

Organizational Mechanism for Environmentally Responsible Education of Youth Considering the Values of Sustainable Development and Security Challenges

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ABSTRACT:

The goal of this study is to develop theoretical and applied provisions for the formation of an organizational mechanism for environmentally responsible education of youth, considering the values of sustainable development and security challenges. The study identified the components of the organizational mechanism for environmentally responsible education of youth and clarified the interconnections between them. The environment for forming the organizational mechanism was refined. A system of indicators for monitoring the rationality of the mechanism was developed, and regulatory solutions for its adjustment were proposed. Overall, the authors advanced theoretical and applied provisions for the formation of an organizational mechanism for environmentally responsible education of youth, considering the values of sustainable development and security challenges. Methodological provisions were developed for forming the organizational mechanism for environmentally responsible education of youth, considering the values of sustainable development and security challenges. These provisions are based on a functional-structural scientific approach and, unlike the work of other authors in this area, involve causal parameterization of the organizational mechanism. The proposed methodological provisions for forming the organizational mechanism for environmentally responsible education of youth, considering the values of sustainable development and security challenges, are already being applied in Ukraine within the framework of the project "EcoFortress: Restoring Together." These methodological provisions can also be implemented in any project activity based on environmental responsibility as a behavioral principle of societal development in the 21st century.

Keywords: education, environmental project, environmental responsibility, management, rationality monitoring, security, sustainable development, sustainable education.

1. Introduction

The issue of forming an organizational mechanism for environmentally responsible education of youth in modern conditions is highly relevant due to the growing challenges of sustainable development and security, especially in the context of the events unfolding in Ukraine since 2022. The full-scale war initiated by the Russian Federation has had a significant impact on all spheres of life, including ecology, educational processes, and social stability, requiring a comprehensive approach to educating the younger generation in the spirit of responsibility and resilience.

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According to the Ministry of Environmental Protection and Natural Resources of Ukraine, as of 2023, the damage to Ukraine's environment caused by military actions exceeded 2 trillion UAH. The destruction of infrastructure, pollution of water resources, soil, and air, as well as large-scale fires in forests and industrial facilities, poses a serious challenge to environmental safety. In this context, fostering environmental consciousness among youth becomes a key task, as this generation will form the foundation for the country's recovery and further development after the war.

The Sustainable Development Goals (SDGs) adopted by the UN aim to achieve a balance between economic, environmental, and social components of development. However, the implementation of these goals in Ukraine has been significantly complicated by the war. For instance, SDG #13 "Climate Action" and SDG #15 "Life on Land" have suffered major setbacks as ecosystems were damaged or destroyed by military actions. At the same time, security challenges such as population migration, infrastructure destruction, and increased social tensions highlight the need to educate youth in resilience, responsibility, and adaptability.

Youth plays a key role in addressing these issues as they are capable of adapting to new conditions, applying innovative solutions, and fostering environmentally responsible behavior. However, studies show that only 28% of Ukrainian youth are actively involved in environmental initiatives (according to the Renaissance Foundation). This indicates the need to create systematic organizational mechanisms to foster environmental awareness, integrate sustainable development values into the educational process, and address security challenges.

Special attention must be paid to challenges related to the integration of internally displaced persons (IDPs) and social cohesion. According to the International Organization for Migration, more than 5 million Ukrainians were forced to leave their homes, creating additional pressure on educational and social systems. In these circumstances, educational programs should be used as a tool to unite young people and form shared values aimed at sustainable development and environmental responsibility.

The relevance of studying the organizational mechanism for environmentally responsible education of youth is thus driven by the need to integrate environmental, educational, and social aspects into the country's post-war recovery, preserve natural resources, achieve sustainable development goals, and overcome security challenges. The effectiveness of such mechanisms depends on their ability to address modern challenges and foster sustainable values among the younger generation, which is the foundation of Ukraine's future.

In today's world, the issue of environmentally responsible education for youth is becoming increasingly relevant, particularly in the context of sustainable development and security challenges. In Jansen study, the complexity of integrating sustainable development principles into society was highlighted, emphasizing the need for a comprehensive approach to education and youth engagement [1]. This idea is supported by McCormick et al., who examined the role of educational programs like the Young Masters Program in fostering sustainable development values among youth [2].

Similarly, Müller and Siebenhüner [3], Siebenhüner and Arnold [4] explored organizational tools and learning processes aimed at achieving sustainable development, emphasizing the importance of organizational adaptability to new challenges. Their

approach is complemented by Frank, who examined universities as hubs for fostering environmentally responsible thinking, noting the key role of higher education institutions in shaping environmental consciousness [5]. In a related vein, De Matos and Clegg studied organizational changes aimed at implementing sustainability strategies, emphasizing the importance of innovative thinking [6].

In the Ukrainian context, Kniaz proposed an interconnected approach involving ecological-economic, tourism, and eco-informational systems, which is an important aspect of fostering environmental awareness among youth [7]. Faham et al. utilized system dynamics to develop sustainable development education in higher education institutions, focusing on building students' competencies in sustainability [8]. Wade addressed the challenges and opportunities for regional centers of expertise in education for sustainable development, proposing strategies to overcome barriers [9].

Ericson presented findings on the role of youth initiatives such as the International Indigenous Youth Cooperative in fostering resilience and cultural vitality [10]. Koya analyzed how education can help achieve sustainable development goals and enhance resilience [11]. Ian et al. demonstrated how strategic planning affects adolescents' perceptions of sustainable development [12]. Perez emphasized the importance of environmental education through youth organizational programs, promoting "green" thinking [13].

The results of a long-term study by Ramísio et al. in higher education institutions show that long-term sustainability strategies must be integrated into university policies [14]. Filho et al. identified university leadership as a key element in achieving sustainability [15]. Al-Nuaimi & Al-Ghamdi evaluated students' knowledge, attitudes, and practices regarding sustainability, emphasizing the importance of their engagement [16]. Based on an analysis of the results of moral education of primary, middle and high school students in different regions of Vietnam, Le Khanh & Dang Thi Thanh proposed sustainable solutions for moral education of students in universities [17].

Ukrainian researchers have made significant contributions to the study of sustainable education and environmental responsibility. Shelest et al. identified the role of the achievements of prominent natural scientists in the formation of competencies in academic integrity and scientific research methodology among students of natural sciences in the context of education for sustainable development [18]. The article by Koshkalda et al. reveals the content and feasibility of using world experience in training land managers for the sustainable development of agricultural education in Ukraine [19]. Kniaz and co-authors explored the role of simulation modeling in improving mentorship management and information support [20; 21], these tools can contribute to environmentally responsible education.

Yildiz et al. shown a relationship between human capital and environmental degradation. In particular, high levels of education and wealth in European countries contribute to an increase in the number of environmentally sensitive individuals. This improves environmental quality and is therefore an important factor in reducing environmental impacts [22]. Finally, Kumar emphasized the importance of youth involvement in environmental initiatives that promote a sustainable future [23].

The reviewed sources demonstrate a multifaceted approach to forming an organizational mechanism for environmentally responsible education of youth, which

takes into account modern security challenges and sustainable development priorities.

2. Methods

The purpose of this study is to develop theoretical and applied provisions for forming an organizational mechanism for environmentally responsible education of youth, considering the values of sustainable development and security challenges.

To achieve this goal, several tasks were completed:

- Identifying the components of the organizational mechanism for environmentally responsible education of youth and specifying the interconnections between them;
- Clarifying the environment for forming the organizational mechanism for environmentally responsible education of youth;
- Creating a system of indicators to monitor the rationality of the organizational mechanism for environmentally responsible education of youth;
- Developing regulatory solutions for adjusting the organizational mechanism for environmentally responsible education of youth.

Various methods and scientific approaches were used in the study. The identification of the components of the organizational mechanism and the specification of the interconnections between them involved methods of system analysis, structural-functional modeling, and logical analysis. The clarification of the environment for forming the organizational mechanism was carried out using contextual analysis, comparative methods, and case study analysis. The creation of a system of indicators for monitoring the rationality of the organizational mechanism was based on model-building methods, quantitative analysis, data normalization, and expert evaluation. The development of regulatory solutions for adjusting the organizational mechanism employed forecasting methods, problem-oriented analysis, decision design, and a systems approach.

While the regulatory solutions for adjusting the educational mechanism have been outlined, we recognize that their successful implementation is contingent upon several practical challenges. Specifically, timely updates and adaptations may be hindered under strained resources and fluctuating socio-political contexts. Therefore, developing a clear procedural framework that outlines the steps for applying these solutions in practice is essential. This framework should consider educational institutions' capacity, policymakers' role, and the need for a flexible, adaptive approach. To effectively implement regulatory solutions, it is necessary to develop adaptive strategies that allow for adjustments in educational programs based on changes in resources and the socio-political context. An essential aspect is the creation of monitoring and evaluation mechanisms that enable timely identification of issues and adjustments to the strategy. Additionally, focusing on incremental implementation and resource allocation will help ensure that regulatory solutions can be adapted to different institutional contexts while responsive to the dynamic socio-political environment.

3. Results and Discussion

Based on a critical analysis of scientific works [1–23] and empirical data from the NGO “All-Ukrainian Environmental League,” it has been substantiated that the formation

of an organizational mechanism for environmentally responsible education of youth should be carried out using a functional-structural approach. This approach ensures clear interaction between its components, contributing to the achievement of sustainable development goals. It allows for defining the functions of each component of the mechanism as well as their structural integration to effectively address the challenges of education under modern environmental and security conditions.

The functional-structural approach enables the creation of a flexible, integrated, and adaptive system that meets the needs of both local communities and national initiatives. Table 1 highlights the components of the organizational mechanism for environmentally responsible education of youth based on the application of the functional-structural approach.

Table 1: Components of the Organizational Mechanism for Environmentally Responsible Youth Education

Component	Description
Target Component (TC) Formulating tasks considering global sustainable development goals and contemporary challenges, including security aspects related to ecological disasters, war, and climate change	Defining the main goal: fostering environmental consciousness, responsible use of natural resources, and integrating sustainable development principles into personal and societal values
Functional Component (FC) Implementing coordination and management mechanisms for fostering environmental responsibility among youth. Integrating monitoring, education, awareness, and engagement functions into a unified system of educational activities	Ensuring the sequence of environmental education processes at the level of educational institutions, non-governmental organizations, and local governments
Organizational-Structural Component (OSC) Distributing roles and responsibilities among key stakeholders in education to ensure coherence and efficiency. Establishing local and regional environmental education centers for coordinating efforts and disseminating best practices	Forming an institutional structure that includes government agencies, educational institutions, non-governmental organizations, and businesses
Content Component (CCI) Incorporating security challenges into curricula, including aspects of environmental risks, adaptation to climate change, and resilience during crises. Using an interdisciplinary approach to provide comprehensive education covering ecology, economics, social sciences, and security	Integrating environmental knowledge, skills, and sustainable development values into educational programs, additional courses, and extracurricular activities
Motivational Component (MC) Introducing an incentive system (grants, scholarships, public recognition) for youth actively involved in environmental programs. Using social influence by supporting opinion leaders and youth environmental activists	Developing personal motivation for environmentally responsible behavior through participation in volunteer initiatives, competitions, and environmental projects
Communication Component (CC2) Using digital platforms, social networks, and media to promote environmental responsibility and spread sustainable development values. Creating a partnership network for experience sharing and joint project implementation	Developing effective interaction channels between educational institutions, the public, and youth
Normative-Legal Component (NLC) Implementing national standards and recommendations	Developing a legislative framework regulating environmental education

for environmental education in response to contemporary challenges. Adapting international practices to national conditions, considering specific security challenges	processes and ensuring their integration into the education system
Resource Component (RC) Utilizing the material and technical base of educational institutions for implementing educational initiatives. Developing and implementing digital and informational resources to support environmental education	Providing financial support for environmental education programs through state, private, and international funding
Evaluation-Correction Component (ECC) Analyzing feedback from participants in the educational process to adjust approaches and methods. Developing an indicator system to assess the sustainability and long-term outcomes of environmental education	Monitoring the effectiveness of environmental education programs through quantitative and qualitative indicators

Source: created by the authors based on State Statistics Service of Ukraine (n.d.), Global Gender Gap Report (2024).

The interconnections between the components of the organizational mechanism for environmentally responsible education of youth form a cohesive system that ensures the effective achievement of its goals (Fig. 1).

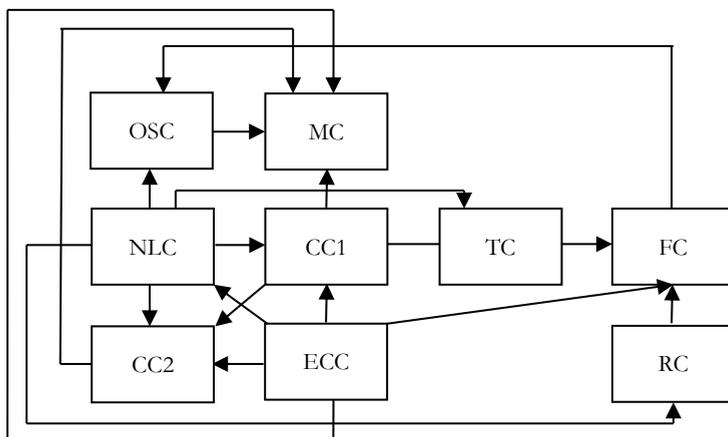


Figure 1: Interconnections between the components of the organizational mechanism for environmentally responsible education of youth

Source: created by the authors.

The target component defines the main direction of work by setting goals and objectives that influence all other components. Without a clear articulation of the mechanism's goals, the activities of other components lose coordination and purpose.

The functional component ensures the implementation of the set goals through the development of processes, management, and coordination of activities. It integrates functions such as monitoring, education, awareness-raising, and engagement, enabling the effective fulfillment of tasks defined by the target component. This component is closely linked to the organizational-structural component, as it provides a clear distribution of roles and responsibilities among stakeholders involved in the educational process, such as

government agencies, educational institutions, non-governmental organizations, and businesses.

The content component determines how the mechanism's tasks are carried out. It integrates environmental knowledge, skills, and values into educational programs and supplementary activities, taking into account the objectives defined by the target component and implemented through the processes outlined by the functional component. Additionally, the content component considers security challenges, which form an essential part of educational programs, ensuring alignment with the normative-legal component.

The motivational component fosters youth participation in environmental initiatives by stimulating personal interest and supporting active participants. Its effectiveness depends on the quality of the content component, which ensures youth are informed and educated, and on the organizational-structural component, which provides the conditions for implementing motivational programs.

The communication component establishes connections between all participants in the mechanism through the development of interaction channels, the use of digital platforms, and the formation of partnerships. It disseminates the values developed by the content component and enhances the motivational component by popularizing environmental responsibility within society. Its effectiveness directly depends on the normative-legal component, which creates the framework conditions for communication.

The normative-legal component ensures the legitimacy and standardization of processes within the mechanism by establishing the rules of engagement for all participants. It supports the organizational-structural component by providing its legal foundation and facilitates the implementation of the content and functional components by setting standards for educational programs and activities.

The resource component provides financial, material, and informational support for the functioning of all other components. Its connection with the functional component lies in forming the resource base for accomplishing tasks, while its connection with the normative-legal component ensures the rules for resource allocation are established.

Finally, the evaluation and corrective component provides feedback and improves the mechanism's operation. Its interaction with the functional component involves monitoring task implementation, with the content component in enhancing educational programs, and with the motivational component in creating an effective system of incentives. It also interacts with the communication component by analyzing the effectiveness of informational campaigns and with the normative-legal component by adjusting regulations based on obtained results.

Thus, all components of the organizational mechanism are closely interconnected, forming an integrated system that ensures sustainable and effective environmentally responsible education of youth, taking into account the values of sustainable development and security challenges.

Research findings emphasize that environmentally responsible education for youth must be implemented in both educational and project settings while addressing the values of sustainable development and security challenges. This approach ensures the seamless integration of theory and practice in preparing a new generation of environmentally conscious specialists. However, it is essential to note that the unique

Ukrainian context, shaped by wartime dynamics and the nation's specific educational infrastructure, adds a distinctive layer to this study. The situation in Ukraine, with the ongoing Russian-Ukrainian war, underscores the social implications of war education, making the findings highly context-dependent. Therefore, the generalizability of these conclusions to other regions or settings without similar conditions may be limited.

According to the Ministry of Environmental Protection and Natural Resources of Ukraine, as of 2023, 600,000 hectares of forests have been damaged or completely destroyed. In response to these challenges, a number of successful environmental projects are being implemented in Ukraine, such as "Green Recovery of Ukrainian Communities," "Underground Waste Bins in Vinnytsia," and "Separate Waste Collection in Vyshgorod," which contribute to sustainable development and the adoption of innovative ecotechnologies.

The project "EcoFortress: Restoring Together" is a notable example of such integration, combining theoretical training in ecological economics, restorative biology, geoengineering, and natural resource management with practical activities. For example, it includes the planned cleanup of 150 hectares of polluted areas, the restoration of more than 30 water bodies, and the reclamation of 50 hectares of land contaminated by military actions. Students' participation in field studies not only solidifies theoretical knowledge but also develops practical skills needed to address the consequences of ecological disasters.

Educational institutions involved in the project provide the necessary theoretical foundation. The curricula now include 12 new courses on ecosystem restoration and ecotechnology implementation. The project environment fosters practical application of this knowledge. For instance, within "EcoFortress: Restoring Together," over 75% of participating students have mastered modern methods of cleaning water bodies and soils, as evidenced by their contributions to restoring natural landscapes in post-conflict regions.

In modern Ukraine, which faces large-scale environmental consequences of military actions, such initiatives are critically important. In 2023 alone, public awareness of environmental protection issues increased by 25% compared to 2021 (data from a sociological survey by the Ukrainian Institute for the Future). The results of the "EcoFortress: Restoring Together" project, such as the cleanup of water resources and restoration of forest areas in affected regions, demonstrate the synergy between educational and project approaches. This confirms that education in both academic and project environments is the optimal path toward achieving sustainable development goals, enhancing security, and restoring natural balance in Ukraine.

The research also highlights that project activities require ongoing monitoring to promptly identify the need for corrective decisions. A system of indicators for monitoring the rationality of the organizational mechanism for environmentally responsible education of youth has been developed, focusing on various evaluation aspects. It includes four key groups of indicators: informative, flexible, adaptive, and integrated, enabling comprehensive analysis of the mechanism's effectiveness.

The use of quantitative metrics, such as the percentage of updated courses, the number of implemented projects, or the level of youth awareness, minimizes subjectivity in evaluation and provides objective results. A notable advantage of the system is the

application of an integrated efficiency index, which consolidates all indicators into a single numerical metric, allowing for an overall assessment of the mechanism's state.

Weight coefficients for each indicator add flexibility to the system, enabling adjustments based on changing priorities or external conditions. This is especially important in dynamic environments where influencing factors can shift rapidly. Emphasis is placed on reducing subjectivity through automated data collection and normalization of indicators. For example, comparisons with maximum values or baseline standards avoid discrepancies and improve accuracy.

The system incorporates multi-channel data collection, such as survey results, project reports, and automated platforms, ensuring reliability and representativeness of the findings. Below is a formalized representation of the constructed system of indicators:

In general, the system of indicators is defined as a set of functions:

$$S = \{I_1, I_2, \dots, I_k\}, \quad (1)$$

where I_k is a function characterizing a specific indicator.

We assume that each function depends on: a set of input data (X); time variables (T); weighting coefficients (W) and additional parameters considering the specifics of the indicator (P).

The proposed classification of indicators can be structured as follows:

1. Informative Indicators. These indicators most accurately reflect the essence of a process or phenomenon. They include:

1.1. Awareness Level of Youth on Sustainable Development Values:

$$I_1 = \frac{\sum_{i=1}^n S_i \cdot W_i}{\sum_{i=1}^n W_i}, \quad (2)$$

where S_i – average test score in the group;

W_i – weight of the group based on its importance or size.

1.2. Number of Implemented Environmental Initiatives:

$$I_2 = \sum_{j=1}^m P_j, \quad (3)$$

where P_j – number of projects in categories (educational, community, business initiatives).

2. Flexible Indicators. These are dynamic indicators that adapt to changes in the external or internal environment, ensuring a timely assessment of the state of an object or process. Examples include:

2.1. Adaptation Level of Educational Programs:

$$I_3 = \frac{N_o}{N_{tot}} \times 100\%, \quad (4)$$

where N_o – number of updated courses;

N_{tot} – total number of courses.

2.2. Response Speed to New Challenges:

$$I_4 = I / T_r, \quad (5)$$

where T_r – time between identifying a challenge and implementing updates.

3. Adaptive Indicators. These indicators can automatically or semi-automatically adjust their characteristics or evaluation criteria depending on external conditions or internal system parameters. Examples include:

3.1. Youth Engagement in New Project Activities:

$$I_5 = N_u / N_t \times 100\%, \quad (6)$$

where N_u – number of students participating in new initiatives;
 N_t – total number of project initiatives.

3.2. Introduction of Innovative Technologies:

$$I_6 = \frac{N_{tech}}{N_{pr}} \times 100\%, \quad (7)$$

where N_{tech} – number of implemented technologies;
 N_{pr} – number of analyzed projects.

4. Integrated Indicators

4.1. Institutional Collaboration Indicator:

$$I_7 = \frac{N_{coll}}{N_{tot.coop}} \times 100\%, \quad (8)$$

where N_{coll} – number of joint projects;
 $N_{tot.coop}$ – total number of cooperative institutions.

4.2. International Participation in Program Implementation:

$$I_8 = \frac{N_{memb}}{N_{ttl}} \times 100\%, \quad (9)$$

where N_{memb} – number of participants in international projects;
 N_{ttl} – total number of international projects.

Overall Efficiency Index

To evaluate the system's efficiency, an integrated efficiency index is introduced:

$$I_e = \sum_{k=1}^k W_k \times I_k, \quad (10)$$

where I_k – value of each indicator;

W_k – weighting coefficient representing the importance of the indicator I_k in the overall framework.

The weighting coefficients and indicator parameters are updated annually based on analysis results using a regulatory review mechanism:

$$W_k^n = f(W_k^{pr}, R_k), \quad (11)$$

where R_k – actual impact of the indicator from the previous period, determined through expert evaluation.

To reduce subjectivity, data collection for the system is automated through digital platforms, with normalization and comparison against baseline values applied:

$$I_k^{norm} = \frac{I_k}{I_k^{max}}, \quad (12)$$

This mathematical model ensures the objectivity, accuracy, and adaptability of the monitoring system, enabling efficient assessment of the organizational mechanism's rationality.

It should be acknowledged that this system has certain limitations. It requires a well-established data collection mechanism, which may be challenging to implement in conditions of insufficient technical infrastructure or limited resources. Additionally, weight coefficients can become a source of subjectivity if they are not determined based on a transparent and well-justified methodology. While regular reviews of these coefficients are a positive aspect, they require expert involvement and additional resources.

Overall, the proposed system is sufficiently informative, flexible, and adaptive, enabling effective monitoring of the organizational mechanism. Its integrative nature ensures consistency between different groups of indicators and helps build a

comprehensive understanding of the effectiveness of youth education in the context of sustainable development and security challenges. However, its effectiveness will largely depend on the implementation of high-quality monitoring infrastructure and continuous methodological improvements.

The need to make regulatory decisions based on the proposed system of indicators arises from the complexity and multifaceted nature of the organizational mechanism for environmentally responsible education of youth. The indicator system allows for identifying problematic aspects of the mechanism's functioning, analyzing their impact on overall effectiveness, and promptly proposing corrective actions. Through quantitative and qualitative indicators based on objective data, subjectivity in management can be minimized, and efforts can be more effectively directed toward addressing specific deficiencies.

Table 2 presents regulatory decisions for adjusting the organizational mechanism for environmentally responsible education of youth, taking into account the values of sustainable development and security challenges.

One of the key issues identified in the system is the insufficient level of youth awareness about the values of sustainable development. This creates risks of low youth engagement in environmental initiatives and weak integration of environmental consciousness into their behavior. Proposed solutions, such as updating educational programs, organizing informational campaigns, and implementing practical tasks, aim to enhance theoretical and practical knowledge. This will help foster sustainable awareness among young people about the importance of sustainable development and encourage their active participation in relevant projects.

Table 2: Regulatory Decisions for Adjusting the Organizational Mechanism

Problem	Solution
Insufficient youth awareness of sustainable development values	<ol style="list-style-type: none"> 1. Updating educational programs: integrating courses on sustainable development, eco-technologies, and environmental management into mandatory curricula. 2. Conducting informational campaigns: organizing interactive seminars, workshops, and online courses. 3. Implementing practical tasks: enabling students to carry out their own mini-projects in the field of ecology.
Delays in adapting the mechanism to new environmental challenges	<ol style="list-style-type: none"> 1. Establishing rapid response teams: forming groups to quickly analyze new challenges. 2. Regularly updating educational programs: setting a schedule for course content reviews. 3. Developing crisis scenarios: creating ready-to-implement solutions for rapid adaptation to emergencies.
Low youth engagement in new forms of project activities	<ol style="list-style-type: none"> 1. Integrating innovative technologies: using digital tools to engage youth. 2. Financial support for student initiatives: providing grants and scholarships for implementing ecological projects. 3. Expanding international exchanges: involving students in international programs.
Insufficient collaboration between educational institutions, businesses, and NGOs	<ol style="list-style-type: none"> 1. Establishing public-private partnerships: mechanisms for co-financing projects. 2. Organizing joint cooperation platforms: online platforms for coordinating efforts.

	3. Hosting cross-sectoral conferences: facilitating experience sharing across different sectors.
Low overall effectiveness of the mechanism due to uneven development of components	<ol style="list-style-type: none"> 1. Prioritized funding for weaker components: reallocating resources. 2. Creating a centralized monitoring system: using digital dashboards to track results. 3. Introducing incentives for achieving target indicators: implementing KPIs with appropriate rewards.

Source: created by the authors.

Another important issue is delays in adapting the mechanism to new environmental challenges. In today's dynamic environment, the ability to respond quickly to environmental and security challenges is critical. Solutions such as creating rapid response task forces, regularly updating educational programs, and developing crisis scenarios are designed to ensure the mechanism's flexibility and adaptability. This will enable timely consideration of new threats and the integration of appropriate measures into the educational process.

The next issue concerns the low level of youth engagement in new forms of project activities, which limits the impact of educational and project environments on fostering environmental responsibility. Integrating innovative technologies, providing financial support for student initiatives, and expanding international exchanges can motivate youth to participate in projects. Such measures promote increased youth activity and the development of practical skills necessary to address environmental issues.

The fourth group of issues relates to insufficient collaboration between educational institutions, businesses, and non-governmental organizations. This slows down the implementation of environmental initiatives and limits resource mobilization opportunities. Establishing public-private partnerships, creating joint cooperation platforms, and hosting cross-sectoral conferences will facilitate better coordination of efforts among different stakeholders. As a result, this will allow for optimal resource utilization and scalability of project implementation.

The final issue concerns the low overall effectiveness of the mechanism due to the uneven development of its components. Proposed solutions, such as prioritizing funding for weaker components, creating a centralized monitoring system, and introducing KPIs, are aimed at balancing the development of all parts of the mechanism. This will enable more effective achievement of goals while considering the specifics of each direction.

Thus, the proposed regulatory decisions not only address the identified issues but also create conditions for the continuous improvement of the organizational mechanism. This will contribute to more effective fostering of environmentally responsible thinking among youth, in line with the challenges of sustainable development and modern security conditions.

The proposed system of indicators for monitoring the effectiveness of the organizational mechanism for environmentally responsible youth education, along with a set of regulatory decisions, is examined using empirical data from the project "EcoFortress: Restoring Together." The indicators were calculated from 2022 to 2024 to assess the project's impact on these indicators. To strengthen the findings, a longitudinal

study will be conducted to track behavioral changes in youth over time, providing insights into the long-term effects of the educational interventions.

The chart illustrating the dynamics of eight indicators (I1–I8) over 2022–2024 (see Fig. 2) shows a clear trend of improvement in key aspects of environmentally responsible youth education. Indicator I1 (level of youth awareness about the values of sustainable development) increased from 80.0 in 2022 to 85.6 in 2024, demonstrating the effectiveness of educational efforts and youth awareness campaigns. This growth is particularly significant, as awareness is the foundation for fostering environmental consciousness.

The selection of these specific indicators – awareness, behavioral changes, and attitudes towards sustainability – was based on their direct relevance to the project's core goals. These indicators are critical for understanding the immediate impact of educational activities and their potential for long-term influence on youth behavior. The study aims to provide a precise, data-supported evaluation of the effectiveness of educational interventions by focusing on these measurable aspects.

A similar positive trend is observed in Indicator I2 (number of implemented environmental initiatives), which increased from 6 in 2022 to 12 in 2024. This highlights increased activity in environmental projects, particularly in the areas of community, educational, and business initiatives. Such growth underscores the strengthening of the practical component of environmental education, resulting in tangible outcomes in the form of new initiatives.

Indicator I3 (level of adaptation of educational programs) also shows substantial improvement, rising from 30.0% in 2022 to 50.0% in 2024. This reflects the updating of educational courses in response to current environmental challenges, demonstrating the flexibility of the educational system.

At the same time, Indicator I4 (response speed to new challenges) showed a reduction in response time from 30 to 15 days over the same period, which is an important measure of the adaptability of the management system.

Indicator I5 (youth engagement in new forms of project activities) grew from 240.0% in 2022 to 400.0% in 2024, indicating significant success in motivating youth for active participation. Such high growth levels confirm that innovative approaches to working with youth have a significant impact.

Indicator I6 (implementation of innovative technologies) also increased from 20.0% to 40.0%, highlighting the growing role of technology in addressing environmental issues.

The dynamics of indicators for institutional collaboration (I7) and international participation (I8) show significant improvement: I7 increased from 20.0% to 40.0%, and I8 from 10.0% to 30.0%. This demonstrates the expansion of interactions between institutions and the engagement of international partners, which are key factors in improving the quality and effectiveness of environmental education.

At the same time, the initially low level of collaboration between educational institutions, businesses, and NGOs highlights the complexity of cross-sectoral engagement in the Ukrainian context. However, the initially low level of cooperation between educational institutions, businesses, and NGOs reveals persistent systemic barriers that require further attention. Among the key obstacles are a lack of mutual trust, insufficient understanding of the benefits of cooperation, limited experience in cross-sectoral project implementation, bureaucratic rigidity, and competition for limited resources and visibility. Moreover, the absence of established communication channels and coordination

platforms hinders the ability to effectively align efforts and share responsibilities. While positive trends are observed, further development in this area requires a deeper understanding of the existing barriers – such as limited trust, misaligned priorities, and a lack of sustained communication platforms. Addressing these challenges calls for deliberate trust-building strategies, creating shared incentives, and institutionalizing regular dialogue mechanisms. Enhancing such collaboration is crucial for the long-term success of joint environmental initiatives and for fostering a resilient ecosystem of actors committed to sustainable development goals.

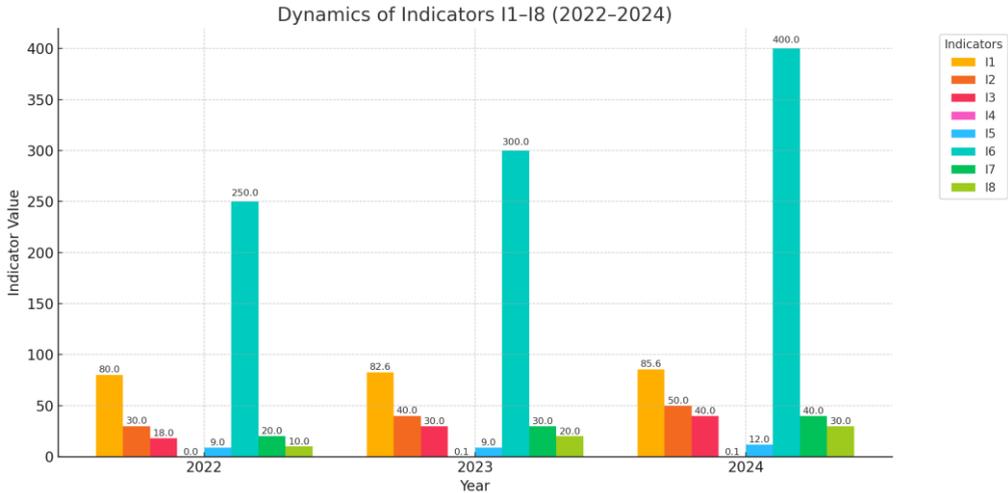


Figure 2: Dynamics of Indicators Reflecting the Rationality of the Organizational Mechanism for Environmentally Responsible Youth Education for the Period 2022–2024

Source: created by the authors.

All eight indicators demonstrate steady growth, indicating the effectiveness of implementing the organizational mechanism for environmentally responsible youth education. The positive dynamics of these indicators highlight that the measures taken not only address current challenges but also lay the foundation for sustainable development in the future.

The chart of normalized indicators and the integrated efficiency index (see Fig. 3) shows positive year-on-year dynamics, demonstrating improvements in the organizational mechanism for environmentally responsible youth education. Notably, Indicator I1 (level of youth awareness) gradually increased from 0.800 in 2022 to 0.856 in 2024, confirming the success of educational initiatives aimed at promoting sustainable development. Similarly, Indicator I3 (level of adaptation of educational programs) rose from 0.3 in 2022 to 0.5 in 2024, reflecting significant updates to educational materials and their improved alignment with contemporary challenges.

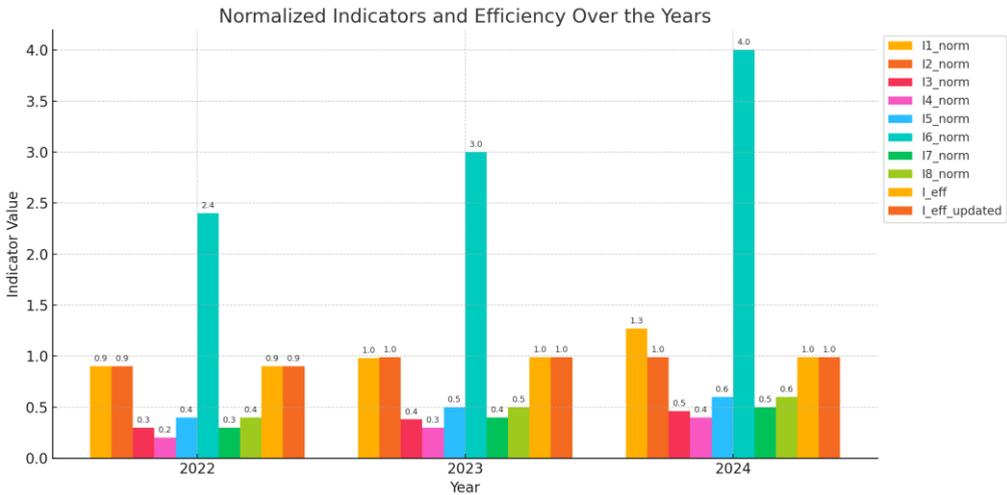


Figure 3: Dynamics of Normalized Indicators and the Integrated Efficiency Index for the Period 2022–2024
Source: created by the authors.

Indicator I5 (youth engagement in new forms of project activities) showed significant growth, increasing from 2.4 in 2022 to 4.0 in 2024. This can be attributed to intensified efforts in youth initiatives and the adoption of more innovative approaches. At the same time, Indicator I8 (international participation in programs) tripled, rising from 0.2 to 0.6 during the 2022–2024 period, reflecting the expansion of international cooperation and the involvement of foreign partners in joint projects.

The updated integrated efficiency index, which incorporates new weight coefficients, increased from 0.778 in 2022 to 1.267 in 2024. This demonstrates that the cumulative impact of different aspects of the mechanism is growing, and the weight coefficients have become better adapted to current realities, as they reflect the actual influence of the indicators. For instance, the increased weight of Indicators I1 and I3 to 0.1818 and 0.2020, respectively, underscores their importance in the overall evaluation.

A comprehensive assessment using normalization and updated weight coefficients allows for an objective tracking of progress in implementing environmentally responsible youth education under the influence of the “EcoFortress: Restoring Together” project while identifying key areas for further improvement.

The chart illustrating the values of weight coefficients for each year (see Fig. 4) depicts the evolution of priorities in the indicator evaluation system for environmentally responsible youth education. In 2022, weight coefficients were evenly distributed; for example, I1 (youth awareness level) had a weight of 0.2, while I3 (level of adaptation of educational programs) also held a significant weight of 0.2, highlighting the importance of these indicators in the initial system.

In 2023, the process of adapting weight coefficients to the actual impact of the indicators began. For instance, the weight coefficient for I1 was reduced to 0.181, possibly reflecting a consistently high level of awareness, while the weight coefficient for I5 (youth engagement) increased to 0.181, indicating greater emphasis on youth activity in projects.

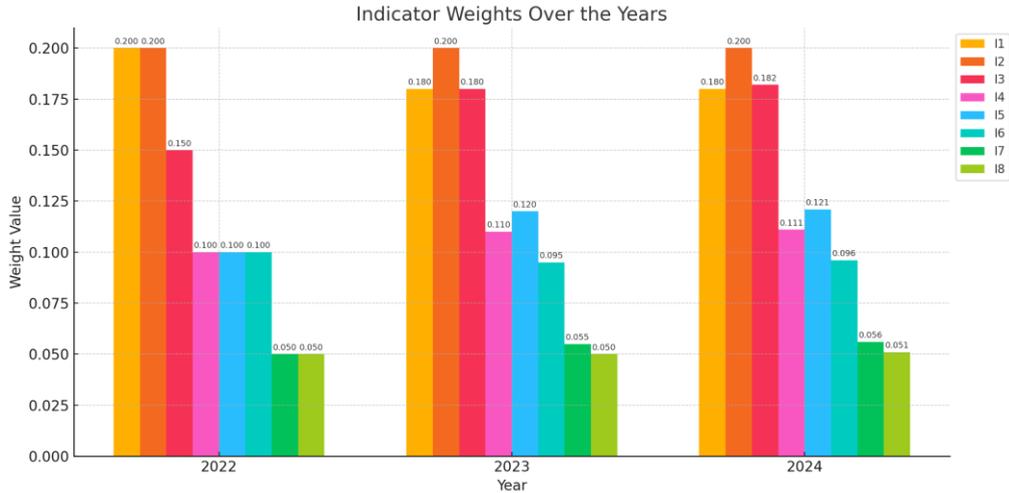


Figure 4: Dynamics of Weight Coefficient Values for the Period 2022–2024
Source: created by the authors.

In 2024, weight coefficients were finally adjusted to reflect the current impact of each indicator. Notably, the weight coefficient for I3 remained the highest (0.202), emphasizing its critical role in ensuring the rationality of the mechanism through the updating of educational programs. Conversely, the weight coefficients for I7 (institutional collaboration) and I8 (international participation) remained the lowest – 0.050 and 0.055, respectively – indicating their importance but secondary role in the overall evaluation system.

The chart shows that the process of regularly revising weight coefficients allows the evaluation system to adapt to environmental changes and the actual impact of each indicator. For example, the increased weights for indicators reflecting youth engagement (I5) and adaptation of educational programs (I3) highlight a strategic focus on these areas, while the reduced weight of some stable indicators, such as I1, optimizes the distribution of priorities. This indicates that the system is not only flexible but also effective in identifying key growth areas.

Based on the obtained results, the following conclusions were drawn regarding the regulations of the organizational mechanism. The analysis of indicator dynamics (I1–I8) for 2022–2024, changes in weight coefficients, and normalized values highlights the need for systematic regulation of the organizational mechanism, which should focus on the following areas:

- Improvement of educational programs and awareness efforts. The data indicate an insufficient level of youth awareness (I1 increased only from 80.0 in 2022 to 85.6 in 2024). This underscores the need for implementing interactive activities such as seminars, workshops, and updated educational courses incorporating sustainable development, eco-technologies, and environmental management. Additionally, introducing practical tasks, such as student mini-projects, will enable youth to better absorb knowledge.

- Enhancing adaptability to environmental challenges. Although response speed (I4) improved from 0.033 in 2022 to 0.066 in 2024, further progress is needed. It is

recommended to establish rapid response task forces and update educational programs regularly (e.g., every two years). Moreover, developing crisis scenarios for quick adaptation to emergencies will enhance the mechanism's effectiveness.

- Encouraging youth participation in project activities. Despite significant growth in I5 (youth engagement) from 240.0% in 2022 to 400.0% in 2024, there is potential for further expansion. Integrating modern digital tools, such as simulations or online collaboration platforms, can boost engagement. Additional measures, such as grants for student initiatives and participation in international programs, will provide motivation and new opportunities.

- Strengthening cross-sector collaboration. Indicators of collaboration (I7) and international participation (I8) remain low (20.0% and 10.0% in 2022, 40.0% and 30.0% in 2024). This highlights the need to establish public-private partnerships and organize cross-sectoral conferences to coordinate efforts. Creating joint online platforms can facilitate communication between institutions, businesses, and non-governmental organizations.

- Enhancing the overall effectiveness of the mechanism. The growth of the integrated efficiency index (Ie) from 0.778 in 2022 to 1.267 in 2024 is a positive signal, but the uneven development of individual components remains a challenge. Prioritizing funding for weaker components, such as I7 and I8, along with implementing digital monitoring systems, will help ensure balance. Additionally, introducing key performance indicators (KPIs) for students, educators, and project managers will incentivize the achievement of target outcomes.

The regulation of the organizational mechanism is critical for improving its effectiveness. This requires the implementation of modern educational approaches, stimulating youth engagement, strengthening cross-sectoral collaboration, and adapting to external challenges. Continuous monitoring of indicators and regular updates to weight coefficients will ensure the system remains effective and responsive to real-world conditions.

4. Implications and further research

1. The organizational mechanism for environmentally responsible education of youth, considering the values of sustainable development and security challenges, is a cohesive system in which each component performs a clearly defined function, complementing the others. The close interaction between the target, functional, organizational-structural, content, motivational, communication, normative-legal, resource, and evaluation-correction components ensures the effectiveness of achieving educational goals in today's complex conditions. Through its integration and flexibility, this mechanism promotes the formation of environmentally responsible behavior among youth, addressing current challenges and contributing to a sustainable and secure future.

2. Environmentally responsible education of youth, considering the values of sustainable development and security challenges, is an important tool for preparing a new generation of conscious professionals capable of addressing contemporary environmental issues. The integration of educational and project environments, as implemented in the "EcoFortress: Restoring Together" project, ensures the combination of theoretical

knowledge with practical skills, fostering responsible civic consciousness. This approach allows for achieving sustainable development goals, enhancing safety, and restoring natural balance, which is critically important for Ukraine's recovery following military actions.

3. The proposed system of indicators provides a comprehensive approach to monitoring the rationality of the organizational mechanism for environmentally responsible education of youth, combining informativeness, flexibility, adaptability, and integration. The use of quantitative metrics, data normalization, and automated information collection minimizes subjectivity and facilitates obtaining objective results that reflect the actual state of the mechanism. The integrated efficiency index enables the evaluation of the overall effectiveness of the mechanism while remaining flexible enough to adapt to changing conditions and priorities.

4. The proposed system of indicators helps identify key issues in the functioning of the organizational mechanism for environmentally responsible education of youth, ensuring an objective approach to their analysis. Based on the obtained data, regulatory decisions have been formulated to address identified shortcomings and enhance the mechanism's flexibility, adaptability, and integration. Implementing these decisions will contribute to more effectively achieving sustainable development goals, strengthening environmental consciousness among youth, and preparing them to meet modern security challenges.

Further research should focus on developing practical tools for integrating environmentally responsible education into the processes of environmental and security recovery in Ukraine. Special attention should be given to studying effective approaches for engaging youth in ecosystem restoration, cleaning up polluted areas, and creating resilient local communities that address the contemporary challenges of war and climate change.

References

1. Jansen, L. (2003). The challenge of sustainable development. *Journal of Cleaner Production*, 11, 231–245. [https://doi.org/10.1016/S0959-6526\(02\)00073-2](https://doi.org/10.1016/S0959-6526(02)00073-2)
2. McCormick, K., Mühlhäuser, E., Nordén, B., Hansson, L., Foung, C., Arnfalk, P., Karlsson, M., & Pigretti Öman, D. (2005). Education for sustainable development and the young masters program. *Journal of Cleaner Production*, 13(11–12), 1107–1112. <https://doi.org/10.1016/j.jclepro.2004.12.007>
3. Müller, M. & Siebenhüner, B. (2007). Policy instruments for sustainability-oriented organizational learning. *Business Strategy and the Environment*, 16(3), 232–245. <https://doi.org/10.1002/bse.481>
4. Siebenhüner, B. & Arnold, M. (2007). Organizational learning to manage sustainable development. *Business Strategy and the Environment*, 16(5), 339–353. <https://doi.org/10.1002/bse.579>
5. Frank, H. (2011). Sustainability school: the role of universities. *Toxicological & Environmental Chemistry*, 93, 841–843. <https://doi.org/10.1080/02772248.2011.582673>
6. De Matos, J., & Clegg, S. (2013). Sustainability and organizational change. *Journal of Change Management*, 13(4), 382–386. <https://doi.org/10.1080/14697017.2013.851912>
7. Kniaz, S. V. (2015). The essence of ecological-economic, tourism, and eco-informational systems and the interconnections between them. *Actual Problems of Economics*, 9, 280–285. URL: http://nbuv.gov.ua/UJRN/ape_2015_9_37
8. Faham, E., Rezvanfar, A., Mohammadi, S., & Nohooji, M. (2017). Using system dynamics to develop education for sustainable development in higher education with the emphasis on the sustainability competencies of students. *Technological Forecasting and Social Change*, 123, 307–326. <https://doi.org/10.1016/j.TECHFORE.2016.03.023>

9. Wade, R. (2016). Education for sustainability-challenges and opportunities: the case of RCEs (regional centres of expertise in education for sustainable development). *Management in Education*, 30(3), 131–136. <https://doi.org/10.1177/0892020616656292>
10. Ericson, M. (2016). International indigenous youth cooperative (IYCY): youth, cultural sustainability, resilience, and survivance. *Journal of American Indian Education*, 55(3), 111–133. <https://doi.org/10.5749/JAMERINDIEDUC.55.3.0111>
11. Koya, C. (2018). Sustainability and resilience: can education deliver? Thematic Issues Paper 19–23 February 2018 Suva, Fiji. URL: <https://keithlewin.net/wp-content/uploads/2021/03/Sustainability-and-Resilience-Commonwealth-Ministers-Thematic-Paper-CCEM20.pdf>
12. Ian, C., John, R., Suzy, U., David, G., Graham, D., Bobby, C., Aman, M., ... & James, G. I. (2019). Education for sustainable development: a study in adolescent perception changes towards sustainability following a strategic planning-based intervention. *Sustainability*, 11(20), 5817. <https://doi.org/10.3390/su11205817>
13. Perez, R. (2019). Promoting a greener curriculum through environmental youth organizational program: A Policy Evaluation. *Environmental Science, Education*. URL: <https://eric.ed.gov/?id=ED602043>
14. Ramísio, P. J., Pinto, L. M., Gouveia, N., Costa, H., & Arezes, D. (2019). Sustainability strategy in higher education institutions: lessons learned from a nine-year case study. *Journal of Cleaner Production*, 222, 300–309. <https://doi.org/10.1016/j.jclepro.2019.02.257>
15. Filho, L., Eustachio, J., Caldana, A., Will, M., Lange Salvia, A., Rampasso, I. S., Anholon, R., ... & Kovaleva, M. (2020). Sustainability Leadership in Higher Education Institutions: An Overview of Challenges. *Sustainability*, 12(9), 3761. <https://doi.org/10.3390/su12093761>
16. Al-Nuaimi, S. R., & Al-Ghamdi, S. G. (2022). Assessment of knowledge, attitude and practice towards sustainability aspects among higher education students in Qatar. *Sustainability*, 14(20), 13149. <https://doi.org/10.3390/su142013149>
17. Le Khanh, T., & Dang Thi Thanh, H. (2025). Sustainable solutions for moral education of students in pedagogical universities. *Journal of Innovations and Sustainability*, 9(1), 02. <https://doi.org/10.51599/is.2025.09.01.02>
18. Shelest, Z., Chyzhevs'ka, L., Herasymchuk, O., & Sannikova, S. (2023). Development of competences regarding academic integrity and scientific research methodology among students of natural sciences. *Journal of Innovations and Sustainability*, 7(2), 03. <https://doi.org/10.51599/is.2023.07.02.03>
19. Koshkald, I., Knyaz, A., & Tyshkovets, V. (2015). Using of world experience of land managers training for sustainable development of agrarian education in Ukraine. *Agricultural and Resource Economics*, 1(2), 40–50. <https://doi.org/10.51599/are.2015.01.02.03>
20. Kniaz, S., Brych, V., Heorhiadi, N., Shevchenko, S., Dzvonyk, R., & Skrynkovskyy, R. (2024). Enhancing the informativeness of managing mentoring activities based on simulation modeling. *Proceedings of the 2024 14th International Conference on Advanced Computer Information Technologies (ACIT)*, 384–388. <https://doi.org/10.1109/ACIT62333.2024.10712547>
21. Kniaz, S., Brych, V., Heorhiadi, N., Shevchenko, S., Dzvonyk, R., & Skrynkovskyy, R. (2024). Informational-reflective management of mentoring activities development in the enterprise. *Proceedings of the 2024 14th International Conference on Advanced Computer Information Technologies (ACIT)*, 389–392. <https://doi.org/10.1109/ACIT62333.2024.10712601>
22. Yildiz, T., Arslan, Ünal, & Sağlam Çeliköz, Y. (2022). The relationship between human capital and environmental destruction: the case of European countries. *Agricultural and Resource Economics*, 8(1), 187–203. <https://doi.org/10.51599/are.2022.08.01.10>
23. Kumar, A. (2023). Promoting youth involvement in environmental sustainability for a sustainable future. *Edumania-An International Multidisciplinary Journal*, 01(03), 261–278. <https://doi.org/10.59231/edumania/9012>