International Journal of Sustainable Development and Planning
Vol. 19, No. 3, March, 2024, pp. 1089-1097
Journal homepage: http://iieta.org/journals/ijsdp

Planning to Improve the Efficiency of Open Systems Commercial Relations to Ensure Uninterrupted Sustainable Development: Regional Legal Aspect

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https://doi.org/10.18280/ijsdp.190327

Received: 7 December 2023
Revised: 8 March 2024
Accepted: 13 March 2024
Available online: 29 March 2024

Keywords:
legal environment, region, open socio-economic system, commercial relations, sustainable development, environmental protection, legal activity

ABSTRACT

The main purpose of the article will be to plan the process of implementing a strategy for increasing the efficiency of open systems commercial relations to ensure uninterrupted sustainable development in accordance with the level of key parameters. The object of the study is the open systems of commercial relations to ensure the uninterrupted sustainable development. In the context of the study, a separate region was chosen - Liberec Region. The research methodology involves the use of fuzzy sets and linguistic variables. As a result of using the method, a system was formed for selecting the best strategy for increasing commercial relations of sustainable development in accordance with the parameters established by experts. The study is limited to taking into account the parameters of open systems commercial relations to ensure uninterrupted sustainable development in accordance with the level of key parameters in the context of sustainable development of only one region. In addition, the choice of strategy for increasing the efficiency of open systems commercial relations to ensure uninterrupted sustainable development was limited to three parameters. Prospects for future research will include expanding the parameters and unifying them.

1. INTRODUCTION

In today's world, where environmental and social issues are becoming increasingly important, the effectiveness of commercial relationships is key to achieving sustainable development goals at both the national and regional levels. This means creating systems that ensure economic growth while respecting the principles of environmental balance and social justice.

Analyzing the basic principles of the concepts of sustainable development and green economy, we can conclude that open socio-economic systems of different levels in modern theory and practice of organizing society are not considered open models, and therefore are not considered from the standpoint of the fundamental principles of their functioning. Natural principles of the development organization, their dialectical connection with economic and social relations, as well as human potential, are the fundamental foundations of social development. The principles of the natural organization of open socio-economic systems are implicit in spatiotemporal terms and are not taken into account at the system level when choosing a development alternative and making management decisions.

Every management decision on commercial activity, and every action can result in consequences that are so distant in time and differentiated that it is not possible to foresee them in modern development conditions. Any local change can cause fluctuations that can cause widespread changes. Local changes increase their potential due to chain reactions that form global cause-and-effect relationships from the perspective of space and time. The effects of economic activity spread across hierarchical levels of the global ecosystem. Many effects appear in the future when irreversible changes have already taken place. Therefore, an important task arises to ensure balanced development in space, based on the basic principles of the systematic methodology of sustainable development, which is consistent with the concept of a green economy. The development of open socio-economic systems must also be balanced over time, fully consistent with the concept of sustainable development. Studying the region through the prism of analysis methodology as a subject of the emergence of economic interests allows us to show the complexity and multidimensionality of its modern interpretation. At the same time, the political and economic basis for the functioning of such an economic entity is the following factors: property relations, which provide the material basis for the independence of the entity; a system of institutions that provides real opportunities for their functioning; and having

your budgets. All of the above determines the isolation of the economic interests of the region.

The functioning and development of regions as economic entities of the emergence and implementation of their interests is associated with the separation of powers, legislative conditions and restrictions. It should be taken into account that the regional authorities, in addition to expressing the interests of the residents of the territory, also have their own, different from the interests of taxpayers, aimed at obtaining additional benefits, called political rent.

The effective implementation of regional economic interests is justified by the function of the reproduction process at the meso level to meet the needs of the population of a given territory and business entities. At the same time, there is a clear functional relationship between the sufficiency of the material base and the development of formal institutions, especially in the field of property, land and financial-tax relations, and the implementation of regional economic interests.

At the present stage, the development of national and regional economies is largely determined by the laws of global, globalization processes, which, on the one hand, contribute to an increase in the rate of economic growth and, thereby, provide the opportunity to satisfy the growing needs of an increasing number of the planet's population, and on the other hand, entail. This leads to increased uncertainty and instability of development. Emerging disturbances are unpredictable and are a destabilizing factor that significantly complicates the management of socio-economic processes. These circumstances require a search for ways to comprehensively solve economic, social and environmental problems in the context of globalization and pose the problem of the country's transition to a model of sustainable development of socio-economic systems.

Given all of the above, open socio-economic systems, dependent on a wide range of external interactions and conditions, must be flexible and adaptive to rapid changes in the global economic and technological landscape.

In the context of open systems commercial relations, "efficiency" could be defined as the ratio of useful output to total input, which can encompass economic, environmental, and social inputs and outputs. This includes not only financial performance but also resource utilization, environmental impact, and social equity. Uninterrupted sustainable development" refers to continuous progress in achieving economic growth, environmental protection, and social equity over time, without significant setbacks or periods of decline.

Taking into account all of the above, the purpose of the article will be to formulate ways to increase the efficiency of commercial relations of open systems to ensure sustainable, uninterrupted development. To achieve these goals, the structure of the article will include the following sections: an introduction indicating the relevance of the study, a literature review, a description of methodology, a presentation of results, discussion and conclusions.

In the context of our research, we chose a region - with a separate open socio-economic system, and its legal environment for implementing and ensuring commercial relations.

The main purpose of the article will be to plan the process of implementing a strategy for increasing the efficiency of open systems commercial relations to ensure the uninterrupted sustainable development in accordance with the level of key parameters. The object of the study is the open systems of commercial relations to ensure the uninterrupted sustainable development.

The Liberec Region, like many areas, possesses a unique blend of economic activities, environmental assets, and societal structures. This distinct mix offers a rich ground for exploring how commercial relations can be optimized within open systems while also addressing the challenges and opportunities of sustainable development. Studying these interactions in a specific, localized context provides deeper insights into the dynamics at play, which might be less apparent in more generalized studies.

We introduced an innovative approach by applying fuzzy sets and linguistic variables to the strategic planning process within the context of sustainable development in the Liberec Region. This method diverges from traditional strategies by allowing for a more nuanced and flexible analysis of the complexities inherent in open systems commercial relations. Unlike conventional models that often rely on rigid, binary decision-making frameworks, our approach embraces the ambiguity and uncertainty characteristic of sustainable development challenges. By forming a system for selecting the best strategy based on expert-established parameters, we provide a novel, adaptable framework that enhances decision-making precision in the realm of sustainable commercial relations, setting a precedent for future research in similar contexts.

2. LITERATURE REVIEW

The issue of determining the key characteristics and features of increasing the efficiency of commercial relations of open socio-economic systems to ensure uninterrupted sustainable development is important for the modern scientific community.

The general issue of the concept of sustainable development, in the issue of shaping the commercial policy of regions as open socio-economic systems, is being studied by many scientists. Thus, Tomislav [1] and Ukko et al. [2] in their works provided a general overview of the concept of sustainable development on the issue of regional development and its commercial relations. Understanding historical developments and contemporary challenges in the field of sustainable development is critical to developing effective approaches to planning commercial relationships, especially in changing external and internal conditions.

For example, in a study by Szopik-Depczyńska et al. [3], and Łozowicka [4], the level of effectiveness of the implementation of sustainable development policies in selected EU countries is assessed in the context of sustainable development of the region. These studies vividly describe how different regions are implementing sustainable development policies, especially from an environmental responsibility perspective. This information may be particularly useful in developing plans to improve efficiency in commercial relationships, taking into account environmental standards and practices.

The issue of studying the sectoral policy of commercial relations of open socio-economic systems is actively considered by Cyrek and Fura [5] and Chaurasia et al. [6]. Thus, these studies clearly demonstrate how different economic sectors influence the consistency and effectiveness of commercial relationships. Knowledge of the performance of different sectors can help shape strategies to balance economic development with sustainable practices. In addition,

these studies highlight the importance of taking into account the factor of human resources in improving the efficiency of open systems commercial relations to ensure smooth sustainable development.

No less important for modern sustainable development is the innovative component. Thus, Awan et al. [7] and Chaparro-Banegas et al. [8] studied the role of innovation facilitators in sustainable development and commercial relations of open socio-economic systems. This highlights the importance of innovation for improving the efficiency of open socio-economic systems, and in particular, these studies take a regional perspective, providing insights into how innovation can be integrated into commercial relationships to promote sustainability.

Other scientists [9, 10] identified issues of increasing the efficiency of commercial relations between regionals as open socio-economic systems to ensure uninterrupted sustainable development as an integrated approach that combines economic, environmental and social aspects. Thus, Tsalis et al. [11] emphasized the importance of integrating sustainable practices into commercial strategies, where flexibility, innovation and responsible use of resources are key. They also focus on the role of technology and information systems in increasing transparency and interaction between various stakeholders operating in the region. At the same time, Yan [12] and Ahmed et al. [13] noted the social responsibility of regional governments, in particular the importance of supporting local communities and creating conditions for economic growth that do not harm the environment. Thus, this issue is viewed through the lens of the complex interaction of various factors affecting persistence and efficiency in open economic systems.

Thus, the issue of studying the features of increasing the efficiency of commercial relations of open systems to ensure uninterrupted sustainable development is a relevant topic for the modern scientific community. In general, the relevance of studying the features of increasing the efficiency of commercial relations of open systems to ensure uninterrupted sustainable development lies in the need to adapt to rapidly changing global economic, environmental and social conditions. But, despite this relevance, today there are still several theoretical and practical gaps in this topic.

The advent of digitalization and globalization has necessitated a nuanced understanding of commercial relations within open systems, particularly in the context of sustainable development. This literature review explores various perspectives on legal, regulatory, and technological frameworks that underpin the efficiency and resilience of commercial relations in an increasingly interconnected world. Alazzam et al. delve into the integration of modern socio-economic systems within the digital landscape, highlighting the pivotal role of legal compliance and information models in E-Commerce platforms. Their study provides a comprehensive framework for understanding how digitalization influences commercial interactions and underscores the importance of aligning E-Commerce practices with contemporary legal standards to foster sustainable development. In exploring the regulatory and legal components critical to a state's financial security, Rushchyshyn et al. emphasize the necessity of robust legal frameworks to safeguard economic interests and ensure the stability of commercial relations. Their findings suggest that a well-defined regulatory environment is indispensable for nurturing trust and efficiency in open systems, which in turn contributes to uninterrupted sustainable development [14, 15].

Yesimov and Borovikova examine the administrative and legal mechanisms that support the rights of business entities, shedding light on the significance of legal protections in maintaining fair and efficient commercial practices. Their research underscores the role of legal frameworks in creating a conducive environment for business operations, which is crucial for achieving sustainable growth in open systems. Kronivets et al. address the utilization of artificial intelligence (AI) in educational processes, providing insights into the legal foundations necessary for integrating advanced technologies into traditional systems. While focusing on education, their study offers valuable parallels to commercial relations, where AI can enhance decision-making and efficiency. The discussion on legal considerations for AI deployment is particularly relevant for planning sustainable development strategies in commercial relations [16, 17].

Finally, Sylkin et al. [18] investigated the financial security of engineering enterprises, highlighting the role of anti-crisis management in sustaining business operations during economic downturns. Their analysis on assessing and managing financial risks is pertinent to the study of open systems commercial relations, where understanding and mitigating financial vulnerabilities is key to ensuring uninterrupted development.

So, first of all, the key scientific gap in this context is the lack of understanding among the scientific community regarding the effective integrated interaction of various factors of sustainable development: economic, environmental and social. In addition, today most scientists are trying to substantiate the issues of increasing the efficiency of commercial relations of open socio-economic systems to ensure uninterrupted sustainable development using outdated methods and activities. In our opinion, not taking into account technological and methodological innovations in this matter is incorrect and can damage the level and pace of sustainable development in the region.

Another important gap in improving the efficiency of open systems commercial relationships to ensure smooth sustainable development is the failure to take into account the role of improving and developing new legal and regulatory aspects. Thus, today there is a need for a more in-depth study of the legal and regulatory aspects governing commercial relations in the context of sustainable development, in particular, in the context of regional development.

Thus, the scientific task will be to plan the process of implementing a strategy for increasing the efficiency of open systems commercial relations to ensure sustainable development in accordance with the level of parameters chosen by experts. In our case, the open system will be the region.

3. METHODOLOGY

The methodology of fuzzy sets and linguistic variables was used in the research process. These methodologies are applicable to study planning strategies for increasing the efficiency of commercial relations of open systems to ensure sustainable development and some factors influencing its results.

The multitude of requirements and rules relating to the characteristics associated with various planning strategies for improving the effectiveness of open systems commercial

relationships for sustainable development cannot be specified only in numerical parameters: a significant number of them are verbally descriptive. A set of such descriptive characteristics of processes, phenomena or procedures is usually called linguistic variables, which are the basis of the theory of fuzzy sets.

Linguistic variables in the planning tasks of increasing the efficiency of commercial relations of open systems to ensure sustainable development of electronic security can be factors and parameters that influence the strategy for managing these processes. Allowable values of linguistic variables form a term-plural number or fuzzy set, which is subject to certain restrictions. The transition from descriptive values of a term set to their formalized values is carried out through a mapping that is identified by membership functions. With their help, linguistic information is converted into numerical data, which, in turn, provides computer processing models regarding planning strategies for improving the efficiency of open systems commercial relationships to ensure sustainable development. Linguistic variables are identified with factors influencing the results of planning to improve the efficiency of open systems commercial relations to ensure sustainable development and can be used to predict this indicator relative to individual planning strategies to improve the efficiency of open systems commercial relations to ensure sustainable development.

In this case, the assigned tasks are solved at the information level, since the forecast is carried out based on models, the main paradigm of which is not the physical characteristics of the factor (if it has one in principle), but the advantages between the factors during their pairwise comparison and the priority of the factor's influence on the process being studied. This principle is universal since it ensures the application of a unified methodology not only to factors that can be specified in the form of numerical values but also to cover weakly formalized requirements described verbally.

Taking into account the above conditions, the task can be formulated as follows: the planning strategy for increasing the efficiency of commercial relations of open systems to ensure sustainable development must be adequate to the existing capabilities for ensuring sustainable development. This means that each of the parameters influencing the sustainable development strategy must be used to the full extent of its capabilities, i.e. The solution to this problem can be obtained using methods and tools of the theory of fuzzy sets, the main component of which are membership functions constructed using a set of values and linguistic terms of the parameter.

To determine these parameters, we involved 20 experts who helped assess the level of sustainable development in the context of assessing the level of indicators we identified.

To better objectify the study, we chose a specific region of the Czech Republic – Liberec Region. The reason for choosing the region is that the authors of the study live in this country and there is the possibility of scientific cooperation with the country's leading experts in the field of sustainable development and commercial relations in the region.

Graphically, the input parameters for the formation of strategies are shown in Figure 1.

In the spatial scheme, the following are selected as the X, Y, Z axes:

- level of commercial activity;
- level of environmental safety;
- level of legal activity.

For accuracy, it should be noted once again that these parameters were chosen as key ways to survey experts, as well as official data from our chosen region.

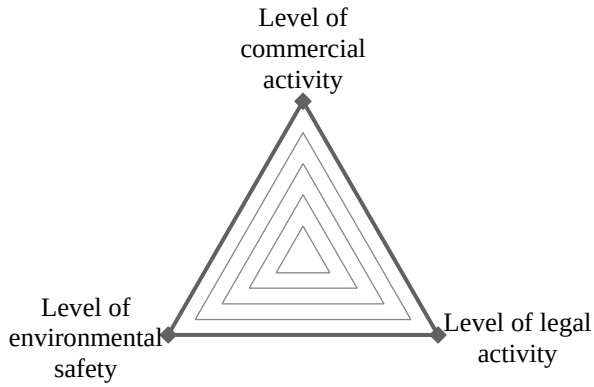

Figure 1. Scheme for choosing parameters to increase the efficiency of commercial relations of open systems to ensure sustainable development

Let's look at the characteristics of planning strategies to improve the efficiency of open systems commercial relationships to ensure sustainable development. At the same time, we note once again that in the structure of our study, the open socio-economic system will be the region. These strategies are described by different balances of security and external and internal threats. The listed characteristics will be considered parameters specified in the form of linguistic variables, thanks to which the logical variable "chosen strategy" to ensure planning for increasing the efficiency of commercial relations of open systems to ensure sustainable development can be reproduced as a function of its characteristics, which can be described by the formula:

$$Z = F\ (z_1, z_2, \dots z_m) \qquad (1)$$

To further study the selected parameters of planning strategies for increasing the efficiency of commercial relations of open systems to ensure sustainable development, we use parameters that, according to expert assessment, have a dominant influence on commercial relations of the region in the context of sustainable development, namely:

z_1 –commercial activity; z_2 – legal activity; z_3 – environmental safety. The task is to establish such values of the parameters of the selected strategy (within a given range) that ensure the maximum of the function Z.

We consider the chosen strategy of parameters to be a linguistic term *P*. We will formalize it using the universal fuzzy term set $G = \{g_1, g_2, \dots, g_n\}$, on which each of the parameters of the planning strategy for increasing the efficiency of commercial relations of open systems to ensure sustainable development is specified in the established range of numerical values $g_i = (i = \overline{1,n})$ and their expert ranks $r_p(g_i)$, which determine the priority of the parameter's influence on the selected planning strategy for increasing the efficiency of commercial relations of open systems to ensure sustainable development. As a result, the formalized representation of the linguistic term *P* can be reflected by a fuzzy set, the elements of which contain sets of pairs depicted by formula (2).

$$P_F = \left\{\frac{\mu_p(g_1)}{g_1}, \frac{\mu_p(g_2)}{g_2}, \dots, \frac{\mu_p(g_n)}{g_n}\right\}, \quad (2)$$

where, $P_F \subset G$, $\mu_p(g_i)$ is the measure of belonging to the fuzzy set P_F of the element $g_i \in G$.

The required integral value of the membership function of the linguistic term P is found from the expression that combines, by logical operations $\wedge$ and $\vee$, the maximum values of the membership functions $\mu_p(g_i)$, identifying the optimal characteristics of the planning strategy for increasing the efficiency of commercial relations of open systems to ensure sustainable development based on real conditions. Based on the above-stated research problem, we formulate it as follows:

$$\begin{gathered} P_F = F(z_j) \to max, j = \overline{1,3}; \\ z_j > 0, z_j = f(g_i), i = \overline{1,5} \\ \mu_p(g_i) \to max, g_i \in G, P_F \subset G \end{gathered} \quad (3)$$

Designated $\mu_i = \mu_p(g_i)$ and $r_i = r_p(g_i)$ and taking into account the fact that $\mu_1 + \mu_2 + \dots + \mu_n = 1$, we obtain the condition for the distribution of membership measures, which we write in the form (4).

$$\frac{\mu_1}{r_1} = \frac{\mu_2}{r_2} = \dots \frac{\mu_n}{r_n} \quad (4)$$

If the ranks are unknown, it is advisable to use the Saaty scale of the relative importance of objects and paired comparison matrices constructed on its basis for each of the parameters of the universal set of values for planning a strategy for increasing the efficiency of commercial relations of open systems to ensure sustainable development.

In this case, a scale for assessing importance should be formed:

1 – equilibrium value, meaning no advantage of g_1 over g_2.

3 – one value slightly predominates over the other, and there is a basis for the presence of a slight advantage of g_1 over g_2.

5 – one value significantly predominates over the other, and there is a basis for the presence of a significant advantage of g_1 over g_2.

7 – one value significantly predominates over the other, while there is a clear advantage of r_1 over r_2.

9 – one value absolutely predominates over the other, and there is no doubt about the absolute advantage of g_1 over g_2.

2,4,6,8 – intermediate values.

The characteristics of the parameters of the chosen strategy can be in a fairly wide range, so it is important to set their values that would ensure increased efficiency of commercial relations of open systems to ensure sustainable development. It is for this purpose that membership functions are calculated as the degree of priority of a specific value of the corresponding characteristic. To construct them, we divide the range of possible values of linguistic variables into four ranges. At each of the five division points, measures of membership $\mu_p(g_i)$ to the fuzzy term P_F elements $g_i \in G$ (i = 1,...,5) and according to estimates of the relative importance of Saaty objects are calculated. This number of points is also sufficient for the graphical reproduction of high-quality linguistic terms.

Relative estimates of the ranks of numerical values for each of the parameters of the planning strategy for increasing the efficiency of commercial relations of open systems to ensure sustainable development form a square inversely symmetric matrix $A = a_{ij}$, where $a_{ij} = r_i/r_j$ for i, j = 1,...,5.

$$A = \begin{bmatrix} 1 & \frac{r_2}{r_1} & \frac{r_3}{r_1} & \frac{r_4}{r_1} & \frac{r_5}{r_1} \\ \frac{r_1}{r_2} & 1 & \frac{r_3}{r_2} & \frac{r_4}{r_2} & \frac{r_5}{r_2} \\ \dots & \dots & \dots & \dots & \dots \\ \frac{r_1}{r_5} & \frac{r_2}{r_5} & \frac{r_2}{r_5} & \frac{r_4}{r_5} & 1 \end{bmatrix} \quad (5)$$

At the same time, the values of the membership functions are calculated for each of the characteristics of the selected planning strategy for increasing the efficiency of commercial relations of open systems to ensure sustainable development:

$$\begin{gathered} \mu = \left(1 + \frac{r_2}{r_1} + \frac{r_3}{r_1} + \dots \frac{r_i}{r_1}\right)^{-1} \\ \mu = \left(\frac{r_1}{r_2} + 1 + \frac{r_3}{r_2} + \dots \frac{r_i}{r_2}\right)^{-1} \\ \mu = \left(\frac{r_1}{r_2} + \frac{r_3}{r_2} + \frac{r_i}{r_2} + \dots + 1\right)^{-1} \end{gathered} \quad (6)$$

Based on the above, each of the parameters in accordance with those specified in the Table 1 universal term-sets of values of planning strategies for increasing the efficiency of commercial relations of open systems to ensure sustainable development and linguistic terms, the values of the membership function μi are calculated first for each of the characteristics of the level of commercial activity, then for the level of environmental safety, the level of legal safety.

Table 1. Term sets of values of linguistic variables of strategies

Parameter	Linguistic Essence of the Parameter	Universal Set	Evaluation Terms
X	level of commercial activity	0 – 1,0	low, average, high
Y	level of environmental safety	0 – 1,0	low, average, high
Z	level of legal activity	0 – 1,0	low, average, high

This approach allows for a more flexible and nuanced analysis of qualitative data, accommodating the ambiguity that traditional quantitative methods may not effectively address. By employing fuzzy logic, we are able to incorporate expert knowledge and preferences into the decision-making process, facilitating the identification and selection of optimal strategies that align with the established parameters for sustainable growth in the Liberec Region. This methodological choice underscores our commitment to developing a tailored, robust framework capable of navigating the intricate dynamics of commercial relations within open systems, thereby ensuring their contribution to uninterrupted sustainable development.

The study's concentration on the Liberec Region, while providing in-depth insights into this specific area, may limit its applicability to other regions with different economic, environmental, and social contexts. Regions vary widely in terms of industrial composition, regulatory environments, and sustainability challenges, which means strategies effective in the Liberec Region may not be directly transferable or equally effective elsewhere. While the use of fuzzy sets and linguistic

variables allows for a nuanced analysis of complex and ambiguous data, this approach relies heavily on the expertise and subjective judgments of the selected experts. The interpretations and weights assigned to various factors can vary among experts, potentially leading to results that are specific to the perspectives of those consulted for this study. This subjectivity might limit the findings' applicability in contexts where expert opinions differ significantly.

All subsequent calculations, according to the chosen methodology, will be made in the next chapter of the study.

4. RESULTS OF RESEARCH

Having determined the ranks of the characteristics of the parameters of the planning the strategy for increasing the efficiency of commercial relations of open systems to ensure sustainable development at the points of separation of the universal set, based on we build a matrix for the linguistic variable "level of commercial activity" concerning the linguistic terms "low", "medium" and "high" (Table 2).

Table 2. Linguistic matrix and reliability function for the parameter X - "level of commercial activity"

	g_1	g_2	g_3	g_4	g_5
A_{low}	1	7/9	5/9	3/9	1/9
	9/7	1	5/7	3/7	1/7
	9/5	7/5	1	3/5	1/5
	9/3	7/3	5/3	1	1/3
	9/1	7/1	5/1	3/1	1
μ	0.36	0.280	0.2	0.120	0.040
A_{aver}	1	3/1	6/1	4/1	2/1
	1/3	1	6/3	4/3	2/3
	1/6	3/6	1	4/6	2/6
	1/4	3/4	6/4	1	2/4
	1/2	3/2	6/2	4/2	1
μ	0.062	0.187	0.3750	0.250	0.125
A_{hight}	1	2/1	4/1	6/1	8/1
	1/2	1	4/2	6/2	8/2
	1/4	2/4	1	6/4	8/4
	1/6	2/6	4/6	1	8/6
	1/8	2/8	4/8	6/8	1
μ	0.087	0.130	0.174	0.261	1

For linguistic terms, we normalize the reliability functions concerning unity:

$$k_l = 1/max\ \mu_l(g_i),\ (i = \overline{1,5}),$$
where l = "low", " average ", "high";
$$\mu_{ln}(g_i) = k_l \times \mu_l(g_i)$$

As a result of using the formulas, we will get the following normalized values:

1.$\mu_{low.n}(g_1) = 1$; $\mu_{low.n}(g_2) = 0.7$; $\mu_{low.n}(g_3) = 0.5$; $\mu_{low.n}(g_4) = 0.3$; $\mu_{low.n}(g_5) = 0.1$;
2.$\mu_{awer.n}(g_1) = 0.165$; $\mu_{awer.n}(g_2) = 0.499$; $\mu_{awer.n}(g_3) = 1$; $\mu_{awer.n}(g_4) = 0.666$; $\mu_{awer.n}(g_5) = 0.333$;
3.$\mu_{high.n}(g_1) = 0.129$; $\mu_{high.n}(g_2) = 0.373$; $\mu_{high.n}(g_3) = 0.50$; $\mu_{high.n}(g_4) = 0.75$; $\mu_{high.n}(g_5) = 1$.

After forming and solving a matrix of paired comparisons of the influence of the level of commercial activity on the choice of planning strategy for increasing the efficiency of commercial relations of open systems to ensure sustainable development in relation to the terms "low", " average", "high", we obtain the following fuzzy sets, the general form of which is described by the universal set, containing a number of split points:

$$G = \{0.2;\ 0.4;\ 0.6;\ 0.8;\ 1.0\}$$

Let us similarly form the matrices of the linguistic matrix and reliability function for the parameter Y - "level of environmental safety" (Table 3).

Table 3. Linguistic matrix and reliability function for the parameter Y - "level of environmental safety"

	g_1	g_2	g_3	g_4	g_5
A_{low}	1	6/8	4/8	2/8	1/8
	8/6	1	4/6	2/6	1/6
	8/4	6/4	1	2/4	1/4
	8/2	6/2	4/2	1	1/2
	8	6	4	2	1
μ	0.380	0.286	0.190	0.095	0.048
A_{aver}	1	5/3	7/3	4/3	1
	3/5	1	7/5	4/5	3/5
	3/7	5/7	1	4/7	3/7
	3/4	5/4	7/4	1	3/4
	1	5/3	7/3	4/3	1
μ	0.136	0.227	0.318	0.182	0.136
A_{hight}	1	3	5	7	9
	1/3	1	5/3	7/3	9/3
	1/5	3/5	1	7/5	9/5
	1/7	3/7	5/7	1	9/7
	1/9	3/9	5/9	7/9	1
μ	0.04	0.12	0.20	0.28	0.36

As a result of using the formulas, we will get the following normalized values:

1.$\mu_{low.n}(g_1) = 1$; $\mu_{low.n}(g_2) = 0.753$; $\mu_{low.n}(g_3) = 0.5$; $\mu_{low.n}(g_4) = 0.250$; $\mu_{low.n}(g_5) = 0.126$;
2.$\mu_{awer.n}(g_1) = 0.428$; $\mu_{awer.n}(g_2) = 0.849$; $\mu_{awer.n}(g_3) = 1$; $\mu_{awer.n}(g_4) = 0.572$; $\mu_{awer.n}(g_5) = 0.428$;
3.$\mu_{high.n}(g_1) = 0.111$; $\mu_{high.n}(g_2) = 0.333$; $\mu_{high.n}(g_3) = 0.555$; $\mu_{high.n}(g_4) = 0.777$; $\mu_{high.n}(g_5) = 1$.

After forming and solving a matrix of paired comparisons of the influence of the level of environmental safety on the choice of planning strategy for increasing the efficiency of commercial relations of open systems to ensure sustainable development in relation to the terms "low", " average", "high", we obtain the following fuzzy sets, the general form of which is described by the universal set, containing a number of split points:

$$G = \{0.2;\ 0.4;\ 0.6;\ 0.8;\ 1.0\}$$

To avoid oversaturation with formulas, for the last indicator – "level of legal activity", we present the final calculations:
1.$\mu_{low.n}(g_1) = 1$; $\mu_{low.n}(g_2) = 0.777$; $\mu_{low.n}(g_3) = 0.555$; $\mu_{low.n}(g_4)$

= 0.332; $\mu_{low.n}(g_5)$ = 0.222;
2.$\mu_{awer.n}(g_1)$ = 0.333; $\mu_{awer.n}(g_2)$ = 0.666; $\mu_{awer.n}(g_3)$ = 1; $\mu_{awer.n}(g_4)$ = 0.666; $\mu_{awer.n}(g_5)$ = 0.333;
3.$\mu_{high.n}(g_1)$ = 0.250; $\mu_{high.n}(g_2)$ = 0.250; $\mu_{high.n}(g_3)$ = 0.500; $\mu_{high.n}(g_4)$ = 0.750; $\mu_{high.n}(g_5)$ = 1.

In this case, the universal set will contain a number of split points:

$$G = \{0.2; 0.4; 0.6; 0.8; 1.0\}$$

Having determined the numerical values for choosing a planning strategy to improve the efficiency of commercial selected regions of systems to ensure sustainable development, we have formed three strategies that will correspond to each level: low, medium and high.

1. Low level - Resource Efficient Approach Strategy. This strategy involves maximizing the use of local resources while minimizing environmental impact. It includes investing in technologies that make more efficient use of natural resources such as water and energy and focusing on renewable energy sources. Another important aspect is to promote recycling and reuse of materials, which reduces the need for new resources and reduces environmental impact. The strategy also involves working with local businesses to develop more efficient and environmentally friendly production methods.

2. Average level - Integration and Partnership Strategy. The central idea of this strategy is cooperation between different sectors of the economy to create synergies and improve overall efficiency. It includes developing partnerships between industrial, agricultural and other sectors, as well as engaging research institutes to develop new technologies and approaches. An important aspect is the development of infrastructure to improve logistics and efficiency in resource allocation, which helps reduce costs and increase the competitiveness of the region.

3. High level - Environmentally oriented strategy. The main goal of this strategy is to reduce the environmental impact of business activities, including investments in green technologies, the development of sustainable agriculture and the reduction of air emissions. It also provides for the development of eco-tourism as a means of increasing the region's income without harming the natural environment. This strategy requires active public engagement and the development of educational programs to raise awareness of the importance of environmental safety and sustainable development.

Thus, in accordance with the level of each parameter, the sustainable development management system of the selected region will apply one of three strategies.

5. DISCUSSIONS

To better characterize and systematize the results obtained, let us compare our study and its results with existing ones.

Thus, the research of Spijkers [19] and Yang et al. [20] also analyzed methods for improving the efficiency of commercial relations of open systems to ensure uninterrupted sustainable development. At the same time, various factors were taken as indicators of sustainable development, such as intersectoral relations, as well as the impact of urbanization on the sustainable development of the region. We agree that these factors are important, and the nexus of exploring the relationship between urbanization, human capital and the ecological footprint is important for understanding the impact of urban development on sustainable development, which can influence commercial strategies within open socio-economic systems. But the modern paradigm of sustainable development takes into account a larger list of factors that often have to be grouped into a functional group to study the cumulative impact. Our study took into account various contemporary factors influencing the sustainable development of open socio-economic systems and their commercial relations.

At the same time, Lafortune et al. [21] and Trane et al. [22] have studied the innovative components in models for improving the effectiveness of sustainable development. In their research, they focused on external influences and information support for commercial relations and the general functioning of open socio-economic systems. In their opinion, this issue is key, since it is important for understanding how external influences and information can contribute to innovation in the commercial relations of regions and their sustainable development.

Considering scientists who used specific methodologies in the context of the process of improving the efficiency of commercial relations of open systems to ensure uninterrupted sustainable development, it should be noted Stanujkic et al. [23], who used CoCoSo and Shannon Entropy methods in their research. These are approaches that can help determine the effectiveness of commercial relationships from a sustainability perspective. In our opinion, such methods are effective, but difficult to implement and determine basic elements. However, these methods are static and will not allow changes (Figure 2).

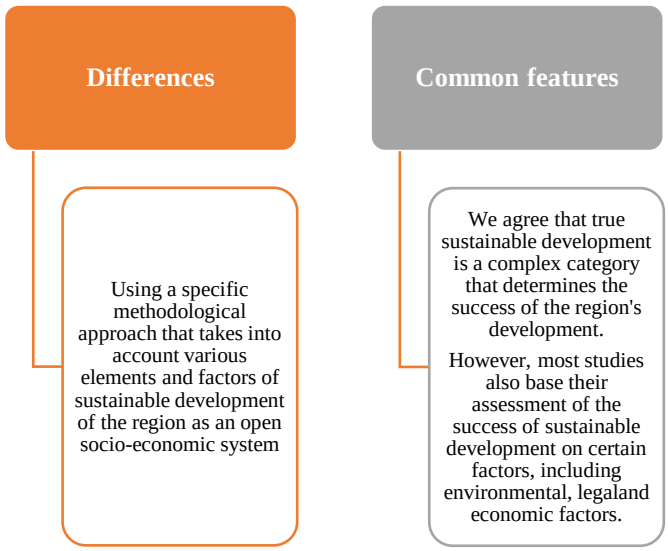

Figure 2. The main differences and common features of our research and others in the field of increasing the efficiency of commercial relations of open socio-economic systems to ensure sustainable uninterrupted development

The focus on the regional level of sustainable development and the definition of its key characteristics can be seen in the works of Allen et al. [24] and Baesu and Bejinaru [25]. These studies compared the extent to which individual regions in different countries are ready or not ready for transformations in the system of sustainable development. These results

provide information on how different countries approach the integration of sustainable development into their policies and practices. These studies are informative and useful in the context of analytical research and assessment of the positive and negative aspects of each region and its level of sustainable development, but at the same time, these studies do not propose specific measures to level out these shortcomings.

The implications of our research are its potential practical value for regional authorities seeking to change their own sustainable development strategy and develop existing commercial relationships.

Our results will improve knowledge in the field of sustainable development through the proposed methodological approach to choosing the correct and most effective strategy for increasing the efficiency of open systems commercial relations to ensure sustainable development.

6. CONCLUSIONS

Summing up, it should be noted that the global problems of humanity, its further existence and development have led to the concentration of efforts of the world community on solving sustainable development. Among the significant and most threatening dangers of human civilization are the shortage of natural resources, constant significant losses of human potential and growing risks associated with inequality in the quality of life, distribution of resources, living conditions and development. Future generations are threatened with a decent existence due to a decrease in natural resources and deterioration in the quality of the environment (air, water, land, pollution of habitats, etc.), as well as a decrease in the spiritual and cultural potential of the current generation.

In a world where globalization increases the interdependence between countries and markets, the efficiency of commercial relations of open socio-economic systems becomes a key success factor, allowing the latter to quickly adapt to global trends and challenges. Such a socio-economic system as a region is no exception. The relevance of the study of the regional level of implementation of commercial relations and their impact on sustainable development lies in expanding the rights and powers of regional and local self-government.

The development and practical implementation of conceptual approaches to the formation of mechanisms for ensuring sustainable development requires taking into account the conditions for the successful functioning of a market economy. These conditions are constancy and dynamics. In economic theory, constancy is considered as the ability of a system to maintain its quality in conditions of a changing environment and internal transformations.

Theoretical contributions of this study extend to the domains of systems theory, decision-making under uncertainty, and sustainable development. By integrating fuzzy sets and linguistic variables into the analysis of commercial relations, this research underscores the value of accommodating qualitative assessments and expert judgment in theoretical models. This approach challenges and potentially expands existing theoretical frameworks that predominantly rely on quantitative data, offering a new lens through which complex systems can be understood and analyzed. In environmental studies, this methodological innovation encourages the re-examination of sustainability indicators and their interactions within commercial ecosystems, promoting a more holistic understanding of environmental impact within the context of economic activities. Practically, the findings offer actionable insights for policymakers, business leaders, and regional planners in the Liberec Region and beyond. By identifying strategies that align with expert-defined parameters for sustainable development, stakeholders can make informed decisions that balance economic growth with environmental stewardship and social well-being. This approach is particularly relevant for industries facing the challenge of digital transformation, as it provides a framework for navigating the legal and socio-economic implications of integrating new technologies into existing commercial practices. Furthermore, the application of fuzzy logic to strategic decision-making has broader utility across various sectors, including energy management, where it can help optimize resource allocation in pursuit of sustainability goals.

The interdisciplinary nature of this research opens avenues for exploration in fields beyond law and economic development. In environmental studies, the methodology could be adapted to assess the environmental impact of commercial activities, aiding in the development of strategies that mitigate negative outcomes while promoting economic resilience. By incorporating expert opinions and qualitative data, it offers a nuanced approach to evaluating the trade-offs between development and environmental conservation. In political science, the study's emphasis on the legal and regulatory aspects of commercial relations provides a foundation for analyzing the governance of open systems and their role in sustainable development. It can inform discussions on policy formulation, particularly in relation to global environmental agreements and regional cooperation for sustainable development. The focus on a specific region highlights the importance of localized strategies, offering insights into decentralized governance and the role of regional authorities in shaping sustainable economic policies.

The research methodology involves the use of fuzzy sets and linguistic variables. As a result of using the method, a system was formed for selecting the best strategy for increasing commercial relations of sustainable development in accordance with the parameters established by experts. The study is limited to taking into account the parameters of open systems commercial relations to ensure uninterrupted sustainable development in accordance with the level of key parameters in the context of sustainable development of only one region. In addition, the choice of strategy for increasing the efficiency of open systems commercial relations to ensure the uninterrupted sustainable development was limited to three parameters. Prospects for future research will include expanding the parameters and unifying them.

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