Mon22-268

Environmental risks in implementing a sustainable development model: a scientific and practical approach

*O. Komelina (National University "Yuri Kondratyuk Poltava Polytechnic"), A. Komelina

SUMMARY

Problems of implementation of sustainable development of Ukraine remain extremely important, also the directions and mechanisms of their solution require further development of scientific support. The importance of this problem is increasing in the context of the emergence of cascade and interconnected economic, social, technological risks. The scale and specificity of the risks of enterprises influence the overall dynamics of a country's sustainable development. The article offers an algorithm of carrying out an integral assessment of the goals of sustainable economic development in Ukraine. The role, functionalities of enterprises as innovative ecosystems has been determined, as well as assessment of the contribution to the national model of sustainable development has been approached. The article specifies approach to determination of criteria of formation of indicators of assessment of risks of stable ecological development. The proposed integral assessment of environmental risks allows to determine priorities of practical implementation of innovative technologies, alternative energy sources, environmental protection measures at enterprises. An approach to selecting the direction of transformation of business models of enterprises whose operation is associated with changes in the natural environment is proposed.

Introduction

The problems of implementing the sustainable development model of the countries of the world remain extremely important in the context of the increasing influence of cascade and interrelated risks in the ecological sphere. For Ukraine, which joined the 2030 Agenda for Sustainable Development (UN, 2015), the implementation of such a direction ensures its integration into the European Union. It is important that a number of crises of a global and local nature pose a serious threat to the sustainable ecological development of the country. It is very important to assess the extent and specificity of environmental risks and to establish scientific principles, criteria, and indicators for their assessment. This approach gives the opportunity to substantiate the directions of transformation of business models of enterprises, the functioning of which is connected with changes in the environment.

Method

Methods: system analysis of sustainable development, economic and statistical analysis, economic and mathematical modelling and forecasting, integral assessment, design of business models of enterprises.

Results

The sustainable development model has three main sub-systems: economic, ecological, social. These subsystems are interconnected, and their joint functioning is accompanied by a number of cascading and interrelated risks that determine the specifics of sustainable development of the national economy, the content and nature of the reaction of economic entities to the impact of global challenges (global climate change, the global energy crisis, the impact of geopolitical factors, etc.)
The emergence of additional environmental risks associated with the war in Ukraine significantly complicates the possibilities of sustainable ecological development and is accompanied by large-scale environmental consequences (*The Sustainable Development…, 2022*). In this context, it is important to conduct systematic monitoring and diagnostics of the implementation of the country's sustainable ecological development goals (macro- and mesolevel), as well as to study the response of enterprises to new environmental challenges and crisis phenomena.

Assessment and diagnostics of environmental risks in realization of the model of sustainable development of the enterprise is proposed to conduct according to officially approved ecological goals of sustainable development of Ukraine: Goal 6. Clean water and sanitation; Goal 7. Affordable and clean energy; Goal 11. Sustainable cities and communities; Goal 12. Responsible consumption and production; Goal 13. Climate action; Goal 14. Life below water; Goal 15. Life on land. Such an approach allows to define more clearly the role, functions, and tasks of enterprises as innovative ecosystems (*Fedulova, Marchenko, 2015*), assess and specify the contribution of enterprises to the achievement of the sustainable ecological development goals of the country.

In modern conditions, the enterprise is studied as a complexly structured socio-ecological-economic system. It has its own value propositions, where the interests of various stakeholders regarding the attraction, preservation, use and further development of the environment. The enterprise flexibly responds to changes in the conditions of its operation, global challenges, and crises by creating new values and maintaining competition on the relevant market of goods and services; performs the functions of a focus center for the preservation and reproduction of the environment; is an element of spatial development of territories *(Adner, 2017)*. At the same time, the business model of the enterprise, based on the specifics of its activity, legal and economic basis of functioning, system of relationships in the internal and external environment, acts as a platform for cooperation of all stakeholders, an element of the market of environmental services, and must also provide its own income. In this context, the business entity must design its own business model to ensure reduce

environmental impact, prevent or avoid environmental risks, and evaluate their consequences. Therefore, the assessment of environmental risks in the implementation of the model of sustainable ecological development of the enterprise should take place considering the goals of sustainable development of the country.

Such an approach involves the implementation of three main stages.

The first stage. Integrated assessment of the dynamics of ecological processes and environmental risks in realization of the goals of sustainable development of Ukraine.
To estimate the vector of changes in ecological processes and environmental risks when making managerial decisions regarding the sustainable ecological development of the economy, it is necessary to define an appropriate indicator system. We denote the set of such indicators by X. This set is a combination $X = \bigcup_{i=1}^{n} X_i$ of subsets X_i, which include indicators corresponding to various goals of sustainable ecological development of Ukraine. Sets X_i can be divided into subsets X_{ij}, which include indicators close in content. Then the set X can be written in the form $X = \bigcup_{i=1}^{n}\bigcup_{j=1}^{m_i} X_{ij}$ where m_i is the number of subsets X_{ij} that are included in the set Xi. Denote by X_{ijk} the k-th index in the subset X_{ij}. Then the set X can be written in the form $X = \left\{\left\{\left\{x_{ijk}\right\}_{k=1}^{q_{ij}}\right\}_{j=1}^{m_i}\right\}_{i=1}^{n}$, where q_{ij} is the number of indicators in the subset X_{ij}.

Thus, we can study the dynamics of changes in the indicators of each individual goal and its subgoals, as well as determine their integral indicators.
To study the dynamics of these indicators, we choose a retrospective period of T years. Denote by $x_{ijk(t)}$ the value of the indicator x_{ijk} in the t year of the retrospective period. To identify trends in the dynamics of indicators and predict their future values, we determine the equation of pairwise linear regression

$$x_{ijk(t)} = a_{ijkt} + b_{ijk},$$

where the coefficients a_{ijk} and b_{ijk} are determined from the system of equations

$$\begin{cases} a_{ijk}\sum_{t=1}^{T} t^2 + b_{ijk}\sum_{t=1}^{T} t = \sum_{t=1}^{T} t x_{ijk}(t) \\ a_{ijk}\sum_{t=1}^{T} t + b_{ijk} T = \sum_{t=1}^{T} x_{ijk}(t) \end{cases}.$$

The adequacy of the obtained equation to the initial data is checked by Fisher's criterion. If the adequacy is confirmed, we determine the predicted value of x_{ijk}

$$x_{ijk}(t+\tau) = a_{ijk}(t+\tau) + b_{ijk},$$ where τ - forecasting period.

For each indicator x_{ijk}, it is possible to define such limits x_{ijk}^1 and x_{ijk}^2 that the values of this indicator in the interval $[x_{ijk}^1, x_{ijk}^2]$ are considered acceptable from the point of view of sustainable ecological development. For the nominator indicators it is possible to determine the optimal value x_{ijk}^0 deviation from which is undesirable.

Determine the integral score for each subset x_{ij}. To do this, we use the following algorithm:
1) For each indicator x_{ijk} we define the values x_{ijk}

$$x_{ijk}^{\min} = \min\{\min_t\{x_{ijk}(t)\}, x_{ijk}^0, x_{ijk}^1, x_{ijk}^2, x_{ijk}(t+\tau)\}$$

$$x_{ijk}^{\max} = \max\{\max_t\{x_{ijk}(t)\}, x_{ijk}^0, x_{ijk}^1, x_{ijk}^2, x_{ijk}(t+\tau)\}.$$

2) Normalize x_{ijk} indicators by the formulas

$$y_{ijk}(t) = \frac{x_{ijk}(t) - x_{ijk}^{\min}}{x_{ijk}^{\max} - x_{ijk}^{mim}} \text{ – for stimulants,}$$

$$y_{ijk}(t) = \frac{x_{ijk}^{\max} - x_{ijk}(t)}{x_{ijk}^{\max} - x_{ijk}^{mim}} \text{ – for destimulants,}$$

$$y_{ijk}(t) = 1 - \frac{|x_{ijk}(t) - x_{ijk}^{0}|}{\max\{x_{ijk}^{\max} - x_{ijk}^{0}, x_{ijk}^{0} - x_{ijk}^{mim}\}} \text{ – for nominators.}$$

Define the covariance matrix k_{ij}, whose elements are the covariance coefficients between the normalized indicators y_{ijk}.

3) Determine the maximum eigenvalue λ_{max} of the matrix k and the corresponding eigenvector G_{ij}.

4) Determine the integral estimate W_{ij} for the subset x_{ij} by the formula

$$w_{ij} = \sum_{k=1}^{q_{ij}} \alpha_{ijk} y_{ijk}$$

where the coefficients α_{ijk} are proportional to the squares of the components of the vector G_{ij}.

5) Based on the obtained integral estimates corresponding to the subsets x_{ij}, we determine the integral estimates for the subsets x_i, that is, the integral estimates of the degree of achievement of the goals corresponding to these sets. Such estimates are determined by the formula

$$W_i = \sum_{j=1}^{m_i} \beta_{ij} w_{ij}$$

where the coefficients β_{ij} are proportional to the squares of the components of the eigenvector F_i corresponding to the maximum eigenvalue of the covariance matrix R_i of the integral estimates W_{ij}.

Similarly, based on the integral estimates W_i, we determine the integral estimate W of the environmental component of sustainable ecological development

$$W = \sum_{i=1}^{n} \gamma_i W_i \cdot$$

Thus, the formula for the integrated assessment W of the environmental component of sustainable ecological development is

$$W = \sum_{i=1}^{n} \gamma_i \sum_{j=1}^{m_i} \beta_{ij} \sum_{k=1}^{q_{ij}} \alpha_{ijk} y_{ijk} \cdot$$

Denote by y_{ijk}^{1} and y_{ijk}^{2} the normalized values corresponding to the permissible limits of x_{ijk}^{1} and x_{ijk}^{2}, respectively. Then we can determine the permissible limits for the integral evaluation W

$$W^1 = \sum_{i=1}^{n} \gamma_i \sum_{j=1}^{m_i} \beta_{ij} \sum_{k=1}^{q_{ij}} \alpha_{ijk} y_{ijk}^{1}$$

$$W^2 = \sum_{i=1}^{n} \gamma_i \sum_{j=1}^{m_i} \beta_{ij} \sum_{k=1}^{q_{ij}} \alpha_{ijk} y_{ijk}^{2} \cdot$$

Calculations on the developed method are carried out on the example of Goal 6 of sustainable development of Ukraine «Clean water and sanitation». The significance of this goal is confirmed by the fact that Ukraine is the least provided by its own water resources in Europe, has a significant level of anthropogenic loading on water sources and a lack of sufficient quantity of freshwater, outdated technical and technological composition of treatment facilities and water treatment. The proposed algorithm of integrated assessment of changes in drinking water quality parameters has shown instability of influence of varied factors (Fig. 1).

Second stage. Integrated assessment of the dynamics of environmental risks in the sustainable development of enterprises can be conducted according to the above algorithm. The selected assessment criteria and indicators should consider the relevant specifics of the company's influence on nature, allow to determine their specific contribution to ensuring the sustainable development of regions and Ukraine. For example, the activity of enterprises on the provision of quality of drinking water is connected with the indices of volumes of discharge of polluted (without cleaning and insufficiently purified) sewage in water objects, characteristics of polluting substances, water capacity of the products being produced.

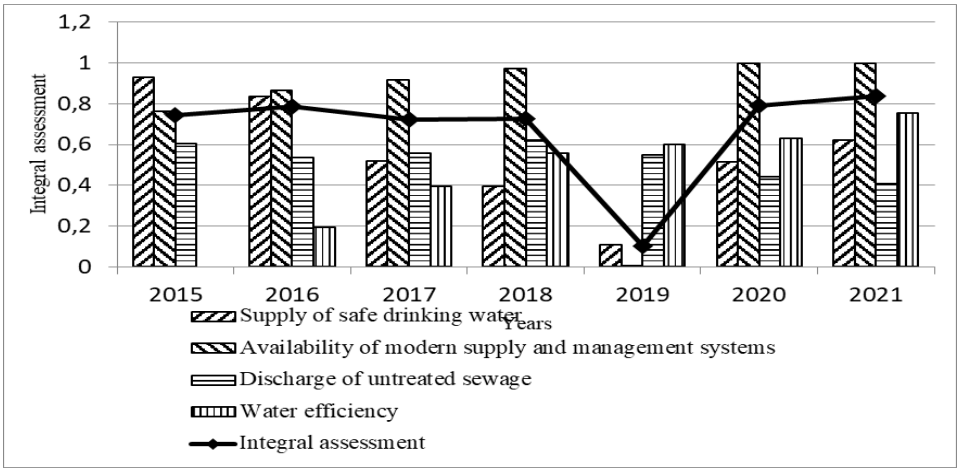

Figure 1 *Dynamics of integrated assessment of drinking water quality in Ukraine, 2015-2021*

The third stage. Creation of integrated management of sustainable development of Ukraine. Management decisions on sustainable ecological development at the level of the country (regulatory, administrative and other) or economic entities should ensure that the integral assessment of W of sustainable ecological development is appropriate to the interval [W^1, W^2] (permissible limits of environmental risks). Accordingly, the nature of the integral assessment of W and its components, their forecasting and modelling, allows to determine the probability of occurrence of environmental risks. This approach can be considered when choosing an investment and innovation project for the environmental protection of enterprises. At the same time, the output of the integral evaluation of W beyond the limits of this interval will determine the degree of risk of the project for the enterprise.

Conclusion

The proposed approach is an important instrument of integrated management of sustainable development, which combines various components (environmental, social, economic, etc.) (1); enables to balance requirements of different enterprises and branches of economy to use natural resources; and at the state level – boundary limits of pollution of nature (2); it allows to determine the effectiveness of mechanisms of ensuring sustainable ecological development (3); it is a tool of determining directions of improvement of business models of sustainable ecological development of enterprises (4).

References

Adner, R. (2017). Ecosystem as Structure: An Actionable Construct for Strategy. *Journal of Management*, 43(1), 39–58. https://doi.org/10.1177/0149206316678451

Fedulova, L., Marchenko, O. (2015). Innovation ecosystems: essence and methodological principles of formation. *Economic theory and law*, № 2, 21-33.

The Sustainable Development Goals Report 2022. (2022). Retrieved from https://dashboards.sdgindex.org/