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EDITED BY
Elena G. Popkova,
Moscow State Institute of International Relations, Russia

REVIEWED BY
Anastasia Smetanina,
Institute of Scientific Communications (ISC-Group LLC), Volgograd, Russia
David Mhlanga,
University of Johannesburg, South Africa

*CORRESPONDENCE
Marija A. Troyanskaya,
m_troyanskaya@mail.ru

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The role of education and social policy in the development of responsible production and consumption in the AI economy

Nurgul K. Atabekova[1], Valentin A. Dzedik[2], Marija A. Troyanskaya[3]* and Denis E. Matytsin[4]

[1]International University of Kyrgyzstan, Bishkek, Kyrgyzstan, [2]Department of Applied Informatics and Mathematical Methods in Economics, Volgograd State University, Volgograd, Russia, [3]Department of State and Municipal Administration, Orenburg State University, Orenburg, Russia, [4]Department of Civil and International Private Law of Institute of Law, Volgograd State University, Volgograd, Russia

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Introduction

Responsible production and consumption is one of the key mechanisms of the environmental economy. The advantage of this mechanism is its market nature. An alternative (or complementary) mechanism of state regulation involves, for example, the introduction of environmental norms and standards, taking into account the strategic priorities of the economic system (Peng and Jiang, 2021). Its disadvantage is a certain disconnection from economic reality and generalization, as a result of which the environmental practices provided by this mechanism may be formal and limited due to the narrow framework outlined by the state.

In contrast, responsible production and consumption is associated with increased flexibility and includes a much wider range of eco practices. And these practices are based on the actual current opportunities of business and society, providing fertile ground for the implementation of their "green" initiatives. Voluntary environmental protection based on altruism implies a more thoughtful and serious approach, as well as a strict focus on achieving concrete outcomes, thereby eliminating formality and false results (Liu et al., 2021; Ravina-Ripoll et al., 2021; Smith et al., 2021; Whitson and French, 2021; Vecchi, 2022).

The formation of the environmental AI economy in the context of industry 4.0 has endowed "smart" technologies (automation tools controlled by artificial intelligence) with a key role in responsible production and consumption. Advanced production and consumption technologies really contribute to the introduction of "green" innovations in many ways, increasing the degree of control over the consumption of natural resources and production waste, as well as providing intellectual support for their reduction (Schwartz et al., 2020; Bianchet et al., 2021; König et al., 2022).

The problem is that the high level of digital competitiveness of the AI economy does not guarantee its great contribution to environmental protection. For example, the global leaders of responsible production and consumption according to the *UNDP, (2022)* on the

countries' progress towards achieving SDG 12 in 2021 are Ethiopia (96.1588 points, 1st place), Mozambique (96.1192 points, 2nd place), Benin (96.0360 points, 3rd place) and other countries that are not even included the IMD World Digital Competitiveness ranking (2022), while the SDG 12 Index of the AI economies leading the *IMD (2022)* is low. For example, Singapore ranks 178th (16.3123 points), Iceland—175th (28.5343 points), Switzerland—173rd (39.4245 points) in the UNDP ranking (2022).

In the existing literature, Amos and Lydgate (2020), Cappelen and Ognedal (2017), Jacob-John et al. (2021), Palakshappa and Dodds (2021) the issues of responsible and consumption are covered in sufficient detail. Digital competitiveness as the basis for the development of the AI economy is considered in the publications of Anisha et al. (2022), Cheng et al. (2022), Vekaria et al. (2021). The importance of the development of responsible and consumption in the environmental AI economy is noted and emphasized in the works of Fraga-Lamas et al. (2021), Ruffolo (2022), Wilson et al. (2022). However, the cause-and-effect relationships and features of the development of responsible production and consumption in the AI economy remain poorly understood and insufficiently developed in the available literature.

Consequently, there is a gap in the logical chain of development of responsible production and consumption in the environmental AI economy. The originality of this study lies in the fact that it critically re-examines the scientific concept of the economy of artificial intelligence and the essence of the Fourth Industrial Revolution. The article substantiates that the main source of development of responsible production and consumption in the environmental AI economy is the increase in the level of environmental awareness in society and business. The purpose of the article is to study the role of education and social policy in the development of responsible production and consumption in the AI economy.

Case experience of the Kyrgyz republic in the development of responsible production and consumption in the artificial intelligence economy based on education and social policy

The experience of the Kyrgyz Republic, which demonstrated serious results in the practical implementation of SDG 12 (86.505 points according to the *UNDP, 2022*), is also very notable. Though the statistics of *IMD (2022)* and *Times Higher Education (2022)* are not available for the Kyrgyz Republic, its case experience shows that knowledge and its diffusion are very important for the development of the responsible production and consumption.

The Concept of the green economy of the Kyrgyz Republic "Kyrgyzstan – country of the green economy", which was adopted by the decree of the Jogorku Kenesh of the Kyrgyz Republic (2022) dated 28 June 2018, No. 2532-VI, notes the necessity and planned measures on the increase of awareness and development of environmental education as a very important direction of the green economy. "Green thinking, green upbringing, green education" were adopted as a special "green" direction of the Kyrgyz Republic. In this context, the following measures of stimulating the domestic production and consumption through the development of education and diffusion of knowledge are implemented:

- Using the 3R principle in the development of green thinking: Reduce (consumption), Reuse, and Recycle;
- Multiple courses on the foundations of environmental knowledge in the educational establishments of all levels of the educational system;
- Environmental upbringing and education for sustainable development;
- Large-scale training of specialists on the issues of ecology, nature protection, and the green economy;
- Training programs on the development of green entrepreneurship;
- Dissemination of traditional folk knowledge in nature used, reflected in national epic, sagas, legends, and literary works of Kyrgyz writers, which foster humans' caring attitude toward nature, flora, and fauna;
- 'Environmental informational and educational centres, which are oriented at the work with the population based on specially protected areas;
- Green PR in mass media, publication of popular scientific literature on the issues of preservation of biodiversity, regular preparation and publication of annual overview on biological resources and biodiversity, publication of school and university study guides in view of the specifics of the biodiversity of the Kyrgyz Republic.

The report on the course of achievement of the Sustainable Development Goals in Kyrgyzstan, prepared by the UN interdepartmental task force within the MAPS mission (2022), notes that the basis of the provision of transitioning to the rational models of consumption and production (achievement of SDG 12) includes the increase in the level of education and awareness of the current problems of environment and the opportunities to solve them in the practice of business and households.

Literature review and gap analysis

The fundamental basis of this study is the Theory of Ecological Economics, according to which the ecological

economy is defined as a set of economic practices and economic systems that support and contribute to sustainable development: the implementation of sustainable development goals (SDGs) (Ali et al., 2022; Singh et al., 2022; Li et al., 2022; Zhou et al., 2022). Artificial intelligence (AI) is treated in the existing literature as an end-to-end Industry 4.0 technology (Patel et al., 2018; Hayhoe et al., 2019; Jin, 2019; Mhlanga, 2020; Paynabar and Callicott, 2021; Spanaki et al., 2021).

The concept of an ecological AI economy interprets it as an economy in which artificial intelligence (AI) is widespread and actively used to support sustainable development and the implementation of the SDGs (Cao et al., 2021; Khan et al., 2021; Dragomir, 2022; Dwivedi and Paul, 2022; Howe et al., 2022; Jia et al., 2022; Xu et al., 2022).

In their works, Pan et al. (2020) define social policy as a direction of state economic policy designed to improve the quality of life of the population through support for employment and social adaptation to changes (economic crises, scientific and technological progress). So that social policy does not undermine the population's initiatives to improve the quality of life, it is necessary to preserve the market mechanism. In this regard, the development of education is a promising tool of social policy, as it expands employment opportunities and increases the income of the population while maintaining market relations in the labour market.

In the existing literature, Dimitropoulos et al. (2021), Wearn et al. (2019), the Fourth Industrial Revolution is interpreted as a path to automation—the replacement of humans with machines. Artificial intelligence is considered a non-human subject of management, which ensures responsible (more economical use of natural resources) production and consumption through strict measures and total control. From the standpoint of responsible production and consumption, the environmental AI economy is interpreted as a cyber-ecological system in which artificial intelligence acts as the controlling entity and the environment is the controlled object (Pan et al., 2020; Zhang et al., 2020).

Although the potential of artificial intelligence to protect the environment (for example, through automated waste sorting, high-tech circular production, and monitoring of waste disposal through AI-controlled machine vision) is well known and high, it remains unclear how this potential is realized in practice. The uncertainty of the causal relationships between the development of responsible production and consumption in the environmental AI economy is a gap in the literature, which this article aims to fill.

The works of (Fai Pun 2006), Pérez et al. (2021), Rezaei et al. (2021) (Singh et al., 2022), note that the subject of responsible production and consumption is a human being. Studies by Dzindolet et al. (2006), Karim et al. (2022) indicate that there are two subjects in automated production and consumption processes at once—although artificial intelligence performs command functions, as well as execution and control ones, the decision-making function is performed by a human. This means that responsibility is human property, not artificial intelligence.

The works of D'Souza et al. (2022), Li and Wang (2022), Mamzer et al. (2021) indicate that environmental responsibility is rooted in human nature (a part of a human being). In terms of practice, it can be seen that the ecological economy develops as knowledge about the environment and ways to protect it is gained. "Green" innovations are created purposefully in response to identified and widely publicized environmental problems and are implemented only if they have benefits for the environment. That is, the environmental economy is rooted in social progress.

Based on this, the article raises a research question (RQ) about the role of education and social policy in the development of responsible production and consumption in the AI economy, and also puts forward the hypothesis that responsible production and consumption are achieved by increasing the level of public consciousness, diffusion of new knowledge and technologies. The hypothesis states that responsible production and consumption act as humanity's initiative to protect the environment, which is based on the knowledge gained.

Methodology

The basis of the research conducted in this article is an empirical analysis of the role of education and social policy in the development of responsible production and consumption in the AI economy. To obtain the most accurate and reliable results, the article relies on econometric methodology, as it allows using the mathematical apparatus in the study.

To take into account the special context of the era of artificial intelligence, *IMD (2022)* is chosen as a source of data on social policy. Education in the era of artificial intelligence is specific and involves the training of digital personnel - this feature is taken into account and reflected by IMD statistics (2022). "Knowledge" and "knowledge transfer" are chosen as indicators of social policy, since they collectively represent the creation and dissemination of knowledge in the AI economy.

Times Higher Education (2022) "Impact Rankings 2021: responsible consumption and production" was chosen as an indicator of the development of education for responsible production and consumption since this indicator most accurately reflects the contribution of higher education to responsible production and consumption and allows us to quantify this contribution.

As a result in the field of responsible production and consumption in the AI economy, the progress achieved in the implementation of SDG12 is assessed by *UNDP (2022)* as the most reliable and authoritative source of statistics in the field of sustainable development and the implementation of the SDGs.

To form a representative sample, it includes developed and developing countries that show the best values in the *Times Higher Education (2022)*, from different geographical regions of the world: Europe (United Kingdom, Ireland, Russia), America (United States, Canada, Mexico) and Asia (Thailand, Indonesia, Saudi Arabia), Oceania (Australia). To take into account the characteristics of developed and developing countries, their experience is studied separately. The study is based on data for 2021.

To determine the relationship between responsible production and consumption and its support in society and university education, the method of correlation analysis was chosen. The choice of this method is explained by the fact that it allows establishing relationships between variables without the need to separate them into factor and result variables. This is valuable for this article since from a qualitative point of view it is impossible to state categorically what is primary (and what is secondary): the development of education and social policy or responsible production and consumption.

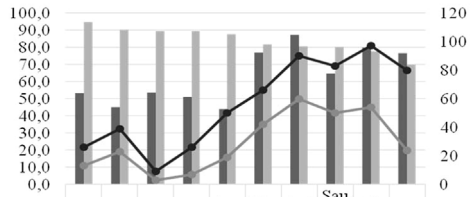
The regression analysis method, which uses equations of type $Y = a + bX$ to predict the value of dependent variable Y according to the known value of independent variable X, serves as a potential alternative in this paper. In contrast to it, the statistical concept of correlation measures the direction and intensity of the relation between the two number variables.

Since all the variables under consideration are social in nature, they are closely interrelated in a cohesive way. Thus, a preliminary qualitative analysis shows that, on the one hand, the implementation of social policy through the development of education is based on the current level of progressiveness of society, which characterizes and ensures responsible production and consumption in the AI economy. On the other hand, the implementation of social policy through the development of education is instrumental in social progress and promotes responsible production and consumption in the AI economy.

The above-described two-way relation between variables in the continuous cycle of social progress is indicative of a consistent interrelation between the indicators under consideration. As a result, it is difficult and even incorrect to divide them into factor variables and resulting variables, since all of them are equivalent. Therefore, the correlation analysis is preferred in this paper, which has constituted a ground for choosing this method for the research.

Empirical analysis of the role of education and social policy in the development of responsible production and consumption in the artificial intelligence economy

To test the hypothesis put forward, the role of knowledge (the "knowledge" indicator calculated by *IMD, 2022*), its dissemination (the "knowledge transfer" indicator calculated by *IMD, 2022*), as well as universities [based on the materials of the *Times Higher Education (2022)* World University Rankings "Impact Rankings 2021: responsible consumption and production"] in achieving results in the field of responsible production and consumption in the AI economy [implementation of SDG 12 according to the *UNDP (2022)*]. The international experience is studied and the peculiarities of developed and developing countries are identified.



	UK	Ireland	USA	Canada	Australia	Thailand	Indonesia	Saudi Arabia	Mexico	Russia
Goal 12 Score, 0-100	53,3	45,2	53,6	51,0	44,1	77,1	87,2	64,7	80,0	76,7
THE World University Rankings "Impact Rankings 2021: responsible consumption and production", score 0-100	94,9	90,3	89,7	89,5	87,6	81,9	80,7	80,1	77,5	69,9
Knowledge transfer, places 1-64	13	16	6	19	31	24	30	33	43	56
Knowledge, places 1-64	13	23	3	7	19	42	60	50	54	24

FIGURE 1
Responsible production and consumption and its support in society and university education in 2021.

To conduct the study, a sample of five developed and five developing countries were formed, demonstrating the best values in the *Times Higher Education (2022)*. The sample contains data on the university from each country that occupies the best position in the ranking. The list of universities is as follows: the United Kingdom: University of Manchester; Ireland: University College Cork; the United States: Arizona State University (Tempe); Canada: University of British Columbia; Australia: University of Wollongong; Thailand: King Mongkut's University of Technology Thonburi; Indonesia: Institut Teknologi Sepuluh Nopember; Saudi Arabia: Prince Mohammad Bin Fahd University; Mexico: Metropolitan Autonomous University; Russia: Altai State University. The factual basis of the study is shown in Figure 1.

Source: systematized and constructed by the authors based on materials from *IMD (2022)*, *Times Higher Education (2022)*, and *UNDP (2022)*.

Using the method of correlation analysis based on statistics from Figure 1, the relationships of indicators are established. It should be noted that there is a positive correlation between SDG12 and its support by universities, and a negative correlation with knowledge (*IMD, 2022*), since the higher the score, the better, and the lower the values in places, the better. In

developed countries, the link between the implementation of SDG 12 and the "knowledge society" is very close (correlation −84.47%), as well as with the diffusion of knowledge (correlation −77.46%) and with the support of universities (correlation 58.16%).

In developing countries, the relationship between the implementation of SDG 12 and the diffusion of knowledge is moderate (correlation −2.95%), as well as with the support of universities (correlation 2.13%). And the connection with the "knowledge society" is contradictory (correlation 27.58%).

The results obtained are consistent with the existing literature by D'Souza et al. (2022), Li and Wang (2022), Mamzer et al. (2021) that the environmental economy is rooted in social progress and developed through social policies with a focus on education.

The difference between the obtained results and the available publications (Jiang et al., 2020; Zhang et al., 2020) is that the environmental AI economy includes not only a cybernetic (artificial intelligence, AI) and physical (environment) but also a social component that plays a connecting role and largely determines achievements in the field of responsible production and consumption.

Differences in results between developed and developing countries indicate that, in contrast to Dimitropoulos et al. (2021), Wearn et al. (2019) responsible (environment-friendly) production and consumption are not a guaranteed result of the Fourth Industrial Revolution, that is, not a property of artificial intelligence (AI), but an achievement of humanity through social policy and education.

The obtained results confirm the hypothesis put forward by the authors and indicate that factors such as knowledge, increasing environmental awareness and university support contribute to the development of responsible production and consumption in the economy of environmental AI, but their role differs significantly between countries—it is more pronounced in developed countries, but insignificant in developing countries.

Case experience of the Kyrgyz republic in the development of responsible production and consumption in the artificial intelligence economy based on education and social policy

The experience of the Kyrgyz Republic, which demonstrated serious results in the practical implementation of SDG 12 (86.505 points according to the *UNDP, 2022*), is also very notable. Though the statistics of *IMD (2022)* and *Times Higher Education (2022)* are not available for the Kyrgyz Republic, its case experience shows that knowledge and its diffusion are very important for the development of the responsible production and consumption. The Concept of the green economy of the Kyrgyz Republic "Kyrgyzstan—country of the green economy", which was adopted by the decree of the Jogorku Kenesh of the Kyrgyz Republic (2022) dated 28 June 2018, No. 2532-VI, notes the necessity and planned measures on the increase of awareness and development of environmental education as a very important direction of the green economy. "Green thinking, green upbringing, green education" were adopted as a special "green" direction of the Kyrgyz Republic. In this context, the following measures of stimulating the domestic production and consumption through the development of education and diffusion of knowledge are implemented:

– Using the 3R principle in the development of green thinking: Reduce

(consumption), Reuse, and Recycle;

– Multiple courses on the foundations of environmental knowledge in the

educational establishments of all levels of the educational system;

Recommendations for the development of education and improvement of social policy for responsible production and consumption in the artificial intelligence economy

Based on the established evidence base, a new approach to managing responsible production and consumption in the economy of artificial intelligence, based on the development of knowledge and technology, is proposed. The central role in the authors' approach is assigned to universities as drivers of AI-economy development. Based on the recommended approach, the following recommendations are proposed for public administration aimed at developing education and improving social policy in support of responsible production and consumption in the AI economy:

– Inclusion of the SDG 12 support factor in the organization of universities' activities and their scientific research when distributing state (e.g., grant, subsidiary) funding among them;
– Inclusion of knowledge about the problems of environmental AI economics, as well as skills and abilities for the implementation of SDG 12 in the practice of responsible production and consumption in the requirements for the competencies of university graduates and their consolidation in state educational standards;

– Increasing the accessibility of higher education, as well as encouraging young people to obtain higher education and advanced training in university educational programs that provide for the development of competencies of responsible production and consumption.

Discussion

The review and empirical analysis of international experience revealed the significant role of education and social policy in the development of responsible production and consumption in the AI economy. In developed countries, this role is more pronounced as they have already finally entered the era of artificial intelligence (AI) and are characterized by a larger and more effective social policy and a higher level of competitiveness in universities.

Unlike the existing studies of Dimitropoulos et al. (2021), artificial intelligence in this article is endowed not with a direct, but an intermediary function in the environmental AI economy and is considered as a technology to support decision-making by people who are subjects of management in the implementation of responsible production and consumption practices. In this regard, a new interpretation of the Fourth Industrial Revolution is proposed as a new stage in the development of the "knowledge economy"—the evolution of man (with the secondary role of machines).

Unlike (Jiang et al., 2020; Zhang et al., 2020) responsible production and consumption in the environmental AI economy are represented in the form of cyber-socio-ecological systems. The added new (social) component clarified the causal relationships between the development of responsible production and consumption in the environmental AI economy. Unlike D'Souza et al. (2022), Li and Wang (2022), Mamzer et al. (2021), the authors reasoned that environmental responsibility is not natural, but a human property acquired through education, a competence that should be mastered and developed.

Conclusion

So, as a result of the study, its goal has been achieved—the role of education and social policy in the development of responsible production and consumption in the AI economy has been studied. The hypothesis put forward was confirmed based on econometric methodology (correlation analysis method) and it was proved that knowledge, environmental awareness and university support contribute to the development of responsible production and consumption in the environmental AI economy has been confirmed and proven. At the same time, it was revealed that the role of knowledge and universities is more significant in developed countries, while in developing countries it is not so pronounced and contradictory. One of the possible explanations for this fact may be the reduced effectiveness of institutions in developing countries—it is proposed to devote future scientific research to test this assumption.

The following are proposed as recommendations for the development of education and the improvement of social policy in support of responsible production and consumption in the AI economy. Firstly, taking into account support for SDG12 in the activities of universities and their scientific research when distributing public funding among them. Secondly, the inclusion of knowledge about the problems of environmental AI-economics, the skills and abilities to implement SDG12 in the practice of responsible production and consumption in the competencies of university graduates and their consolidation in state educational standards. Thirdly, increasing accessibility and stimulating the acquisition of higher education and advanced training in university education programs that provide for the development of the competencies of responsible production and consumption.

The novelty of the article is connected with the development of a new approach to the management of responsible production and consumption in the economy of artificial intelligence, based on the development of knowledge and technology. The contribution of the article to the literature is to substantiate the central role of universities in the development of responsible production and consumption in the environmental AI economy.

The theoretical significance of the results and the conclusions of this study lies in the disclosure of the essence and explanation of subject-object relations, as well as the relations of responsible production and consumption in the environmental AI economy. The practical significance of the authors' recommendations is that they make it possible to achieve increased flexibility and efficiency of state incentives for responsible production and consumption in the economy of ecological AI by shifting from direct to indirect (based on a market mechanism) regulation.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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