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ADAPTATION SET OF FACTORS FOR ASSESSING THE COMMERCIAL POTENTIAL OF TECHNOLOGIES IN DIFFERENT TECHNOLOGY MANUFACTURING BRANCHES

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Abstract. In the course of previous research, it has been revealed, that specifics of different technology manufacturing branches are important for assessing the commercial potential. Several technology manufacturing branches already had big input from past and now cover the most promising part of the national economy. For these reasons, it was decided to customize the model for assessing the commercial potential to biotechnology, mechatronics, laser technology, information technology, nanoelectronics. Development of a set of factors for assessing commercial potential for different technology manufacturing branches is the first stage of the model's customization process and the main purpose of this article. The next steps will include an expert study aimed at clarifying a set of factors based on the literature analysis, identifying the significance and the meanings of factor values. The literature of technology management did not take into account the specifics of the different technology manufacturing branches, therefore sources analysing the problems of intellectual property law, problems of different engineering sciences was used. With the help of the aforementioned literature in order to adapt the set of factors to each technology manufacturing branch aims to identify the challenges and problems are faced by representatives of different technology manufacturing branches in the process commercialization.

Keywords: adaptation set of factors, specifics of different technology manufacturing branches, assessment of the commercial potential, multiple criteria decision making (MCDM), biotechnology, mechatronics, laser technology, information technology, nanoelectronics.

JEL Classification: O32.

Introduction

The commercialization of technologies while creating new technology-based products is a source of a competitive advantage ensuring company's prosperity and, at the same time, represents risk full activity. Most of the attempts to commercialize technologies end in failure, and thus the ability to timely and objectively assess the experience of technology

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commercialization, in order to avoid non-productive investments is a crucial step for the institutions engaged in scientific research and R&D. When the owner of technology, the potential investor or buyer must make a decision on the future of technology and to answer questions such as if it is worth developing the technology, investing in it or buying it? In order to answer these questions and to make the right decision, tools for assessing the commercial potential of technologies are in use.

Previously developed model for assessing the commercial potential of technologies (Zemlickienė, 2015; Zemlickienė, Bublienė, & Jakubavičius, 2018) is universal – dedicated for assessment of technologies in all manufacturing branches. Until this moment in the scientific space proposed tools for assessment commercial potential of technologies (Cho & Lee, 2013; Price, Huston, & Meyers, 2008; Dereli & Altun, 2013; WIPO, 2005; EPO, 2012; NASA, 2017; VentureQuest Ltd., 2015; International Islamic University Malaysia, 2017) was fragmented, difficult quantitatively to apply in practice. The development of this model was a significant contribution to the quantitative methodological work of the commercial potential, however, in the course of research it has been revealed, that specifics of different technology manufacturing branches are important for assessing the commercial potential. Both the dissertation and the scientific literature of the last year did not take into account the specifics of different technology manufacturing branches. Customization model for assessing the commercial potential of technologies for different technology manufacturing branches would allow achieving a more objective assessment of the commercial potential and a more rational use of resources.

This article presents the first stage of the model's customization process – development a set of factors for assessment commercial potential of technologies in different technology manufacturing branches. Based on multiple criteria decision making (MCDM) methods, the set of factors is the basis for determining the significance of the factors and the meanings of factor values. Afterwards, sets of factors will be revised based on an expert survey, will be used as the research tool for determination meanings of factors value and the significance of factors for every manufacturing branch.

1. Adaptation set of factors for assessing the commercial potential of technologies for different technology manufacturing branches

Previously proposed set of factors (Table 1) have been developed referring to the analysis of scientific literature (Cho & Lee, 2013; Price et al., 2008; Dereli & Altun, 2013), information sources provided by different organizations (WIPO, 2005; EPO, 2012; NASA, 2017; VentureQuest Ltd., 2015; International Islamic University Malaysia, 2017), expert survey and the principles suggested by V. Belton and T. J. Stewart (2002). A set of factors for the assessment of the commercial potential of technologies is universal for all technology manufacturing branches but takes into account different technological levels. Selected technology manufacturing branches belong to the high tech category, for this reason, all the factors presented in Table 1 are appropriate for this analysis. This set of factors will be used as a guideline in the analysis of the specifics of the different manufacturing branches.

Table 1. Set of factors for assessment commercial potential of technologies (Zemlickienė, 2015; Zemlickienė, Mačiulis, & Tvaronavičienė, 2017; Zemlickienė et al., 2018)

Set of factors for assessment of the commercial potential of high technologies

Set of factors for assessment of the commercial potential of traditional technologies

Situation on the market (A)	Value for consumer (B)	Financial environment (C)	Competitive environment (D)	Technology features (E)	Competence of technology developers (F)	Legal environment (G)		Circumstances relating to inventors (H)	Internal policy of institution (I)
						For legally unprotected	For legally protected tech.		
Share of the target market of the potential product at the moment of evaluation (A1)	Predicted offered value for the final consumer (B1)	Financial potential (C1)	Duration of the existence of the predicted technology (D1)	Complexity of technology (E1)	Competence of scientific personnel in tech. commerc. (F1)	Benevolence of national legislation for tech. commerc. (G1)	Benevolence of national legislation for tech. commerc. (G11)	Inventor’s experience in tech. commerc. (H1)	Compliance of the project on tech. commerc. with activity of institutional strategy (I1)
Predicted share of the target market at the moment when a product is prepared for launching (A2)	Feedback of target customers regarding products concept (B2)	Competitive pricing of the product unit (C2)	Ability to copy technology (D2)	Dependence of technology functioning on geographical / climatic circumstances (E2)	Competence of marketing department’s personnel in tech. comm. (F2)	Utility/use level of technology (G2)	Strength of legal protection (G12)	Inventor’s academic recognition (H2)	Acceptance of the strategy of the commerc. of institution by the inventor (I2)
Level of needs regarding the potential product (A3)	Level of the uniqueness of the value provided to the potential user (B3)	Predicted contribution of technology to the profit of the company (C3)	Intensity of competition (D3)		Competence of the personnel of the technology transfer bureau in tech. commerc. (F3)	Confidentiality of technology (G3)	Geographic barriers for technology protection (G13)	Inventor’s predicted level of involvement as a team member in tech. commerc. (H3)	Image of the institution in the area of tech. commerc. (I3)
Level of the readiness of the market for the product (A4)		Predictable period for covering cost of the project (C4)			Competence of the personnel of the sales department in the tech. comm. (F4)	Difference comparing to similar analogue (G4)		Inventor’s financial contribution to tech. commerc. (H4)	
		Evaluation of the durability of the potential product and its importance for creating a recrudescent flow of income (C5)			Competence of the personnel of the production department in tech. comm. (F5)	Price of legal protection (G5)			
		Predicted period of product development (C6)							
	Level of difficulty to use of the potential product (B4)			Adaptability of the potential product for the existing products (E3)					
	Relative advantages of the potential product (B5)			Novelty of technology (E4)					

Analysing the expediency of existing factors and the need to add additional factors that will be used to develop tools for measuring the commercial potential of technology in different technology manufacturing branches it is important to take into account the specifics of the intended use method and the prospects for using the complex of factors. In recent years, multiple criteria decision-making (MCDM) techniques and approaches have been suggested to choosing the optimal probable options. The main idea of the MCDM methods is to combine the values and significance of factors into a single criterion of multi-criteria evaluation (Hwang & Yoon, 1981). The significance of factors and factors groups are determined on the basis of the set factors and expert survey. The formation of the meanings of factor values covers the preparation of the assessment scale for every factor indicated in the set, which is a measure for an evaluator of technology in the process of technology assessment. To achieve the goal, the values of the factors have to be identified, i. e. have to be selected a value in every scale, by applying a set of the meanings of factor values.

The literature on the assessment of the commercial potential of technology did not take into account the specifics of the different technology manufacturing branches, therefore sources analysing the problems of technologies development, of intellectual property law and the problems of different engineering sciences was used. With the help of the aforementioned literature, the author seeks to find out challenges and problems are faced representatives of different technology manufacturing branches in the process commercialization and realization of technologies. In order to adapt the set of factors to each technology manufacturing branch, at the end of each subsection proposals will be presented.

2. Challenges and problems of biotechnology in the process commercialization

Industrial biotechnology is one of the most promising technologies around; it has the potential to address some of the world's greatest challenges, such as feeding a growing population and offering new alternatives to our scarce natural resources. Although there is a long way to go, if industrial biotechnology reaches its full potential it has the potential to impact the world.

The biotechnology pathway in the market in the human and animal health field is very complex limited by the need for comprehensive safety tests, multi-level clinical trials and regulatory approvals. For example, genetic material and microorganism development validation process is one of the longest and most bureaucratically complicated. In the field of biotechnology, the development of the product from conception to material product creation and realization is considerably longer than in other technology fields. The normal duration of a product development in the field of biotechnology is usually at least 7–10 years, in some cases, the launch of a new drug into the market takes up to 12–15 years. In general, the following steps can be identified in the development of biotechnological innovations:

1 phase: the discovery phase, during which the target and the particular molecule are identified without basic fundamental research (2–6 months);

2 phase: initial validation of the molecule of the target (12–24 months);

3 phase: secondary validation of the molecule of the target (24–36 months);

4 phase: clinical phase during which the final validation of the molecule of the target is performed (5–7 years);

5 phase: an introduction to the market (typically 1–3 years).

The biotechnology development model described above supposes that the essential parts of the invention are known at an early phase and the subsequent steps are necessary to obtain the experimental data necessary for the verification and justification of the invention. Generally, modern biotechnology is characterized by rapid developmental trends in the pre-clinical 4 phase but is limited in the phases of slow and bureaucratic processes in the clinical and market entry phases (Kiškis & Limba, 2016).

The process of patenting in biotechnology projects interfere with development processes. In biotechnology projects, the most valuable part of the technology (genetic sequence, protein structure etc.) is known years before the experimental data that enables the patent to be obtained. At best, a patent application may be submitted at the end of 2 phase if the experimental data justify the technology. After the submission of a patent application, the further long development process of technology and launch to the market awaits. These further steps while the technology reaches the market usually takes up a significant part of the useful period of patent protection (Vu, Lee, Chan, & Oh, 2018). A slow cycle in the development of biotechnology means that the ability to generate revenue in the future depends on the term of protection of intellectual property.

Large expenditure and risk causes difficult attraction of investments. Biotechnology research is very expensive and requires adequate infrastructure, reagents and specialized staff or open access to public (university and research institutes) infrastructure (Mamzer, Sophie Duboisb, & Saoutc, 2018). Based on the empirical research conducted by the US biotechnology industry, the cost of drug development, testing and launch to market is between 250 million and 1 billion USD. This determines that basic biotechnology costs are fixed and do not show a quick return on investment. Risks in biotechnology projects manifests itself in two aspects: 1) enormous costs are often unsuccessful if technology is not validated at one of the validation phases; a large proportion of biotechnology is already failing in animal models (Phase 3), and only a few reach clinical trials where success is also rare; 2) Confidentiality is essential for biotechnology projects and should be maintained for a long period of time. During such a long time, the risk of disclosure of technology is high. These reasons mean that external investment in biotechnology projects is usually attracted at the beginning of the clinical phase after the pre-clinical phases. In addition, in the field of biotechnology, the patent portfolio is usually a prerequisite for attracting external investment (Volpatti & Yetisen, 2014).

Based on the specificity of the commercialization of biotechnology discussed above and the proposed set of factors for evaluating the commercial potential of technologies, it can be stated that the factors most relevant to the commercialization of biotechnology are (Table 2).

It is important to emphasize that the factors which reflect a need of infrastructures need of specialized staff and the consequences of patenting for the development of technology was not included in the complex of factors, therefore this possibility should be considered.

Table 2. Essential factors for the set of factors of biotechnology

Factors included in previously set of factors for assessing the commercial potential of biotechnology		Factors are recommended to be included in the set of factors for assessing the commercial potential of biotechnology	
Factors group	Factors	Factors group	Factors
Financial environment (C)	Financing potential (C1)	Financial environment (C)	Accessibility of the infrastructure
	Evaluation of the durability of the product and its importance for creating a recrudescent flow of income (C5)		
	Predicted period of product development (C6)	Competencies of technology developers and related opportunities (F)	Accessibility of specialized staff
Competitive environment (D)	Ability to copy technology (D2)		
Competence of technology developers	Competence of the personnel of the technology transfer bureau in technology commercialization (F3)	Legal environment (G)	The consequences of patenting for the development of technology
Legal environment (G)	Benevolence of national legislation for commercialization (G1)		

3. Challenges and problems of mechatronic technology in the process commercialization

Mechatronics is the engineering discipline concerned with the construction of systems incorporating mechanical, electrical, automation and information technology components. The word mechatronics as a blend of mechanics and electronic has already been invented 40 years ago by a Japanese company. Then, mechatronics just meant complementing mechanical parts with some electronic units, a typical representant being a photo camera, with an autofocus function. All shooting settings focusing, aperture, exposure time, etc. are automatically selected by the machine itself. Today, mechatronics is an area combining a large number of advanced techniques from engineering, in particular, sensor and actuator technology, with computer science methods (Neumann, 2015).

The smart devices of today's mechatronic systems will turn into "populations" of smart devices, exchanging information for optimising their global behaviour as well as possibly competing for limited resources. This movement imposes in particular new challenges on the computer science side in mechatronics. The mechatronic systems of the future will be characterised by the following properties: a high degree of concurrency: Systems will consist of a large number of autonomous components, exchanging information while running in parallel. Components may form cluster to collaborate on a common goal but may also compete as to optimise their own aims; decentralisation: due to the high degree of concurrency and distribution systems cannot be centrally observed and as a consequence not centrally controlled;

self-Coordination: as a result of the previous two points, advanced mechatronic systems will largely have to rely on principles of self-coordination (Schafer & Wehrheim, 2007).

The development and operation of modern mechatronics facilities require specialists who not only have advanced knowledge in mechanics but also are well acquainted with electronics and computer science. In recent years, the development of communication and medical devices requiring a highly skilled multi-level workforce and modern technological equipment is being expanded. Companies of mechatronics develop and manufacture products for both mass use and manufacturing companies that facilitate and automate production processes. When it comes to the factors influencing commercial potential, the user's access to the product is also an opportunity to realize the product.

In the literature of mechatronic technology development, many authors emphasize the problems arising from the increased complexity of mechatronic products, a variety of different disciplines and highlight the consequences of these problems (Neumann, 2015):

- In the mechatronic product development systems, it is apparent that time-lines are very different in different disciplines. The synchronization of the different disciplines is consequently a major challenge for project management mechatronic products. The highest chances for success are in the project if regular cross-discipline synchronization meetings are attended by the project managers, were launched early, were carried out throughout the process;
- The main objective of process management (or systems engineering) is to provide a guidance concerning the logical relationship within complex systems. It is a major challenge during the development of mechatronic products to keep the over the functional and physical relationship between modules of different disciplines. The consequence for process management is twofold: on the one hand, it gets more and more difficult for process management to keep the overview, on the other hand, the necessity for an effective process management is stronger than ever (Stetter & Pulm, 2009);
- Current mechatronic products are usually realized by means of a combination of modules. This strategy allows a large number of product variants with a relatively small number of modules which can be combined in different ways. Further modules allow a reduction of complexity. The main problems concerning modules are to define binding and stable interfaces, which often go beyond the borders of disciplines, and the fact that a modular design (due to variants, production etc.) is suboptimal compared to an integrated design. Very often these modules are developed by electronics departments but have to measure physical phenomena which are the core competency of mechatronic engineering. Such modules are mechatronic systems and require appropriate procedures and tools; such modules have to be identified and treated as mechatronic systems themselves;
- The notion "testing" summarize virtual and physical analyses of the product and process performance. Due to the comparably high expenditures for mechatronic product tests, a small amount of test represented a large product variety. In electronic engineering, elaborate testing procedures were applied which included most of the probable situations. Regarding research, the communication between the testing departments was less frequent than design departments. This phenomenon may be caused one the on hand by the difference in testing philosophy, on the other hand, because communication between these departments was considered less valuable (Stetter & Pulm, 2009).

Based on previously discussed the specifics of the commercialization of mechatronics technologies and the proposed set of factors for evaluating the commercial potential of technologies, it can be stated that the most relevant factor in the commercialization of mechatronics technologies are (Table 3):

Table 3. Essential factors for the set of factors of mechatronics technology

<table>
<tr><th colspan="2">Factors included in previously set of factors for assessing the commercial potential of mechatronics technology</th><th colspan="2">Factors are recommended to be included in the set of factors for assessing the commercial potential of mechatronics technology</th></tr>
<tr><th>Factors group</th><th>Factors</th><th>Factors group</th><th>Factors</th></tr>
<tr><td>Technology features (E)</td><td>The complexity of technology (E1),</td><td rowspan="4">Competence of technology developers (F)</td><td>Competence of the project manager’s</td></tr>
<tr><td rowspan="3">Competence of technology developers (F)</td><td rowspan="2">Competence of scientific personnel in the technology commercialization (F1)</td><td>Competence of mechanics specialists</td></tr>
<tr><td>Competence of electronics specialists</td></tr>
<tr><td>Competence of the personnel of the production department in the technology commercialization (F5)</td><td>Competence of informatics specialists</td></tr>
</table>

However, in assessing the competencies of mechatronics technology developers, it is necessary to take into account the competence of mechanics, electronics and informatics specialists and the experience of the project manager.

4. Challenges and problems of lasers technology in the process commercialization

The letters in the word laser stand for Light Amplification by Stimulated Emission of Radiation. A laser is an unusual light source. It is quite different from a light bulb or a flashlight. Lasers produce a very narrow beam of light. This type of light is useful for lots of technologies and instruments.

- Lasers in comparison with other technologies are characterized by adjustment in different fields, different problems. Lasers are a versatile and flexible production tool:
- most of the lasers are used in the metalworking industry to cut metal sheets. These are powerful systems in kilowatts with a power output of up to 6 kW and can quickly and accurately cut sheets of 20–30 mm thick steel;
- lower power (100–500 W) CO2-lasers are installed in the sewing and upholstered furniture industry. They are used for the fabric, artificial leather. Similar laser cutting systems are increasingly used for the production of advertising;
- laser welding technologies have not yet entered the major machinery industry but dotted welding is widely used in pulsed solid-state lasers, for example, in the manufacture of telecommunication devices (Tsai et al., 2017);
- the technology of laser marking and engraving is quickly spreading in Lithuania. Laser equipment records personal information in passports, driving licenses, other

personal or discount cards thus protecting them from fraud. Stamps are also made using laser engraving.

Medical Lasers are applicable to:

- ophthalmology (excimer lasers);
- vascular reconstructions (semiconductor lasers);
- dentistry (semiconductor lasers);
- dermatology (CO2, Er-YAG, Nd-YAG, semiconductor lasers).

In the defence industry lasers have a lot of potentials. For example, various laser radars, otherwise known as the leaders, are used for both the targeting of various weapons, the targeting of extremely precise missile launchers, and precision mapping. Recently Boeing introduced its own mobile laser system "Compact Laser Weapon System" designed to knock down drones. Increasingly gaining polarity drones are dangerous to planes. This weapon is capable of aiming in a few seconds and destroying such an aircraft. Other application: lasers are also used in electronic equipment: CD players, computers, and the production of electronics are also unimaginable without lasers. Microchips, flat panel TV's, solar panels - all of these devices would not work without the help of lasers. The automotive conveyor contains dozens of laser robotic operations. The precise positioning of Earth-bound satellites is determined only by lasers. It would be possible to name a lot of industries that would not survive without lasers (Vasantha, Roy, & Corney, 2014).

Comparing the use of lasers with the use of other technological products, it is important to understand that this is not a mass-market product, and laser technology product developers use the business-to-business (B2B), model. This means that their users will be specialists in specific fields with specific competencies in the field, so in this case, a ease of use of the new product is important i. e. the product must be designed in such a way that its users have sufficient competence to use it. In the development of technology, there are a lot of investments for research. On average 5 to 10 years passes from the beginning of the technology development to the first profits. High-tech laser technology is particularly used in the war industry. In order to prevent illegal use of laser technology in the military industry, there are sufficiently strict regulations on the export of optical components outside the EU. Laser development is not possible without special equipment. Precise mechanisms, electronics, optics manufacturers are required. These components have to be pre-ordered.

Lithuanian lasers are niche products that occupy more than 50 per cent scientific picosecond laser market. In Lithuania, high added-value products are being developed and produced, the added value contains two-thirds of the production price. Using the technology available in Lithuania, several complex devices are being developed, which only 10 per year are ordered globally. This is a total frequency spectrometer that allows exploring the surface of a substance in a single molecule layer. 5 to 7 units per year are sold, but it yields a sufficient profit (Lithuanian Laser Association, 2017).

Highly skilled professionals are important for increasing business competitiveness. Intellectual capital the knowledge-based resources of an organization (Soo, Tian, Teo, & Cordery, 2017), has been found to have a strong and positive relationship with strong firm performance (Ferreira & Franco, 2017; Khalique, Bontis, Shaari, & Isa, 2015). Laser companies face shortages of highly skilled professionals and tend to hire people without work experience and educate skilled professionals themselves. Universities train highly qualified specialists, and later they have learned how to work with laser technologies for 1–1,5 years because this is a very narrow area. The laser technology sector is changing very rapidly, which requires continuous improvement beyond national capabilities.

Based on the presented set of factors for assessing the commercial potential of technologies and the specifics of laser technologies, the factors reflecting the specifics of these technologies and included in the complex of factors are (Table 4):

Table 4. Essential factors for the set of factors of laser technology

<table>
<tr><th colspan="2">Factors included in previously set of factors for assessing the commercial potential of laser technology</th><th colspan="2">Factors are recommended to be included in the set of factors for assessing the commercial potential of laser technology</th></tr>
<tr><th>Factors group</th><th>Factors</th><th>Factors group</th><th>Factors</th></tr>
<tr><td>Value for the consumer (B)</td><td>Level of experiencing difficulty in the use of the potential product (B4)</td><td rowspan="2">Financial environment (C)</td><td rowspan="2">Accessibility of the infrastructure (C7)</td></tr>
<tr><td rowspan="2">Group financial environment (C)</td><td rowspan="2">Predicted period of product development (C6)</td></tr>
<tr><td rowspan="2">Competencies of technology developers and related opportunities (F)</td><td rowspan="2">Accessibility of specialized staff (F6)</td></tr>
<tr><td>Technology features (E)</td><td>Dependence of technology functioning on geographical/climatic circumstances (E2)</td></tr>
</table>

It is important to emphasize that the factor reflecting the infrastructure needs and the possibility to find the necessary specialists in the complex of factors has not been included, therefore this possibility should be considered.

5. Challenges and problems of information technology in the process commercialization

Information technology (IT) is the use of any computers, storage, networking and other physical devices, infrastructure and processes to create, process, store, secure and exchange all forms of electronic data. Typically, IT is used in the context of enterprise operations as opposed to personal or entertainment technologies. The commercial use of IT encompasses both computer technology and telephony. The term IT was coined by the Harvard Business Review, in order to make a distinction between purpose-built machines designed to perform a limited scope of functions and general-purpose computing machines that could be programmed for various tasks. IT includes several layers of physical equipment (hardware), virtualization and management or automation tools, operating systems and applications (software) used to perform essential functions. User devices, peripherals and software, such as laptops, smartphones or even recording equipment, can be included in the IT domain. IT can also refer to the architectures, methodologies and regulations governing the use and storage of data.

In the field of IT, here the development of the product from idea to material product creation and sale is much shorter than in the field of biotechnology, where product development terms are extremely short and rarely exceed 18 months. In the area of IT, an enterprise that has not been able to deliver a competitive product over a period of more than 3 years is generally considered to be unsuccessful (Park, Y. B. Kim, & M. K. Kim, 2017). For IT companies, key costs are variable and fully expected from human resources available – actually human resource costs are the main expenses of developing IT. IT workers can specialize in fields like software development, application management, hardware – desktop support, server or storage administrator – and network architecture. Many businesses seek IT professionals with mixed or overlapping skill sets (SearchDataCenter, 2018). Laser companies face shortages of highly skilled professionals.

Impact of the patent process for the development: software technologies are being introduced so quickly that the patent becomes inexpedient. The mere receipt of international patent protection in accordance with the statutory deadlines takes more than 2 years. In the case of software, this is an unacceptably long period. In many cases, a technology that was patented for protection 2 or 3 years ago would be outdated at the time of obtaining the patent. Patent protection becomes inexpedient for a long time to receive patent protection and short time for product development. For these reasons, many software innovators provide patent applications only at a later stage in their evolution, when the original technology is validated and the start-up has attracted enough external capital (for example, venture capital). This also means that patenting does not interfere with the development of original technology, i.e. it does not use the financial resources and time that can be allocated to the development and validation of the technology. In addition, rapidly changing technologies, such as software, are still stuck in legal dilemmas regarding the patentability of an object. The biotechnology situation is very different from software technology, where the patenting process complements a well-established development process and only takes place after the necessary additional resources are acquired for patenting (Kiškis & Limba, 2016).

Based on previously set of factors for assessing the commercial potential of technologies and the specificity of informational technologies, the factors reflecting the specifics of these technologies and included in the set of factors are (Table 5):

Table 5. Essential factors for the set of factors of information technology

Factors included in previously set of factors for assessing the commercial potential of IT		Factors are recommended to be included in the set of factors for assessing the commercial potential of IT	
Factors group	Factors	Factors group	Factors
Group financial environment (C)	Predicted period of product development (C6)	Legal environment (G)	The consequences of patenting for the development of technology (G6)
Legal environment (G)	Benevolence of national legislation for commercialization (G1)		

The consequences of patenting for the development of technology (G6) would be expedient to include in the legal environment (G) group of factors for not legally protected technologies.

6. Challenges and problems of nanoelectronic technology in the process commercialization

This science explores the ways in which any material is shredded into ultra-small particles or structures – the so-called nanoparticles. They are extremely small – on average the diameter can reach several nanometres (one millimetre is a million nanometres). Extremely popular use of nanotechnology in the development of various cleaning products, cosmetics, as well as in medicine. Nanotechnology has also become the subject of the study of mechanics and electronics, in particular, trying to make ever smaller articles and so close to nanoparticles that are just above the size of an atom. Microelectronics is a field of electronics that includes the research, design, manufacture and application of microelectronic devices. At the beginning of this century, microelectronics has moved into the era of nanoelectronics. In the history of mankind, there is no other industry such make so huge and rapid changes in the world economy and society.

Currently, the most important issue for Europe and Lithuania is preparing new creative designers in the field of nanoelectronics. According to forecasts of European scientists, nanotechnology sector will need 500 times more designers over the next ten years.

In the nanoelectronics sector, the mere receipt of international patent protection in accordance with the statutory deadlines takes more than 2 years. In the case of the computer and communications technology, this is an unacceptably long period. In many cases, a technology that was patented for protection 2 or 3 years ago would be outdated at the time of obtaining the patent. Patent protection becomes inexpedient because of a long time required to receive patent protection and short time for product development. For these reasons, many computers, and communications innovators provide patent applications only at a later stage in their evolution, when the original technology is validated and the start-up has attracted enough external capital (for example, venture capital) (Kiškis & Limba, 2016).

Along with the technology development, the business trends of micro/nanoelectronics are mainly represented by cost reduction, shorter-time-to-market and outsourcing. The combination of technology and business trends drives micro/nanoelectronics into an unknown level of complexity. As the consequences, industries are confronted with ever increased design complexity, dramatically decreased design margins, increased chances and consequences of failures, decreased product development and qualification times, increased the gap between technological advance and availability of fundamental knowledge, and increased difficulties to meet quality, robustness and reliability requirements (Ozcan & Islam, 2017).

Based on a set of factors for assessing the commercial potential of technical factors that reflect the specifics of nanoelectronics technologies and included in complex factors are (Table 6):

Table 6. Essential factors for the set of factors of nanoelectronics technology

Factors included in previously set of factors for assessing the commercial potential of nanoelectronics technology		Factors are recommended to be included in the set of factors for assessing the commercial potential of nanoelectronics technology	
Factors group	Factors	Factors group	Factors
Financial environment (C)	Predicted period of product development (C6)	Competencies of technology developers and related opportunities (F)	Accessibility of specialized staff (F6)
Technology features (E)	The complexity of technology (E1),	Legal environment (G)	The consequences of patenting for the development of technology (G6)

The factor the consequences of patenting for the development of technology (G6) it is expedient to include in the factors group legal environment (G) for legally not protected technologies and factor accessibility of specialized staff (F6) include in factors group competencies of technology developers and related opportunities (F).

Conclusions

The current study is based on the MCDM methods the selection of which has been determined by the motive related to the goal of assessment – to apply quantitative methods for assessing and ranking the compared objects in terms of the aim of the conducted research. Development a sets of factors for assessing commercial potential for different technology manufacturing branches is the first stage of the model's customization process and the main purpose of this article. The next steps will include an expert study aimed at clarifying a set of factors based on the literature analysis, identifying the significance and the meanings of factor values.

Summing up what has been mentioned about specifics of commercialization of different technology manufacturing branches: slow biological and bureaucratic processes restrict commercialization of biotechnology. Duration of a product development is from 7 up to 15 years. Steps while the technology reaches the market usually takes up a significant part of the useful period of patent protection. Biotechnology research requires expensive infrastructure and reagents. High cost and risk cause difficult attraction of investments. Confidentiality is essential for biotechnology projects and should be maintained for a long period, during such time, the risk of disclosure is high.

Mechatronics technology is an area combining a large number of advanced techniques from engineering, in particular, sensor and actuator technology, with computer science methods. Companies of mechatronics develop products for both mass use and manufacturing companies. The development of mechatronics facilities requires specialists who not only have advanced knowledge of mechanics but also are well acquainted with electronics and computer science. Many authors emphasize the problems arising from the increased complexity of mechatronic products, a variety of different disciplines and highlights the consequences of these problems: the synchronization of the different disciplines; control problems; problems to define binding and stable interfaces; the synchronization of the testing process.

Lasers are characterized by adjustment in different problems: lasers are a flexible production tool; a surgical tool in medicine and instrument in the defence industry. Specific aspects only to the laser industry are very high added-value of product and very small quantity produced products. The development of laser takes a long time, on average 5 to 10 years. In order to prevent illegal use of lasers in the military, there are strict regulations on the export of components outside the EU. Laser development is not possible without special equipment: precise mechanisms, electronics, optics. In order to buy this equipment, the manufacturers are needed. Laser companies face shortages of highly skilled professionals.

In the field of IT the development of the product is much shorter than in the field of biotechnology, rarely it exceeds 18 months. For IT company's human resource costs are the main expenses of development; patent protection becomes inexpedient for a long time patenting process and short time for product development; patenting does not use the financial resources and time that can be allocated to the development and validation of the technology. the software is still stuck in legal dilemmas regarding the patentability of an object.

In history is no other industry such make so huge and rapid changes in the world economy like electronic. The business trends of nanoelectronics are mainly represented by cost reduction, shorter-time-to-market. Currently, the most important issue for Europe becoming preparation a new designer in the field of nanoelectronics. This sector will need 500 times more designers over the next ten years. For short time for development patent protection becomes inexpedient. The combination of technology and business trends drives nanoelectronics into a high level of complexity.

Summarizing the issues of research, it is safe to say that the commercialization of technology manufacturing branches is unique; therefore, in assessing the commercial potential of technology, it is necessary to take into account the specifics of each of them. Based on previously discussed specifics of biotechnology, mechatronics, laser technology, information technology, nanoelectronics technology, relevant factors for these branches was detected. Some of them are already included in the set of factors, others are proposed to be included. In many cases, the same factors are relevant to different technology manufacturing branches, which means that the set of factors to different branches will change slightly. Factors in the universal factor complex correspond to the common trends in the evaluation of the commercial potential of technology.

It is possible to expect that the significance of the factors and the meanings of the factors values will be markedly different, for example, because of different duration of time for technology development, the scale of the meanings of factor values will be completely different due to time differences in technology development. A similar situation is with other factors: costs, legal regulation and other differences existing in branches and etc.

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