Inzinerine Ekonomika-Engineering Economics, **2014, 25(5), 530–537**

Universally Sustainable Development Strategy for a Small Country: A Systemic Decision

Aleksandras Vytautas Rutkauskas, Viktorija Stasytyte, Edvard Michnevic

Vilnius Gediminas Technical University
Sauletekio av. 11, LT-10223 Vilnius, Lithuania
E-mail. ar@vgtu.lt; viktorija.stasytyte@vgtu.lt; edvard.michnevic@vgtu.lt

crossref http://dx.doi.org/10.5755/j01.ee.25.5.3797

The concept of sustainability, and especially sustainable development, is among the most ambitious and controversial concepts in the scientific literature. Knowledge and research concerning the condition, development or transformation of sustainability has become not only the original means of the generation of socio-economic science knowledge. It is also an alternative for the analysis of especially sophisticated development problems – e.g. the problems of survival, effective change and avoidance of huge losses pertaining to such complexes as cities, countries or regions. Finding the ways of such knowledge conversion into the field of science is complex, but there is no alternative. Research of sustainable development has already become especially prevalent, and, thus, the objects of cognition should be structured, possibilities should be consolidated, and the efficiency of the use of resources must be elevated. The first challenge of sustainability research conversion into the sustainability science is a thorough mastering of the systemic research technologies, as well as the development of the principal methodology of systemic research while evolving the possibilities of civilisation survival on Earth.

The objective of the research is to find an adequate quantitative measure of complex system development sustainability and investigate in detail the type of development of a small country or region that could be named as a realisation of sustainable development possibilities. The methodology of the research includes the application of an adequate portfolio model, stochastic optimisation, and systemic analysis. The conclusions obtained by the research state that development possibilities of a small country should not be evaluated only in terms of economic-ecological aspects; more components, such as politics, integration, marketing, social-demographics, creativity, religion, innovation, finance, and investment should be included, which could be logically divided into four subsystems of country universal sustainability. The research also presents the adequate composition of efficiency and reliability of the general effect pertaining to the activity of all the subsystems, as well as the optimal allocation of marginal investment unit among the four subsystems.

Keywords: *Sustainability, Sustainable Development, Quantitative Measure of Development Sustainability, Complex System, Stochastically Informed Expertise.*

Introduction

Research of development sustainability being of high demand and in the spotlight of many authors, have become difficult to follow. First, unsystematic investigation of the objects of sustainable development not only inflated the value of such research, but also started to discredit the power of sustainability as a unique system of knowledge. At this point, the overall credo of scientific research can be recalled – to perceive consistent patterns and notice possible exceptions. The presumption mentioned is considered by many researchers conducting research in the field of development or evolution sustainability (Bell & Morse, 2008; Fiksel, 2006; Gallopin, 2003; Streimikiene & Barakauskaite-Jakubauskiene, 2012).

Additionally, a discussion has taken place about the sustainable development concept, as well as about the full-rate knowledge system on practical management of such development on the generalised level. A perception is being formed that in analysing complex phenomena, processes or subjects, one needs to invoke an ideology of system analysis. This, in turn, would allow for the clustering of the research objects according to the types of systems for which the identification, analysis, and management principles are created and approved (Fiksel, 2006; Innes & Booher, 1999).

However, one cannot avoid the ambiguity of the cognition methodologies (Moles *et al.*, 2008), at least because of the abundance and diversity of instruments for reality cognition. Also, it is worth noting that the possibilities of systems to identify sustainable development cases for extremely sophisticated processes are limited, or simply require further development. Perhaps the main obstacle while seeking the efficient solution of sustainability management problems for extremely sophisticated subjects and processes is the inflexibility and inadequacy of the categorisation apparatus, or simply the system of categories used for the cognition of the sustainability phenomenon. This could be illustrated by sophisticated systems, such as complex systems (Amaral & Ottino, 2004; Kang & Golay, 2000; Spangler & Peters, 2001) possessing the powerful instrumentation for the search of complex and multidimensional processes of subsystems' analysis and management, which in majority are oriented towards the analysis of sophisticated social-economic-biological-technological complexes (Katz, 2006; Rammel *et al.*, 2007). Considering the above-mentioned trends of research in the field of sustainable development, the *scientific research problem* could be formulated as a need to find and apply adequate methods, capable of analysing and measuring sustainability, as well as to invoke a proper ideology in order to treat and investigate sustainability as a unique system of knowledge.

The aim of the research is to find an adequate quantitative measure of complex system development sustainability and investigate in detail the type of development of a small country or region that could be named as a realisation of sustainable development possibilities.

The tasks could be formulated as attempts to answer these questions:

- What composition of efficiency and reliability should constitute the essence of subject's condition or development sustainability?
- What is the content of the country's universally sustainable development — i.e. what components of the country's demographic, social, economic, political, religious, biological, and natural development should construct the unique background of sustainability in order to include their condition and development in the country's strategic documents?
- What is the optimum allocation of the country's disposable resources among the above-mentioned components to ensure the universally sustainable development?
- How does the solving of the above mentioned tasks under the conditions of the Republic of Lithuania look like?

The methods applied in the research are an adequate portfolio model, stochastic optimisation, and systemic analysis.

Features and Characteristics of Systems

After investigating general characteristics of systems, the features possessed by all types of systems can be generalised as follows:

- A system has its structure, and its elements or subsystems have a special variety of dependencies.
- A system has certain behaviour — i.e. the process of transforming inputs into output results.
- A system handles certain interconnectivity among subsystems — i.e. the relationships expressed through the interdependence of the structural elements and through interdependence of consistent patterns of behaviour.
- Consistent patterns of system structure and behaviour can be disaggregated with the help of subsystems or sub-processes.

This is an impressive list of requirements in order for the real existing aggregate of elements to be analysed and managed using general system management principles. However, almost none of the formalised systems possess such a characteristic, which is common for a real existing system. Let us say that the majority of social systems, as well as mechanical or universe systems, behave in a way that conforms to the following consistent patterns:

- The system has gravitational forces and gravitation centres.
- The behaviour of the system can also be identified using the allocation of gravitation centres and the media of the gravitation.
- The formalised mechanisms of the analysis and management of the system are credited with uncertainty, which is an important aspect of the behaviour or interdependence of virtually all processes. In turn, uncertainty is the core aspect that should be recognised in order to perceive the concept of sustainability clearly, as well as its management possibilities.

The major obstacle to the application of possibilities of systemic analysis is that in analysis of separate countries' or regions' development sustainability, an assumption is being made that the core, if not unique, problem is a trade-off between the economic growth and environment protection (Ang *et al*., 2011; Liobikiene & Mandravickaite, 2011; Makiela & Misztur, 2012; Meadows, 1998; Raslavicius & Straksas, 2011; Streimikiene *et al.*, 2009; Urban & Govender, 2012). Due to the many failures of such an assumption, some authors (Baumgartner & Quaas, 2009; Innes & Booher, 1999; Nadal, 2011; Rutkauskas, 2012a) strictly take the position that the dichotomy of environment protection and economic development should not be the main obstacle in preparing the scheme of complex systemic thinking in order to seek the development sustainability. However, as mentioned above, the theoretical perception of reality takes place under favourable conditions — i.e. in a California metropolis, when incomparably more powerful, intellectual, technical, and technological potential is possessed, as well as resources required for decisions' management in order to ensure the economic growth and upturn of the state of environment protection for a long time, guaranteeing high environment protection standards. But the success of using the principles of complex systemic analysis is oriented towards the search of adaptive principles of the complex system under varying conditions.

Sustainability as a Feature Integrating Economic Efficiency and Reliability of Development

The science of economics patiently raises its child – the science of event, process, or system existence or development sustainability (Bartelmus, 2010; Xu *et al.*, 2006). For a long time, economic activity has been searching for correct solutions under conditions of uncertainty. Finally, appropriate knowledge and skills have been accumulated in the field of economics, and they have at last been taken up by the science of sustainability. Sustainability as a valid composition of efficiency and reliability reveals its conceptual and practical utility in the following example: the adequate utility function helps to determine the possibility of maximum utility when making a future forecast. Reliability or guarantee are perceived and assessed here as probability (P) of the possible effect (ξ) being higher than the desired effect (ξ_k) will be equal to the selected probability P_k:

$$P\{\xi > \xi_k\} = P_k \tag{1}$$

This is the analogue of the survival function found in the analysis of population survival, which, in turn, is an add-on of the distribution function:

$$P\{\xi > \xi_k\} = 1 - P\{\xi \le \xi_k\} \tag{2}$$

The adequacy of the utility function form:

$$N(\xi_k, P_k)$$

often is dictated by the particular situation, but for the initial evaluation, the following form is quite suitable:

$$N(\xi_k; P_k) = \frac{\xi_k \times P_k}{r}, \quad (3)$$

where r is the riskiness of the efficiency possibilities' set.

The concept of reliability or guarantee has been developed from the categories of probability theory. In its content, it is completely adequate in relation to density or accumulated density functions. It clearly reveals its utility through the research of population survival. While analysing the problem mentioned above, it is worth noting that the critical number of population units should be retained with the certain guarantee. There is no doubt that this is the key problem also in projecting the development sustainability, when it is especially important to determine whether the necessary efficiency of development can be retained with the certain guarantee.

Complex System as a Scheme of Country Sustainable Development

Let us recall the thoughts of Innes and Booher (1999) concerning the application of complexity theory in research on the condition of complex systems and development sustainability. The complexes of social, political and economic problems will be selected as the components of country sustainability. Also, they will be related to physical and biological components that influence development sustainability. Thus, we will obtain the possibility to use directly the ideology and methods of complex systems' research (Innes & Booher, 1999). The principles of complexity theory are especially important because special attention is given to the evaluation of uncertainty as an inherent component of development. This allows us to understand, forecast, and quantitatively assess the impact of stochastic changes on the possibilities of country development. Additionally, the necessity to consider the mechanistic models of system centricity ideas must be highlighted, and without its social, economic, political, and other subsystems, the research would be incomplete. However, the necessity to take into account the ideas of gravitation centres, as well as the concept of the gravitation force itself, for the social and other subsystems, requires an innovative point of view.

Dependence of Sustainability Concept and Management Methods on the Character of the Analysed Object

The technique of sustainability analysis and management must undoubtedly be universal. It should be capable of solving the main problems by relying as little as possible on the nature of the analysed object. However, the category of validity, which becomes an increasingly important component while analysing the sustainability management problem, often demands a specification or even investigation of the principal features of the subject (Rutkauskas & Stasytyte, 2012). As already mentioned, the object of the research of this paper is a problem of development sustainability of the independent country, which possesses a small geographical territory, little natural resources, and at the same time low results of economic activity. And even if the functioning of the state is perceived as a system of complex interactions and dependences, it must be able to react sensitively to both global and local-regional changes. The definition of the system has changed since the times of Plato, Aristotle, and Euclid. However, in terms of the sustainability of a system, the central gravitation force is still considered because it is the centre of the system's existence. There is still truth therein. In social systems this force can be substituted by the interest, which is credited with the artificial system's ability to retain the historically formed system or a similar one.

When the gravitation force (the gravitation of the sun) or engineering constructions (a water supply system) are considered, it is not so important — or may be impossible — to perceive the interests and resources that are required in order to ensure the sustainability of these systems in their constantly regenerating state. In universally sustainable systems, regeneration must be identical to perfection, because otherwise any system is doomed to failure. In such kinds of systems, the ability to allocate resources optimally among the subsystems and the retention of their interaction possibilities are often the key factors of the survival of the whole system.

The Analysis of the Structure of a Sustainable Development System

The strategies of retention or development of a sustainable system of Lithuania as an independent country constitute the particular object of the conducted research, where these strategies are grounded by the historically formed need for the retention of country self-sufficiency and the ability to generate and implement the intelligent development strategies. The guarantee and motto of survival of Lithuania as a self-sufficient country is the historically formed intelligence of self-sufficiency retention and development. The immediate assumption of country self-sufficiency survival and the successful implementation of development strategies is the intelligent use of natural, as well as human-possessed and created resources. The main guarantee context of country development effectiveness and success is a universally sustainable development. Here, in order to touch more thoroughly on all the moments of development, as well as to use all the created powers, the following subsystems of country sustainable development are distinguished (Figure 1).

Further, each subsystem is described in detail (Rutkauskas, 2012b):

Religious sustainability is the possibility for humankind to face up to its temporary existence on the Earth and eternal existence in the afterlife, to recognise the spiritual values of one other, to avoid a contraposition of religious gospel, and to focus particular attention on the weak and unfortunate.

Political sustainability is the possibility of citizens to ensure democratic regeneration of country's political institutions, which would guarantee public representation of all citizens' interests and represent the country's interests in international affairs.

Socio-demographic sustainability is the possibility to combine harmoniously the interests of all social groups, ensuring proper conditions of human existence on the ground level of hierarchy, and, most importantly, the ability to perceive the evolution of society based on the scientific consistent patterns.

Economic sustainability is the consequence of the ability to rationally use the internal disposable resources as well as resources gained from the outside, at the same time ensuring the sustainable growth of achieved economic results.

Ecological sustainability is most often referred to as the possibility to sustain bio-system diversity and efficiency in the territory of the state.

Educational-professional sustainability is the ability to combine the learning, professional education, and creativity in developing business analytics, creative industries, and creativity domination, as well as knowledge economy, which would ensure the balance of supply and demand in the market.

Creative and cultural sustainability is the ability to create something new and valuable with the help of intelligence.

Innovative-technological sustainability is the ability to ensure the use of the most modern technologies, based on the most efficient innovations, in producing products and providing services.

Integration sustainability is intelligent country integration into the local, regional, or global security or economic safety organisations guaranteeing general security and economic safety under costs acceptable for the country.

Marketing sustainability is the use of the country's marketing powers in order to ensure sustainable flow of export-import, and the development of the utility provided by the general social and economic programs' results.

Financial sustainability is the power of the financial system, forming the pool of financial resources for a country's businesses and public sector and making it possible to settle international liabilities.

Investment sustainability is the ability to generate investment strategies that can mobilise the country's businesses, public sector and broader society. Cooperation should disclose the ways and methods by which the capital invested in the past can help ensure the possibilities for future generations to reach their objectives.

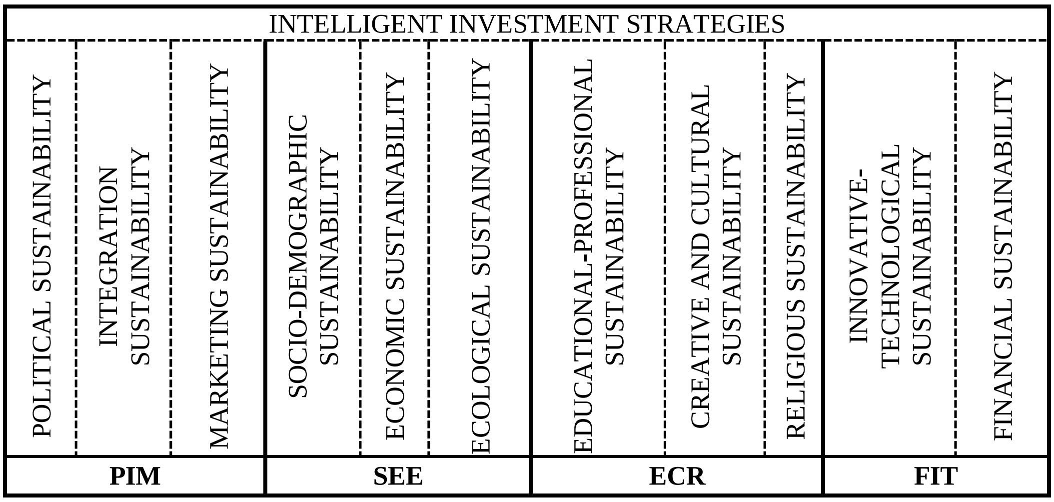


Figure 1. Sub-systemic structure of the country's universally sustainable development

If an assumption is made that country development sustainability should be analysed with the help of the model of a complex system, then it should be taken into account that for all of the elements existing in the reality, the following characteristics are typical:

- It has a very complex structure.
- It has high sensitivity to even small changes of dependencies among the separate components.
- It is difficult to identify and verify all of the elements, even if their design and/or functional dependence are known.
- It is characterised by the abundance of interactions among the different components.
- New characteristics or even states of the whole can be revealed over time.

There is no doubt that all of these characteristics are typical for the phenomenon of country sustainability development. It is also required that this is a self-regulating open system, the functional purpose of which demands certain resources. These resources become the input elements that can cause not only changes in internal dependences, but also the effects of separate subsystems and the effect created by the whole system. It is worth acknowledging that the system, the content of which is composed of all the characteristics mentioned above, requires adequate possibilities in relation to the system's cognition and management.

In Figure 2 the conception of interaction among subsystems and all instruments for decision formulation and search is presented: the information systems of knowledge, decisions management, uncertainty evaluation, as well as stochastic models of quantitative decisions and expert evaluation. However, the evaluation of separate problems should be recognised here as exceptional, when, with the help of the gathered and generated information, a search for the compatibility of different aspects of development is performed. As a separate challenge while analysing the sustainable development problems in the context of systems' methodology, a question arises regarding the unification of measurement dimensions of separate subsystems and the effectiveness of the whole system. First, let us recall that sustainability measurement is related to two-dimensional measures: effectiveness and reliability.

Reliability has an non-dimensional way of measurement, but while measuring the effectiveness one cannot get along without the indicators expressing the content of existence of subsystems or the whole system, such as created product, grown harvest, etc.

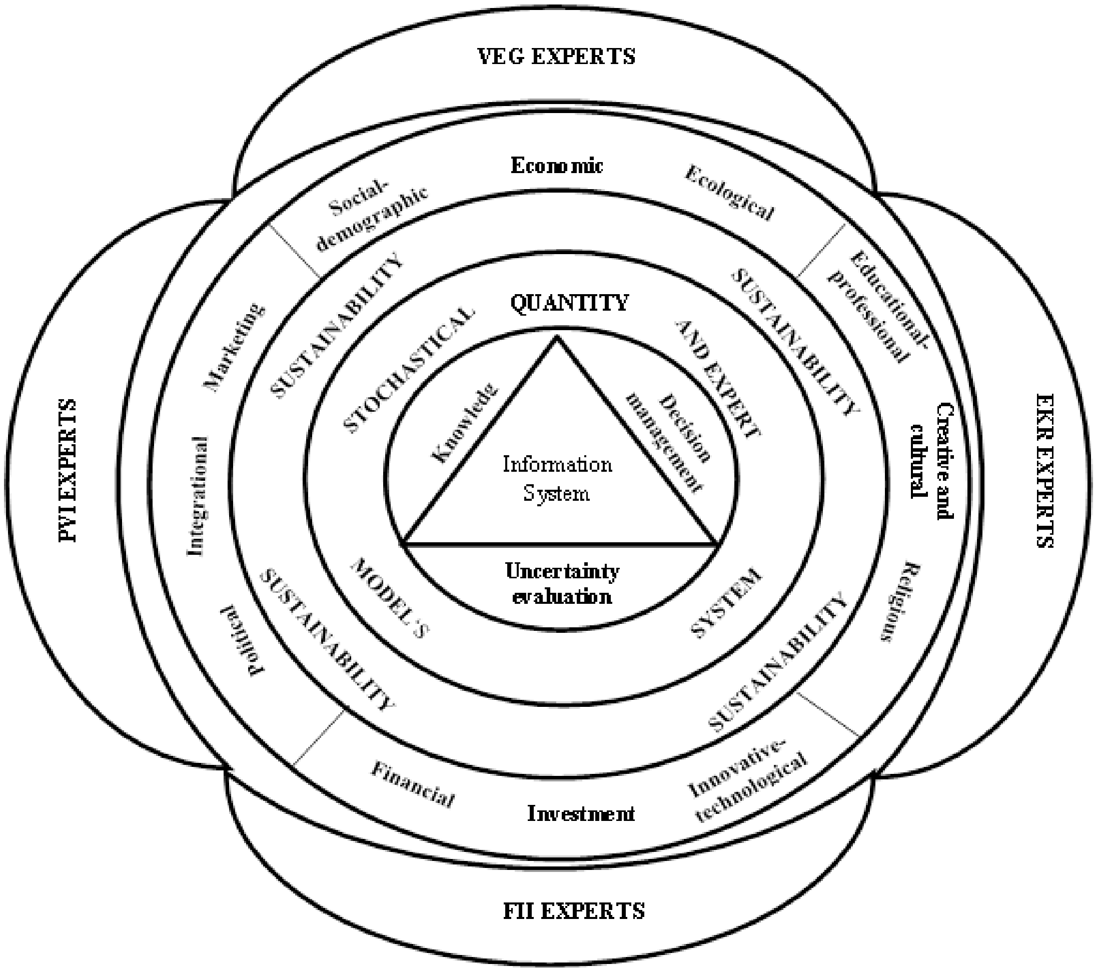


Figure 2. The idea of the round table: the formation of components delivering the development sustainability and preparation of the means of knowledge and expert valuations pursuing the possibilities of development sustainability management.

In addition, in complex systems it is accepted that if reality serves as the object of their cognition, there are possibilities that the condition of one subsystem can be a factor influencing another subsystem's condition. Also, the ultimate indicator of the condition of the whole system or the effect it generates can be a complex function of separate subsystems' indicators. But the most difficult problem arise when it is necessary to solve the key economic problem — how to allocate rationally the possessed scarce resources with the objective to orient the system's movement to the optimal state or trajectory.

Further simplifying the situation for the time being, let us suppose that the state of every subsystem can be measured with an undimensional indicator, and that by using the stochastically informed expert valuation one can determine the effectiveness of marginal investment unit, if it is used for the training of subsystem *i* functioning. Then we can form a task — how one should search for the optimal allocation of resources among the subsystems under the conditions of uncertainty.

Illustration of the Experimental Situation of Resource Allocation Optimisation

The expert valuation demonstrates that the possibilities of the use of marginal investment unit with certain investment proportions among the subsystems described, as well as within the subsystems formed, represent the change in the index of every subsystem's state (which is *a priori* treated as one). These possibilities can increase along the following stochastic multipliers:

$$D_1(a_1, S_1), D_2(a_2, S_2), D_3(a_3, S_3), D_4(a_4, S_4), \quad (4)$$

where a_i, S_i are the mean values and standard deviations of the random variables.

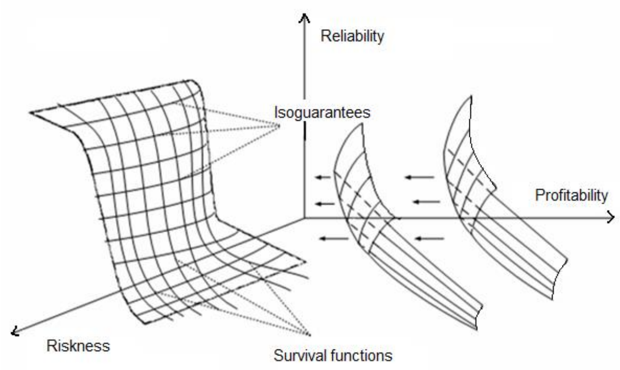
Let us try to determine by what proportions we should divide the marginal investment among the distinguished subsystems if the indicator *I* of the whole system's state is being formed as a product of subsystems' indicators I_i:

$$I = I_1 \times I_2 \times I_3 \times I_4. \quad (5)$$

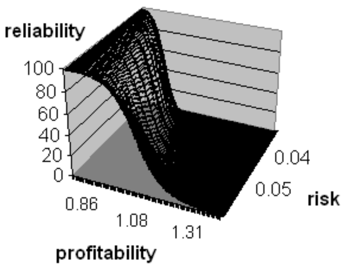
Let us analyse the two cases:

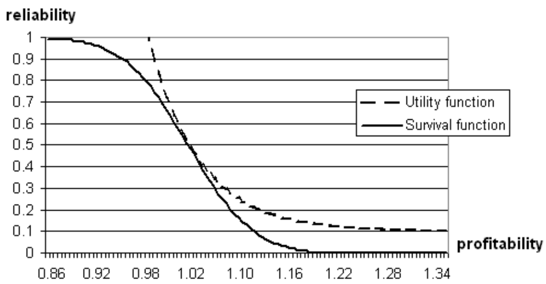
1. When we assume that the mentioned multipliers are the Normal random variables.

2. When the situation is complex and the mentioned variables achieve specific forms that are typical for these subsystems: D_1 becomes Lognormal probability distribution, D_2 – Gumbel, D_3 – La Place and D_4 stays as Normal probability distribution.

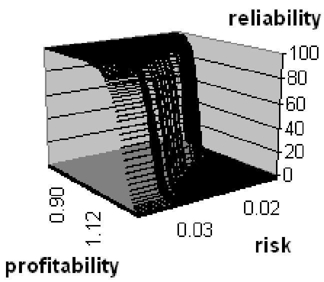


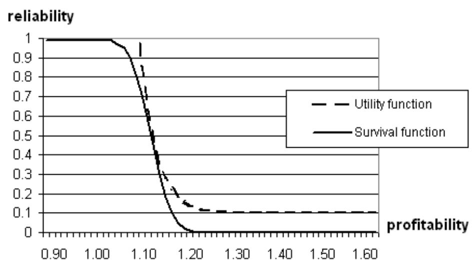
Section a





1st case





2nd case

Section b

1st case				2nd case			
1st asset	2nd asset	3rd asset	4th asset	1st asset	2nd asset	3rd asset	4th asset
Normal probability distribution				Gumbel probability distribution	La Place probability distribution	Normal probability distribution	Lognormal probability distribution
0,38	0,08	0,28	0,26	0,26	0,32	0,2	0,22
Parameters: e = 1,023116 p = 0,57 r = 0,013701				Parameters: e = 1,151202 p = 0,57 r = 0,029649			

Section c

Figure 3. Optimal resource allocation among the four subsystems: section a presents the general scheme of decision search; the left side of section b presents the possible surfaces of decisions, and right side presents the finding of a particular solution; section c presents the detailed description of the decisions.

For both cases the probability distributions are described by the following mean values and standard deviations:

$a_1 = 0,94$; $s_1 = 0,03$;

$a_2 = 1,22$; $s_2 = 0,06$;

$a_3 = 0,99$; $s_3 = 0,05$;

$a_4 = 0,90$; $s_4 = 0,02$.

The results are presented in Figure 3, which were obtained by applying the logic and technique of adequate investment portfolio (Rutkauskas, 2006).

Conclusions

Recently, in the research of countries', territories', and regions' sustainability, a lot of attention has been paid to certain inconsistencies. In the evaluation of development possibilities using only the dichotomy of environment and economics, neither the full-rate development possibilities nor the revelation of the factors forming these possibilities will be used.

To form development factors efficiently, the optimal use of disposable resources is required. Also, there is a need to determine the appropriate proportion of resources for the efficiency and reliability of development conditions. Also, the principles of complexity theory and systems theory should be applied in the proper investigation of small country sustainable development.

The possibilities for country conditions and development to influence efficiently political, integration, marketing, socio-demographic, economic, ecological, creative, religious, innovative, financial and investment factors are disclosed. These possibilities can objectively be foreseen and a more powerful synergy in the interaction of factors can be created. The adequate composition of efficiency and reliability should become the quantitative measure of state or development sustainability.

After performing two experiments on resource allocation among the four determined subsystems of sustainability, it has been concluded that treating the effect of each subsystem as Normal probability distribution after investing a marginal investment unit into them seems logical. However, the presumption that this effect conforms to different and more complex forms of distributions (Lognormal, Gumbel, and La Place) is more in line with the reality. The mean value of the general effect is higher in the second case (1,15 compared to 1,02 in the first case), while the risk is also higher (0,03 compared to 0,01). The results of optimal allocation of investment resources among the four analysed subsystems of sustainability are obtained after solving the problem of stochastic optimisation. The difference between the results of the two mentioned cases is mainly in the distribution of resources among the two first subsystems.

References

Amaral, L. A. N., & Ottino, J. M. (2004). Complex Systems and Networks: Challenges and Opportunities for Chemical and Biological Engineers. *Chemical Engineering Science,* 59, 1653–1666. doi:10.1016/j.ces.2004.01.043

Ang, F., Van Passel, S., & Mathijs, E. (2011). An Aggregate Resource Efficiency Perspective on Sustainability: A Sustainable Value Application to the EU-15 Countries. *Ecological Economics,* 71, 99–110. doi:10.1016/j. ecolecon.2011.08.008

Bartelmus, P. (2010). Use and Usefulness of Sustainability Economics. *Ecological Economics*, 69, 2053–2055. doi:10.1016/j.ecolecon.2010.06.019

Baumgartner, S., & Quaas, M. F. (2009). Ecological-economic Viability as a Criterion of Strong Sustainability under Uncertainty. *Ecological Economics*, 68, 2008–2020. http://dx.doi.org/10.1016/j.ecolecon.2009.01.016

Bell, S., & Morse, S. (2008). Sustainability indicators: Measuring the immeasurable? 2nd edition. London: Earthscan.

Fiksel, J. (2006). Sustainability and Resilience: Towards a Systems Approach. *Sustainability: Science, Practice & Policy,* 2(2), 14–21.

Gallopin, G. (2003). A systems approach to sustainability and sustainable development. CEPAL ECLAC. Santiago, Chile: March.

Innes, J. E., & Booher, D. E. (1999). Metropolitan Development as a Complex System: A New Approach to Sustainability. *Research and Practice*, 13(2), 141–156.

Kang, C. W., & Golay, M. W. (2000). An Integrated Method for Comprehensive Sensor Network Development in Complex Power Plant Systems. *Reliability Engineering and System Safety*, 67, 17–27. http://dx.doi.org/10.1016/S0951-8320(99)00039-3

Katz, J. S. (2006). Indicators for Complex Innovation Systems. *Research Policy*, 35, 893–909. doi:10.1016 /j.respol. 2006.03.007

Liobikiene, G., & Mandravickaite, J. (2011). Sustainable Development during the Integration Process into the European Union. *Technological and Economic Development of Economy,* 17(1), 62–73. doi:10.3846/13928619.2011.554000

Makiela, K., & Misztur, T. (2012). Going Green versus Economic Performance. *Inzinerine Ekonomika-Engineering Economics*, 23(2), 137–143. http://dx.doi.org/10.5755/j01.ee.23.2.1546

Meadows, D. (1998). Indicators and information systems for sustainable development. The Sustainability Institute. Hartland, VT. 78 p.

Moles, R., Foley, W., Morrissey, J., & O'Regan, B. (2008). Practical Appraisal of Sustainable Development: Methodologies for Sustainability Measurement at Settlement Level. *Environmental Impact Assessment Review,* 28, 144–165. doi:10.1016/j.eiar.2007.06.003

Nadal, A. (2011). Rethinking macroeconomics for sustainability. London: Zed Books.

Rammel, C., Stagl, S., & Wilfing, H. (2007). Managing Complex Adaptive Systems: A Co-evolutionary Perspective on Natural Resource Management. *Ecological Economics*, 63, 9–21. doi:10.1016/j.ecolecon.2006.12.014

Raslavicius, L., & Straksas, A. (2011). Motor Biofuel-powered CHP Plants: A Step towards Sustainable Development of Rural Lithuania. *Technological and Economic Development of Economy,* 17(1), 189–205. doi: 10.3846/13928619.2011.560639

Rutkauskas, A. V. (2006). Adekvaciojo investavimo portfelio anatomija ir sprendimai panaudojant imitacines technologijas [Adequate investment portfolio anatomy and decisions using imitative technologies]. *Ekonomika: mokslo darbai [Economics: scientific papers],* 75, 52–76.

Rutkauskas, A. V. (2012a). Sustainability as valid composition of efficiency and reliability. In *Contemporary Issues in Business, Management and Education 2012* (pp. 444–458), Selected papers: conference proceedings, 15 November, 2012. Vilnius: Technika, Lithuania.

Rutkauskas, A. V. (2012b). Using Sustainability Engineering to Gain Universal Sustainability Efficiency. *Sustainability,* 4(6), 1135–1153. http://dx.doi.org/10.3390/su4061135

Rutkauskas, A. V., & Stasytyte, V. (2012). With Sustainability Engineering to Sustainability Efficiency. In *The 7th International Scientific Conference "Business and Management 2012"* (May 10-11, 2012, Vilnius, Lithuania). Vilnius: Technika. (pp. 173–184).

Spangler, W. E., & Peters, J. M. (2001). A Model of Distributed Knowledge and Action in Complex Systems. *Decision Support Systems*, 31, 103–125. http://dx.doi.org/10.1016/S0167-9236(00)00122-6

Streimikiene, D., & Barakauskaite-Jakubauskiene, N. (2012). Sustainable Development and Quality of Life in Lithuania Compared to Other Countries. *Technological and Economic Development of Economy*, 18(4), 588–607. http://dx.doi.org/10.3846/20294913.2012.708676

Streimikiene, D., & Simanaviciene, Z., & Kovaliov, R. (2009). Corporate Social Responsibility for Implementation of Sustainable Energy Development in Baltic States. *Renewable and Sustainable Energy Reviews,* 13(4), 813–824. doi:10.1016/j.rser.2008.01.007

Urban, B., & Govender, D. P. (2012). Empirical Evidence on Environmental Management Practices. *Inzinerine Ekonomika-Engineering Economics,* 23(2), 209–215. doi:http://dx.doi.org/10.5755/j01.ee.23.2.1549.

Xu, F. L., Zhao, S. S., Dawson, R. W., Hao, J. Y., Zhang, Y., & Tao, S. (2006). A Triangle Model for Evaluating the Sustainability Status and Trends of Economic Development. *Ecological Modelling,* 195, 327–337. doi:10.1016/j.ecolmodel.2005.11.023

The article has been reviewed.

Received in March, 2013; accepted in December, 2014.