KAUNAS UNIVERSITY OF TECHNOLOGY

LITHUANIAN ENERGY INSTITUTE

RASA LALIENĖ

EFFECTIVENESS ASSESSMENT OF RESEARCH ORGANIZATIONS

Summary of Doctoral Dissertation
Social Sciences, Economics (04S)

2015, Kaunas

The Doctorial Dissertation has been prepared between 2010–2015 at Kaunas University of Technology, School of Economics and Business, Department of Management.

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The public defence of the doctoral dissertation will be held at 14 p.m. on 18th of December, 2015 at a public session of the Board of Economics Science field in the Doctoral Dissertation Defence Hall of Kaunas University of Technology (K. Donelaičio str. 73 – 403, Kaunas).

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The summary of the Doctoral Dissertation is sent out on 18th of November, 2015.
The Doctoral Dissertation is available at the libraries of Kaunas University of Technology (K. Donelaičio str. 20, Kaunas) and Lithuanian Energy Institute (Breslaujos str. 3, Kaunas).

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MOKSLINIŲ TYRIMŲ ORGANIZACIJŲ VEIKLOS EFEKTYVUMO VERTINIMAS

Daktaro disertacijos santrauka
Socialiniai mokslai, Ekonomika (04S)

2015, Kaunas

Daktaro disertacija rengta 2010–2015 Kauno technologijos universitete, Ekonomikos ir vadybos fakultete, Vadybos katedroje.

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Disertacija bus ginama viešame Ekonomikos mokslo krypties tarybos posėdyje, kuris įvyks 2015 m. gruodžio 18 d. 14 val. Kauno technologijos universiteto disertacijų gynimo salėje (K. Donelaičio g. 73 – 403, Kaunas).

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Disertacijos santrauka išsiųsta 2015 m. lapkričio 18 d.
Su disertacijos santrauka galima susipažinti Kauno technologijos universiteto (K. Donelaičio g. 20, Kaunas) ir Lietuvos energetikos instituto (Breslaujos g. 3, Kaunas) bibliotekose.

INTRODUCTION

Relevance of the research

As the processes of openness, international competition and business growth based on knowledge gathers increasing momentum, the role of Research and Development (R&D) in society becomes ever more important. The application of scientific research and its results become the main goal that ensures the social and economic development in society. R&D is listed as one of the conditions that ensures competitiveness, with its contribution to economic development and public welfare (Hall, Mairesse and Mohnen, 2010; Khan, 2006; Kirstukas et al, 2013; Knašas, 2014, Melnikas et al, 2000; Pessoa, 2007; Rodríguez-Pose, Crescenzi, 2008; Wieser, 2005 and others). R&D constitutes the main area of activity in research organizations. The increase in demand for R&D caused an expansion of such organizations. Alongside academic and public research centres, institutes and laboratories, the emergence of private research laboratories, research and technology (or innovation) centres, research and technology transfer centres, joint research centres, research competence centres etc. is observed (all these organizations are listed as Research Organizations (ROs) in this dissertation). The abundance and variety of R&D organizations indicate the problem of their effectiveness assessment. ROs differ in forms of ownership, mission and range of activities, all of which determine the specialization of activities undertaken in ROs, the specifics of the processes executed, varying need of resources and, of course, the variety of products created.

The topic of effectiveness assessment of R&D in business companies (Bond, Harhoff, Van Reenen, 2005; Chiesa et al, 2008; Hall et al, 2010; and others) and the paradigms of interaction between R&D and economics (Khan, 2006; Pessoa, 2007, Rodríguez-Pose, Crescenzi, 2008; and others) has been examined quite extensively in many academic sources. However, as the concept of R&D develops, the view on ROs and their effectiveness changes as well. Activities carried out in ROs, as in other organizations, becomes more oriented to efficient use of resources by transforming them into R&D products. That is an especially important task when those resources are limited. Traditional methods for effectiveness assessment that are based on profitability, net profit, return on equity and other indicators and that are used in business enterprises cannot be applied to ROs successfully (see Gimžauskienė, 2007; Hatry, 2006; Klovienė, 2012; Rompho, Boon-itt, 2012; Sližytė, 2009; Taticchi, Asfalti and Sole, 2010; and others) as they differ from business enterprises in work content, specificity of created products, spontaneity of activities, time lag between the development stages and production of results and so on.

Level of research done on the topic

Ojanen and Vuola (2003) note that before, work done in ROs was viewed as a "black box" and R&D was seen as an isolated function that cannot be controlled or managed systematically, let alone measured. In addition, even though research on R&D effectiveness assessment had become more extensive in the past few decades, as Hall and others (2010) noted, the majority of research carried out took place in enterprises that belong to the manufacturing sector, whereas the assessment of effectiveness in ROs received much less attention.

The existet structures and the available effectiveness assessment models created for ROs (Cincera, Czarnitzki and Thorwarth, 2008; Coccia, 2001, 2004, 2005; Leitner, Warden, 2004; Lin, Bozeman, 2006; Paul et al, 2010; and others) lack complexity, a systematic approach and empirical substantiation from the perspective of ROs. Due attention is not paid to the clarification of the concept of effectiveness assessment, the type of activities carried out in ROs and the selection of evaluation parameters according to the type of R&D undertaken in those organizations. The need to make a comprehensive evaluation is not met and the view on evaluation itself lacks a comprehensive approach that would allow making timely decisions for the increase of effectiveness in these organizations.

The problem of the research is thus expressed by the following question – how to evaluate the effectiveness of ROs according to different activities undertaken in these organizations. The relevance of the problem is determined by the following:

- a significant increase in the variety of ROs that signifies the diversity of prospective activities and that raises a question – is it possible to have a unified evaluation system for all types of Ros;
- the specificity of products supplied by ROs in respect to their value assessment. These include a wide array of products – from concepts to finalized products or prototypes. Clearly, we cannot evaluate the entirety of these products only in regard to the financial aspect, therefore the need for a multiparameter evaluation arises. Quality assessment and its incorporation into effectiveness assessment in order to determine the value of production is relevant as well;
- time lag is characteristic to products created and achievements produced by Ros;
- difficulties in planning and estimating the scope of activities and results arise because of the spontaneous and indeterminate character of R&D products.

The main goal of research – to create an effectiveness assessment model for ROs that allows an evaluation of their work depending on the activity differences carried out in those organizations.

Research objectives:

1) To delineate and expound the concept of effectiveness assessment of ROs.
2) To present a classification of ROs in respect to the character of their work that corresponds to the changing institutional paradigm of R&D.
3) To form the principal points of effectiveness assessment of ROs.
4) To form a comprehensive structure of ROs effectiveness assessment.
5) To create a processual model of effectiveness assessment of ROs.
6) To validate the created model empirically by evaluating the impact of time lag on the results of effectiveness assessment.

Research object – effectiveness assessment of ROs.

Research methods

Different methods were applied in order to achieve the goals of this dissertation. First, an extensive comparative and comprehensive analysis of academic sources concerning the operation of ROs, concept of R&D, effectiveness assessment of ROs and related topics were performed. Concepts of efficiency, productivity and effectiveness were analyzed as seen in Colquhoun, Baines and Crossley (1993), O'Donnell and Duffy (2005), Paul et al (2010), Bogetoft and Otto (2011), Balezentis, Krisciukaitiene and Balezentis (2014) and others, and the concept of effectiveness assessment of ROs was formed according to that analysis. Main deficiencies and limitations of existent effectiveness assessment models and structures (as seen in Coccia, 2001, 2004, 2005; Leitnerand, Warden, 2004; Lin, Bozeman, 2006; Cincera et al, 2008, Paul et al, 2010; and others) were identified and the main processes, components and interrelations in ROs were established after a critical and extensive analysis of the sources mentioned.

Analysis of actual documents was performed to identify the particularity of assessment parameters when evaluating the activities of ROs. The main assessment parameters applied in practice were identified by carrying out a comprehensive analysis of RO performance reports, the R&D evaluation methodology used by the Ministry of Education and Science of the Republic of Lithuania and the Frascati manual. The analysis of the aforementioned academic sources and documentation allowed the identification of their limitations. Additionally, the focus group method was applied in order to identify the specifics of assessment of ROs in practice.

Knowledge gained from the academic sources, performance reports and documents, as well as from information gathered during meetings with scientist teams, was integrated into the main postulates of the effectiveness assessment in ROs. On the basis of these postulates, a comprehensive structure of RO activities and their effectiveness assessment model was created, taking into account the diversity of these organizations and the field of activities they operate in.

The new model was empirically tested by evaluating 9 ROs. In order to evaluate the effectiveness of these ROs, the following methods were applied: nonparametric linear programming Data Envelopment Analysis method (DEA) and superDEA, as well as multi-criteria decision making analysis methods VIKOR, TOPSIS and ARAS. The Expert evaluation method was used to determine the significance of parameters and their most frequent time lag.

Novelty, significance and practical application of the dissertation results

RO's activities and created outputs differ from others by its value and quality measurement, the expected outputs and results uncertainty, the possibilities of standardization and other aspects. It raises a need for separate analyse of the term and the concept of RO's effectiveness and its performance effectiveness assessment. The novelty of this dissertation lies in the concept of effectiveness assessment in ROs, which does not receive due attention in the available academic sources. The postulates of effectiveness assessment in ROs were identified, which must be taken into account in order to produce valid effectiveness assessment results. Based on these postulates, the ROs effectiveness assessment structure and the processual effectiveness assessment model was created. The effectiveness assessment structure was modelled on the basis of the main elements in the process of these activities. These elements link the entirety of RO activities into a coherent process: Input – Process – Output – Transfer system – Outcome. This structure of activities serves as a tool that allows the understanding and interpretation of the concepts of efficiency, productivity, results evaluation and effectiveness, and it both integrates and shows the interconnectivity of the main elements of activities associated with ROs. Based on this structure, a processual effectiveness assessment model was created: it allows the evaluation of either the different stages of ROs activities or the general effectiveness according to the type of activities undertaken. The theoretical novelty of this method is signified by the complexity of the model, when ROs effectiveness assessment structure clearly defines the concept of the effectiveness assessment together with the included elements of the activity and the heterogeneity of the ROs activity, whereas the processual model specifies the assessment stages. One of the main exceptional features of this model is the explication and validation of its operation that is based on evaluation parameters being chosen according to the type of an RO activity and the created outputs. Priority attention is given to the ROs homogenous group setting, using the research area and the scope of R&D covered as the main criteria in order to assess their performance effectiveness properly.

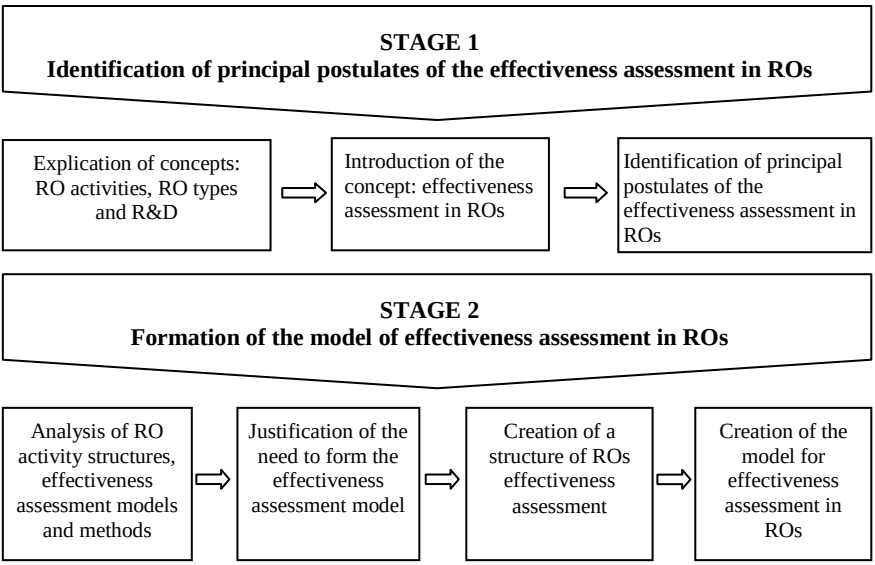
Global changes in the contemporary world, brought about by the ever accelerating progress of science and technology, harsh competition and the indeterminate character of the market processes, is forcing different organizations and countries to look for ways to speed up R&D and ensure that its

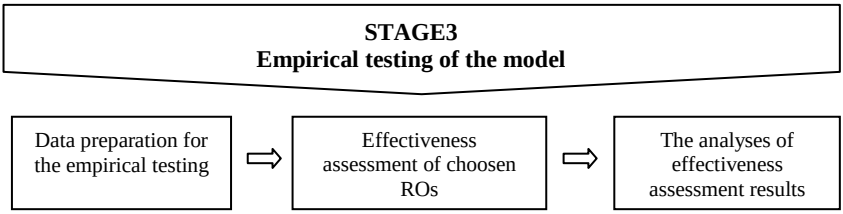
contribution to the economy is significant enough. The effectiveness assessment model introduced in this work has a practical significance. The model can be used as a tool by the executives of ROs to manage resources more effectively and to allocate them towards the desired R&D direction, thereby ensuring optimal use of limited resources for achieving the best results. The processual effectiveness assessment model and the methods suggested not only allow ROs to evaluate the position of the organization as compared to other ROs, but also to indicate its quantitative deviation from other organizations.

Innovative activities are crucial for economic development and it all starts from the development of R&D production. Therefore, it is evident that effective and well directed activities of ROs would condition growth on both local (organization) and global (country, world) levels. The model is beneficial to the executives of ROs and public institutions that develop and oversee R&D policies and need to identify the opportunities of growth in effectiveness and to focus limited resources on a more effective implementation of set goals.

The structure of the dissertation

The logic of the structure was determined by the sequence of objectives set in the dissertation. The dissertation is composed of an introduction, three chapters, conclusions, reference list and 6 annexes. The dissertation has 150 pages. The number of academic sources used in this dissertation – 221. A block diagram that shows the stages of development of the effectiveness assessment model is given in Figure 1.





1 Fig. Stages of Development of the Effectiveness Assessment Model

REVIEW OF DISSERTATION CONTENT

The results produced when working on the first stage are given in the first chapter of the dissertation. The following can be found there:

- the conception of R&D as the main activity carried out in ROs and its role in economic and social development is disclosed;
- the variety of ROs in respect to the types of activities carried out is disclosed;
- the conception of effectiveness assessment in ROs and the benefit of such assessment to the organization is disclosed;
- the principal postulates of the effectiveness assessment in ROs are identified.

The main activity carried out in research organizations (ROs) is research and development (R&D), therefore, only when the conception of R&D and its content is understood clearly and when the production created from R&D is defined, the effectiveness assessment of ROs becomes possible. The ideas found in the OECD Frascati manual are used as a basis in cases when R&D covers the basic, applied and experimental development activities that have the potential to produce a scientific or a technological product with a clear element of novelty or when a solution to the academic/technological indeterminacy problem is the main criteria that draws a line between R&D and other related academic or innovation based activities. An important point in the context of RO assessment is the fact that R&D covers different stages, from solely academic research to the creation of an end product, all of which determine a different demand of resources be used, different types of products are created and different results of realizing these products are observed. Additionally, different types of R&D products are measured by different parameters that cannot be compared to each other, e.g. number of publications, number of patents, assets earned or number of projects carried out. The majority of R&D products are not market goods that can be measured by their market price. Therefore, it is mandatory to use multi-criteria analysis methods in order to make a general evaluation of R&D activities. R&D is also characteristic of a unique property – that of indeterminacy and spontaneity. This sort of activity does not always end as expected or

envisioned. Therefore, when planning the scope and results of such activity, it is important to take into account the fact that it is impossible to fully foresee, and even more so, to plan out accurately the extent of the R&D production or to determine the accurate time of its creation, which is extremely important in assessing the effectiveness of these activities if the evaluation is based on the ratio of achieved results and planned activities. Another distinctive feature of R&D production is that R&D results occur with a certain delay – the so called time lag – because of the need to assess the quality of R&D production with expert evaluation or because of other administrative or procedural reasons.

R&D considered as a factor of social and economic development allows the claim that the so sought after social and economic development is determined not only by the creation of R&D production itself, but also the dissemination and transfer of this production and the ability to implement it. R&D is not aimless and its value goes beyond it: the new knowledge produced must be applicable and beneficial to society. Therefore, the operation of ROs can be beneficial not only on a personal level to an organizational unit, but also for the whole organization and its environment or other enterprises, all of which constitutes social value. The benefits of ROs for the social and economic development is not in question, however, the assessment of external effectiveness of the results produced by ROs is still quite complicated, because scientific activities are qualitative and dispersed by nature, the occurrence of results is affected by time lag and the chain of cause-effect is lengthy.

The analysis of the variety of ROs shows that the institutional organization of academic research is changing rapidly. If before, universities were the main institutions that produced knowledge, they are slowly but surely giving way to ROs of other types and profiles or universities themselves contribute to the establishment of ROs. ROs are more and more characteristic to the principles and practices of "marketability", "economy" and "entrepreneurship", with closer cooperation with business, greater responsibility for external sources of income and greater attention to efficient use of intellectual and other resources. New forms of ROs are established that cover different interests, from solely academic ones to successful commercialization of R&D results. In addition, even though a detailed presentation of RO groups classified by the types of activities they carry out requires a separate study, a few such groups that differ in orientation of activities carried out can be distinguished in general terms. These are: universities and ROs under them, technology-oriented universities and ROs under them, independent public research centres or institutes, private research centres or institutes, technological innovation and research centers or institutes and ROs in private enterprises or corporations or their subdivisions.

The first chapter also introduces the variety of evaluation goals, with emphasis on the fact that for the organization the evaluation is beneficial,

because it can be taken as a review of its activities. Having this goal in mind, the effectiveness assessment of an organization helps the organization to make the right decisions in terms of activities undertaken, to adapt to changing environmental conditions, set future goals and pushes the organization to continuous improvement. It is recommended to include the widest possible range of performance parameters in order to get a more comprehensive picture. Arthus and Lyster (2007), Hatry (2006), Taticchi, Asfaltiand and Sole (2010) define effectiveness assessment as a regular assessment of efficiency, effectiveness and results of production. According to these authors, exactly this kind of assessment is central to a business or an organization if it strives for maximum benefit. Therefore, the ideas proposed in this dissertation are based on the conception of RO assessment as a gradual system that allows the evaluation of an RO comprehensively, by determining its strengths and weaknesses and by aiming to make the right timely decisions on the improvement and development of the activities carried out. As ROs transform, for an RO, as for any other business enterprise, the aspects of cost reduction, rational use of resources, quality improvement of production and increasing effectiveness have become particularly relevant. Therefore, the created effectiveness assessment system will add to the presentation of the actual objective situation of an RO and the search for continual improvement reserves.

In order to elucidate the conception of effectiveness assessment of ROs, firstly, a detailed analysis of the terms "efficiency", "effectiveness" and "productivity" were carried out. Academic literature does not provide a uniform definition of any of these terms, however, the most valid concept of effectiveness is the one connected to the benefits received by the organization or the assessment of a result produced. However, the effectiveness assessment of ROs that is based only on the assessment of gains or results would represent an overly pragmatic view on both the activities carried out in ROs and their assessment. In business companies, manufactured products are not that valuable in themselves if they are not sold, whereas it is not so in ROs. The reason for this lies in the particularity of some basic features of R&D activities and products. First of all, not all R&D products can be commercialized. Secondly, not all R&D activities are successful, i.e. the initial objectives of the project are not always reached and beneficial results are not always generated. However, even when a positive outcome is not produced, the R&D carried out does not lose its significance. Thirdly, the development of some technology from the initial idea to the creation of an end product for the market might take up to 9-10 years, and the success of each development stage is highly reliant on the success of the previous stage. Subsequently, the results of R&D are highly dispersed and intended not only for the development of a specific company but for the entire society as well. Having all these features of R&D in mind, the assessment of results produced by ROs is treated only as a part of the overall effectiveness assessment of ROs, by

including the gains possible to achieve in the short term and by measuring them from the perspective of an RO. Therefore, effectiveness is treated as an overall activity assessment parameter in this dissertation, whereas efficiency, productivity and results assessment are treated as basic effectiveness assessment parameters detailing it. Effectiveness of ROs is seen as an aspiration to produce scientific production of the highest value with the help of an efficient manufacturing process. This production is expected to maximize the benefits (deliver the highest results) for the founders and other actors in ROs. The concept of effectiveness is compound – it includes two perspectives of activity: first, the ability of an RO to produce high quality production (high RO productivity) from all R&D carried out on all levels; second, the ability to realize the created production when assessing the produced results in the short term from the position of the RO itself (high count of results in the RO).

After summarizing the results of a comprehensive comparative analysis on the variety of ROs and the content of R&D as seen in the available academic literature found in the first chapter of the dissertation and after presenting the concept of effectiveness assessment for ROs, the basic principles of effectiveness assessment of ROs were formed. In turn, these were indicative of the specific requirements for the formation of the effectiveness assessment model:

1) The disclosed conception of R&D content requires the forming an assessment model that takes into account the whole variety of R&D products and activities – from the ones oriented to "pure science" to the ones oriented to meeting practical needs or to the coordination of innovation continuity. The content of R&D (basic research (BR), applied research (AR) or experimental development (ED)) and the variety of ROs that carry out these activities, as well as the relationship with the environment, makes the realization of this principle very difficult.
2) The diversity of R&D production determines the manifold character of the assessment parameters used for evaluating it. That, in turn, creates the requirement to choose the right evaluation methods that allow the use of multi-criteria indicators.
3) When forming the effectiveness assessment system for ROs, due attention must be paid to the assessment and establishment of the quality of R&D production and results, and the most objective measurement principles must be chosen.
4) The main aspects of change in the activities and infrastructure of R&D – the changing institutional paradigm of R&D, the growing number of different type ROs – determines the need to take into account the unique identity of each RO and its area of research when assessing R&D, because they differ in purpose, mission or strategic objectives. One cannot make a valid assessment of an RO directed toward applied

research with the parameters used for the assessment of basic research. This requirement points to the importance of classification of ROs.

5) The manufacturing of R&D production is a lengthy process that is characteristic of spontaneity and indeterminacy, both in terms of expected results and the duration of the process. In order to make an objective assessment of R&D productivity and results, it is important to take into account the principles of time lag and R&D indeterminacy.
6) The paradigm of R&D as the main factor for economic growth indicates that not only the creation of R&D should be taken into account, but also the ways ensuring its spread to the outside world.
7) The principle of complexity requires thorough evaluation of the content of activities carried out in ROs according to its organizational structure and type of activities carried out. As the requirement principle of holistic assessment, the widest possible spectrum of parameters that cover RO actors, available resources, processes, created production and achieved results must be used when making an evaluation.
8) The principle of effectiveness assessment of R&D carried out by ROs requires the forming of a parameter system that would allow assessing the efficiency, productivity and results gained by an RO in the most objective and comprehensive manner.
9) The effectiveness assessment of ROs cannot be fragmentary, on the contrary – it must be a systematic and an ongoing process. The results of the assessment must be comparable in time, so progress or regress in certain areas can be assessed as well. Additionally, the possibility to observe not only final but also interim results must be ensured, which would allow making timely decisions in an organization.
10) A systematic approach to ROs requires treating the object as a complex dynamic system, composed of multiple interrelated elements – subsystems. The dynamics of the environment of an RO, its transformation and dependence on external factors must be taken into account. The parameters of assessment must interrelate with the principles and tendencies of R&D policies outside of the RO.
11) The assessment of ROs must be based on objective parameters, reliable information and reliable research methods, all of which allow providing impartial conclusions.

The results of the second stage of the effectiveness assessment for ROs are given in the second chapter of the dissertation. The following can be found there:

- the available effectiveness assessment models and structures of ROs are analyzed and evaluated in respect to the previously identified principles;

- the variety of activity assessment methods and their suitability for the effectiveness assessment of ROs is investigated;
- a comprehensive structure of ROs effectiveness assessment is created;
- a processual model for the effectiveness assessment in ROs is created according to the formed structure.

The problem of effectiveness assessment of ROs is analyzed quite extensively in academic literature, however, only a few of the authors provide an exhaustive assessment model for ROs or show how it operates in practice. A part of the assessment models analyzed are quite conceptual – structural, i.e. the effectiveness assessment is analyzed in respect to the elements of the process of an activity, levels, assessment perspectives and other constituents. Other assessment models concentrate more on the processual modeling of activity assessment, i.e. provide assessment steps, stages, parameters or their groups. After analyzing these effectiveness assessment models for ROs, it can be stated that:

- they reflect the basic principles of effectiveness assessment, and the growing level of detail in separate constituents does not change the essence of the model but only enhances its capabilities.
- Most models have a clearly distinguished chain of Input – Process – Output – Outcome. This clearly confirms the importance of all these constituents for the end process, the existence of direct and reciprocal relations and requires that all these constituents are thoroughly evaluated;
- the importance of resources is stressed in all the models. Recently, the importance of research staff (human capital) is emphasized. However, the recognition of the importance of such resources should not overshadow the recognition of other – material and financial – resources;
- most effectiveness assessment models are only validated empirically from the perspective of business enterprises;
- many authors treat the strategy of an RO as the decisive or primary dimension of the assessment, however, only a few of these (Kerssens-van Drongelen, Bilderbeek, 1999; Griffin, Page, 1996) elaborate on the application of this dimension in practice, but they do so from the perspective of private enterprises that invest in R&D, and not from the perspective of ROs themselves;
- the diversity of R&D activities carried out in ROs create the necessity to classify ROs according to the area of activities they operate in, the level of development or other parameters specific to these organizations, e.g. if they are public or private and such. However, this is taken into account only in a few of the models (Coccia (2004,

2005); Vijayalakshmi, Iyer (2011)) but the grouping of ROs is not sufficiently covered.

Therefore, it is obvious that there is no comprehensive effectiveness assessment model for ROs available that would allow the evaluation of activities carried out in ROs from the perspective of activity types. For this reason, such a perspective is created in this dissertation by joining the positive qualities of different models into one. It can be clearly seen from the comprehensive effectiveness assessment structure (Fig. 2) that ROs activities are extremely heterogeneous. The ROs effectiveness structure is defined by these basic attributes:

- the concept of activity assessment where the subsystems of effectiveness assessment of ROs are specified;
- the sequence of RO activities: Input – Process – Output – Transfer system – Outcome and their elaboration;
- the connection between the strategy of an RO, process, products created and results achieved.

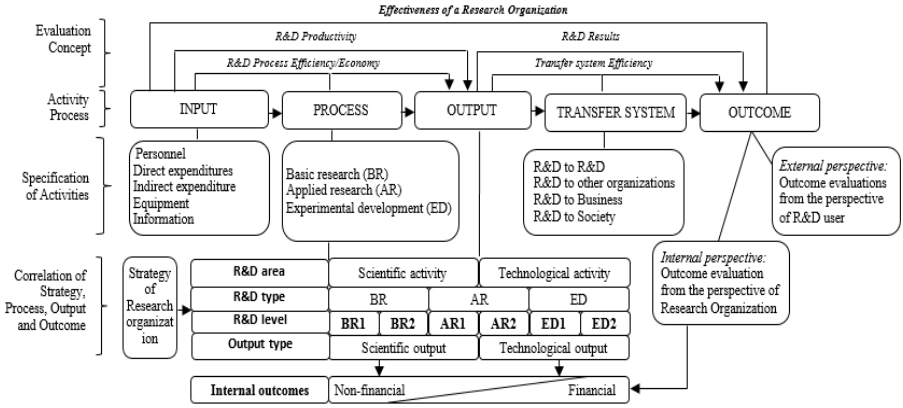


Fig. 2. A Structure of ROs Effectiveness Assessment

The three main subsystems can be distinguished in the structure of effectiveness assessment in ROs:

1) The Input – Output level: the assessment is based on the evaluation of the ratio between expenditure and scientific production created (productivity) and the evaluation of any changes in that ratio.
2) RO process level: the efficiency or the economy of this process is evaluated, as well as any changes that occur during the process (work force, the utilization rate of material resources and such).
3) Output – Outcome level: the assessment is based on the evaluation of the ratio between production created and the results achieved from it

(ability to achieve results) and the evaluation of any changes in that ratio.

Partial productivity indexes, or single-factor efficiency inputs, are fully sufficient to evaluate the resources an RO has and their utilization. These indexes or inputs, as can be seen from the terms themselves, indicate only partial productivity, i.e. detail its individual components through a prism of one or the other single resource (work, capital and such) or a product (e.g. number of articles published per employee, percentage of technological capacity utilization rate and such). These parameters show the level of resource allocation and utilization, which plays an important role in determining the productivity and ability to achieve results and helps identify the reserves that can be used for the increase of productivity if the resources are not utilized to their full capacity.

When dealing with homogenous R&D production and resources, the assessment algorithm of total productivity can be implemented successfully. This algorithm that used for the assessment of productivity of an RO is based on the evaluation of the ratio between aggregated inputs and aggregated outputs (production). The main problem associated with the implementation of this algorithm, and most other parametric methods for the assessment of ROs, is that the majority of activity parameters in ROs are multidimensional, and as for the assessment of the latter, multi-criteria decision making methods (MCDM) are most suitable. Each of these methods has its limitations, features, hypotheses and perspectives. A comprehensive axiomatic analysis of the measurement stages by different methods and algorithms has not been performed to this day, which would prove the superiority of one method or the other, so researchers suggest using several methods and comparing the results received.

If an RO has a comprehensive business strategy with parameters for all levels of achievement metrics established and set, and a detailed normative basis for the assessment of these parameters is ensured, the effectiveness of an RO can be assessed by measuring the level of goals achieved. However, in most cases, activities of ROs are limited to boisterous slogans of their strategic goals. On the other hand, because of the spontaneity of RO activities mentioned before, it is quite difficult to define its expected results or to establish the boundaries of effectiveness performance. In such cases, benchmarking methods should be applied: here, the achievements of an RO are compared to other advanced ROs or the dynamics of results achieved in time.

Based on the ROs effectiveness assessment structure in Fig. 2, a processual effectiveness assessment model for ROs was formed. The model is oriented towards the application of benchmarking (Fig. 3). Two segments of evaluation are distinguished in this model and are further detailed in smaller stages.

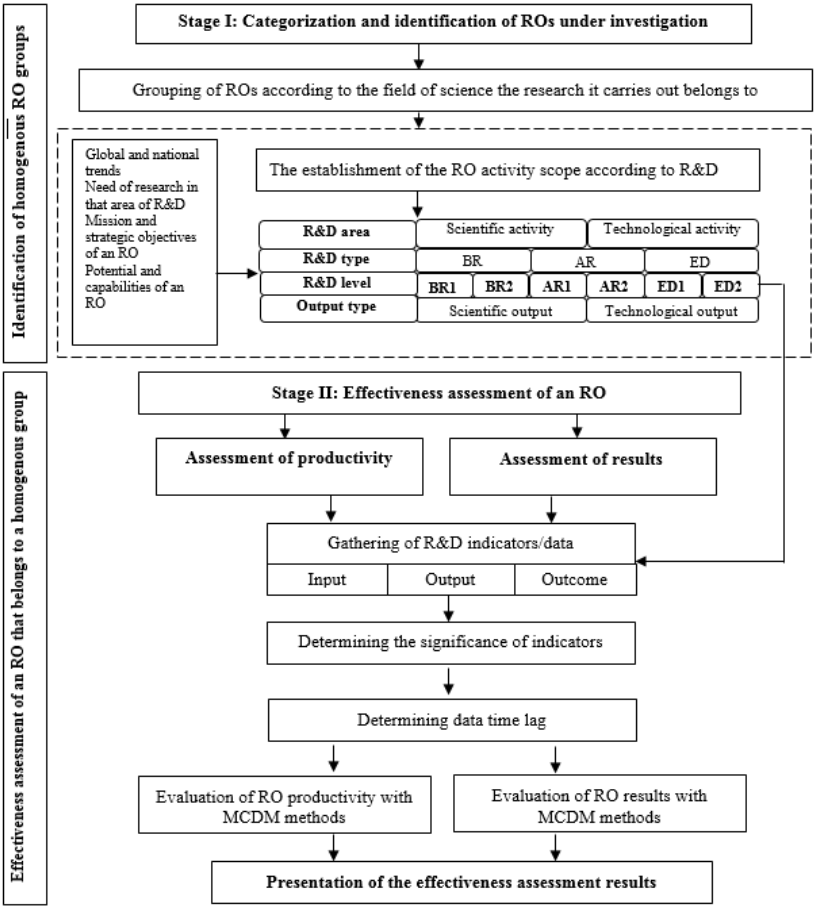


Fig.3 Processual Model of Effectiveness Assessment of ROs

Identification of homogenous RO groups

In view of the fact that the methodology of comparative analysis was chosen for the effectiveness assessment of ROs, it is extremely important to ensure that ROs belonging to one group (in respect to the scope of R&D carried

out and the area of science in which an RO operates) are comparable. Therefore, a categorization of ROs under investigation is carried out in the first stage of the assessment in respect to their field of research and type of R&D carried out. Although when analyzing the specifics of R&D, the classification of ROs was stressed by claiming that different types of R&D require different resources as different types of production are created according to R&D carried out in the organization. The classification of the entire R&D system only according to its type (basic, applied or experimental development) when assessing its effectiveness, would produce an overly simplified view of the operation of the science and technology system and thus, inaccurate effectiveness assessment results.

Therefore, the first stage of assessment is aimed at a successful comparative analysis of effectiveness assessment in ROs that carry out research in the same areas of science. Such approach to assessment is validated by the following points:

1) Assessment of ROs is based on the ratio of costs, production and results, however, costs vary greatly in different areas of science, even when the knowledge of the same type (e.g. fundamental knowledge) is sought for. For example, carrying out a social study might require as little as a piece of paper, a pen or conducting an internet survey, whereas the majority of chemistry studies require additional chemicals or special equipment, all of which translates into additional costs.

2) The qualitative evaluation of scientific production and results is mostly based on bibliometric criteria, such as impact factor of a publication, number of citations per paper and others. However, the quality of science, frequency of publishing, number of prestigious journals or their accessibility in different scientific categories might differ significantly, so it can be claimed that the "initial conditions" for creating a certain product are not the same for researchers working in different research areas.

The nature of activities carried out by ROs in respect to the type of R&D undertaken is determined largely by global and national trends or the need for research in certain areas and organizational aspects as well, such as the mission of an RO, strategic objectives and capabilities. When identifying the scope of activities carried out by an RO, it is recommended to follow the six levels of R&D (from BR1 to ED2). This conception is formed according to Technology Readiness level (TRL) method and it takes into account the diversity of ROs. The first three levels of R&D in this conception correspond to undertaking scientific activities and the "manufacture" of scientific production. The other three constitute production, or – utilization of knowledge in creation of new technological or other material products, systems and such. Every type of R&D is further detailed by two levels of R&D. Therefore, an RO can be assigned to a certain type (according to the type of activities it carries out) of RO on the basis

of its mission, strategic objectives, resources at its disposal, capabilities or priority research directions. The type of activities that an RO carries out can include more than one level of activities. For example, activities carried out by a university institute of social sciences can cover BR1-BR2 types, institute of technological sciences – AR1-ED2, whereas a private research centre can only cover ED1-ED2 activity levels.

Effectiveness assessment of ROs

In the second stage of assessment of ROs, effectiveness assessment tasks are solved for each of the established RO groups by dividing it into three stages – assessment of productivity, assessment of results and the summarization of effectiveness assessment by showing the position of each RO on the matrix of effectiveness or by presenting the effectiveness in percentages. Assessment parameters are established, study data is gathered, processing of this data is carried out and the results are presented in this stage.

A certain set of assessment parameters must be chosen for each RO group. Thus, the first stage is not only meant to determine the scope of activities undertaken in an RO but also the mandatory assessment parameters established according to the types of activities carried out and levels of R&D. When assessing ROs, it is important to choose the parameters that cover the activities carried out. The assessment requires three parameter groups: Input parameters that cover the financial and non-financial resources used in the activities carried out by an RO; Output parameters – all the R&D production created; Outcome parameters – parameters of R&D achievements or the realization of products created, all from the perspective of the RO. An expert evaluation is recommended for the assessment of the most frequent occurrence of time lag and the significance of parameters.

The effectiveness assessment model for ROs introduced in this dissertation is not meant to determine specific or finalized parameters – it is a more general framework for the assessment of ROs, where special attention is given to ensuring the homogeneity of RO activity types and to assessing those activities according to the principles of comparative analysis. The assessment system must merge into the general environment of an RO, which means that the parameters used for assessment should be the ones that are most significant and reflective of the current activities carried out.

Once the assessment alternatives (ROs), parameters and data were obtained and their value and time lag established, the estimation of the productivity and results is carried out by applying the chosen multi-criteria analysis methods. The efficiency of R&D process and of the transfer system is not included into the evaluation process because an efficient process will reflect in high productivity, and the efficient operation of the transfer system will determine a higher evaluation of results.

Lastly, effectiveness assessment results are presented by providing a matrix where ROs are shown depending on the rank of productivity and results achieved or by expresing the effectiveness level in percentages. The effectiveness assessment matrix shows the relative position of an RO in terms of the effectiveness of its activities as compared to other ROs under investigation. The effectiveness assessment principle that includes the assessment of R&D productivity and the results in the short term provides information about the capacity of ROs, their strengths and weaknesses and enables them to make the right decisions in respect to maximization of effectiveness.

The created effectiveness assessment model for ROs is validated empirically in the study of selected Lithuanian ROs. The results of this empirical study are presented in the third chapter of the dissertation. In the first subsection of the third chapter, the main items of the empirical research are introduced: ROs investigated, variables of the study, methods used and the realization of these methods. The second subsection contains the results of the effectiveness assessment and the analysis of those results.

Taking into account the first stage of assessment, the ROs chosen for the study where the ones that belong to the same area of research, are oriented to the same goals in terms of R&D type and the proportions of those activities. The *aim of the study* is as follows: to assess the effectiveness of the chosen ROs by taking into account the products created and results achieved, and to determine the significance of data time lag for the assessment results. For this purpose, the productivity assessment of ROs is carried out twice: firstly by making estimations with time lag, secondly – without taking time lag into account for each output indicator. The results are then compared. The effectiveness of ROs is assessed for the year of 2012. This particular year was chosen because of the need to carry out an additional empirical study to determine the impact of time lag when assessing effectiveness, i.e. the production data was gathered depending on each of its time lag by choosing data from year 2012, 2013 or 2014. Data used in the study was gathered by analyzing the financial reports for year 2012 submitted by ROs and using data from activity reports of 2012 – 2014. The significance of used parameters and their most frequent time lag was determined by the Expert evaluation method. A nonparametric linear programming Data Envelopment Analysis method (DEA) and superDEA, as well as the multi-criteria decision making analysis methods VIKOR, TOPSIS and ARAS were used to calculate the productivity and the results reached for selected ROs. As the result of the calculation, the final coefficients from 0 to 1 were obtained for each RO for their productivity and the results reached. The final effectiveness assessment results are presented in two ways on the basis of those coefficients. First way provides a ranking and ranks all the 9 ROs from the best to the worst (Fig.4).

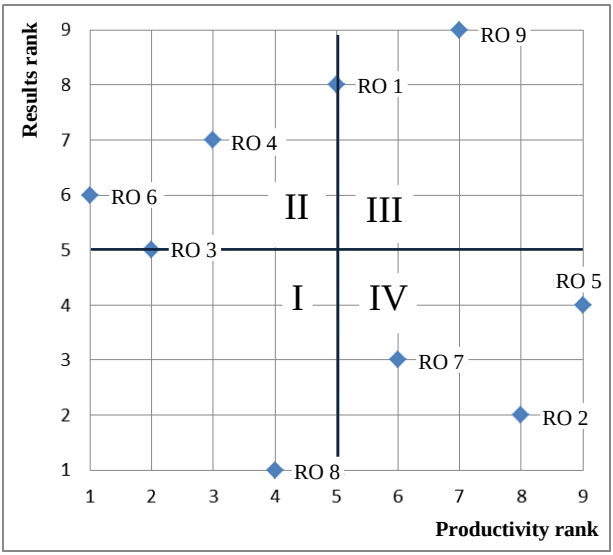


Fig. 4. The Effectiveness Assessment Matrix of ROs

The highest possible effectiveness is reflected at the point (1:1), whereas the least effective RO are at the point (9:9). According to the matrix results, the most effective ROs distributed in - quarter I of the matrix (i.e. RO 8 and RO 3) and least effective are placed in quarter III (i.e. RO 9). The matrix also gives more precise information about the strengths and weaknesses of ROs performance in the terms of capacities to create the R&D products or to reach high results by getting high outcomes from them. The I and II quarters distributed ROs, which have a higher capacity by R&D production, in comparison with other ROs. RO 8, RO 3, RO 6, RO 4, RO 1 are attributable to such organizations. In the meantime, the ROs, placed into quarter I and IV, have a comparable higher capacity for the spread of the R&D. RO 8, RO 2, RO 7 and RO 5 are attributable to such organizations.

At the same time, it should be noted that rank as the submission of the final evaluation of the measure indicates only the sequence number in the assessed ROs, and does not reflect the true place of emergence, i.e., distance from the best or the worst existing RO. Thus, the calculation of the final presentation of the results can be presented as percentages as well. This alternative uses the same coefficients obtained from the MCDM assessment by expressing the effectiveness as the ratios derived by comparing their actual deviations from the RO with the highest coefficient, considering it as the operational target (Table 1).

Table 1. The Operational Productivity and Effectiveness of Higher Development RO Group

Indicators	RO 6	RO 3	RO 4	RO 8	RO 1
Productivity level, MCDM coeff.	0,71	0,61	0,58	0,55	0,52
Effectiveness level, coeff.	1,00	0,86	0,82	0,77	0,73
Effectiveness level, %	100,0	85,9	81,69	77,46	73,24

The central conclusions of the empirical research are summarized in sections 6 and 7 of the conclusions.

CONCLUSIONS

1. The concept of effectiveness assessment in ROs with respect to the characteristics of activities undertaken in them, the specifics of products created and the measurability and occurrence of results was disclosed. On the one hand, ROs are expected to produce tangible value for the benefit of economic and social welfare, therefore the important measure of effectiveness in this context must be the R&D knowledge transfer. On the other hand, R&D covers a wide range of activities: from solely academic – basic research to the creation of an end product or a technology, a large part of which is not developed to the level of commercialization or cannot be commercialized at all. Basic research can only be oriented towards furthering the accumulation of knowledge, but not to the application of that knowledge in the short term, whereas the expected results of applied R&D might be tangible but cannot be guaranteed. The value produced by the majority of academic activities is qualitative and fragmented by nature, and a lengthy time lag alongside a long cause-consequence chain is characteristic to the occurrence of actual results. After assessing the characteristics of activities undertaken in ROs, it becomes evident that the effectiveness of ROs lies in the aspiration to create scientific products of the highest value by utilizing an effective production process. These products are expected to maximize the benefits (deliver highest results) for the founders and other people involved in ROs. The concept of effectiveness is compound – it includes the assessment of the two phases in the activities undertaken: first, the ability of the RO to produce high quality production (high RO productivity) from all R&D carried out on all levels; second, the ability to realize the created production when assessing the achieved short-term results from the perspective of the RO itself. Effectiveness is treated as a compound parameter for the assessment of activities that includes efficiency, productivity and results achieved.
2. The transformation of knowledge economy and the development of R&D paradigm influenced the spread of ROs and its variety. These differ in forms of ownership, mission and range of activities, all of which

determine the specialization of activities undertaken in ROs, the specifics of the processes executed, varying need of resources and, of course, the variety of products created. Therefore, in order to assess their effectiveness, the ROs are categorized according to the types of R&D carried out. The main groups of ROs were identified: universities and ROs under them, technology-oriented universities and ROs under them, independent public research centres or institutes, private research centres or institutes, technological innovation and research centers or institutes, ROs in private enterprises or corporations or their subdivisions. The range of activities of each of these according to the types of R&D carried out and belonging to the field of research allows for the determination of the main parameters for their evaluation.

3. The following was disclosed by comparing ROs with business enterprises: the specifics of the activities and the processes executed in ROs, the problematics of the products created and results produced, as well as other specific features of the operation of ROs. According to these, the list of the main principal postulates was formed, which must be taken into account in order to carry out valid effectiveness assessment. The most important of these are – the diversity of ROs, the diversity of R&D production, the manifold character of R&D activity parameters, the time lag in R&D outputs and results and their indeterminate character, the systemic character of ROs.
4. Taking into account the identified principal postulates of effectiveness assessment in ROs, a comprehensive structure of ROs effectiveness assessment was created. The structure helps elucidate the main activity components in ROs, relations between them and the subsystems of effectiveness assessment. Operation of ROs is detailed following the sequence Input – Process – Output – Transfer system – Outcome. Special attention is paid to depicting the interrelations between the strategy of an RO, the process, products created and results produced. The comprehensive ROs effectiveness structure introduced in this dissertation is significant in both academic and practical terms. Contribution to the academic field consist in the comprehensive character of the model introduced: the main features of activities carried out in ROs are integrated into a whole by showing their interconnectedness and the diversity of ROs in terms of the activities carried out in these organizations. In terms of practical application, the model can be used as a tool that helps to validate the conception and subsystems of effectiveness assessment for ROs and to show all the elements that constitute that assessment.
5. A processual effectiveness assessment model for ROs was created, based on the formed comprehensive structure of ROs effectiveness assessment

structure that elucidates the main stages of effectiveness assessment of ROs. The order of the categorization of ROs into homogeneous groups in respect to areas of research and type of activities carried out is given in the first stage of the model. The main focus of this part is concentrated on the identification of the science field to which an RO belongs to, as well as the identification of strategy in ROs and the establishment of the R&D scope. The tasks of effectiveness assessment are solved in the second stage of the model. This process includes assessment of productivity in ROs, evaluation of results achieved and the summarization of effectiveness assessment by presenting the position of each studied RO in two ways. The first way places all the ROs into the effectiveness matrix according to the ranking system. The second way presents the effectiveness level, by calculating the percentage of performance under actual achievement level compared to the highest-performing RO. The effectiveness results allow not only to present the ROs ranking according to their effectiveness results, but also gives more precise information about the strengths and weaknesses of each RO by showing their capacities to create the R&D products or to reach high results by getting the high outcomes from them. The theoretical novelty of the model lies in the validation and explication of a method of choosing the evaluation parameters according to the type of an RO. In terms of practical application, it can be used as a tool for executives in ROs or R&D policy makers, and ensures the efficient functioning of ROs by executing a well-timed revision of the activities carried out and by establishing the strengths and weaknesses of the organization for the purpose of reasonable allocation and use of resources that could consequently have a bigger impact on economic and social development.

6. The reliability of the model, as well as the logical consistency and coherency of the components and their interrelations were tested by carrying out an empirical study of 9 ROs operating in Lithuania. ROs chosen for the study carried out activities directed towards the same goals and had the same orientation in terms of area of research they operated in, the type of R&D, types of activities and their proportions. After summarizing the results of the study, it was evident that the created effectiveness assessment model can be successfully applied in practice. The available multi-criteria assessment methods VICOR, TOPSIS and ARAS can be applied when evaluating a relatively low number of ROs when a sufficiently large number of assessment parameters are used. So in terms of methodology, quite a small set of studied ROs is possible, which is very important to assure a successful assessment of homogeneous ROs. The DEA method is more favorable and informative when a relatively large number of ROs are assessed, depending on the

number of parameters used. The created effectiveness assessment model for ROs presents a general assessment platform that allows the assessment of the effectiveness of ROs based on the data access and parameters applied in the actual practice of an RO, without trying to produce a final or a single set of parameters or indicators. The empirical study helped define the significance and time lag of outputs used for activity assessment in academic ROs carrying out research in the area of technological sciences. A few limitations that were identified when recording and accounting the activity indicators should also be noted. These were observed in cases when the parameters were susceptible to duplication of information, indirect recording of created production or the problem of separating R&D activity parameters from other related activities.

7. No significant difference between assessment with or without time lag was observed after the assessment of productivity in ROs was carried out by applying multi-criteria analysis methods. This prompted a scientific assumption that the theoretically significant postulate about R&D output data delay and its impact on effectiveness assessment is not so significant when an RO is operating in its normal rhythm. However, in order to prove this assumption in general terms, additional study is required. If it were proven, the application of the model in practice would become even simpler because of the option to use input and output data from the same year.

Further research opportunities exist, either in terms of developing the assessment model introduced in this dissertation further, or in continuing the study of the general problem of effectiveness assessment in ROs:

- study of RO categorization with the aim to determine the principles of the grouping of ROs, to clarify the criteria by which ROs are assigned to one group or the other; or to define the characteristics of different RO groups so that a detailed account of application in practice of the first stage of the effectiveness assessment model could be carried out;
- the study on the RO planning and accounting system and metrics in order to create both the objectives formation as well as cost and results accounting system is certainly an important next task of the research which needs to be done;
- study of the impact that a time lag occurrence in RO activity parameters has on the effectiveness assessment of ROs with the aim to either confirm or deny the assumption formed in this dissertation about the small impact it has on the effectiveness assessment results;
- study of MCDM methods and the analysis of their algorithms that confirm the superiority of one or the other methods in effectiveness assessment of Ros;

- study of the indeterminate character of activities carried out in ROs with the aim to determine the "success factors" in different activity areas of R&D, or to determine the ratio of planned-unplanned R&D that yields most results.

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1. Lalienė, Rasa; Sakalas, Algimantas. (2014). Development of R&D Effectiveness Assessment System in the Research Organizations. *Procedia-Social and Behavioral Sciences*, *156*, 340-344.
2. Lalienė, Rasa; Sakalas, Algimantas. (2014). Conceptual Structure of R&D Productivity Assessment in Public Research Organizations // *Economics and management* / Kaunas University of Technology. Kaunas: KTU. ISSN 1822-6515. No. 19 (1), p. 25-35. [Business Source Complete; Current Abstracts; TOC Premier; Central & Eastern European Academic Source].
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Papers, accepted for publishing:

1. Lalienė, Rasa; Liepė, Žiedūna. (2015). R&D Planning System Approach at Organizational Level. Accepted to publish in the journal *Procedia-Social and Behavioral Sciences.*
2. Lalienė Rasa; Ojanen, Ville. (2015). R&D Performance Measurement: a Process Perspective Revisited. Accepted to publish in the IEEM conference proceedings, 6-8th of December, 2015.

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REZIUMĖ

Temos aktualumas

Spartėjant atvirumo, tarptautinės konkurencijos ir žiniomis grįsto verslo augimo procesams, vis svarbesnį vaidmenį visuomenėje įgyja moksliniai tyrimai ir eksperimentinė plėtra (MTEP). Jų pritaikymas, rezultatų diegimas tampa svarbiausiu visuomenės socialinę ir ekonominę raidą užtikrinančiu tikslu. MTEP įvardijama kaip viena iš konkurencingumo sąlygų, neabejotina jos nauda ekonomikos plėtrai ir visuomenės gerovei (Hall, Mairesse ir Mohnen, 2010; Khan, 2006; Kirstukas ir kt., 2013; Knašas, 2014, Melnikas ir kt., 2000; Pessoa, 2007; Rodríguez-Pose, Crescenzi, 2008; Wieser, 2005 ir kt.). MTEP yra pagrindinė mokslinių tyrimų organizacijų veikla. O išaugęs MTEP poreikis lėmė pastebimą šių organizacijų išplitimą. Be universitetinių ir valstybinių, atsirado privačių mokslinių tyrimų laboratorijų, mokslinių tyrimų ir technologijų (ar inovacijų), technologijų perdavimo, jungtinių mokslinių tyrimų, mokslinių tyrimų kompetencijų centrų ir kt. (visos šios organizacijos disertacijoje įvardijamos kaip mokslinių tyrimų organizacijos, MTO). MTEP veiklą vykdančių organizacijų įvairovė suponuoja ir jų veiklos efektyvumo vertinimo problemą. MTO skiriasi veiklos pobūdžiu, turi savitą identitetą, specializaciją, tad ir jų veiklos procesai, veiklos resursų poreikis, sukuriama

produkcija, taip pat ir vertinimo perspektyvos bei parametrai privalo būti diferencijuojami.

Mokslinėje literatūroje gan plačiai išnagrinėta mokslinių tyrimų veiklos efektyvumo vertinimo verslo įmonėse tema (Bond, Harhoff, Van Reenen, 2005; Chiesa ir kt., 2008; Hall ir kt. 2010 ir kt.) bei mokslinių tyrimų sąveikos su ūkio ekonomika paradigmos (Khan, 2006; Pessoa, 2007, Rodríguez-Pose, Crescenzi, 2008 ir kt.). Tačiau keičiantis MTEP koncepcijai, keičiasi požiūris ir į pačias MTO bei jų veiklos efektyvumo vertinimą. MTO, kaip ir visų kitų organizacijų, veikla vis labiau nukreipiama į efektyvų išteklių panaudojimą, paverčiant juos mokslinių tyrimų produktais. Tai ypač svarbus uždavinys, turint ribotus išteklius. Tradiciniai įmonių veiklos efektyvumo vertinimo metodai, besiremiantys pelningumo, grynojo pelningumo, kapitalo grąžos ar kt. rodikliais (Gimžauskienė, 2007; Hatry, 2006; Klovienė, 2012; Rompho, Boon-itt, 2012; Sližytė, 2009; Taticchi, Asfalti ir Sole, 2010 ir kt.), sunkiai pritaikomi MTO, kurios nuo verslo įmonių skiriasi darbo turiniu, sukurtos produkcijos savitumu, veiklos spontaniškumu, laiko lagu tarp veiklos vykdymo ir jų rodiklių ar rezultatų atsiradimo ir pan.

Temos ištyrimo lygis

Kaip teigia Ojanen ir Vuola (2003), anksčiau MTO veikla buvo traktuojama kaip juodoji dėžė, o MTEP – kaip izoliuota funkcija, kurios neįmanoma sistemiškai valdyti, kontroliuoti, tuo labiau išmatuoti. Ir nors per pastaruosius kelis dešimtmečius šios veiklos efektyvumo tyrimų tematika buvo nagrinėjama plačiau, pasak Hall ir kt. (2010), daugiausia tyrimų atlikta gamybos sektoriaus įmonėse, o pačių MTO veiklos efektyvumui vertinti skiriama žymiai mažiau dėmesio.

Esamoms mokslinių tyrimų organizacijų veiklos struktūroms ir jų veiklos efektyvumo vertinimo modeliams (Cincera, Czarnitzki ir Thorwarth, 2008; Coccia, 2001, 2004, 2005; Leitner, Warden, 2004; Lin, Bozeman, 2006; Paul ir kt., 2010 ir kt.) trūksta kompleksiškumo, sistemiškumo bei empirinio pagrindimo iš MTO perspektyvos. Nepakankamai dėmesio skiriama MTO veiklos efektyvumo sampratai išgryninti, veiklos tipui ir vertinimo parametrams parinkti pagal MTEP rūšis. Reikia įvairiapusiškai įvertinti veiklą, todėl pasigendama kompleksinio požiūrio į vertinimą, kuris leistų laiku priimti šių organizacijų veiklos efektyvumo didinimo sprendimus.

Mokslinė problema išreiškiama klausimu – kaip įvertinti mokslinių tyrimų organizacijų veiklos efektyvumą skirtingo jų veiklos pobūdžio aspektu. Problemos reikšmingumą lemia:

- pastaruoju metu ypač padidėjusi pačių MTO įvairovė, pasižyminti skirtingomis veiklos perspektyvomis, pobūdžiu ir klausianti, ar įmanoma vieninga vertinimo sistema visų tipų MTO;
- MTO skirtumai veiklos, sukuriamų produktų ir jų rezultatų matavimo pobūdžiu. Šios veiklos produkcija – aibė nuo

konceptualių idėjų iki galutinių produktų ar prototipų. Akivaizdu, jog ne visą ją galime išmatuoti vien finansiniais svertais, dėl to vertinant MTO reikia atsižvelgti į daugybę parametrų. Nustatant sukurtos produkcijos vertę, svarbus kokybės matavimo ir jo įtraukimo į veiklos efektyvumo vertinimą aspektas;

- egzistuojantis laiko lagas tarp veiklos resursų panaudojimo ir sukuriamos produkcijos rodiklių atsiradimo ar pasiektų rezultatų pasireiškimo. MTEP veikla pasižymi spontaniškumu ir neapibrėžtumu, dėl to sunkiai nustatomas laukiamų rezultatų pasirodymo ir jų panaudojimo ūkiniame ar visuomeniniame gyvenime laikas.

Darbo tikslas – parengti mokslinių tyrimų organizacijų veiklos efektyvumo vertinimo modelį, leidžiantį įvertinti jas pagal veiklos pobūdį.

Uždaviniai:

1) atskleisti mokslinių tyrimų organizacijų veiklos efektyvumo sampratą;
2) pateikti mokslinių tyrimų organizacijų grupes pagal jų veiklos pobūdį besikeičiančios MTO institucinės paradigmos kontekste;
3) suformuoti pagrindines mokslinių tyrimų organizacijų veiklos efektyvumo vertinimo nuostatas;
4) sudaryti kompleksinę mokslinių tyrimų organizacijų veiklos efektyvumo vertinimo struktūrą;
5) sudaryti procesinį mokslinių tyrimų organizacijų veiklos efektyvumo vertinimo modelį;
6) empiriškai patikrinti sudarytą mokslinių tyrimų organizacijų veiklos efektyvumo vertinimo modelį, nustatant laiko lago reikšmę efektyvumo vertinimo rezultatams.

Darbo objektas – mokslinių tyrimų organizacijų veiklos efektyvumo vertinimas.

Tyrimo metodai

Disertacijos uždaviniams spręsti naudoti skirtingi metodai. Visų pirma buvo atlikta išsami lyginamoji ir sisteminė mokslinės literatūros MTO veiklos ir jos efektyvumo vertinimo, MTEP koncepcijos ir su tuo susijusiomis temomis analizė. Remiantis autoriais Colquhoun, Baines ir Crossley (1993), O'Donnell ir Duffy (2005), Paul ir kt. (2010), Bogetoft ir Otto (2011), Baležentis, Kriščiukaitienė ir Baležentis (2014) ir kt., išanalizuotos veiksmingumo, produktyvumo ir efektyvumo sampratos, pagal kurias suformuota MTO veiklos efektyvumo samprata. Kritiškai išanalizavus autorių Coccia (2001, 2004, 2005), Leitner ir Warden (2004), Lin ir Bozeman (2006), Cincera ir kt. (2008), Paul ir kt. (2010) ir kt. MTO veiklos efektyvumo vertinimo modelius ir struktūras, įvardinti jų ribotumai ir didžiausi trūkumai

bei nustatyti pagrindiniai MTO veiklos procesai, komponentai ir jų tarpusavio ryšiai.

MTO veiklos matavimo rodiklių savitumui nustatyti pasitelkta dokumentų analizė. Remiantis išsamia MTO veiklos ataskaitų, Lietuvos Respublikos švietimo ir mokslo ministerijos mokslo ir studijų institucijų mokslo darbų vertinimo metodikos bei Frascati vadovo analize, nustatyti pagrindiniai praktikoje naudojami MTO veiklos matavimo rodikliai. Šių dokumentų ir mokslinės literatūros sintezė leido nustatyti jų ribotumus. Nustatant praktinius MTO veiklos išmatavimo savitumus, taip pat buvo naudotas atrinktosios grupės (angl. *focus groupe*) metodas.

Žinios, gautos išanalizavus mokslinę literatūrą ir veiklos ataskaitas, dokumentus bei susitikimų su mokslininkų grupėmis informaciją, buvo integruotos į pagrindines MTO veiklos efektyvumo vertinimo nuostatas. Atsižvelgiant į jas, buvo sudaryta kompleksinė MTO veiklos struktūra ir jos efektyvumo vertinimo modelis, leidžiantis įvertinti MTO pagal veiklos pobūdį.

Sudarytas modelis empiriškai patikrintas, įvertinus 9 pasirinktas MTO. Veiklos efektyvumui įvertinti panaudoti tiesinio programavimo duomenų apgaubties analizės (DEA) ir superDEA metodai bei daugiakriteriai vertinimo metodai VIKOR, TOPSIS ir ARAS. Ekspertinio vertinimo metodas pasitelktas rodiklių reikšmingumui ir dažniausiam jų laiko lagui nustatyti.

Disertacijos struktūra

Loginę darbo struktūrą lėmė iškeltam tikslui įgyvendinti skirtų uždavinių sprendimo seka. Disertaciją sudaro įvadas, trys skyriai, išvados, literatūros šaltiniai ir 6 priedai. Disertacijos apimtis – 150 p. Disertacijoje panaudotas 221 literatūros šaltinis.

Mokslinio darbo naujumas ir reikšmingumas

Mokslinį disertacijos naujumą, reikšmingumą ir praktinį pritaikymą nusako gauti rezultatai. Tai atskleidžia pateikta MTO veiklos efektyvumo samprata, kuri pagrįsta išsamia MTO veiklos ypatumų analize. Darbe taip pat nustatytos MTO veiklos efektyvumo vertinimo nuostatos, į kurias privalu atsižvelgti, siekiant patikimo įvertinimo. Remiantis jomis, sudaryta MTO veiklos efektyvumo vertinimo struktūra bei procesinis modelis. Struktūra sumodeliuota pagal pagrindinius veiklos proceso konstruktus, jungiančius visą MTO veiklą į nuoseklų procesą: įvestys – procesas – išvestys – perdavimo sistema – rezultatai. Ji tarnauja kaip priemonė, leidžianti suvokti MTO veiklos veiksmingumo, produktyvumo, rezultatyvumo ir efektyvumo koncepcijas ir jas apimančius svarbiausius MTO veiklos elementus, parodo jų sąsajas. Remiantis šia struktūra, sudarytas procesinis MTO veiklos efektyvumo vertinimo modelis, leidžiantis įvertinti atskirus MTO veiklos etapus arba bendrai jos efektyvumą pagal veiklos pobūdį. Teorinį naujumą atskleidžia vertinimo modeliui būdingas kompleksiškumo elementas, kuomet MTO veiklos efektyvumo vertinimo struktūra aiškiai apibrėžia vertinimo koncepciją, į ją

įtrauktus MTO veiklos elementus ir daugybę jos variantų, o procesinis modelis detalizuoja pačią vertinimo eigą. Vienas svarbiausių parengto modelio išskirtinumų – vertinimo parametrų parinkimo pagal MTO veiklos pobūdį bei produkcijos tipą pagrindimas ir išplėtojimas. Išskirtinai daug dėmesio skiriama MTO homogeniškoms grupėms nustatyti, pagrindiniais kriterijais laikant mokslinės veiklos sritį ir aprėptį MTEP pobūdžio aspektu.

Suformuotas MTO veiklos efektyvumo vertinimo modelis yra naudingas ir praktiškai. Tai – įrankis MTO vadovams, leidžiantis efektyviau valdyti organizacijos resursus ir nukreipti juos norimų mokslinių tyrimų plėtojimo linkme bei, siekiant aukščiausių veiklos rezultatų, prisidedantis prie geriausio turimų ribotų resursų panaudojimo. Pasiūlytas efektyvumo vertinimo principas, apimantis MTEP produktyvumo ir rezultatyvumo iš MTO perspektyvos vertinimą, suteikia informacijos apie MTO pajėgumus, jų stipriąsias ar silpnąsias veiklos sritis bei leidžia priimti tinkamus veiklos efektyvumo didinimo ar užtikrinimo sprendimus. Parengtas procesinis MTO veiklos efektyvumo vertinimo modelis ir pasiūlyti metodai leidžia ne tik palyginti organizaciją su kitomis MTO, bet ir parodo kiekybinį jų nuokrypį.

Ekonominei plėtrai svarbi inovacinė veikla prasideda nuo MTEP produkcijos kūrimo, tad akivaizdu, jog efektyvi ir kryptinga MTO veikla nulemtų ir inovacijų augimą atskirose organizacijose, taip pat ir šalyje. Parengtas modelis naudingas MTO vadovams ar MTEP politiką formuojančioms šalies institucijoms, atskleidžiant organizacijų efektyvumo didinimo galimybes ir sutelkiant pastangas bei ribotus išteklius efektyvesnei veiklai.

Tolesnės tyrimų kryptys:

- MTO kategorizavimo tyrimai, nustatant MTO grupavimo principus, aiškius priskyrimo vienai ar kitai grupei kriterijus ar apibūdinant atskiras MTO grupes, pateikiant detalų parengto MTO veiklos efektyvumo vertinimo modelio pirmojo etapo įgyvendinimą praktikoje;
- patikimas MTO veiklos duomenų bazės formavimas yra sėkmingo jų veiklos efektyvumo vertinimo prielaida. Todėl MTO planavimo ir apskaitos sistemos tyrimas, parengiant tiek tikslų formavimo, tiek rezultatų bei kaštų apskaitos sistemą, yra neabejotinai svarbus tolesnis uždavinys;
- MTO veiklos rodiklių pasireiškimo laiko lago svarbos MTO veiklos efektyvumo vertinimui tyrimai, patvirtinant arba paneigiant disertacijoje suformuotą prielaidą dėl nedidelės jo įtakos rezultatams;
- daugiakriterių vertinimo metodų ir jų taikomų algoritmų analizės, patvirtinančios vieno ar kito metodo pranašumą vertinant MTO veiklą, tyrimai;

- MTEP veiklos neapibrėžtumo tyrimai, nustatant MTEP „sėkmės koeficientus“ atskirose MTO veiklos srityse arba efektyviausią numatytų ir nenumatytų MTEP tyrimų proporciją.

UDK 001 : 061 (043.3)
SL344. 2015-11-11, 1,75 leidyb. apsk. l. Tiražas 50 egz. Užsakymas 430.
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