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# FIGHT AGAINST CLIMATE CHANGE IN THE DIGITAL ECONOMY BASED ON GREEN MANAGEMENT OF KNOWLEDGE AND INFORMATION SYSTEMS

Asel A. Dzhumakova
Ilxom A. Nosirov
Odina K. Rakhmatova
Elena G. Popkova[1]

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A B S T R A C T

*This paper presents a study of the features, problems, and prospects of implementing knowledge and information systems in the fight against climate change, which are based on the digital management of knowledge and information systems. We demonstrate practices that are applied in Norway and China and determine the key directions for implementing these technologies. We confirm the offered research hypothesis on the effect of such components as finances, infrastructure, and digital readiness of the workforce for the implementation of new ICT. We also establish the prospects for an increase in the effectiveness of the realisation of the consideration process in the conditions of mass implementation of sectorial technologies and the focus on global climate integration in China and Norway.*

*The objective of this research is to identify the directions for tackling climate change in the digital economy that are focused on green management of knowledge and information systems.*

*The methods used in this work include the method of scientific abstraction, comparison, statistical analysis, and factor analysis. The scientific novelty of this research consists in the establishment of the directions for digitalization of environmental growth in the conditions of climate change and the quick emergence of innovative ICT.*



## 1. INTRODUCTION

Climate initiatives of companies and countries are connected with two positions: the focus on environmental protection for the current and next generations and the striving towards external integration through the positioning of green management. Leaders of such initiatives create and promote their practices and approaches, which can be adapted in the future by other subjects that acknowledge and share the opinion on the necessity for implementing changes in the traditional methods of economic management. In the 2020s, most countries of the world support and implement green methods of management which can stop climate change.

[1] Corresponding author: Elena G. Popkova
Email: 210471@mail.ru

There are global and international partnerships, in which environmental norms of the management of economy and infrastructure are adopted and implemented. This depends on the supranational measures of promoting the idea of nature protection as the basis for the further existence of life on Earth and the measure of supporting the stability of economic development. The national level of support for the fight against climate change involves the activities of the government, business environment, R&D sphere, education, and civil initiatives.

Despite the criticism regarding the existing model of employment, the formation of the digital economy allows achieving certain positive results in the sphere of ecologization. This includes the possibility of reducing product defects, which saves energy and decreases environmental pollution, and the use of various tools of the digital economy for CO2 capture and the creation of smart technologies that raise productiveness of eco-friendliness of production and logistics processes. Besides, there is a possibility for mass implementation of the mechanism of remote work, which ensures employment and reduces the need for spending resources for office personnel. The list of effects, including synergetic, grows due to the application of digital tools together with the quick implementation of new ICT. These include sectorial and universal ones. The modern tools of digitalization (including digitalization based on green initiatives) are connected not with the formation of new production processes but with their digital support, which creates the basis for the management of knowledge and information systems. Initiatives connected with sustainable environmental and economic growth in the conditions of the digital economy are peculiar primarily for developed or quickly developing countries, for countries with a low level of economic development do not have enough stimuli for the achievement of the results (Karbekova et al., 2022). Given the initiatives, an adaptation of the best practices allows achieving significant growth and receiving perspectives for further development.

The objective of this research is to identify the directions for tackling climate change in the digital economy, which are oriented towards green management of knowledge and information systems. For this, a set of tasks is solved: revealing a range of directions demonstrated by the leading countries in green digital economic growth and identifying the prospects for transformations in this sphere given the emergence of new ICT in green management of knowledge and information systems.

## 2. EXPERIMENTAL SECTION

Further on in this paper, we check a hypothesis that the efficiency of implementing the directions for the fight against climate change in the digital economy depends on such elements as finance, digital infrastructure of the management of knowledge and information systems (high level of Internet and availability of data on the environmental indicators), and digital readiness of workforce for the use of new green ICT.

General scientific and special methods, which allow reaching the research tasks, are used in this study. The method of scientific abstraction allows determining the main features and mechanisms of green management of knowledge and information systems.

The method of comparison enables us to assess the indicators of the efficiency of climate management with the use of ICT in the selected countries. Statistical analysis allows presenting official data in the sphere of digital green management of knowledge and information systems in the selected countries. Factor analysis is used to establish the preconditions of the achieved results in the fight against climate change in the conditions of the digital economy.

As for the selected countries, we study China, which, due to quick economic growth, achieved substantial results in the sphere of green digital technologies, and Noway, which has a developed economy that is oriented towards high environmental sustainability (7th position in the Sustainable Development Report for 2024) (SDSN, 2024).

We also use the materials of theoretical and empirical works that establish the main provisions required for this research.

Korsnes et al. (2023) presented the analysis of features (advantages and contradictions in society) of the process of the energy transition to renewable energy in Norway. An important provision of this research is stating the problems of the energy transition which are connected with high risks of transition to renewable energy sources which are not stable (wind energy); complexity of refusal of the large part of the population from comfort that was during the 100% use of fossil fuels. The authors prove the necessity of using the structural approach, which involves consideration of the advantages of fossil energy resources and their use and obligations of the government within international and global climate partnerships.

Li (2022) presents a comparative analysis of approaches to the management of training and retraining of personnel for large-scale dissemination of technologies within Industry 4.0 in such countries as the UK, Norway, China, Mexico, and countries of Eastern and Central Europe. The important contribution of the author is the presentation of a plan for the digital training of personnel in the conditions of the sector's digitalization. Attention should be also paid to the key feature in ensuring the competitiveness of personnel in the conditions technologies Industry 4.0: life-long professional self-education.

Karbekova et al. (2022) presented an analysis of the formation of the entrepreneurial sector of countries that import agrarian products given their focus on sustainable development. The authors showed top-priority directions for the sustainable development of the subjects of the selected countries, which would allow implementing import substitution programmes.
Sljivic et al. (2023) elaborated on the advantages and features of using 3D technologies in production in various spheres with a focus on environmental norms and standards.

## 3. RESULTS

Let us consider the key directions for fighting climate change which are connected with green digital management of knowledge and information systems in China and Norway.

In the context of Norway, the first considered direction is green energy. Focus on the use of renewable energy in Norway could be considered revolutionary because the country has large reserves of fossil fuels. According to the statistical data (Korsnes et al., 2023), the country accounted for 2.3 % of oil production and 3 % of natural gas production in the world in 2020. Despite the large reserves of fossil energy sources, Norway chose the policy of eco-oriented international and global integration, supporting many developing countries in nature protection. As of 2024, Norway does not have an adopted plan for energy transition, which is caused by the ongoing discourse regarding the time period of this transition, the interests of all concerned parties, and gradual transition or full refusal from oil refining or natural gas production (Korsnes et al., 2023).

An important step regarding the extension of the time for the adoption of the plan of full energy transition is connected with the strengthening of the energy partnership between Norway and countries of the EU.
Arguments in favour of consideration of the importance of the oil and gas industry in the Norwegian economy in the age of high economic and energy risks are as follows:
- Focus on the contribution of the sales of the sector's products (including exports) to the national GDP. The share of sales of the oil and gas sector products in the national GDP changed since 2022 in the following way: 18.1 % in 2002, 18.8 % in 2009, 22.4 % in 2011, 12.7 % in 2016, 17.4 % in 2018, 10.9 % in 2020, 21.3 % in 2021, 35 % in 2022, and 23.2 % in 2023 (Statista, 2024);
- Partnership obligations of Norway in supporting the energy security of partner countries, including in the EU. This argument has economic and foreign political value.

Despite the large reserves of fossil energy resources, Norway has had a focus on renewable energy over the last ten years. Wind energy has been well developed. The level of energy transition at in national consumption was 61.3% in 2020. To reduce public pressure on the companies of the oil and gas industry, the companies implement technologies that are based on green management of knowledge and information systems. This includes CO2 traps with digital sensors, which react to the emergence of CO2 emissions. In 2020, the national budget covered 2/3 of the cost of the project on CO2 capture (Euronews, 2020). Even though the course towards green management of knowledge and information systems is the priority for most subjects of the business environment, the cost of digital tools for these processes is a serious barrier. While participation in decarbonisation projects is affordable for large and medium companies, it is rather expensive for small companies.

Another important direction of tackling climate change in Norway is the preservation of tropical forests. This has been developed by Norway since 2008. Initiatives on tropical forest protection are connected with the focus on the preservation of ecosystems of the planet. Organisation of support for countries' efforts for tropical forest preservation is conducted by Rainforest Foundation Norway, which is a part of the Rainforest Foundation.

Norway started partnerships with fifty human rights and environmental organisations from Central Africa, Oceania, and South-East Asia. Tropical forest protection is aimed at preserving the biodiversity of their territories and supporting the role of forest ecosystems in absorbing large volumes of CO2 emissions from different sources. Global efforts led to a certain reduction in the rates of tropical forest destruction, which equalled 9 % in 2023 compared to 2022 (World Resources Institute, 2024). The level of tropical forests destruction in the world equalled 2.57 million hectares in 2022 (0.17 million hectares – forest fires, 2.5 million hectares - other factors); in 2004 году – 3.4 million hectares (0.2 million hectares – forest fires, 3.2 million hectares – other factors); in 2012 – 3.6 million hectares (0.29 million hectares – fires, 3.31 – other factors); in 2016 – 6.13 million hectares (2.36 million hectares – fires, 3.77 million hectares – other factors); in 2020 – 4.21 million hectares (1.01 million hectares – fires, 3.2 million hectares – other factors); 2021 – 3.75 million hectares (0.62 million hectares – fires, 3.13 million hectares – other factors); in 2022 – 4.12 million hectares (0.59 million hectares – fires, 3.53 million hectares – other factors); in 2023 – 3.74 million hectares (0.69 million hectares – fires, 3.05 million hectares – other factors) (World Resources Institute, 2024).

Norway is one of the key countries ensuring the implementation of the initiative on tropical forest preservation. Financing in this direction means climate investments in global and regional climate projects. A part of the financing of recent projects includes Norway's obligation to support the territories of tropical

forests with investments worth USD 12 billion in 2021-2025 (Nicfi, 2021).

Norway's important contribution to supporting and preserving tropical forests is financing the global project of monthly satellite images of forests and the provision of free access to them for all interested parties (Kongsberg, 2024). Countries and regions that want to participate in financing tropical forest protection can use these images for their policies. Norway also uses these images to control the project obligations from recipients of financing.

Let us analyse green energy in China. Within the framework of cooperation with the UN in the sphere of sustainable development, China adopted obligations on the achievement of the maximum level of CO2 emissions by 2030 and zero emissions by 2060. China implements measures for CO2 emissions reduction not only because of its international obligations but also to avoid the risks of real climate change. China has already faced such risks as salt water in groundwater and fresh surface water; storm surges; soil erosion, etc. According to the World Bank, these climate risks may lead to the reduction of GDP by 0.5 – 2.3 % until 2030 (World Bank, 2022). Though this is not a serious decrease, it is peculiar only to risks that are known to climate specialists; its influence might be much higher in case of unexpected manifestations of certain features of climate change.

As of 2022, China accounted for 1/3 of other greenhouse emissions (including methane) in the world and 27 % of CO2 emissions in the world. Despite the use of green digital technologies, we cannot state that China performed the energy transition to the use of renewable energy. Certain spheres use green management of knowledge and information systems in tackling climate change in the context of the reduction of CO2 emissions and other greenhouse gases. These technologies, which are applied in China, include the following:

- In the coal industry: degassing of underground coal seams with the use of vacuum pumps that are remotely controlled (machine learning technology); methane flaring with the use of technological equipment of closed type with digital sensors for methane detection, technological line of flaring, digital traps for flaring products, and automatized transfer of data about the volumes of flaring and capture. According to the statistical data, methane emissions into the atmosphere in the energy sector (primarily in the coal industry) accounted for 15.6 % of the world indicator (38.6 billion cubic meters) (Euractiv, 2023). During US-China negotiations in November 2023, China adopted obligations to reduce methane emissions and reduction of methane leaks. The measures for the reduction of methane emissions included the plan of government financing of green digital technologies and refusal of flaring of methane without digital capture technologies;
- In the oil industry: the use of digital pump technologies for pumping oil from wells with pumping water containing harmful contaminants. The use of this technology allows protecting groundwater from polluted water. The technology also raises the efficiency of further oil production;
- In the sphere of renewable energy and industry sectors that use green energy. Production of environmentally friendly biofuels for aviation, as well as wind energy production, has become very widespread in China. In 2023, the sector of renewable energy production accounted for 40% of the total growth of the national GDP. Investments in this sector equalled USD 890 billion in 2023, which was 40 % higher compared to 2022. These were mostly domestic investments from the government and private sector. The functioning of this sector supported the targeted indicators of GDP growth in 2023. The main green technologies contributing to the sector of renewable energy in China in 2023 included solar energy technologies (solar panels, solar power plants); electric cars; batteries and solar energy. The growth of renewable energy was largely possible due to subsidies from the government. The national period of subsidies covered 2020-2022. Thus, the growth of electric car production in China by 36 % in 2023 was achieved due to the activities of manufacturing companies that did not use subsidies (Myllyvirta, 2023). However, they were able to achieve high quality of their products, which are characterised by high consumer and technological qualities.

A non-government organisation, the Institute of Public and Environmental Affairs, has been functioning in China since 2006. This institute collects and analyses corporate and government statistical data in the sphere of ecology (IPE, 2024). Since its foundation, this organisation has been forming a database on China's ecology in the context of provinces, cities, and rural communities. In 2013, the Blue Map App was created and implemented; it demonstrates, in real-time, the data on the quality of air and water. These data are collected remotely with the use of an integrated system. There are twenty monitoring stations on the territories of the objects of large-scale pollution (cement plants, companies of the coal and oil & gas industry); information on environmental pollution from companies goes straight to the information system Blue Map; companies transfer information in the electronic form about pollution in the given information system; employees the Institute of Public and Environmental Affairs integrate all data on the indicators of ecology. Despite this institute being a non-government structure, the Chinese government adopted legal norms in 2014 regarding the mandatory hourly data from companies that pollute ecology. In this case, the government positively reacted to the private initiative, which was connected with the necessity of solving the problem of water and air pollution. In 2023, there were 3.8 million users (Landreth, 2023) of the application.

## 4. DISCUSSION

The described directions of the fight against climate change with the use of green digital technologies, based on the management of knowledge and information systems, in China and Norway, have some similarities. However, each country has also its specific features of the level and character of implementation of these technologies.

Norway's experience in using technologies of the given category in the development of green energy conforms to the provisions of the proposed experimental hypothesis. This correspondence is seen in the following:
- Statement that financial support is an important precondition for the implementation of innovative technologies in the sphere of the fight against climate change. As was shown above, though the government's participation in financing the project of CO2 capture and storing allows covering most of the expenses for its organisation, subjects of industry also bear substantial financial burden. Accordingly, financing in this direction is a barrier to digital green growth;
- Assumptions on the influence of digital infrastructure of the management of knowledge and information systems on the effectiveness of the green transition;
- Statement that digital readiness of the workforce for the use of new green technologies contributes to the effectiveness of their implementation. Since Norway is among the top 10 countries in the sphere of sustainable development, the country has a high level of education and personnel training, including digital readiness for innovations. Analysis of empirical data shows that Norway, similar to other countries in Northern Europe, uses an approach that is based on the government's financing of training and retraining of personnel. Most Norwegian companies have a practice of focusing on the quality of knowledge and employees' skills, which are achieved due to group participation in the professional training of employees (Li, 2022). Each industrial company in Norway uses a certain system of stimulation of group interaction, and employees are interested in supporting the professional growth of their colleagues.

It is possible to assume that the global green initiative of Norway in the preservation of tropical forests is partially connected with an attempt at fair compensation to the planet's ecosystem for the intense economic activities of the country in the oil and gas industry. It should be noted that Norway's participation in the provision of satellite images of tropical forests is an equally important measure compared to financing other measures on the protection of eco-systems.

Indonesia, as one of the largest recipients of funds for tropical forest protection, was able to reduce CO2 emissions. The partnership between Indonesia and Norway was suspended several times due to financial and organisational problems. Indonesia had free access to global systems of satellite communication and could receive forest images for planning and assessment of measures of forest protection;
- Assumption that digital readiness of personnel contributes to the effective use of green technologies. An example is the knowledge and experience of specialists of various services in Brazil, which carry out the project of preservation of forests of Amazonia. It includes constant monitoring of the digital map of high-resolution satellite images.

China's practice in the application of green management of knowledge and information systems conforms to the provisions of the experimental hypothesis. This is seen in the following:
- Influence of financial support (primarily from the government) and implementation of technologies on the improvement of climate indicators. The Chinese government has a large range of measures for stimulating high-tech production, which can ensure the growth and competitiveness of the economy. Results in the sphere of decarbonisation in 2004-2024 demonstrate that despite the high level of CO2 emissions, they are reduced. This indicator changed as follows: in 2004 – an increase of 830 MTCO2, in 2011 – an increase of 786 MTCO2, in 2020 – an increase of 220 MTCO2, in 2023 – an increase of 542 MTCO2, and forecast for 2024 – a decrease of 249 MTCO2 (Myllyvirta, 2023);
- Effect of the digital infrastructure of the management of knowledge and information systems on the effectiveness of ecologization. Insufficiently equal territorial support for digital infrastructure, including the Internet, does not allow for a quicker transition from the category of quickly developing countries into the category of developed countries. Attention should be paid to the issue of access to data about old companies in the coal industry, which are located in less economically developed regions of China (Baiyu, 2022). Due to the natural specifics of the territories of their location, it is impossible to use satellites for quality images. Thus, it is necessary to use robots or drones. Data on these mines will allow revealing spots of methane leaks into the atmosphere;
- The role of digital readiness of workforces in supporting the effectiveness of green digital management. This connection is obvious; it is observed in economically developed regions of China and is less relevant for regions that are more oriented towards low-tech sectors.

The case of Blue Map App also proves the proposed hypothesis: private financing ensured citizens' and all interested parties' access to the information about companies' activities and their influence on climate change; the creation of information infrastructure allowed for this access; digital knowledge allowed bringing the problem of environmental degradation of China to public consideration.

## 5. CONCLUSION

Summing up the results of this research, it is possible to state that Norway faces a difficult choice between decisions on full refusal from the activities in the oil and gas industry or its preservation and modernisation given the necessity for large-scale implementation of the green management of knowledge and information systems.

Norway's participation in the global programme of tropical forest preservation is limited to financing of projects and the digital map of tropical forests satellite images. We can assume that new technologies for knowledge and information systems management will be introduced in this sphere – to manage the identification of biodiversity of the given territories. This will allow raising the level of global environmental integration of the country.

China experiences a range of problems connected with an increase in the rates of decarbonisation for climate preservation at the national and global levels. The fact that China neglected the necessity for the fight against climate change for a long time led to serious problems with ecology, including regions that are the main contributors to the national GDP. Therefore, China has to adapt its existing technological capabilities to the resolution of the key environmental problems. As of now, China has rather ambitious programmes for the reduction of emission of polluting substances, which is an important step in the achievement of the task. It is also important to implement programme aspects of ecologization within the main directions, one of which is the reduction of CO2 emissions and greenhouse gas emissions through the replacement of certain productions, which require a lot of resources and energy, with productions based on 3D technologies (Sljivic et al., 2023). The latter might contribute to the manufacture of a wide range of components and spare parts for various sectors and facilitate the ecologization of production.

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**Asel A. Dzhumakova**
Kyrgyz-Russian Slavic University,
Bishkek,
Kyrgyzstan
djumakova@mail.ru
ORCID 0009-0001-1026-3184

**Ilxom A. Nosirov**
Fergana Polytechnic Institute,
Fergana,
Uzbekistan
nosirovilomzon@gmail.com
ORCID 0009-0001-9154-9167

**Odina K. Rakhmatova**
Fergana Polytechnic Institute,
Fergana,
Uzbekistan
rakhmatova.odina@gmail.com
o.raxmatova@ferpi.uz
ORCID 0000-0002-6664-7638

**Elena G. Popkova**
Armenian State University of Economics,
Yerevan,
Armenia
210471@mail.ru
ORCID 0000-0003-2136-2767