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Industry 4.0
Fighting Climate Change in the Economy of the Future

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Mechanism of Implementation of "Green" Investment-Innovative Initiatives in "Smart" Production Under the Control of Artificial Intelligence in the Interests of Environmental Safety of the Region

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1 Introduction

An urgent scientific and practical problem of our time is the gap between the interests of environmental security in the region, shared in the regional community and supported by public authorities in the region, and the interests of regional entrepreneurship, which imply an increase in profits in most cases through an increase in the environmental expenses of production. The increased difficulty in solving this problem lies in its contradiction, since in reality the private and public interests are in many ways similar, but, nevertheless, are implemented in different ways.

In the age of responsible consumption, there is ample room for additional profits from green investment and innovation initiatives. For many enterprises, corporate environmental responsibility is a prerequisite for survival in an aggressive market environment with high green competition. Many enterprises embrace and support sustainable development goals, especially in terms

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of environmental protection, but despite their incorporation into corporate reporting, business operations are not fully sustainable.

In this work, the hypothesis is that the root (true) reason for the problem is not in the divergence of private and public interests, but in the optimality of corporate governance (lack of control, opacity and complexity of management), because of which their own environmental guidelines for business development are not achieved in its economic activities. The problem can be solved by starting smart production, in which the control functions are automated and therefore performed more efficiently.

But not all advanced digital technologies contribute to increasing environmental responsibility of business, and it is necessary to select precisely those technologies that are important for the implementation of green investment and innovation initiatives. This work is aimed at selecting key described technologies in the regions of Russia and developing a mechanism for implementing "green" investment and innovation initiatives in smart production under the control of artificial intelligence in the interests of environmental safety in the region.

2   LITERATURE REVIEW

The theory and practice of implementing green investment innovation initiatives in modern entrepreneurship is described in Ghosh et al. (2020), Melander and Pazirandeh (2019), Shahzad et al. (2020), Skordoulis et al. (2020), Soewarno et al. (2019), Tariq et al. (2019a), (2019b). The organizational and managerial aspects of the launch and functioning of smart industries under the control of artificial intelligence are reflected in the works of Bogoviz (2020), Bogoviz et al. (2018), Ivanova and Smirnova (2019), Lobova and Bogoviz (2019), Popkova et al. (2021), Tskhadadze and Ioseliani (2019).

However, existing publications do not reveal issues at the intersection of smart and green industries, the isolation of which and the uncertainty of the prospects for their systemic implementation are a gap in the available scientific knowledge. To fill the identified gap in this work, a mechanism is being created to implement "green" investment-innovative initiatives in smart production under the control of artificial intelligence in the interests of environmental security in the region.

3   MATERIALS AND METHOD

This research is conducted on the example of all eight allocated federal districts of the Russian Federation based on data for 2020. To test the hypothesis, a correlation between technologies used in smart enterprises (from Table 1) and implemented "green" investment and innovation initiatives (from Table 2) is determined. This is done in order to select those green initiatives that are amenable to smart management, as well as to identify those technologies that contribute to the implementation of green initiatives.

Table 1 The share of organizations engaged in smart production in the regions of Russia in 2020, in terms of applied technologies, %

Federal district of the Russian Federation	Broad Band WL	Cloud services	RFID-technologies	ERP-systems
Central	87.4	25.8	5.3	15.4
Northwest	88.6	23.8	5.2	13.2
Southern	80.8	21.9	4.7	10.3
North Caucasus	80.3	22.2	3.5	5.8
Volga	83.5	20.5	4.8	12.6
Ural	82.9	24.1	6.0	14.5
Siberian	77.8	22.1	4.9	9.9
Far East	78.6	21.8	4.2	7.7

(*Source* Compiled by the authors based on materials of the Ministry of Digital Development, Communications and Mass Communications of the Russian Federation, Federal State Statistics Service, National Research University "Higher School of Economics" (2021))

Table 2 The share of organizations implementing "green" investment and innovation initiatives in the regions of Russia in 2020 in the context of the areas of ensuring environmental safety of production, %

Federal district of the Russian Federation	Material cost reduction per unit of production	Reducing energy costs per unit of production	Carbon Dioxide emission reduction	Substituting raw materials and materials for safe or less hazardous	Reducing Pollution	Recycling waste, water or materials
Central	44.5	54.5	35.6	33.3	68.7	38.9
Northwest	44.7	56.4	36.2	27.7	68.1	36.2
Southern	47.5	60.0	27.5	40.0	62.5	37.5
North Caucasus	54.5	90.9	27.3	36.4	36.4	27.3
Volga	39.8	51.1	30.6	32.3	70.4	34.9
Ural	41.5	43.4	35.8	17.0	69.8	43.4
Siberian	43.9	51.2	20.7	64.6	64.6	39.0
Far East	42.2	60.0	31.1	66.7	66.7	33.3

(*Source* Compiled by the authors based on the materials of Federal State Statistics Service (2021))

In order to clarify correlation relationships on selected technologies and initiatives, regression relationships are established, with the help of which key technologies and their development requirements are selected.

4   RESULTS

In order to determine the technological support and the main directions of the mechanism for implementing "green" investment-innovative initiatives in smart production under the control of artificial intelligence in the interests of environmental safety in the region, refer to the results of correlation analysis of data from Tables 1 and 2 (Fig. 1).

Rice. 1 clearly demonstrated that the implementation of such "green" investment and innovation initiatives in the regions of Russia in 2020, such as reducing material costs for the production of a unit of products, reducing energy costs for the production of a unit of products and replacing raw materials and materials with safe or less dangerous ones, cannot be "smart" controlled, unlike initiatives such as reducing carbon dioxide emissions into the atmosphere (y_1), reducing environmental pollution (y_2) and recycling waste, water or materials (y_3).

At the same time, all the digital technologies under consideration are in demand and promising (at this preliminary stage of analysis). In order to clarify the relationships of the selected green initiatives, their regression dependence from all advanced technologies was determined (broadband Internet: x_1, cloud services: x_2, RFID technologies: x_3, ERP- systems: x_4), which allowed to obtain the following regression equations:

$y_1 = -82.41 + 1.19x_1 + 0.36x_2 + 3.27x_3 - 0.78x_4$, multiple correlation high (82.34%);

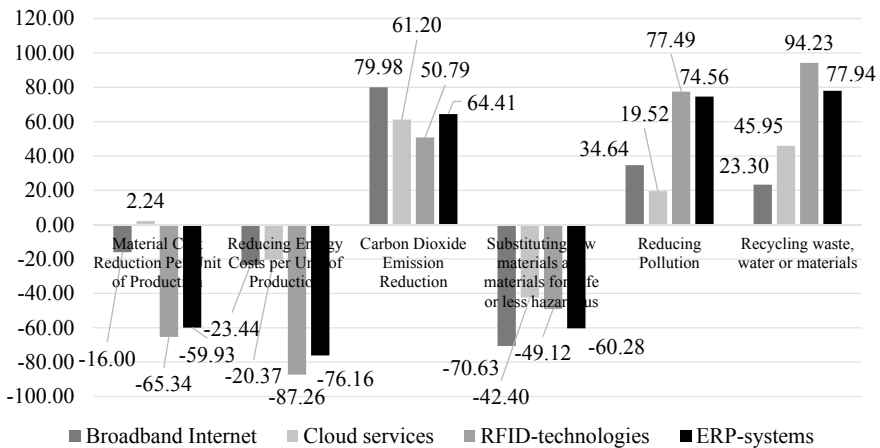$y_2 = 110.48 - 0.56x_1 - 2.46x_2 + 5.18x_3 - 2.69x_4$, multiple correlation high (85.26%);

Fig. 1 Correlation between technologies used in "smart" enterprises and implemented "green" initiatives in the regions of Russia in 2020, % (*Source* Calculated and built by the authors)

$y_3 = 47.89 - 0.60x_1 + 0.32x_2 + 5.34x_3 - 0.45x_4$, multiple correlation high (98.72%).

As it can be seen, the factor variable x_3 was the only one with which all three dependent variables showed a positive regression relationship. Based on the regression equations obtained, it was established that the maximization (100%) of the share of organizations implementing all three selected "green" initiatives in the regions of Russia is achieved with an increase in the share of organizations using RFID technologies to 26.08% (+ 440.49% compared to 2020). Therefore, the use of RFID technologies is the basis of the proposed mechanism for implementing green investment and innovation initiatives in smart production under the control of artificial intelligence in the interests of environmental safety in the region (Fig. 2).

The mechanism presented in Fig. 2 showed that RFID technologies scan each business transaction in smart production at the enterprise. Artificial intelligence transmits, firstly, general information about all business operations of the enterprise in real time and, secondly, environmental characteristics of business operations of the enterprise.

Public administration bodies in the region convey to artificial intelligence the interests of environmental security of the region and dictate requirements for their compliance. According to this, artificial intelligence in smart production at the enterprise manages green investment and innovation initiatives

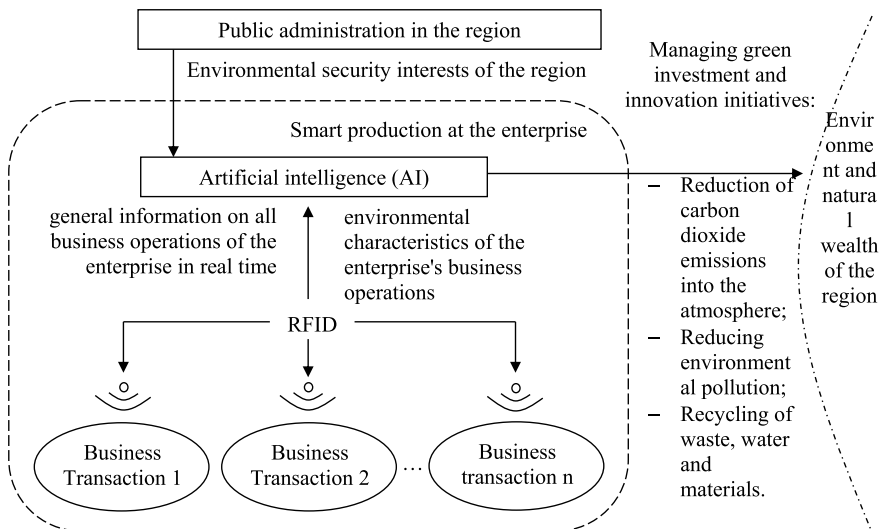**Fig. 2** Mechanism of implementation of "green" investment-innovative initiatives in "smart" production under the control of artificial intelligence in the interests of environmental safety of the region (*Source* Developed and built by the authors)

that reduce carbon dioxide emissions to the atmosphere, reduce environmental pollution and recycle waste, water and materials. This protects the environment and preserves the natural wealth of the region.

5   CONCLUSION

At the end of the research, we note that the developed mechanism for implementing "green" investment-innovative initiatives in smart production under the control of artificial intelligence in the interests of environmental security of the region takes into account the specifics of the regions of Russia. The results of the regression analysis have high scientific value and practical usefulness, since they showed that RFID technologies, the least common in the regions of Russia (used only 4.83% of enterprises, compared with, for example, broadband Internet used by 82.49% of enterprises), make a main contribution to ensuring the environmental security of the regional economy.

Based on regression models, it was found that only an increase in the prevalence of RFID technologies to 26.08% of enterprises (an increase of 6 times compared to 2020) is enough to ensure full coverage of enterprises in the regions of Russia with "green" investment and innovation initiatives. The conclusion is based on the developed mechanism for the implementation of "green" investment-innovative initiatives in smart production under the control of artificial intelligence in the interests of environmental security of the region. In future studies, it is necessary to find out whether the key role of RFID technologies in ensuring corporate environmental responsibility for regions of other countries is characteristic or this is a feature of the regions of Russia.

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