal risks are grouped into the following risk categories: Finance, Management, Organization, Resources, Quality, Technical, Technology, Intellectual Property, Marketing. In addition, external risks are grouped into the following categories: Customers, Market, Economy (Government), Legislation, Policy, Suppliers, Partners, Social, Force Majeure. The assessment of all risks from the list is made twice according to different criteria. The first part is an assessment of the probability of occurrence and the size of possible damage of the risk event in the innovation activity (Table 1). A 5-point scale is used for both parameters. The question here is:….

…….

2.10. Assess the listed risks in the innovative projects according to the criteria:

– probability of risk occurrence (1 – very unlikely, 2 – unlikely, 3 – equally likely to happen and not, 4 – likely to happen, 5 – very likely)

– size of the damage (1 – negligibly small damage, 2 – minimal damage, 3 – moderate damage, 4 – serious damage, 5 – critical damage).

Table 1. Question 2.10. from the questionnaire

Risk category	Risk	Probability of occurrence	Size of damage
Finance	Financial risks		
	Investment risks		
Management	Project Management		
…..			

…..

In the second part, the experts assess the probability of occurrence of risk events in the phases of the innovation process: Phase 1: Marketing research, Phase 2: Scientific and applied research, Phase 3: Design, Phase 4: Preparing the company for innovation, Phase 5: Experimental production and tests, Phase 6: Production Ramp-Up. Again, a 5-point scale is used.

The last third section of the questionnaire contains questions about the company's profile and the profile of the expert completing the survey. The main activity of the company according to the Statistical classification of economic activities in the European Community – NACE (European Commission, 2008), Headquarters of the company, Size of the enterprise, Position of the surveyor are the questions in this section.

3. Results from the research

The questionnaire is structured to allow identifcation of a large number of dependencies between the most important elements of the purpose of the methodology – types of innovation – approaches to innovation management and risks.

As far as we know, no previous research has investigated the relationship between innovation management approach and the types of innovations created by the companies. The results of this survey should give us the opportunity to define these dependencies. Although there are many studies about the innovation risks and particularly the risks in new product development process, the research about risks according the innovation management approach remains limited until the described methodology is used in empirical expert survey and the results of the survey become available. In addition, thanks to the information from the survey questions, we should conclude which is the most used approach for innovation management, whether it differs and depends on the nature of production, the size of the company, or the region of activity of the company.

The assessment of the probability of occurrence and the size of possible damage of the risk makes it possible to create a Risk Estimation Matrix and place all risks in their squares in the matrix. The different place in the risk matrix implies a different response to deal with the risk. Moreover, determining the phases of the innovation process with the highest probability of occurrence of a certain risk, in turn, allows a specific response to a certain

risk at the beginning, middle and end of the innovation process. The use of S-shaped curves to graphically represent the distribution of risk in the phases of the process should make possible to reveals the cause-effect relationship links between the studied risk with the innovation and between each risk. This demonstrates the possibility of a complex impact of risks, their interrelationships and conditions, which is a prerequisite for a proper portfolio of risks (Kirova, 2018).

Conclusions

Innovation risks depend on the type of innovation and the stage of the innovation process, as well as on the chosen approach to innovation management. Many authors identify risks in innovation activities and propose different methods for their assessment and management. In the current literature, there is a gap in the search for risk management methods according to the innovation management approach. To cover this gap, the methodology presented in this paper has been developed. It provides an opportunity to identify direct links between risks, approaches to innovation management and types of innovation. This information will give us a lot of knowledge as a basis for future risk management in innovation activities, both in existing enterprises with already chosen innovation management and in enterprises with minimal innovation, which want to grow.

The authors are working on conducting an empirical expert survey based on the described methodology in the chemical industry companies in Bulgaria.

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