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A model for assessing the commercial potential of high technologies

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Abstract
Research background: technology development and its application for human activities — R&D — have been recognized as the basis of economic performance, a source of technological solutions and of high value-added supply both in scientific literature as well as in the strategic documents of the Government and international organizations. In order to ensure the harmonious activity of the institutions engaged in R&D and to reduce the uncertainty of the commercialization of technologies, an advanced tool for verifying decisions on technology development at early stages of commercialization, i.e. an instrument for assessing the commercial potential of technology, is needed. Over the last decade, the analysis of the tools on a global scale led to the unequivocal conclusion — so far developed methodical basis has suffered from lack of maturity for its practical use in business, a need for assessing commercial potential at an early stage of technology commercialization has been ignored, and the assessment of commercial potential has not considered the specificity of high technology.

Purpose of the article: This article discusses in detail the preparation and application processes of the model for assessment the commercial potential of high technologies.
Methods: in the model the multiple criteria method is applied the selection of which was determined by the motive related to the goal of assessment — assess the commercial potential of high technologies.
Findings & Value added: The essence of scientific novelty embraces the creation of a qualitatively new, original, science-based model for assessing the commercial potential of technologies thus flexibly applying it to assessing different levels of technologies. The original model is based on: the focus on the specificity of high technologies in assessment the commercial potential of technologies; the focus on the early stage of technology commercialization by assessing the commercial potential of technologies; flexibility in the application of the model taking into account the technological level, legal status, opportunity to assess the commercial potential of technologies in different countries and institutions; mathematical calculations based on assessing commercial potential.

Introduction

Ever since the ancient times, almost without any exception, in order to create or invent all necessary tools and reach technological solutions, scientific experiments and ongoing knowledge development have been employed. By the time when modern economic principles were beyond the concept based on natural resources, knowledge had become a major economic and social stimulus. Technology development and its application for human activities — R&D — have been recognized as the basis of economic performance, a source of technological solutions and of high value added supply (e.g. Zemlickiene *et al.*, 2017; Monni *et al.*, 2017; Oganisjana *et al.*, 2017; Kozlovskis, 2017; Akhter, 2017; Tetsman, 2017; Tvaronavičienė & Razminienė, 2017; Kendiukhov & Tvaronavičienė, 2017; Martinaitytė & Kregždaitė, 2015; Skavronska, 2017; Balcerzak, 2016; Balcerzak & Pietrzak, 2016; Balcerzak & Pietrzak, 2017; Furková, Chocholatá, 2017; Żelazny & Pietrucha, 2017; Kondratiuk-Nierodzińska, 2016).

However, most of the attempts to commercialize technologies ends in failure, and thus the ability to timely and objectively assess the expedience of technology commercialization, in order to avoid non-productive investments, is a crucial and unsafe move for the institutions engaged in scientific research and R&D, when the owner of technology, the potential investor or buyer must take a decision on the future of technology and to answer questions such as ’is it worth developing this 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.

This article discusses in detail the preparation and application model for the assessment commercial potential of technologies. In the model multiple criteria decision making method is applied, the selection of which was determined by the motive related to the goal of research — assess and rank the compared technologies.

Theoretical background

Scientific literature (Cooper, 2009; Rahal, 2005; Cho & Lee, 2013; Price *et al*., 2008; Dereli & Altun, 2013; Bandarian, 2007) and information sources provided by different organizations (WIPO, 2005; EPO, 2012; NASA, 2017; VentureQuest Ltd, 2015; International Islamic University Malaysia, 2017) allow to examine the recommended methods and models for assessing the commercial potential of technologies.

When analysing literature sources, which present the tools for the evaluation of the commercial potential of technologies, the most noteworthy method recommended for application is IPscore® 2.0program provided by the European Patent Office (EPO) (2012), which is considered to be the most complicated and upgraded method from the point of view of the input designated for the assessment of the commercial potential of technologies, The judgements derived from the context indicate that one method from a number of multiple-criteria methods could be used for combining the values of factors and significance.

The tool applied by „VentureQuest Ltd“ (2015) for determining the feasibility of commercialization of technologies is based on the multiple criteria decision making methods. The groups with six factors are used for the purpose of assessing. They are comprised of a certain number of factors; ten-point scale is used to specify the values of the system of factors.

A. D. Rahal (2005) presented in his thesis the results of the research, the purpose of which was to determine the latest factors influencing the licensing of technology and the comparative significance of each factor. To summarize the results the logistic, regression method was applied.

International Islamic University Malaysia (2013) applies the significance of factors for the evaluation of new inventions as well as for the commercial potential of technologies.

J. Cho and J. Lee (2013) introduced in their research study a model for the evaluation of the latest products of technology for the assessment of the possibilities of commercialization. Based on the results of the literature review and by means of Delphi method, four areas related to decision making are determined, subsequently sixteen factors are selected, taking into account their priori-

ty by means of fuzzy analytic hierarchy process method based on the unspecified figures.

R. Bandarian (2007) affirms that Strategic Technology Evaluation Program (STEP) is the most applicable tool, which could help to assess the latest technology during its early stage of originating. Cincinnati University applies the STEP method, which is based on the questionnaire, indispensable for decision making, and which allows to evaluate the significance of the indicated factors.

Robert G. Cooper (2009) promotes the idea that the participation of Top Level Managers responsible for diverse fields of enterprise activities are required in the assessment of the commercial potential of technologies such as finance, marketing, sales, manufacturing and etc. The evaluation is performed taking into consideration six factors according to the scale from 0 to 10. The attractiveness of the project is evaluated as weighted and un-weighted taking into account the value of six factors (when determining the averages of the assessing presented by all the evaluators) and by 100 points scale. The obtained evaluation of 60/100 most frequently indicates a positive decision making.

When summarizing the analysis, it is possible to state that the assessing of the commercial potential of technologies is frequently provided by applying completely primitive methods based on the majority of votes of the Top Level Managers or the evaluation results made by few evaluators and validated by the multiplication of values and significance of factors. In rare cases, the multi-criteria analysis methods are provided, but in majority cases it is difficult to decide which particular method has to be applied in one or another case. If multi-criteria methods of assessing are used, then among the most frequently applied forms of tools for assessing there is so called *program*; however the available information is dedicated only to a user who applies the tool and who is an evaluator as well, namely the guidelines how to use the program and thus, the judgements are usually made only with the reference to the context.

The analysis of the tools on the global scale led to the unequivocal conclusion — so far developed methodical basis has suffered from lack of maturity for its limited and complicated practical use in business. A need for assessing commercial potential at an early stage of technology commercialization has been ignored and the assessment of commercial potential has not considered the specificity of high technology. The combination of these problems determines that the institutions engaged in R&D inefficiently use financial resources. Lack of relevant theoretical solutions can be seen as a scientific problem that requires scientific research. In order to ensure the harmonious activity of the institutions engaged in R&D and to reduce the uncertainty of the commercialization of technologies, an advanced tool for verifying decisions on technology development at early stages of commercialization, i. e. an instrument for assessing commercial potential for technology, is needed. A well-

known term of high technology and the possibility of creating the highest value using these technologies is the motive for encouragement to find solutions to assessing the commercial potential of technologies falling in this category. So far, neither scientific nor professional literature assessing the commercial potential of technology considered the specificity of high technology. Therefore, research on assessing the commercial potential of high technology is relevant to the science of management.

Model for assessing the commercial potential of high technologies: preparation and application

In the proposed model legal status and level of technology have been taken into consideration when assessing the commercial potential of technologies (Fig. 1). The level of technologies is determined taking into account the list of high technology products submitted by T. Hatzichronoglou (1997), namely:

- aerospace equipment,
- computer-office machines,
- electronics-telecommunications,
- pharmacy,
- scientific instruments,
- electrical machinery
- chemistry,
- non-electrical machinery,
- armament.

The technologies not included into the mentioned above list are considered to be the traditional ones.

The first stage of technology assessment depends on the obtained result, the set of derived significance of factors (Fig. 2) as well as meanings of factor values (Tables 1–12) are selected regarding legal status and level of technology. The set of meanings of factors values are formed by applying the prepared questionnaire for the assessment of technologies (Tables 1–12). These sets are designated to assess legally protected high technologies, legally unprotected high technologies, legally protected traditional high technologies, legally unprotected traditional high technologies. For to determine the values and significance of factors firs of all was developed the system of the factors which have been formed referring to the analysis of scientific and professional literature and the principles suggested by V. Belton and T. J. Stewart (2012). The significance of factors and factors groups have been determined on the basis of the system factors for assessing the commercial potential of technologies (Fig. 3). Thereafter, an expert evaluation questionnaire was designed and a two-stage expert survey was conducted. The surveyed experts

were selected considering: 1) experience in the process of technology commercialization in Lithuania and other countries 2) and positions held by the experts in the institutions developing technologies as well as in the establishments responsible for the promotion and control of technology commercialization. Following the first stage of the survey, the focus was switched on listening to the position of the experts and on specifying the system for the factors assessing the commercial potential of technologies; as for the second stage, the experts expressed their positions on the meaning of factors values and significance of system factors.

The formation of the meanings of factor values covered the preparation of the assessment scale for every factor indicated in the system, which is a measure for an evaluator of technology in the process of technology assessment. The preliminary meanings of factors values were defined by the author on the grounds of scientific, professional literature and statistics. At the second stage of the investigation, the meanings of factors values were approved by the experts and expressed by five-point factor-characterizing dimension scales (Tables 1–12).

To achieve the goal during second stage, the values of the factors have to be identified, i. e. have to be selected a value in the every scale, by applying set of the meanings of factor values.

To accomplish the objective the relevant information is required, which has to be related to the current situation on the market as well as the existing situation inside the establishment. Thus, on the condition, if the available information is considered to be insufficient or of inadequate quality, the research on marketing as well as the analysis of the internal information have to be provided.

During the final stage of the assessment by the methods of WASPAS, the values have to be combined with the significance of factors into a single criterion, i. e. the calculations have to be performed according to the derived values of factors and significance of factors. The main idea of the multiple criteria decision making methods is to combine the values and significance of factors into a single criterion of multi criteria evaluation (Hwang & Yoon, 1981; Ustinovicious *et al*., 2007).

Combining the values and significance of factors into a single criterion of multiple criteria evaluation using WASPAS

WASPAS method has been compiled by combining two well-known MCDM methods: WSM and WPM. Here come the stages of the calculations with the assistance of WASPAS method:

Stage 1. Initial matrix *X* for decision making is compiled:

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix}, \quad (1)$$

where x_{ij} – i value of the j indicator of the alternative solution; $i = 1, 2, \dots, m$ – the number of the alternatives;$j = 1, 2, \dots, n$ – the number of the values of factors.

Stage 2. To solve multi-criteria discrete problems the significance of factors is appliedw_j, and the equation is the following:

$$w_j = q_j g_k, \quad (2)$$

where q_j – the significance of a factor in a group; j – the serial number of a factor in a group; g_k – the significance of a group of factors; k – the group number of the factors.

Stage 3. The matrix of decision making is normalized. The direction of optimization factors of the problems analysed in the research is considered maximum. The membersx_{ij}, of the comprehensive matrix of decision making are normalized according to the equation:

$$\bar{x}_{ij} = \frac{x_{ij}}{\max_i x_{ij}}, \quad (3)$$

In case the minimization is required:

$$\bar{x}_{ij} = \frac{\min_i x_{ij}}{x_{ij}}. \quad (4)$$

where x_{ij} – the members of the decision making matrix; $\max_i x_{ij}$ – a maximum value in the decision making matrix; $\min_i x_{ij}$ – a minimum value in the decision making matrix; $\bar{x}_{ij}$– the normalized value of j factor of i alternative.

Stage 4. WASPAS method is based on two criteria of optimality. The first criterion of optimality is calculated according to the Weighed Product Model (WPM). Multi Attribute Utility value K_{iP} is calculated according to the equation (Miller & Starr, 1969; Tiantaphyllou & Mann, 1989):

$$K_{iP} = \prod_{j=1}^{n} \bar{x}_{ij}^{w_j}, \tag{5}$$

where n – the number of factors; j – a serial number in a group of a factor; $\bar{x}_{ij}$ – the normalized value of j-indicator of i alternative; i – the number of the alternatives; w_j – significance of the factors is used to solve the discrete problems.

Stage 5. The other criterion of optimality is calculated by WSM method (MacCrimon 1968). The weighted normalized matrix $\hat{x}_{ij}$ is compiled for the equation:

$$\hat{x}_{ij} = \begin{bmatrix} \bar{x}_{11} & \bar{x}_{21} & \cdots & \bar{x}_{m1} \\ \bar{x}_{12} & \bar{x}_{22} & \cdots & \bar{x}_{m2} \\ \vdots & \vdots & \vdots & \vdots \\ \bar{x}_{1n} & \bar{x}_{2n} & \cdots & \bar{x}_{mn} \end{bmatrix}, \tag{6}$$

The values of which are determined according to the equation:

$$\hat{x}_{ij} = \bar{x}_{ij} w_j, \tag{7}$$

where $\bar{x}_{ij}$ – a normalized value of j factor of i-alternative; w_j – the significance of j factor.

Stage 6. Function K_{iS} of multi attribute utility of the weighted sum model is calculated according to the equation:

$$K_{iS} = \sum_{j=1}^{n} \hat{x}_{ij}. \tag{8}$$

Multi attribute utility function K_{iw} of WASPAS method is determined according to the equation:

$$K_{iw} = \lambda K_{iS} + (1 - \lambda) K_{iP}, \tag{9}$$

where λ – a relative ratio, it determines which part of the function belong to WSM and which to WPM. It could be 0.5, and it is possible to determine it according to the equation:

$$\lambda = 0{,}5 \frac{\sum_{i=1}^{m} K_{iS}}{\sum_{i=1}^{m} K_{iP}}. \tag{10}$$

Stage 7. The final stage carries out the analysis of the obtained results. Based on the evaluations of the alternatives, the decision is made. The analysis has provided the information on which type of technology has been closer to the ideal evaluation as well as the priority of the technologies has been proved. The greater is K_{iw}, the higher is rating of the alternative. When the value is equal to 0, WASPAS method turns into WPM, and when there is *1*, it becomes the method of WSM.

Upon completion of the calculations the obtained results have to be ranked and decision have to be made.

Conclusions

It has been concluded that in order to assess the commercial potential of technologies, in a majority of cases, rather primitive methods have been applied, and in rare cases the multi criteria analysis methods have been provided. Moreover, the scientific and professional input in terms of assessing of the commercial potential of technologies in majority cases appears to be of insignificant use when selecting the appropriate methods for the values of the factors of the commercial potential of technologies and significance to be combined together.

The research study has been provided in order to choose the multicriteria assessment structure to be able to work out and apply the model, consequently determined by the motive related to the objective of the research study and for pursuing the compiling of the model for assessing of the commercial potential of technologies and for the evaluation of the relevant technologies from the point of view of the commercial potential.

Guided by the analysis of the scientific literature sources and publications as well as the accomplished expert investigation, the system for assessing of the commercial potential of technologies has been provided, and the values of factors have been derived. During the second stage of the research study, the significance of the factors and groups of factors in the system has been determined, which tends to expose the impact of the groups of factors as well as factors on the assessed object under the consideration. After assessing the groups of factors, the significance has been withdrawn, and factors have been subsequently ranked. The results of the assessment of the factor groups as well as the rating order are provided here below: 1 — value for a consumer (B = 0.178); 2 — competitive environment (D = 0.155); 3 — current situation on the market (A = 0.139); 4 – competence of technology developers (F =

0.138); 5 — financial environment (C = 0.105); 6 — characteristics of technology (E = 0.104); 7 — circumstances related to an inventor/inventors (H = 0.072); 8 — legal environment (G = 0.065); 9 — internal policy of the institution (I = 0.043).

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Annex

Table 1. Meanings of factor values of factors group *situation on the market*

Fill in by evaluating the technologies of all categories	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Rate by points1 – 5: 1 – [0 – 5%] 2 – [6 – 15%] 3 – [16 – 25%] 4 – [26 – 55%] 5 – [56% <)	A1
				Rate by points 1 – 5: 1 – [0,2 – 5%] 2 – [6 – 15%] 3 – [16 – 25%] 4 – [26 – 55%] 5 – (56% <]	A2
				Rate by points from 1 – 5: 1 – demand was not determined, problem is meant for solving a problem, technologically has already been solved 2 – a minimum demand determined, a more perfect solution of the problem is required than it existed so far, but it is not relevant ; 3 – the degree of average demand determined , because more perfect solution of the problem is required than it existed so far; 4 – high degree of demand, a consumer desires a tool for the solution of the problem ; 5 – a very high degree of demand, technology could help to solve a global problem.	A3
				Rate by points from 1 – 5: 1 – target market is not informed on the possible method of the problem solution; 2 – target market is informed on the existence of the technology, but no answer is received or it is negative ; 3 – target market is informed on the existence of technology, a neutral response is received ; 4 – target market is informed on the existence of technology, a positive response is received ; 5 – target market is perfectly informed on the potential product, a positive response is received and a request was expressed to acquire.	A4

The values of the factors have to be identified, by applying set of the meanings of factors values for factors group *situation on the market*, i. e. have to be selected a value from 1 to 5 in the every scale.

Table 2. Meanings of factor values of factors group *value for consumer*

Fill in by evaluating only the traditional technologies	Tech.			Assessment scale	Factors
	1	2	3		
				Rate by points from 1 – 5: 1 – a potential product reveals by its value currently dominating products ; 2 – the choice of the substitutes of the potential product is wide enough; the value of which is similar; 3 – the substitutes of a potential product are currently available, but their functioning and assortment are not perfect ; 4 – the substitutes of a potential product are currently available, but they are not competitive still; 5 – suggested value of a potential product is superior if compared with the substitutes.	B1
				Rate by points from 1 – 5: 1 – more than 90% of the surveyed respondents have a negative opinion or such a survey has not been provided; 2 – more than 50% of the surveyed consumers have a negative opinion 3 – neutrally or negatively and positively inclined to think potential consumers are divided into equal numbers; 4 – more than 50%of positively thinking consumers are potential consumers 5 – more than 90% of the surveyed respondents have positive opinion.	B2
				Rate by points from 1 – 5: 1 – the method chosen to solve the problem by means of technology is widely known and applied; 2 – the method chosen to solve the problem by means of technology is not perfect; 3 – the method chosen to solve the problem by means of technology is upgraded; 4 – the method chosen to solve the problem by means of technology is drastic or completely different from that which existed until now 5 – technology is able to substitute the method currently applied in the particular branch of industry.	B3

The values of the factors have to be identified, by applying set of the meanings of factors values for factors group *value for consumer*, i. e. have to be selected a value from 1 to 5 in the every scale.

Table 3. Meanings of factor values of factors group *financial environment*

Fill in by evaluating the technologies of all categories	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Choose an appropriate factor : 1 – currently available or likely probable financing up to 20% of the required sum for the total and complete project ; 2 – currently available or likely probable financing [20 – 40%) of the required sum for the total and complete project; 3 – currently available or likely probable financing is [40 – 60%) of the required sum for the total and complete project; 4 – currently available or likely probable financing [60 – 80%) of the required sum for the total and complete project ; 5 – currently available or likely probable financing [80 – 100%].	C1
				Choose an appropriate range : 1 – [0-1] 2 – (1-1.43] 3 – (1.43-2.5] 4 – (2.5-5] 5 – (5<)	C2
				Choose an appropriate range: 1 – less than 3% from the profit earned ; 2 – [3 – 10 %) from the profit earned; 3 – [10 – 15 %) from the profit earned; 4 – [15 – 25 %] from the profit earned; 5 – more than 25 % from the profit earned.	C3
				Choose an appropriate range: 1 – [8 years<); 2 – [6 – 8 years); 3 – [3 – 6 years); 4 – [1 – 3 years); 5 – [0,5 – 1 year].	C4
				Rate by points from 1 – 5: 1 – relevant, has not been evaluated ; 2 – moderately relevant, has not been evaluated; 3 – insignificant, has not been evaluated; 4 – moderately relevant, has been evaluated; 5 – relevant, has been evaluated.	C5
				Choose an appropriate range: 1 – [6; +∞); 2 – (4 – 6]; 3 – (4 – 2]; 4 – (2 – 1]; 5 – [0.5 – 1].	C6

The values of the factors have to be identified, by applying set of the meanings of factors values for factors group *financial environment*, i. e. have to be selected a value from 1 to 5 in the every scale.

Table 4. Meanings of factor values of factors group *competitive environment*

Fill in by evaluating the technologies of all categories	Tech.			Assessment scale	Factors
	1	2	3		
				Choose an appropriate range: 1 – (0.5 – 1 m.] 2 – (1 – 2 m.] 3 – (2 – 4 m.] 4 – (4 – 8 m.] 5 – (8 – ∞]	D1
				Rate by points from 1 – 5: 1 – technology is uncomplicated to identify, copy, manufacture; 2 – technology is uncomplicated to copy, manufacture; 3 – technology is relatively uncomplicated to identify, copy, manufacture; 4 – technology is integrated, complicated to copy, manufacture; 5 – technology is integrated, extremely complicated to copy, manufacture.	D2
				Rate by points from 1 – 5: 1 – intensively developed, advantageous, competitive or replaceable technologies; 2 – likely probable that more advantageous, competitive or replaceable technology has been developed; 3 – probability of 50% that competitive or replaceable technology has been developed; 4 – competitive technologies are known, but the evaluated technology distinguishes itself by its exclusivity on the market; 5 – competitive technologies are not known, a sustainable competitive advantage ensures long-term predominance on the market.	D3

The values of the factors have to be identified, by applying set of the meanings of factors values for factors group *competitive environment*, i. e. have to be selected a value from 1 to 5 in the every scale.

Table 5. Meanings of factor values of factor group *technology features*

Fill in by evaluating only the traditional technologies	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Rate by points from 1 – 5: 1 – integrity is considerable; 2 – integrity is less than average; 3 –integrity is average; 4 – integrity is higher than average; 5 – integrity is insignificant.	E1
				Rate by points from 1 – 5: 1 – technology is dependent on the geographic / climatic circumstances , modification is impossible; 2 – technology is dependent on geographic / climatic circumstances, modification is possible, but too expensive; 3 – technology is dependent on geographic / climatic circumstances, but modification is possible; 4 –technology is minimum dependent on geographic / climatic circumstances, minimum modification is required; 5 – technology is independent on geographic / climatic circumstances	E2

The values of the factors have to be identified, by applying set of the meanings of factors values for factors group *technology features*, i. e. have to be selected a value from 1 to 5 in the every scale.

Table 6. Meanings of factor values of factor group *technology developers' competence*

Fill in by evaluating the technologies of all categories	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Rate by points from 1 – 5 the competence of the Head of the Division /a person in charge of this particular activity: 1 – Master Degree and work experience in this particular field [1 – 4 years]; 2 – Master Degree and work experience in this particular field (4 – 9years]; 3 – Master Degree in this particular field and work experience for 9 years<or Doctorate Degree and work experience in this field (4 – 9 years); 4 – Doctorate Degree and work experience in this particular field for 9 years<; 5 – Professor and work experience in this particular field for 4 years <.	F1
				Rate by points from 1 – 5 the competence of the Head of the Division /a person in charge of this particular activity : 1 – University Degree in this particular field and work experience < 1 year, but a division / a person in charge of the activity are missing ; 2 – University Degree in this particular field and work experience [1 – 4 years]; 3 –University Degree in this particular field and work experience (4 – 9 years] or Master Degree in this particular field and work experience (1 – 4 years]; 4 –Master Degree in this particular field and work experience for 4 years <or Doctoral Degree in this particular field or (higher degree) and work experience up to 4 years; 5 – Doctoral Degree (or higher degree) and work experience for 4 years <.	F2

Table 6. Continued

Fill in by evaluating the technologies of all categories	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Rate by points from 1 – 5 the competence of the Head of the Division /a person in charge of this particular activity. 1 – University Degree in Engineering or Social Sciences and work experience in this particular field for < 1 year or a person in charge of this particular activity is missing. 2 – University Degree in Engineering or Social Sciences and work experience in this particular field 1 – 4 years; 3 – Master Degree in Engineering or Social Sciences and work experience in this particular field 4 – 9 years; 4 – Master Degree in Engineering or Social Sciences and work experience in this particular field up to 9 < years or Doctoral Degree (or higher degree) in Engineering or Social Sciences and work experience in this particular field for 4 years; 5 – Doctoral Degree (or higher degree) in Engineering or Social Sciences and work experience for 4 years <.;	F3
				Rate by points from 1 – 5 the competence of the Head of the Division /a person in charge of this particular activity: 1 – University Degree in this particular field and work experience < 1 year or a division / a person in charge of this particular activity is missing; 2 – University Degree in this particular field and work experience [1 – 4 years] or Master Degree in this particular field and work experience up to 1 year; 3 – University Degree in this particular field and work experience for 4 years < or Master Degree in this particular field and work experience [1 – 4 years]; 4 – Master Degree in this particular field and work experience (4 – 9years] or Doctoral Degree in this particular field (or higher degree) and work experience up to 4 years; 5 – Doctoral Degree in this particular field (or higher degree) and work experience for 4 years <.	F4
				Rate by points from 1 – 5 the competence of the Head of Division / a person in charge of this particular activity: 1 – University Degree in this particular field and work experience in this particular field > 1 year or a division / a person in charge of this particular activity are missing; 2 – University Degree in this particular field and work experience [1 – 4 years] or Master Degree in this particular field and work experience > 1 year; 3 – University Degree in this particular field and work experience for 4 years < or Master Degree in this particular field and work experience [1 – 4 years]; 4 – Master Degree in this particular field and work experience (4 – 9 years] or Doctoral Degree in this particular field (or higher degree) and work experience > 4 years; 5 – Doctoral Degree in this particular field (or higher degree) and work experience for 4 years <.	F5

By applying set of the meanings of factors values for factors group *technology developers' competence* have to be selected a value from 1 to 5 in the every scale.

Table 7. Meanings of factor values of factor group *legal environment*, when technology is *legally not protected*

Fill in by evaluating legally not protected technologies	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Rate by points from 1 – 5: – (152 – 189 places] – (114 – 152 places] – (76 – 114 places] – (38 – 76 places] – [1 – 38 places]	G1
				Rate by points from 1 – 5: 1 – technology is not functional in any field of the activities; 2 – technological benefit is uncertain in one field of activity; 3 – technology is beneficial in one field of activity; 4 – technology is beneficial in several fields of activities , but the level of benefit in one of the activities is extremely evident; 5 – technological benefit is especially evident in several fields of activities.	G2
				When evaluating choose 0 or 1: 0 – technology is exposed; 1 – technology is confidential.	G3
				When evaluating choose 0 or 1: 0 – indistinct difference; 1– difference is obvious	G4
				Rate by points from 1 – 5: 1 – ES patent; ES patent and patent of Lithuania ; 2 – Eurasia patent; Eurasia and Lithuania patents; 3 – USA patent; USA patent and patent of Lithuania 4 – Patent of Lithuania ; 5 – Confidentiality Agreement.	G5

The values of the factors have to be identified, by applying the set of the meanings of factors values for factors *group legal environment, when technology is legally not protected*, i. e. have to be selected a values from 1 to 5 in the scales-reflecting factor G1, G2, G5, have to be selected a value from 1 to 2 in the scales-reflecting factor G3, G4.

Table 8. Meanings of factor values of factor group *legal environment*, when technology is *legally protected*

Fill in by evaluating legally protected technologies	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Rate by points from 1 – 5: 1– (152 – 189); 2– (114 – 152]; 3– (76 – 114]; 4– (38 – 76]; 5– [1 – 38].	G11
				Rate by points from 1-5: 1 – search for innovations has not been performed; 2 – fast and imperfect search for innovations has been performed (an ordinary search in the data bases); 3 – search for innovations on the level of governmental institutions or similar positions has been performed; 4 – an international search for innovations has been performed; 5 – an international search for innovations and for violations has been performed.	G12
				Rate by points from 1-5: 1 – legal protection involves the market of only one Member State; 2 – legal protection involves several Market Zone Member States; 3 – legal protection involves the majority of the Market Zone Member States; 4 – legal protection involves all the currently existing Market Zone Member States; 5 – legal protection involves all the currently existing Market Zone Member States as well as those having potential significance	G13

The values of the factors have to be identified, by applying set of the meanings of factors values for factors group *legal environment, when technology is legally protected*, i. e. have to be selected a value from 1 to 5 in the every scale.

Table 9. Meanings of factor values of factor group *circumstances related to inventors*

Fill in by evaluating the technologies of all categories	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Rate by points from 1 – 5: 1– [0 – 4 years]; 2– (4 – 9 years]; 3– (9 – 19 years]; 4– (19 – 40 years]; 5– (40 <years).	H1
				Rate by points from 1 – 5: 1 – lower than Master Degree; 2 – Master Degree; 3 – PhD student ; 4 – PhDs or Doctor of Science; 5 – Professor	H2

Table 9. Continued

Fill in by evaluating the technologies of all categories	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Rate by points from 1 – 5: 1– [0 – 10%); 2– [10 – 30%); 3– [30 – 50%); 4– [50 – 70%); 5– [70 – 100%].	H3
				Rate by points from 1 – 5: 1– [0 – 10%); 2– [10 – 30%); 3– [30 – 50%); 4– [50 – 70%); 5– [70 – 100%].	H4

By applying set of the meanings of factors values for factors group *circumstances related to inventors* have to be selected a value from 1 to 5 in the every scale.

Table 10. Meanings of factor values of factor group *institution's internal policy*

Fill in by evaluating technologies of all categories	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Rate by points from 1 – 5: 1 – activity of the institution is not connected with technical commercialization and no plans for future activities in this field; 2 – activity of the institution is not connected with technical commercialisation, but in future there are plans to expand this particular activity; 3 – the institution is reorganizing its activities; one new field of activity is connected with technical commercialisation 4 – the activities of the institution are developed in several directions; one of the activities is directly related to technical commercialisation 5 – technical commercialisation project corresponds completely the strategy and current activities of the institution.	I1
				Rate by points from 1 – 5: 1 – terms and conditions of the institution are totally unacceptable for the inventor; neither one nor the other side is inclined to compromise; 2 – terms and conditions of the institution are unacceptable for the inventor, but there is a minimal probability to compromise; 3 – because of the unsatisfactory terms and conditions, one side or the other is likely to compromise; 4 – the terms and conditions of the institution are acceptable in principal, but the minimal inadmissibility prevails; 5 – terms and conditions of the institution totally satisfies the inventor.	I2

Table 10. Continued

	Tech.			Assessment scale	Factors
	1	2	3		
Fill in by evaluating technologies of all categories				Rate by points from 1 – 5: 1 – institution is not active in this particular field, commercialisation of technologies is targeted for future; 2 – institution commercializes technologies, but this activity is not profitable 3 – institution commercializes technologies, income covers investments, but its activities are not profitable; 4 – institution commercializes technologies, this field of activity is profitable; 5 – Institution commercializes technologies, the activity of the institution is extremely profitable.	I3

The values of the factors have to be identified, by applying set of the meanings of factors values for factors group *institution's internal policy*, i. e. have to be selected a value from 1 to 5 in the every scale.

Table 11. Meanings of factor values of factor group *value for consumer*

	Tech.			Assessment scale	Factors
	1	2	3		
Fill in by evaluating only high technologies				Rate by points from 1 – 5: 1 – potential product by its value reveals new currently prevailing products; 2 – the choice of substitutes for a potential product is rather wide, the value of which is similar; 3 – the substitutes for a potential product currently exists, but their functioning or assortment is not perfect ; 4 – the substitutes for a potential product currently exists, but they are not competitive so far; 5 – the proposed value of the potential product in comparison to the substitutes is advantageous.	B1
				Rate by points from 1 – 5: 1 – more than 90% of the surveyed respondents have a negative opinion or such kind of a research has not been performed yet; 2 – more than 50% of the surveyed consumers have a negative opinion or such a research has not been performed yet; 3 – potential customers are either neutral or negative or positive and divided in equal parts; 4 – more than 50% of the potential customers have a positive opinion; 5 – more than 90% of the respondents have a positive opinion.	B2
				Rate by points from 1 – 5: 1 – the method which solves the problems by means of technology is widely known and applicable; 2 – the method which solves the problems by means of technology is not perfect; 3 – the method which solves the problems by means of technology is perfected; 4 – the method which solves the problems by means of technology is radical or completely different from the currently existing so far. 5 – technology could change the method used by an industrial branch.	B3

Table 11. Continued

Fill in by evaluating only high technologies	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Rate by points from 1-5: 1 – it is very complicated to use; 2 – it is complicated to use; 3 – the level of usage concerning its complexity is similar to the currently existing alternatives; 4 – it is simple to use; 5 – the usage is absolutely simple	B4
				Rate by points from 1 – 5: 1 – less than the currently used alternatives; 2 – slightly less than the currently existing alternatives; 3 – equivalent to the currently existing alternatives; 4 – slightly higher than the currently existing alternatives; 5 – higher than the existing alternatives.	B5

Fill in by evaluating only high technologies, by applying set of the meanings of factors values for factors group *value for consumer* have to be selected a value from 1 to 5 in the every scale.

Table 12. Meanings of factor values of factor group *technology features*

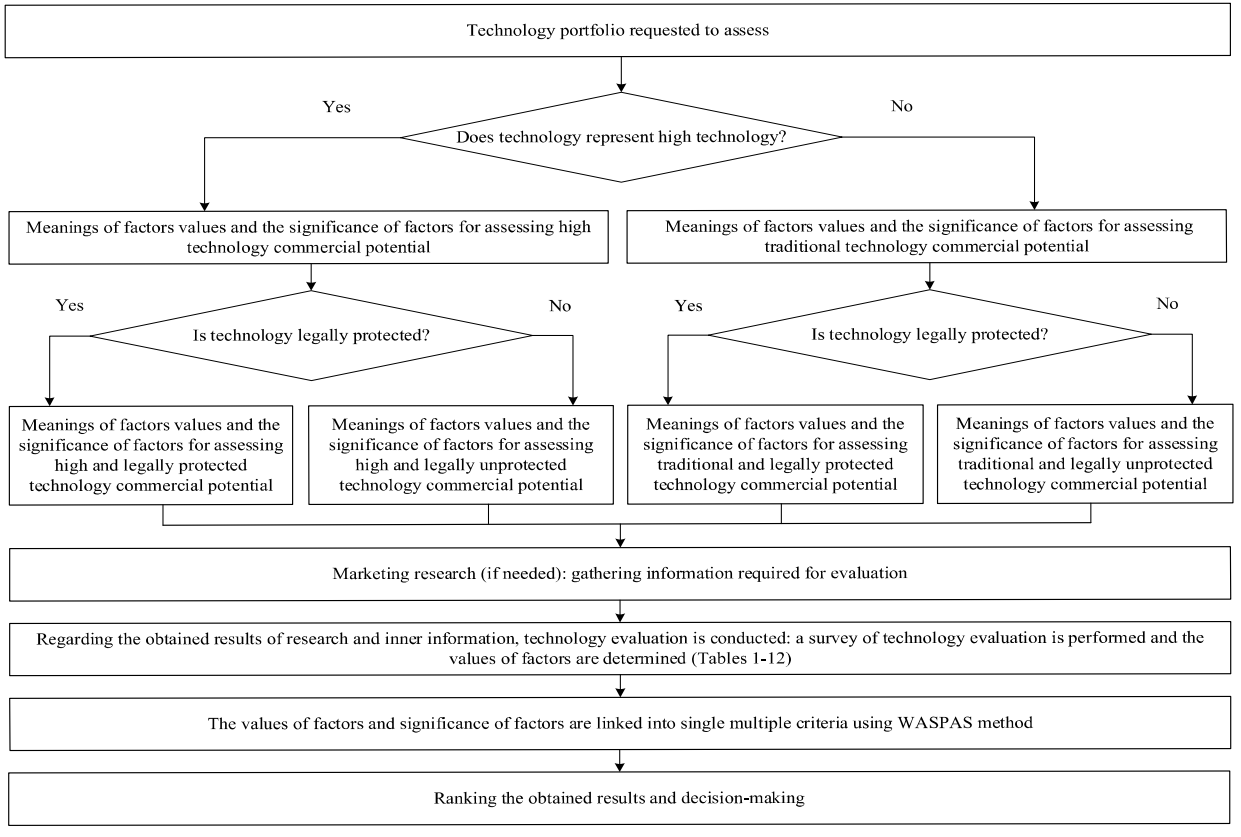
Fill in by evaluating only high technologies	Tech. 1	Tech. 2	Tech. 3	Assessment scale	Factors
				Rate by points from 1 – 5: 1 – high integrity ; 2 – slightly higher than the average; 3 – average integrity; 4 – slightly less integrity than the average; 5 – integrity is small.	E1
				Rate by points from 1 – 5: 1 – technology is dependent on geographic/ climatic circumstances, modification is not possible; 2 – technology is dependent on geographic / climatic circumstances, modification is possible, but too expensive; 3 – technology depends on geographic / climatic circumstances , but modification is possible; 4 – technology is dependent minimally on geographic / climatic circumstances, minimal modification is required; 5 – technology is independent on geographic / climatic circumstances;	E2

Table 12. Continued

Fill in by evaluating only high technologies	Tech.			Assessment scale	Factors
	1	2	3		
				Rate by points 1 – 5: 1 – a potential product is completely inapplicable to the currently existing technologies or excessive investments are required for modification; 2 – a potential product is not adjusted to the currently existing technologies, large investments are required to improve the situation ; 3 – a potential product is adjusted to the currently existing technologies, but investments are required; 4 – a potential product is adjusted to the currently existing technologies, but minimal modification is required; 5 – a potential product is perfectly adjusted to the currently existing technologies.	E3
				Rate by points from 1 – 5:the application of technology for the solution of diverse problems 1 – technology is applicable only in one field of activity; 2 – technology is applicable in one field of activity, but after the modification, it is possible to apply and adapt in the other branches of activities; 3 – technology is applicable in one field of activity, but after minimal modifications it is possible to adapt it in the other branches of activities; 4 – technology is adaptable in two branches of activities ; 5 – technology is applicable in more than two branches of industry.	E4

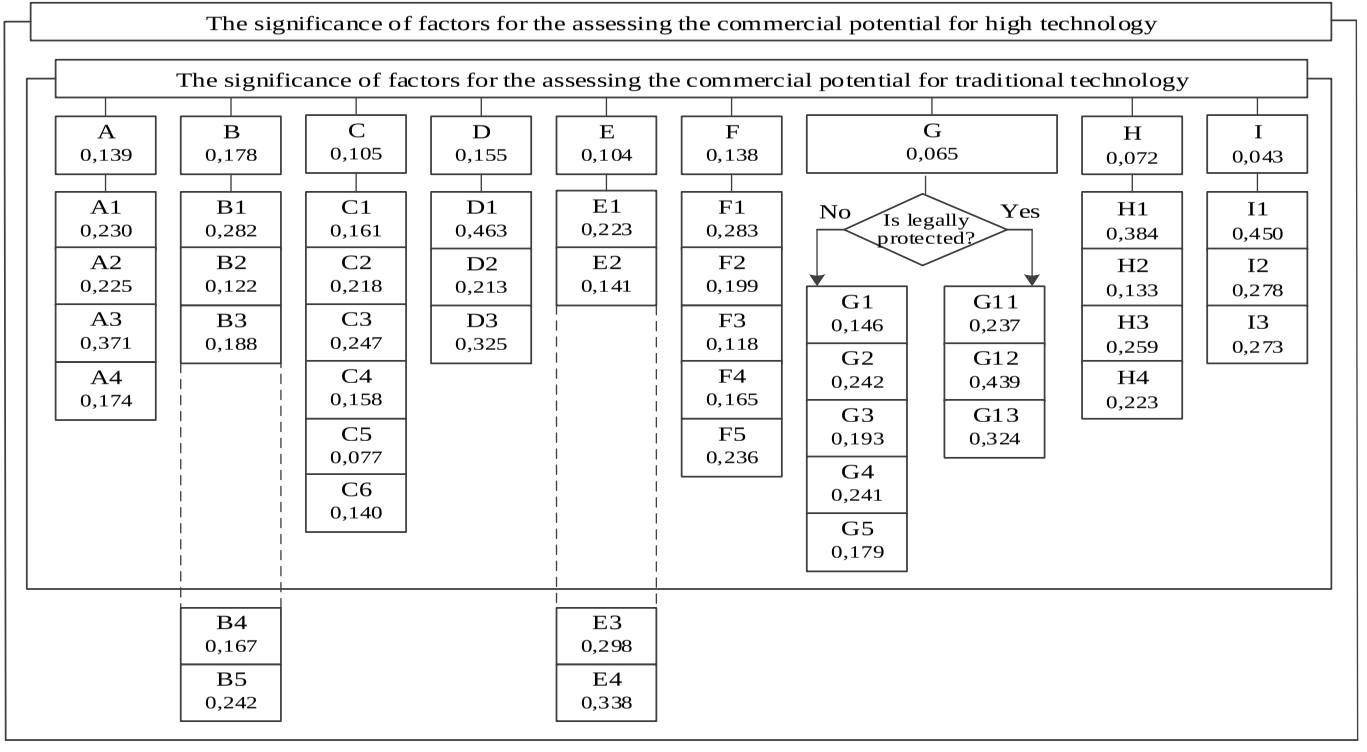
Fill in by evaluating only high technologies. The values of the factors have to be identified, by applying set of the meanings of factors values for factors group *technology features*, i. e. have to be selected a value from 1 to 5 in the every scale.

Figure 1. Model for assessing the commercial potential of technologies



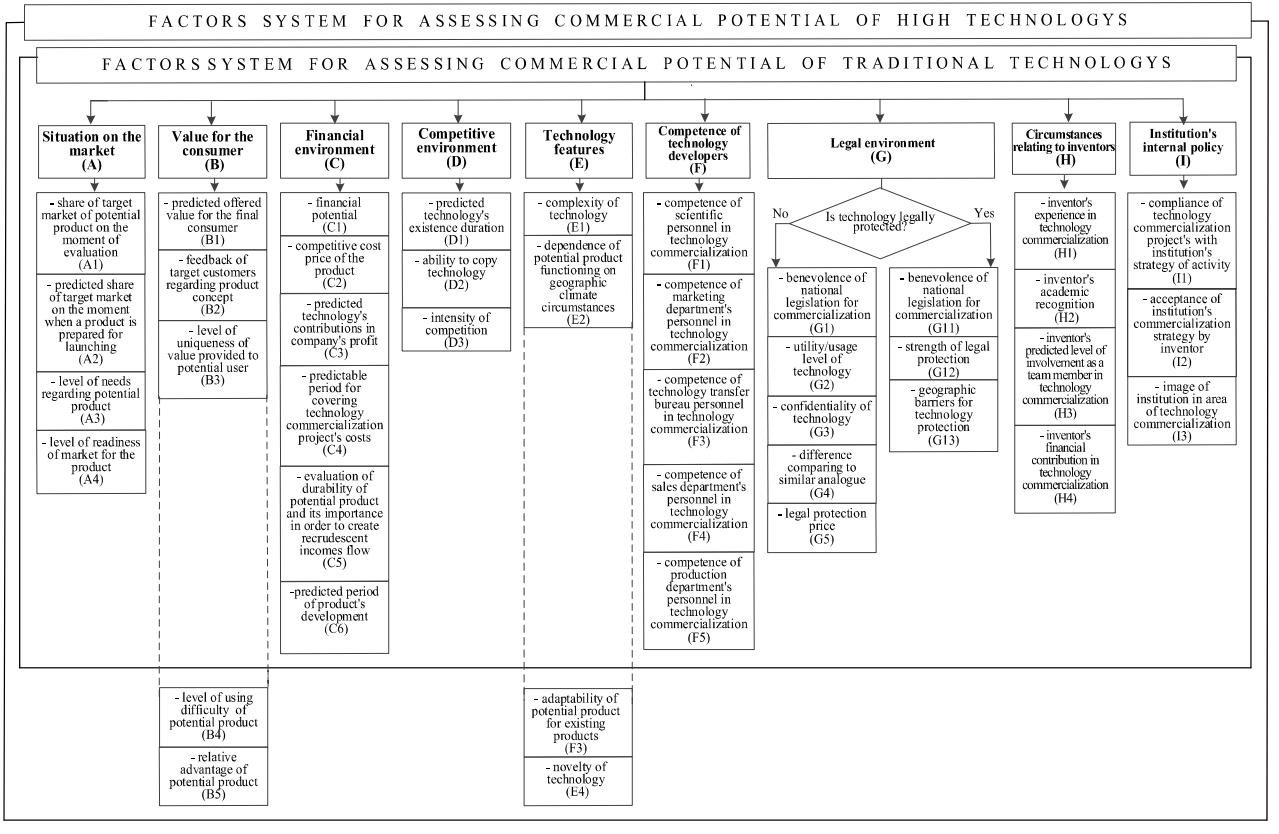
Source: Zemlickienė (2015).

Figure 2. The significance of factors for assessing the commercial potential of technologies



Source: Zemlickienė *et al.* (2017).

Figure 3. Factors system for assessment commercial potential of technologies



Source: Zemlickienė (2015), Zemlickienė et al. (2017).