

THE GOVERNANCE OF INNOVATION IN INDUSTRIAL ENTERPRISES

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Abstract: Innovations become the basis for the competitiveness of enterprises, lead to greater efficiency, better quality of products and services. The process of innovative activity requires enterprises to develop and implement a mechanism for managing innovation activities which is adequate to the requirements of a market economy. Moreover, for the process of implementation of innovative technologies in the enterprise, it is necessary to have a clearly formulated strategy for the development of innovation activity at the level of a country, region, industry and enterprise. Taking into account all the above, it can be noted that a competent policy in the field of innovation is not only a problem of a country, but also a problem of every enterprise, the basis of competitive advantages of which should be the implementation of innovative technologies and application of the results of scientific and technological progress. Scientific and technological progress also means the development of information and communication technologies in the economic sectors. The aim of this study is to consider innovation management systems, analyze and describe the types of innovations and creating recommendations for improving the competitiveness of enterprises in tough innovative competition.

Key words: innovative development, industrial enterprises, technologies, innovation inputs, innovation outputs, integrated analysis

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Introduction

The modern stage of the science development is characterized by a large number of production tasks. One way in which organizations can cope with the competitive pressures of today's rapidly changing business environment is to adopt innovations that will enhance their competitiveness (Cao et al., 2012). According to Smoliy et al. (2018), the level of development of science and technology determines the position of countries in the global economy, the size of the gap between the levels of their economic development and forms the basis for a sustainable economic

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growth. The innovative factor largely determines the quantitative parameters of the economic growth and creates the preconditions for modernization and improving the efficiency of the national economy. It considerably influences also innovation processes on economic mechanisms and determines the degree of innovation economic development, and the most important macroeconomic indicators.

As the world experience shows, the stable economic growth can be achieved only on an innovative basis, with the active use of modern scientific and technological achievements. Only in this case, chances are used for high quality of growth, resource saving, production efficiency, production of competitive products on domestic and world markets. However, the number of domestic investment-innovation-active enterprises is small, especially in the small and medium-sized businesses, traditionally differing from large business with high innovative activity (Tlesova et al., 2018; Mura and Rózsa, 2013; Svec and Madlenak, 2017). According to Pomffyová et al. (2017), the successful business performance is strongly dependent on managers' possibilities to obtain the most available information, expertise, knowledge and wisdom by using all information systems' possibilities and tools supported by information technologies. The process of innovative development requires comprehensive assessment of the effectiveness of technology options, process organization, as well as the cost-effectiveness analysis of the project implementation for the introduction of innovative equipment in production.

In response to changes in the market environment, contemporary companies must search for more perfect and more innovative ways of operating. The ability to change and use innovation as an essential source of a competitive advantage becomes a basic element of the competitiveness and success of the company (Muafi et al., 2019; Czarniewski, 2016; Stasiak-Betlejewska, 2015; Kovács & Gubán, 2017).

An effective innovative activity of the enterprise depends on the quality of the implemented innovative technologies, meeting the requirements of time and economic situation. Therefore, the introduction of new equipment and technologies in the enterprise today is not a whim, but the need for survival, preservation of competitiveness and further prosperity. Enterprises create and strengthen their image by introducing new technologies in production, updating main facilities, releasing new types of products and increasing their quality.

Due to the constant volatility of the information economy, the issue of modernization of industrial enterprises is constantly relevant. After determining the competitiveness of an industrial enterprise for its development, it is necessary to modernize the production sphere to provide a sufficient level of competitiveness of the industrial enterprise within the industry or market. In the conditions of the information economy, special attention needs to be paid to the development of the managerial sphere of an industrial enterprise, which is the completion of the development of other fields, and the integration of automation, robotization and informatization (Kwilinski, 2018).

The introduction of innovative technologies has a huge impact not only on the process of product promotion on the market, effective communication infrastructure, including the field of human resource development management (Lorincová, 2018), but it is also the basis of an economic growth and effective innovation activity of an industrial enterprise.

Kenesheva and Alimbayev (2018) argue that the role of innovative technologies in the modernization of the economy and society is very significant. A change of technological structure determines the trajectory of the development of both social and economic development. At the same time, the modernization of production cannot only consist in the renewal of companies' fixed assets. In return, the technological modernization of the country's industry induces the technological development of industry.

There are many definitions of innovation. Rybárová et al. (2018) defined innovation as a new or significantly improved product or service introduced to the market, a new or significantly improved process, or new organizational or marketing innovation introduced within the company. Innovations are based on the results of new technological development, a new combination of existing technologies or the utilization of other knowledge acquired by enterprises. According to Damanpour (1999), innovation can be a new product or service, a new production process technology, a new structure or administrative system, or a new plan or program pertaining to organizational members. Rogers (2003) defined innovation as an idea, practice, or object considered new by individuals or other adoption units. He argued that innovation is a process that begins with the creation of new elements, with the creation that directs the idea of practical development to an element for commercial use.

The process of innovation is widely recognized and often constitutes the object of worldwide research. Unfortunately, there is no homogeneous approach to the measurement of the quality of the innovation process or innovation performance, and this lack of consensus is an impediment to the process of creating a competitive advantage from innovative organization. The antecedents of innovative performance of enterprises have been studied quite extensively in the recent years (Mazur and Inków, 2017). There are several authors who have examined the measuring of companies' innovation performance, including Saunila (2017); Roszko-Wójtowicz and Białek (2016); Findik and Beyhan (2017) or ter Haar (2018).

In accordance with the foregoing, the current research hypothesis is that innovation is the most important driver of economic development. And their introduction is possible only if there is an innovation environment.

Research Data and Methodology

The chain of reasoning is constructed within the framework of the main provisions of the evolutionary school in the economic theory; the features of each contract, a deal, and a problem situation will be taken into account, if possible. In addition,

scientific abstraction, analysis and synthesis methods, as well as approaches to a system analysis were used (we view economic entities as self-organizing systems within the framework of the system paradigm formulated by Kornai (1998) and developed by Corresponding Member of the Russian Academy of Sciences (Kleiner, 2011).

The sources of information included monographs, scientific papers and other publications in periodicals and scientific collections, Internet resources, etc. The information base of the study was made up of database of statistical office of the European Union, official statistics of the Russian Federal State Statistics Service (FSSS, 2019), reference documents of ministries and departments of the Russian Federation, regulatory and legal materials, author's calculations and personal observations.

Results and discussion

More business enterprises lay stress on the international opportunities, innovation activities and competitive advantages (Mura et al., 2018; Horecký, 2018). A long-term sustainable competitive ability of an economy can only be achieved by a strategy, based on innovation comparative advantages (Hečková and Chapčáková, 2011; Fenyvesi, 2015; Koval'ová et al., 2018). The issue of evaluating the innovation performance requires an analysis of its current state, as well as development trends in this area. The analysis also takes into account key indicators – the principles of Lisbon and Barcelona Strategy. The multicriterial evaluation concentrates its attention on the development of the conditions for the transition to the knowledge-based economy, which is becoming the epicentre of the competitiveness. The evaluation of innovation performance is based on the analysis of 25 indicators which are divided into 5 groups (Pro Inno Europe, 2008).

The first three groups include innovation inputs and the last two groups of indicators include innovation outputs:

- Innovation drivers (5 indicators), which measure the structural conditions, required for innovation potential;
- Knowledge creation (4 indicators), which measure the investments in research and development (R&D) activities; they are considered to be the key determinants for the development of a knowledge-based economy;
- Innovations and entrepreneurship (6 indicators), which measure the efforts, focused on the innovations of companies, small and middle businesses, own and co-operational, expenses on R&D, risk capital/GDP;
- Applications (5 indicators), which measure innovation performance, expressed through business activities, and the share of the employed people and their added value in innovative sectors;
- Intellectual property (5 indicators), which measure the results, achieved in the form of successful know-how as patents (EU, USA), brands, new design.

The following table (Table 1) presents 5 main categories (groups) and within them 25 indicators with a respective data and information source for each indicator.

Table 1: Indicators of innovation inputs and outputs of European innovation scoreboard

European innovation scoreboard	
I. Input – Innovation drivers	Data source
1. The share of university graduates per 1000 population, aged 20-29	Eurostat
2. The share of postgraduates per 100 population, aged 25-64	Eurostat, OECD
3. Broadband penetration rate (number of broadband lines per 100 population)	Eurostat
4. Participation in life-long learning per 100 population, aged 25-64	Eurostat
5. Youth education attainment level (% of population aged 20-24, having completed at least upper secondary education)	Eurostat
II. Input – Knowledge creation	
1. Public R&D expenditures (% of GDP)	Eurostat, OECD
2. Business R&D expenditures (% of GDP)	Eurostat, OECD
3. Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	Eurostat, OECD
4. Share of enterprises, receiving public funding for innovation	Eurostat
III. Input – Innovation and entrepreneurship	
1. SMEs innovating in-house (% of all SMEs)	Eurostat
2. Innovative SMEs co-operating with others (% of all SMEs)	Eurostat
3. Innovation expenditures (% of total turnover)	Eurostat
4. Early-stage venture capital (% of GDP)	Eurostat
5. IT expenditures (% of GDP)	Eurostat
6. SMEs using organizational innovation (% of all SMEs)	Eurostat
IV. Output - Applications	
1. Employment in high-tech services (% of total workforce)	Eurostat
2. Exports of high technology products as a share of total exports	Eurostat
3. Sales of new-to-market products (% of total turnover)	Eurostat
4. Sales of new-to-firm products (% of total turnover)	Eurostat
5. Employment in medium-high and high-tech manufacturing (% of total workforce)	Eurostat
V. Output – Intellectual property	
1. Number of patents (EU) per million population	Eurostat
2. Number of patents (USA) per million population	Eurostat, OECD
3. Patents per million population	Eurostat, OECD
4. New trademarks per million population	OHIM*
5. New community designs per million population	OHIM

Pro Inno Europe: European Innovation Scoreboard.

**/ OHIM - Office for Harmonization in the Internal Market (Trade Marks and Designs)*

The European Commission evaluates and also compares the application of Barcelona and Lisbon strategy, by multicriterial evaluation of the innovation performance of the EU countries. The European innovation score board as a methodology for assessing the innovation development of individual countries allows to see the change in individual indicators related to the innovation system. Taking into account the authors' criticism regarding this methodology (Hollanders and Cruysen, 2008; Schibany and Streicher, 2008), we can say that it assesses areas that are closely related to the innovation process, but the methodology itself is not the one that does it. From the point of view of the state, it is important to evaluate

and use the obtained results to improve its policies from the point of view of global competition in the field of the economy of knowledge and innovation.

Table 2: The results of the correlation analysis of the relationship between the indicators of the Inputs and Outputs of the EIS for countries ranking

	1. PCT patent applications per billion GDP (in PPS)	2. Trademark applications per billion GDP (in PPS)	3. Exports of medium and high technology products as a share of total product exports	4. Knowledge-intensive services exports as % of total services exports	5. Sales of new-to-market and new-to-firm innovations as % of turnover
1. New doctorate graduates per 1000 population aged 25-34				0.63	
2. Percentage population aged 25-64 involved in lifelong learning			0.87		
3. International scientific co-publications per million population	0.76	0.81	0.80	0.62	
4. Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	0.82	0.84	0.58		
5. Foreign doctorate students as a % of all doctorate students		0.65	0.53		
6. R&D expenditure in the public sector (% of GDP)			0.72		
7. R&D expenditure in the business sector (% of GDP)	0.89	0.88	0.63		
8. Non-R&D innovation expenditures (% of turnover)			0.66		
9. SMEs introducing product or process innovations as % of SMEs					0.73
10. SMEs introducing marketing or organizational innovations as % of SMEs					0.70
11. Innovative SMEs collaborating with others (% of SMEs)					0.72
12. SMEs innovating in-house as % of SMEs					0.74

EIS Database 2008-2017

In order to describe the effectiveness of various public administration tools, we used a correlation analysis to identify stable formal relationships between the

individual Inputs and Outputs EIS indicators that would be typical for all countries used in the rating. The results of our calculations are given in Table 2.

As we noted earlier, although the EIS is associated with the innovation process, it is not an exact method for its assessment. From this position, we believe that the list of Inputs and the corresponding tools should always lie in any state policy in the field of science and innovations (Table 3).

Table 3: List of tools and related dependent indicators

1. New doctorate graduates per 1000 population aged 25-34	Grants, international scientific events that promote payments for scientists
2. Percentage population aged 25-64 involved in lifelong learning	Creating an accessible educational environment
3. International scientific co-publications per million population	Co-financing of scientific publications, invitation of leading scientists to scientific events
4. Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	
5. Foreign doctorate students as a % of all doctorate students	Grants and internships for young scientists to build loyalty for the future doctoral studies
6. R&D expenditure in the public sector (% of GDP)	Increased funding, increased funding efficiency Incentive programs for businesses in terms of preferential taxation of innovation
7. R&D expenditure in the business sector (% of GDP)	
8. Non-R&D innovation expenditures (% of turnover)	
9. SMEs introducing product or process innovations as % of SMEs	
10. SMEs introducing marketing or organisational innovations as % of SMEs	
11. Innovative SMEs collaborating with others (% of SMEs)	
12. SMEs innovating in-house as % of SMEs	

Based on our experience and the empirical data from observation of the innovation performance process, we can point out similar features. Innovations are the result of the contact between the intellectual capital of individuals and the scientific and educational environment created in one particular place. It is the data obtained in institutional and informal conditions that determine the density of innovation performance and mediates its results.

As a whole, the proposed tools should be a sufficient basis for the formal side of the innovation process in a competitive country. But as noted above, the institutional environment also plays a key role and its formation is possible only with sufficient concentration of human and intellectual capital in a certain place and under favorable conditions.

These strategies are based on the performance evaluation of the innovative technology implementation in production, carried out on the basis of an integrated analysis (Figure 1).

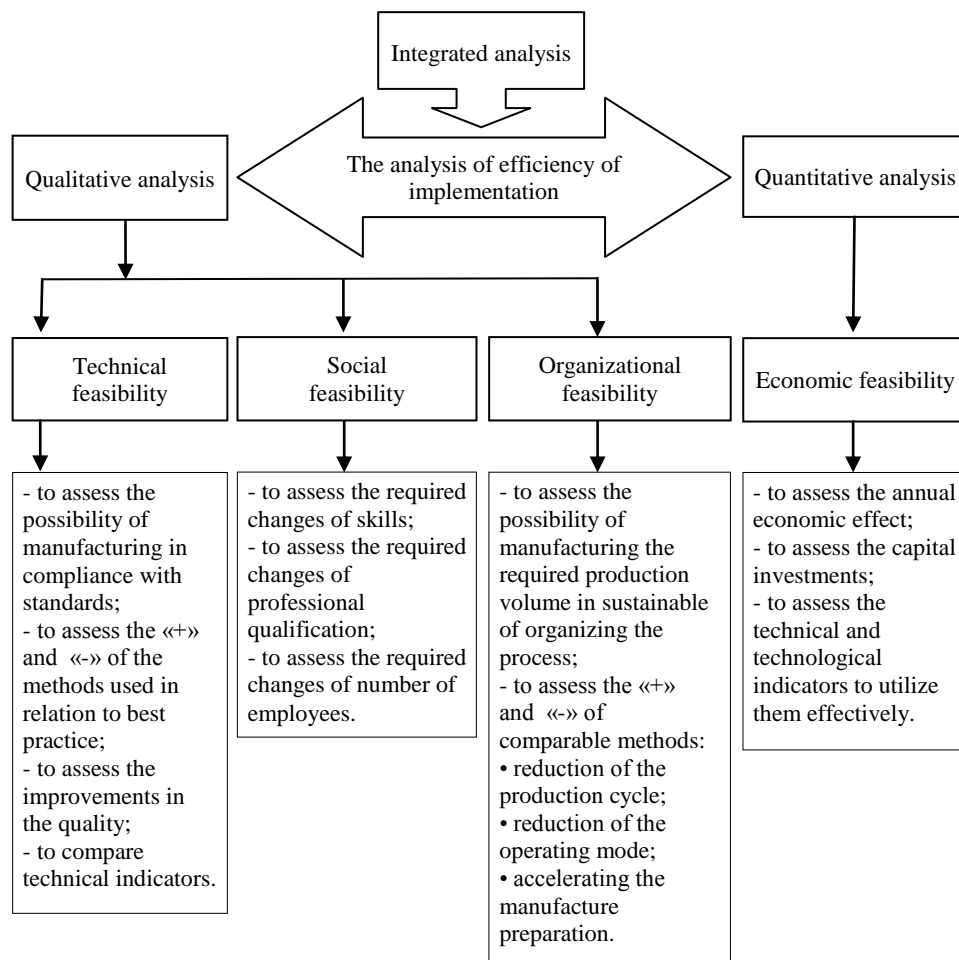


Figure 1: Integrated analysis of the implementation of innovative technologies at the enterprise

When applying an integrated approach, technical, environmental, economic, organizational, and social aspects of activities and their interrelationships should be taken into account. So, to perform the analysis of technical feasibility of innovative technology implementation, it is necessary to:

- Establish the possibility of manufacturing parts for machinery, in full accordance with the technical conditions, operating in production: the parts must be wear-resistant, competent and have all the necessary physical and mechanical properties, as provided for by the design documentation;
- Identify the advantages and disadvantages of methods, in terms of their compliance with advanced trends in the area under the study;

- Identify the methods of manufacturing parts, with the help of which maximum quality is achieved.

When analyzing the organization of production and workplaces, we made the assessment of the possibility of manufacturing the required volume of products, within a given time, with the unchanged organization of the workshops structure in production. The advantages and disadvantages of the compared methods are revealed, for example, shortening the duration of the production cycle, operating mode (interchangeability, utilization ratio, etc.), or accelerating of production preparation. This analysis has the same particular application as the analysis of technical feasibility.

The integrated analysis must be completed by an economic analysis. The economic analysis makes it possible to draw a conclusion about the advisability of making a decision when choosing a certain technique, and includes determining the economic effect, obtained as a result of applying various innovations, the economic efficiency of capital investments, and the optimal technical and technological parameters, ensuring the rational use of technology.

The next stage is the calculation of the economic efficiency of the project implementation for the introduction of innovative equipment. Calculations of the economic efficiency of innovation technology implementation are carried out at all stages of design and planning. The choice of an economically effective option will be determined by the least amount of costs for implementing innovative technology. A variant of the introduction of new equipment into the existing production is also possible. Then, it is necessary to take into account the costs for additional equipment of production facilities, such as, for example, control and management automation equipment, etc.

The economic effect of the new technology implementation in the current production is determined in the comparison of the cost of production in the current production and after the introduction of innovations, as well as the value of production facilities. It should be noted, that with the implementation of new technology, there may be a situation, where a part of the main facilities (for example, equipment) will not be used in the production process. If this equipment can be used in other technological processes, the losses from replacing old equipment with new equipment will be absent.

The development of a project for implementing innovative technology can be considered appropriate, in case when (Alekseeva et al., 2006):

- Additional capital expenses for the introduction of new equipment are repaid within the regulatory period by the branches;
- Technical indicators (for example, material utilization factor, productivity, cutting width, thermal impact zone, energy consumption, etc.) are better than analogous indicators of the equipment which was used for the production of similar products;
- When it becomes possible to produce products that cannot be produced on existing equipment.

The issues of organization and management become particularly important in the process of the transition of any economic system to innovative type of resources reproduction. The main, in our opinion, task of the state is to eliminate the very reasons that hamper development (Khafizov and Mustafin, 2017).

In order to describe and compare the innovation environment of different countries a comparison of Intramural R&D expenditure by sectors of performance of different countries with their GDP is presented (Table 4).

Table 4: Intramural R&D expenditure (GERD) by sectors of performance

In billion euros	2008						
	Country	All sectors	Business enterprise sector	Government sector	Higher education sector	Private non-profit sector	GDP
	Poland	2,19	0,67	0,78	0,738	0,002	287,93
	Slovakia	0,31	0,13	0,10	0,074	0,000	57,66
	Russia	11,84	7,45	3,56	0,793	0,031	1 013,12
	Japan	113,98	89,44	9,49	13,264	1,792	3 701,80
	South Korea	21,48	16,19	2,59	2,394	0,307	653,13
		2018					
	Poland	4,83	3,12	0,11	1,589	0,017	528,77
	Slovakia	0,74	0,41	0,16	0,185	0,003	95,17
	Russia	15,45	9,30	4,7	1,394	0,064	1 479,88
	Japan	138,20	108,90	10,8	16,602	1,905	5 418,74
	South Korea	61,71	49,00	6,603	5,234	0,872	1 184,43

The presented data allows us to say that countries focused on innovative development increase spending on innovation almost in proportion to GDP growth rates. For example, for Korea, this value in 2017 is more than 3 times ahead of the similar value in 2008. In Russia, the growth rate of innovation spending turned out to be significantly lower in comparison with the above countries. Also, it can be seen that the business enterprise sector is interested in innovation more than other. But aggregated data may not be indicative. For example, the experience of the Republic of Tatarstan (the subject of the Russian Federation) which has been recognized as the most innovatively developed region of the country for many years.

The region is considered to be a higher territorial self-government unit (Mustafin et al., 2017). The overall picture of innovation processes in the region is determined by industrial complexes, the share of which is about 90% of all innovative organizations. At the same time, the main innovation activity (62%) is concentrated in the two leading sectors of industry: mechanical engineering and petrochemistry.

The modernization and innovative development of economy are two interrelated sides of one fundamental process, by which the state can optimize the accumulation, updating, distribution and use of tangible and intangible assets, to increase capacities for sustainable development (Mustafin, 2016). To date, the most common innovations, implemented in the territory of the Republic of Tatarstan, are technological innovations, although non-technological, organizational and marketing innovations have a great importance for the innovation potential of the region and the country. As can be seen from many researches, in many enterprises of the Republic of Tatarstan, such innovations have not yet received adequate distribution that limits, in particular, the innovative potential of the enterprise, its effective use, and generally hinders the innovative economic activity.

Summary

In the last decade, the tendencies of socioeconomic and innovative development of the world economies showed that in the context of competition and globalization processes intensification, the most promising form of cooperation between business entities is the transition to models of open innovation (Shinkevich et al., 2018). Technological leadership can give significant advantages in the competitive world today (Seliverstova et al., 2018). The reliance on the international experience, taking into account certain features of the Russian economy, will help to avoid protracted crises and unfavorable circumstances (Vasilova et al., 2018).

Innovations should cover not only the creation of new technologies, their implementation into production, but also the promotion of products on the market, an effective communication infrastructure. Under the conditions of innovative development of the national economy, no enterprise will be able to exist for a long time without making significant improvements to its work. As a result of implementing new equipment and technologies, the quality of products and the product characteristics are improved, the means, methods and organization of the production process are developed. The implementation of innovative equipment into production is a long, complex and costly process for any enterprise. For its performing, the enterprise system requires the introduction of a comprehensive analysis of production activities, the use of effective calculation mechanism, and the cost-effectiveness analysis of project execution for the implementation of innovative technology into production.

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ZARZĄDZANIE INNOWACJAMI W PRZEDSIĘBIORSTWACH PRZEMYSŁOWYCH

Streszczenie: Innowacje stają się podstawą konkurencyjności przedsiębiorstw, prowadzą do większej wydajności, lepszej jakości produktów i usług. Proces działalności innowacyjnej wymaga od przedsiębiorstw opracowania i wdrożenia mechanizmu zarządzania działaniami innowacyjnymi, który byłby adekwatny do wymagań gospodarki rynkowej. Ponadto w procesie wdrażania innowacyjnych technologii w przedsiębiorstwie konieczna jest jasno sformułowana strategia rozwoju działalności innowacyjnej na poziomie kraju, regionu, przemysłu i przedsiębiorstwa. Biorąc pod uwagę wszystkie powyższe, można zauważyć, że kompetentna polityka w dziedzinie innowacji to nie tylko problem kraju, ale także problem każdego przedsiębiorstwa, którego podstawą przewagi konkurencyjnej powinno być wdrożenie innowacji technologicznej i zastosowanie wyników postępu naukowego i technologicznego. Postęp naukowy i technologiczny oznacza także rozwój technologii informacyjnych i komunikacyjnych w sektorach gospodarki. Celem tego badania jest rozważenie systemów zarządzania innowacjami, analiza i opisanie rodzajów innowacji oraz opracowanie zaleceń dotyczących poprawy konkurencyjności przedsiębiorstw w trudnej konkurencji innowacyjnej.

Słowa kluczowe: rozwój innowacyjny, przedsiębiorstwa przemysłowe, technologie, wkład innowacyjny, produkt innowacyjny, zintegrowana analiza

工业企业创新治理

摘要: 创新成为企业竞争力的基础, 可以带来更高的效率, 更好的产品和服务质量。创新活动的过程要求企业开发和实施一种机制, 以管理足以满足市场经济要求的创新活动。此外, 在企业中实施创新技术的过程中, 有必要为国家, 地区, 行业和企业层面的创新活动的发展制定明确的战略。考虑到以上所有内容, 可以注意到, 创新领域的有效政策不仅是一个国家的问题, 也是每个企业的问题, 其竞争优势的基础应该是实施创新技术的应用和科学技术进步的成果。科技进步也意味着经济部门信息通信技术的发展。这项研究的目的是考虑创新管理系统, 分析和描述创新的类型, 并提出提高企业在激烈的创新竞争中的竞争力的建议。

关键词: 创新发展 工业企业技术创新投入创新产出综合分析