Humanities & Social Sciences Communications

ARTICLE

https://doi.org/10.1057/s41599-023-02444-w OPEN

Development of the potential of the digital economy of Russian regions through artificial intelligence humanisation

Ksenia V. Ekimova[1]✉

This paper is aimed at balancing the interests of business and society in the digital economy, to reduce the social risks of the Fourth Industrial Revolution. The goal of this paper is to study the experience and prospects of the humanisation of AI through the improvement of the practice of corporate social responsibility in Russia. By the example of the experience of Russian regions in 2021, we use econometric modelling to prove that the digital regional economy has a large potential in the sphere of humanisation of AI. The potential for the humanisation of AI in the digital economy of Russian regions is determined by responsible innovations, responsible production and logistics, as well as responsible marketing and sales, which contribute to the implementation of SDGs 9–12. The theoretical significance of the paper lies in its presenting smart region as a socio-economic environment for the humanisation of AI. The scientific novelty of the paper lies in its offering a new—meso-level—view of the humanisation of AI. The advantages of the new view include, first, consideration of socio-economic conditions for the humanisation of AI in a region; second, the most precise identification and correct measuring of the consequences of humanisation of AI for the quality of life in a region. The practical significance of the research results consists in the fact that the new proposed approach to the humanisation of AI, which implies public administration of this process at the level of a region, allows accelerating the considered process.

[1] Plekhanov Russian University of Economics, Moscow, Russia. ✉email: ekimova.kv@rea.ru

Introduction

"Artificial intelligence is a complex of technological solutions that allows imitating cognitive functions of a human (including self-education and search for solutions without a previously set algorithm) and obtaining, during completion of specific tasks, results that are comparable, at least, with the results of the intellectual activities of humans"—this definition is given in the "National strategy of the development of artificial intelligence in the Russian Federation for the period until 2030" (President of the Russian Federation, 2023).

Examples of the use of artificial intelligence include automatic recognition of faces and objects for the identification of targeted subjects or actions (Said et al. 2023), automatic voice or text recognition for interactive man-machine communications (Abdulqader and Zedan, 2023), and automatized processing of digital data based on them—intellectual decision support (Zhai and Liu, 2023).

AI is a technological core of the digital economy under the conditions of the Fourth Industrial Revolution. This is explained by the fact that AI is used to perform smart automation, for it expands the limits of the functional purpose and raises the effectiveness of other digital technologies (İçen, 2022). Together with AI, smart means of automatization include digital technologies and special software means, such as cloud computing, databases, big data, blockchain, etc. Smart means of automatization pervade the modern digital economy in the conditions of the Fourth Industrial Revolution (Hauer, 2022).

A large scale of the AI economy has been achieved by now. Smart tools of automation are not limited by separate economic processes anymore. The integration of automatized processes in different spheres of economic activities led to the formation of smart systems of various levels, e.g., smart companies (at the micro level) and smart regions (at the meso level) (Morimoto, 2022). Human (society) is the participant in the economic activities in these systems, so it is necessary to take into account human interests. They may contradict the interests of business, which implements automation based on the available market infrastructure (Li et al. 2022).

A prospective tool, which allows balancing the interests of business and society, is corporate social and ecological responsibility. Interests of business are brought down to accelerated automation for the rationalisation and increase in the effectiveness of its activities (Akter et al. 2022; Wamba-Taguimdje et al. (2020). Interests of society are connected with gradual automation, which allows each human to be able to adapt to it and which preserves a comfortable social environment and favourable conditions for life and professional activities (Chong et al. 2022; Jarrahi, 2018). We suggest calling the process of harmonisation of the interests of the above interested parties the humanisation of AI (Cubric, 2020; Tomašev et al. 2020).

A lot of attention is paid to the development of the AI economy in Russia. In recent years, the focus on these issues from the government has been rather large. The Decree of the President of the Russian Federation (2022) dated 10.10.2019 adopted the "National strategy of development of AI for the period until 2030". The problem is that this strategy and the practice of the development of the AI economy on the whole in Russia, similarly to other modern countries of the world, are mainly focused on the interests of business.

The benchmarks, which are set in the strategies and are used in practice, are brought down to accelerated development of the technological and infrastructural provision of high-tech business, as well as stimulation of the active implementation of AI in the activities of the business and expansion of the range of spheres of the use of AI (Lobova et al. 2020; Velinov et al. 2020). Consideration of human interests is limited by state and corporate support for mastering of digital competencies and increase in the accessibility of the technologies and infrastructure of the AI economy for wide masses of the population (Klochko et al. 2016).

Insufficient attention to the humanisation of AI can deepen the imbalance of the interests of business and society in the digital economy, increasing the social risks of the Fourth Industrial Revolution. This paper is aimed at ensuring scientific and methodological support for the resolution of the set problem. The goal of this paper is to study the experience and prospects for the humanisation of AI through the improvement of the practice of corporate social responsibility in Russia.

The paper's originality lies in its offering a new approach to the humanisation of AI, in which public administration of this process at the level of a region is conducted. A new - meso level – view of the humanisation of AI allows, on the one hand, taking into account the socio-economic conditions for the humanisation of AI in the region; on the other hand, this view manifests the consequences of humanisation of AI for the quality of life in the region, due to which it allows for the most precise and correct determination of these consequences.

The research design (paper's content) involves the literature review, which dwells on the concept of the humanisation of AI in the existing literature. The smart region is considered a socio-economic environment for the humanisation of AI – this is the basis for identifying the research gap and setting the research question, with the formulation of the research hypothesis.

After this, the research methodology is described and, in the results, the potential of humanisation of AI in the digital economy of Russian regions is determined. The results also contain policy implications for developing the potential of the digital economy of Russian regions through the humanisation of AI. In the discussion, the results obtained are compared with the existing literature, which allows demonstrating the paper's contribution to the development of the concept of humanisation of AI. Then, the conclusions as the result of the research are drawn, with the indicator of its theoretical and practical significance.

Literature review

Artificial intelligence and its influence on the life of human and society. Socio-ethical aspects of the influence of artificial intelligence on the lives of humans and society were disclosed by Polak (2021) and Rakowski et al. (2021). Ahmad et al. (2023) substantiated the important impact of artificial intelligence on the reduction of the influence of "human loss" (errors) during decision-making, laziness and safety (by the example of education). Zhao (2023) proved that artificial intelligence stimulates the development and disclosure of human talents of employees who use it.

Budhwar et al. (2023) pointed to the fact that artificial intelligence transforms human resources management (HRM), evaluating – more precisely and correctly – the labour efficiency of each employee. Pirrera and Giansanti (2023) substantiated the advantage of man-machine cooperation in the diagnostics of diseases in healthcare in the form of a synergetic effect of clinical visualisation with artificial intelligence. Murugesan et al. (2023) proved the positive impact of artificial intelligence on the digitalisation of human resources in Industry 4.0.

Gong and Li (2023) proved the emergence of psychological barriers and psychological problems due to the interactive communication between humans and robots (on the example of an intellectual system of decision-making and cognitive psychology based on artificial intelligence). Segal et al. (2023) proved the advantages of man-machine cooperation with the use of artificial intelligence for raising labour safety (on the example

of safety of donning and doffing personal protective equipment of hazardous industrial companies' employees). Francisco (2023) proved the positive contribution of artificial intelligence to an increase in environmental safety due to the automatization of control over environmental pollution.

The concept of humanisation of AI in the existing literature. The humanisation of artificial intelligence is understood as bringing it in accordance with the interests of improving the quality of life through environmental responsibility (including responsible innovations, responsible production, and logistics) (Nabavi and Browne, 2023; Stahl, 2023), as well as through social responsibility (responsible marketing and sales, as well as responsible HRM) (Akbarighatar et al. 2023; Tahri Sqalli et al. 2023). Three levels of humanisation of artificial intelligence can be distinguished:

- Micro-level, at which humanisation of artificial intelligence takes place through the development and implementation of a national policy for the development of artificial intelligence, as well as state regulation of the development, implementation, and use of artificial intelligence with a focus on environmental and social consequences (Saheb and Saheb, 2023). For example, the Decree of the President of the Russian Federation (2023) dated 10 October 2019, No. 490 "On the development of artificial intelligence in the Russian Federation" adopted the National strategy of the development of artificial intelligence for the period until 2030. In this strategy, main attention is paid to the use of artificial intelligence to raise the quality of life of the Russian population;
- Meso-level, at which the humanisation of artificial intelligence takes place through the adaptation of artificial intelligence in the specifics of the socio-environmental system of a region to raise the quality of life of the region's population (Yang et al. 2023). For example, in the Volgograd Region (region of Russia), the Committee for the Information Technologies of the Volgograd Region (2023) determined "the main directions for the development of artificial intelligence in the sphere of public administration in the region" to raise the quality of life of the region's population;
- Macro-level, at which the humanisation of artificial intelligence takes place through its harmonisation with the practice of manifestation of corporate social and environmental responsibility (Hu et al. 2023). For example, a Russian well-known transnational corporation Lukoil implements the corporate strategy of the use of artificial intelligence for the automatization of "exploration and production". This strategy implies that "Flexible use of a large number of systematised digital data will raise the quality of design of well construction. The base is also a platform for implementing systems that use the technologies of artificial intelligence with the implementation of predictive analytics of well construction online, which allows preventing extraordinary situations (threatening the life and health of employees and local residents, as well as the environment, including oil spills) before their emergence" (Ministry of Natural Resources and Environment of the Russian Federation, 2023). Thus, in the practice of Lukoil, artificial intelligence is used as a mechanism of manifestation of corporate social and environmental responsibility.

The concept of humanisation of AI, which is well presented in the existing literature, envisages a micro-level view of the humanisation of AI. This view considers business as a subject of the management of humanisation of AI (Clarke, 2019; Kumar et al. 2021; Robbins, 2020).

The approach to the humanisation of AI, which is based on this view, implies corporate management of this process (Cheng et al. 2021; Stahl and Wright, 2018; Vetrò et al. 2019). The business makes independent decisions on the fulfilment of corporate social and ecological responsibility and on spheres in which this responsibility is fulfilled. The advantage of the described approach is its foundation on the market mechanism. Under the influence of market self-regulation, the humanisation of AI naturally takes place and receives the largest response and support from market agents.

A critical view of the existing approach to the humanisation of AI revealed its drawbacks. One of them is that decisions in the sphere of humanisation of AI are made primarily by the representatives of the interests of business, while the carriers of society's interests are not presented. Due to this business implements the humanisation of AI given its commercial profit, which, as a matter of fact, excludes the non-commercial component of corporate social and ecological responsibility in the considered process (Himmelreich and Köhler, 2022; Wearn et al. 2019).

Another drawback is that when choosing the spheres for the application of corporate social and ecological responsibility, business is guided by the interest of only its target audience. If the target audience of the business is small and specific, its preferences may not coincide with the opinion of the majority of society's representatives. In this case, the humanisation of AI will have a limited influence on society and may have a formal character and demonstrate low effectiveness (Rakova et al. 2021; Sambasivan and Holbrook, 2019).

The identified drawbacks define the importance of developing an alternative approach to the humanisation of AI, in which they will be overcome.

Smart region as a socio-economic environment for humanisation of AI: literature gap, research question and research hypothesis. Many published works of modern authors are devoted to the topic of the smart region, which is treated as an economic system that is based on AI technologies (Antonelli et al. 2022; Kryshtanovych et al. 2022; Popkova et al. 2020; Sergi et al. 2019; Wibisono, 2022). It is at the meso level—in a region—that the telecommunication structure of the applied direction is created and developed, and specific smart technologies are implemented.

In a smart region, a set of online government services is implemented, which comprehensively covers the economic activities of the region's residents (Jagatheesaperumal et al. 2023; Maragno et al. 2023). A vivid example is the strategy for the development of Moscow "Smart City—2030", which was developed by the mayor of Moscow (Russia) S. Sobyanin (2018). This strategy, which was prepared in 2018 for Moscow, has expanded to the entire Moscow Region (a region of Russia). Within this strategy, the following smart technologies are used in Moscow and Moscow Region:

- Machine vision: a system of video surveillance with face recognition (it was used during the pandemic to control the self-isolation regime) and cars (it is used for automatic fines for paid parking);
- System of electronic public services;
- Telemedicine (remote provision of medical services), electronic records to the doctor and adjacent digital services;
- Remote training at all levels of the educational system;
- Other smart technologies.

At the macro level, the state forms and strengthens the regulatory framework of the AI economy. It defines general institutional conditions for implementing AI and its use to achieve the strategic benchmarks of national economic development. Main attention is paid to the results of the use of AI. These results can be expressed in the increase in economic growth rate and high-tech development of the economy (Yigitcanlar et al. 2021).

At the micro level, business implements and uses AI in practice. It has limited capabilities in the sphere of humanisation of AI and faces limited market stimuli for this. The financial resources of the business, which it can use for corporate social responsibility, are not large; they are often insufficient for the full-scale implementation of all necessary projects (Deshpande and Sharp, 2022).

Consumers are not always aware of the processes of automation that are implemented by the business and cannot always assess their consequences to rationalise their consumer behaviour, stimulating – with larger loyalty and purchases – the most responsible business, which implements the humanisation of AI. Very often, the pressure of the government and competition is stronger than the pressure of society. As a result, in its striving toward support for the national course at the digital modernisation of the economy, return on investment and maximisation of profit, business implements AI but does not perform its humanisation (Constantinescu et al. 2021; Lee et al. 2020).

Uncertainty of the prospects of humanisation of AI and unclear opportunities for managing this process at the meso level of the digital economy are a literature gap. Between macro and micro levels, there is the meso level, which experience and role in the management of the AI economy have been poorly studied. This leads to a research question of the volume of the potential of the digital regional economy in the sphere of humanisation of AI.

Based on the works of Gianni et al. (2022) and Nakao et al. (2022), in which an important role of public management in a region in raising the quality of life is noted, the following hypothesis is proposed in this paper: the digital regional economy has significant potential in the sphere of humanisation of AI. To test this hypothesis, the practical experience of humanisation of the AI economy by the example of Russian regions is studied.

Materials and method

In this paper, the potential of the humanisation of AI in the digital economy of Russian regions is revealed with the help of the method of regression analysis. For this, the practices of the AI application were systematised. The main directions for using the automation tools were distinguished, each direction's aim from the position of humanisation of the economy and business was determined, and the corresponding Sustainable Development Goals (SDGs) were identified.

Corporate ecological responsibility includes, first, responsible innovations:

- R&D, x_1;
- Design, x_2.

Second, responsible production and logistics:

- Management of automated production and/or individual technical means and technological processes, x_3;
- Company resources planning with the help of ERP systems, x_4;
- Supply chain management with the help of SCM systems, x_5.

Corporate social responsibility includes, first, responsible marketing and sales:

- Generation of financial transactions in the electronic form, x_6;
- Provision of access to databases through global information networks, including the Internet, x_7;
- Management of interrelations with customers with the help of CRM systems, x_8.

Second, responsible HRM:

- Development of employees' human potential with the help of training programmes, x_9.

The values of the selected indicators of the use of special software tools in business were taken from the materials of Rosstat (2022) for 2021. The resulting variable (y) is the quality of life in 2021 according to RIA (2022). The research model has the following form:

$$y = a + \sum_{n}^{i=1} (b_i * x_i) \quad (1)$$

where a – constant;

b – coefficient of regression at factor variable x;

i – the ordinal number of the factor variable, $i = 1 \ldots n$, $n = 9$.

Research model (1) is based on the equation of a multi-factor linear regression, the theoretical and methodological framework of which has been formed in the works of Gackowska et al. (2023) and Lou et al. (2023).

The sign of the humanisation of AI is positive values of the coefficients of regression ($b > 0$). Their totality defines the potential of the humanisation of AI in the digital economy of Russia's regions. The sample contains all 79 regions of Russia for which the necessary data are available. The factual base of the research is provided in the additional materials, in a table form. The proposed hypothesis is deemed proven if model (1) is reliable, and the connection between the factor variables and the resulting variable is statistically significant.

The prospects for the development of the potential for the humanisation of AI in the digital economy of Russian regions are revealed through the determination of the maximum achievable quality of life, through optimisation of the influence of the factor variables on it. The determined regression significance allows offering policy implications for unlocking the potential of the Russian regions' digital economy through the humanisation of AI.

Results

The potential of humanisation of AI in the digital economy of Russian regions. To determine the potential of the humanisation of AI in the digital economy, a regression analysis of the dependence of the quality of life in Russian regions on the factors of the use of automation tools in various directions was performed (Table 1).

As shown in Table 1, the quality of life in Russian regions under the conditions of the digital economy (2022) is by 80.04% explained by the level of the use of automation tools in the business. The regression equation conforms to the significance level of 0.01, at which for 79 observations and 9 factor variables F-table equals 2.6759. Observed F equals 13.6686. It exceeds F-table, therefore the F-test was passed and model (2) is correct and reliable at the significance level of 0.01 (the model's error is minimal). This allows specifying the research model and obtaining the following equation of multiple linear regression:

$$y = 40.3450 - 1.3090 * x_1 + 2.2826 * x_2 - 0.5228 * x_3 + 2.2254 * x_4 - 3.2170 * x_5 - 0.4415 * x_6 + 0.5211 * x_7 + 2.2363 * x_8 - 2.2214 * x_9 \quad (2)$$

In model (2), the constant ($a = 40.3450$) and regression coefficients at factor variables ($b_{1\text{-}8}$) are taken from Table 1 (section "Parameters of the regression model", sub-section "Coefficients"). Results in Table 1 were obtained automatically

Table 1 Regression analysis of the dependence of the quality of life in regions of Russia on the factors of the use of automation tools in the business.

Regression statistics

Multiple R	R-square	Adjusted R-square	Standard error	Number of observations
0.8004	0.6407	0.5938	6.5611	79

ANOVA

	df	*SS*	*MS*	*F observed*	*F-table*	*Significance F*
Regression	9	5295.7149	588.4128	13.6686	2.6759	$2.7*10^{-12}$
Residual	69	2970.3400	43.0484			(level of significance: 0.01)
Total	78	8266.0549				

Parameters of the regression model

	Coefficients	*Standard error*	*t-Stat*	*P-Value*	*Lower 95%*	*Upper 95%*
Constant	40.3450	6.2138	6.4929	$1.1*10^{-8}$	27.9489	52.7411
x_1	−1.3090	1.2665	−1.0335	0.3050	−3.8357	1.2177
x_2	2.2826	0.8932	2.5556	0.0128	0.5008	4.0644
x_3	−0.5228	1.1286	−0.4632	0.6447	−2.7742	1.7286
x_4	2.2254	0.6346	3.5071	0.0008	0.9595	3.4913
x_5	−3.2170	1.4528	−2.2143	0.0301	−6.1153	−0.3187
x_6	−0.4415	0.2473	−1.7854	0.0786	−0.9349	0.0518
x_7	0.5211	0.5537	0.9411	0.3499	−0.5835	1.6257
x_8	2.2363	0.7837	2.8533	0.0057	0.6728	3.7998
x_9	−2.2214	0.5799	−3.8305	0.0003	−3.3783	−1.0645

Source: Calculated and compiled by the author.

with the help of "Regression" function of the analysis package of Microsoft Excel.

In the obtained model (2), only four factor variables demonstrated a positive connection with the resulting variable: x_2, x_4, x_7 and x_8. This means that an increase in the share of organisations that use automation tools for design by 1% leads to an increase in the quality of life in Russian regions by 2.2826 points. An increase in the share of organisations that use automation tools for planning of resources with the help of ERP systems by 1% leads to an increase in the quality of life in Russian regions by 2.2254 points.

An increase in the share of organisations that use automation tools for the provision of access to databases through global information networks, including the Internet, by 1% leads to an increase in the quality of life in Russian regions by 0.5211 points. An increase in the share of organisations that use automation tools for the management of interrelations with customers with the help of CRM systems by 1% leads to an increase in the quality of life in Russian regions by 2.2363 points.

The quantitative and qualitative treatment of results obtained from the position of the correspondence to the SDGs and the contribution to the humanisation of AI in the economy and business is given in Table 2. This allowed determining the potential of the humanisation of AI in the digital economy of Russia's regions with the help of the differentiation of reactions of regional processes in the sphere of improvement of the quality of life through the use of AI in business.

As shown in Table 2, the digital economy of Russian regions has a large potential for the humanisation of AI. In the sphere of corporate ecological responsibility, responsible innovations facilitate the implementation of SDG 9 through the use of automation tools in design. However, R&D does not stimulate responsible innovations, due to which their aggregate contribution to the humanisation of AI is moderate and fragmentary.

The management of automated production and/or individual technical means and technological processes, together with the supply chain management with the help of SCM systems, did not demonstrate the support for responsible production and logistics. At the same time, company resource planning with the help of ERP systems contributes to the achievement of SDG 11. Therefore, responsible production and logistics make a moderate and fragmentary contribution to the humanisation of AI.

In the sphere of corporate social responsibility, no contribution of the development of employees' human potential with the help of training programmes to the achievement of SDG 8 was revealed. Therefore, automation does not contribute to the development of responsible HRM. The generation of financial transactions in electronic form does not support SDG 10. At the same time, there was revealed significant contribution of the provision of access to databases through global information networks, including the Internet and management of interrelations with customers with the help of CRM systems to the achievement of SDG 12. Therefore, the humanisation of AI takes place through responsible marketing and sales.

Policy implications for unlocking the potential of the digital economy of Russian regions through the humanisation of AI. Based on the obtained results of econometric modelling, the prospects for unlocking the potential of humanisation of AI in the Russian regions' digital economy were revealed (Fig. 1).

Figure 1 shows a perspective scenario of unlocking the potential of the humanisation of AI in the Russian regions' digital economy. This scenario proposes one of the possible optimal combinations of the key factor variables that support the humanisation of AI, at which the maximisation (100 points, +111.71%) of the quality of life is achieved. In this scenario, other factor variables are preserved at the 2022 level.

Table 2 The potential of humanisation of AI in the digital economy of Russia's regions.

The purpose from the position of humanisation of the economy and business		Direction for the use of automation tools	Correspondence to the SDGs	Contribution (potential) to humanisation	
				Quantitative measuring	Qualitative measuring
Corporate ecological responsibility	Responsible innovations	R&D	SDG 9	−1.3090	moderate, fragmentary
		Design		2.2826	
	Responsible production and logistics	Management of automated production and/or individual technical means and technological processes	SDG 11	−0.5228	moderate, fragmentary
		Planning of company resources with the help of ERP systems		2.2254	
		Supply chain management with the help of SCM systems		−3.2170	
Corporate social responsibility	Responsible marketing and sales	Generation of financial transactions in the electronic form	SDG 10	−0.4415	has not been identified
		Provision of access to databases through global information networks, including the Internet	SDG 12	0.5211	significant
		Management of interrelations with customers with the help of CRM systems		2.2363	
	Responsible HRM	Development of employees' human potential with the help of training programmes	SDG 8	−2.2214	has not been identified

Source: author.

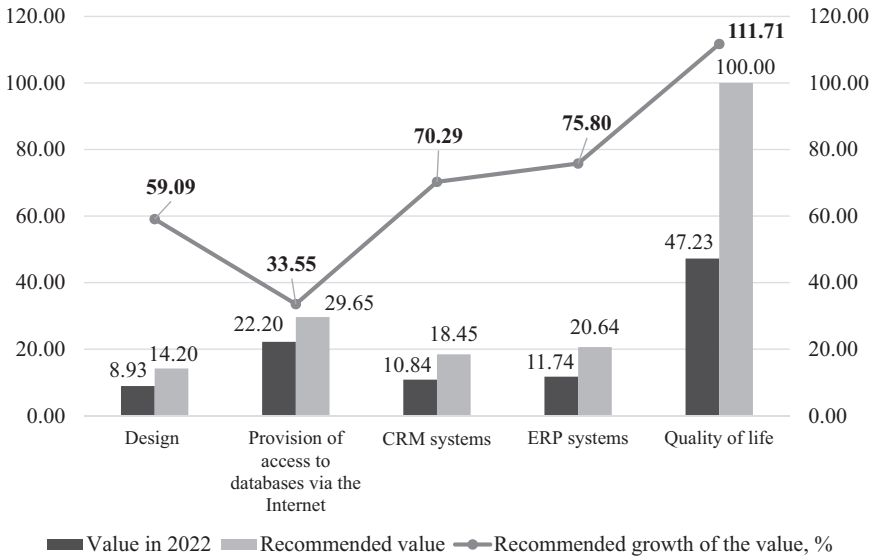

Fig. 1 Prospects for unlocking the potential of humanisation of AI in the digital economy of Russian regions. Source: Calculated and compiled by the author.

Policy implications for unlocking the potential of the digital economy of Russian regions through the humanisation of AI were ranked given the differences in the contribution of the directions of automation to the humanisation of AI. The primary (main) recommendations are as follows:

- Increase in the activity in the use of AI in the design of products and processes of business to create responsible innovations. In the quantitative expression, a growth of 59.09% is recommended;
- Systemic planning of company resources with the help of ERP systems for responsible production and logistics. In the quantitative expression, a growth of 33.55% is recommended;
- More active provision of access to databases through global information networks, including the Internet, for responsible marketing and sales. In the quantitative expression, a growth of 70.29% is recommended;
- The mass transition of companies to the management of interrelations with customers with the help of CRM systems for responsible marketing and sales. In the quantitative expression, a growth of 75.80% is recommended.

Additional recommendations:

- Re-orientation of the use of AI in R&D to create responsible innovations;
- More flexible management of automated production and/or individual technical means and technological processes with the help of the use of AI for the development of responsible production and logistics;
- Supply chain management with the help of SCM systems for

Table 3 Increase of scientific knowledge.

Provisions of the concept of humanisation of AI	Description of provisions in the existing literature	Rethinking of provisions in this paper, which ensures the increase of knowledge
Level of management of humanisation of AI	Micro-level: business (Clarke, 2019; Kumar et al. 2021; Robbins, 2020).	Meso level: region
Key factor (set of factors) that defines humanisation of AI	Corporate management: offer of AI (Cheng et al. 2021; Stahl and Wright, 2018; Vetrò et al. 2019)	The socio-economic environment of region: demand and offer of AI
The logic of selecting the directions for the applications of ways and means of humanisation of AI	Interests of business and its target audience (possibly small audience): Himmelreich and Köhler, 2022; Rakova et al. 2021; Sambasivan and Holbrook, 2019; Wearn et al. 2019)	Interests of most of the region's residents

Source: author.

responsible production and logistics;
- Transition to responsible smart finance;
- Implementation of responsible HRM practices based on AI.

Discussion

This paper's contribution to the literature consists in the specification of scientific provisions of the concept of humanisation of AI through revealing the prospects for the humanisation of AI and the opportunities for the management of this process at the meso level of the digital economy. An increase in scientific knowledge, ensured due to the author's conclusions and results, is demonstrated in comparison with the existing literature (Table 3).

Unlike Clarke (2019), Kumar et al. (2021) and Robbins (2020), this paper substantiated the expedience of managing the humanisation of AI not at the micro level, based on the capabilities of the business, but at the meso level with the use of region's capabilities, which are superior.

Unlike Cheng et al. (2021), Stahl and Wright (2018) and Vetrò et al. (2019), it was substantiated that the key factor that defines the humanisation of AI is not corporate management, which is limited by the offer of AI, but the socio-economic environment of a region, which includes demand and offer of AI.

Unlike Himmelreich and Köhler (2022), Rakova et al. (2021), Sambasivan and Holbrook (2019) and Wearn et al. (2019), a new logic of decision-making was proposed. When selecting the directions for the application of the ways and means of humanisation of AI, it is recommended to be guided not by the interests of the business and its target audience (which might be small) but by the interests of most of the region's residents.

Conclusion

This paper filled a literature gap and answered the research question posed. The following hypothesis was proved by the example of Russian regions: the digital regional economy has a large potential in the sphere of humanisation of AI. The potential of humanisation of AI in the digital economy of Russian regions is defined by responsible innovations, responsible production and logistics, as well as responsible marketing and sales, which contribute to the achievement of SDGs 9–12.

The theoretical significance of this paper is due to its presenting smart region as a socio-economic environment for the humanisation of AI. The scientific novelty of the paper lies in its proposing a new – meso-level – view of the humanisation of AI. The advantages of the new view are, first, the consideration of socio-economic conditions for the humanisation of AI in a region; second, the most accurate identification and correct measuring of the consequences of humanisation of AI for the quality of life in a region.

The practical significance of the research results lies in the fact that the proposed new approach to the humanisation of AI, which involves public administration of this process at the level of a region, allows accelerating the considered process. If the business is interested in humanisation, public administration in the region ensures information support and strengthens market stimuli, directing the initiatives of the business in the directions that are preferable for most of the region's residents.

If the business does not demonstrate a serious intention for the humanisation of AI, and the market does not generate the necessary stimuli, public administration overcomes "market gaps". In the proposed approach, this can take place through standardisation and norming of business initiatives in the sphere of humanisation of AI, as well as through the provision of financial, infrastructural and other stimuli for the humanisation of AI in the activities of the business.

Limitations and future directions

While the developed theoretical provisions of the concept of humanisation of artificial intelligence and opportunities for managing this process at the meso-level of the digital economy are universal, the proposed policy implications for the development of the digital economy potential through humanisation of artificial intelligence are limited by the experience and can be applied mostly in regions of Russia.

To ensure highly-effective practical application of the developed concept of artificial intelligence humanisation and the possibilities of managing this process at the meso-level of the digital economy in regions of other countries, there is a need for additional empirical studies of the experience of these countries' regions.

Thus, in future scientific studies, it is expedience to perform in-depth research on the practical experience of various countries' regions and compile their policy implications, aimed at the development of the digital economy potential through artificial intelligence humanisation. Special attention should be paid to regions in countries of the expanding BRICS bloc and the Eurasian Economic Union (EAEU), since Russia is a member of these integration unions – which simplifies the task of adapting the policy implications, aimed at the development of the digital economy potential through artificial intelligence humanisation, to the specifics of the regions of the above integration unions' countries.

Data availability

Data will be made available on request. The data was taken from open sources: 1. Committee for information technologies of the Volgograd Region (2023). Main directions for the development of artificial intelligence in the sphere of public administration in the

region. URL: https://kit.volgograd.ru/current-activity/cooperation/news/482484/ (data accessed: 18.12.2022). 2. Federal State Statistics Service (Rosstat) (2022). Regions of Russia. Socio-economic indicator – 2021. https://gks.ru/bgd/regl/b21_14p/Main.htm (data accessed: 18.12.2022). 3. Ministry of Natural Resources and Environment of the Russian Federation (2023). "Lukoil-Zapadnaya Sibir" expands the experience of developing the project "Improvement of the effectiveness of the business segment 'Exploration and production'". http://geoinform.ru/lukojl-zapadnaya-sibir-tirazhiruet-opyt-razrabotki-proekta-povyshenie-effektivnosti-biznes-segmenta-geologorazvedka-i-dobycha/ (data accessed: 18.12.2022). 4. President of the Russian Federation (2023). National strategy for the development of artificial intelligence for the period until 2030, adopted by the Decree dated 10 October 2019, No. 490 "On the development of artificial intelligence in the Russian Federation". https://www.economy.gov.ru/material/directions/fed_proekt_iskusstvennyy_intellekt/ (data accessed: 19.09.2023). 5. RIA (2022). Rating of Russian regions by the quality of life – 2021. https://ria.ru/20220214/kachestvo_zhizni-1772505597.html (data accessed: 18.12.2022). 6. Sobyanin, S. (2018). Strategy for the development of Moscow "Smart city – 2030". https://www.mos.ru/upload/alerts/files/3_Tekststrategii.pdf (data accessed: 18.12.2022). 7. President of the Russian Federation (2023). National strategy of the development of artificial intelligence in the Russian Federation for the period until 2030, adopted by the decree dated October 10, 2019 No. 490. http://static.kremlin.ru/media/events/files/ru/AH4x6HgKWANwVtMOfPDhcbRpvd1HCCsv.pdf (data accessed: 17.10.2023).

Received: 31 December 2022; Accepted: 23 November 2023;
Published online: 13 December 2023

References

Abdulqader RA, Zedan MJM (2023) Modelling mechanisms for measurable and detection based on artificial intelligence. IAES International Journal of Artificial Intelligence 12(4):2042–2047. https://doi.org/10.11591/ijai.v12.i4.pp2042-2047

Ahmad SF, Han H, Alam MM, Arraño-Muñoz M, Ariza-Montes A (2023) Impact of artificial intelligence on human loss in decision making, laziness and safety in education. Humanities and Social Sciences Communications 10(1):311. https://doi.org/10.1057/s41599-023-01787-8

Akbarighatar P, Pappas I, Vassilakopoulou P (2023) A sociotechnical perspective for responsible AI maturity models: findings from a mixed-method literature review. International Journal of Information Management Data Insights 3(2):100193. https://doi.org/10.1016/j.jjimei.2023.100193

Akter S, Michael K, Uddin MR, McCarthy G, Rahman M (2022) Transforming business using digital innovations: the application of AI, blockchain, cloud and data analytics. Annals of Operations Research 308(1-2):7–39. https://doi.org/10.1007/s10479-020-03620-w

Antonelli C, Feder C, Quatraro F (2022) Technological congruence and Smart Specialisation: evidence from European regions. Spatial Economic Analysis. https://doi.org/10.1080/17421772.2022.2100921

Budhwar P, Chowdhury S, Wood G, Tung RL, Varma A (2023) Human resource management in the age of generative artificial intelligence: Perspectives and research directions on ChatGPT. Human Resource Management Journal 33(3):606–659. https://doi.org/10.1111/1748-8583.12524

Cheng L, Varshney KR, Liu H (2021) Socially responsible AI algorithms: Issues, purposes, and challenges. Journal of Artificial Intelligence Research 71:1137–1181. https://doi.org/10.1613/JAIR.1.12814

Chong L, Zhang G, Goucher-Lambert K, Kotovsky K, Cagan J (2022) Human confidence in artificial intelligence and in themselves: The evolution and impact of confidence on adoption of AI advice. Computers in Human Behavior 127:107018. https://doi.org/10.1016/j.chb.2021.107018

Clarke R (2019) Principles and business processes for responsible AI. Computer Law and Security Review 35(4):410–422. https://doi.org/10.1016/j.clsr.2019.04.007

Committee for information technologies of the Volgograd Region (2023). Main directions for the development of artificial intelligence in the sphere of public administration in the region. https://kit.volgograd.ru/current-activity/cooperation/news/482484/ (data accessed: 18.12.2022)

Constantinescu M, Voinea C, Uszkai R, Vică C (2021) Understanding responsibility in Responsible AI. Dianoetic virtues and the hard problem of context. Ethics and Information Technology 23(4):803–814. https://doi.org/10.1007/s10676-021-09616-9

Cubric M (2020) Drivers, barriers and social considerations for AI adoption in business and management: a tertiary study. Technology in Society 62:101257. https://doi.org/10.1016/j.techsoc.2020.101257

Deshpande A, Sharp H (2022) Responsible AI Systems: Who are the Stakeholders? AIES 2022 - Proceedings of the 2022 AAAI/ACM Conference on AI, Ethics, and Society, 227–236. https://doi.org/10.1145/3514094.3534187

Federal State Statistics Service (Rosstat) (2022) Regions of Russia. Socio-economic indicator – 2021. https://gks.ru/bgd/regl/b21_14p/Main.htm (data accessed: 18.12.2022)

Francisco M (2023) Artificial intelligence for environmental security: national, international, human and ecological perspectives. Current Opinion in Environmental Sustainability 61:101250. https://doi.org/10.1016/j.cosust.2022.101250

Gackowska M, Cofta P, Śrutek M, Marciniak B (2023) Multivariate linear regression model based on cross-entropy for estimating disorganisation in drone formations. Scientific Reports 13(1):12750. https://doi.org/10.1038/s41598-023-39926-5

Gianni R, Lehtinen S, Nieminen M (2022) Governance of responsible AI: from ethical guidelines to cooperative policies. Frontiers in Computer Science 4:873437. https://doi.org/10.3389/fcomp.2022.873437

Gong X, Li X (2023) Human-robot interactive communication and cognitive psychology intelligent decision system based on artificial intelligence - case study. International Journal of Humanoid Robotics 20(2–3):2240005. https://doi.org/10.1142/S0219843622400059

Hauer T (2022) Importance and limitations of AI ethics in contemporary society. Humanities and Social Sciences Communications 9(1):272. https://doi.org/10.1057/s41599-022-01300-7

Himmelreich J, Köhler S (2022) Responsible AI through conceptual engineering. Philosophy and Technology 35(3):60. https://doi.org/10.1007/s13347-022-00542-2

Hu K-H, Chen F-H, Hsu M-F, Tzeng G-H (2023) Governance of artificial intelligence applications in a business audit via a fusion fuzzy multiple rule-based decision-making model. Financial Innovation 9(1):117. https://doi.org/10.1186/s40854-022-00436-4

İçen M (2022) The future of education utilizing artificial intelligence in Turkey. Humanities and Social Sciences Communications 9(1):268. https://doi.org/10.1057/s41599-022-01284-4

Jagatheesaperumal SK, Bibri SE, Ganesan S, Jeyaraman P (2023) Artificial Intelligence for road quality assessment in smart cities: a machine learning approach to acoustic data analysi. Computational Urban Science 3(1):28. https://doi.org/10.1007/s43762-023-00104-y

Jarrahi MH (2018) Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. Business Horizons 61(4):577–586. https://doi.org/10.1016/j.bushor.2018.03.007

Klochko EN, Fomenko NM, Nekrasova VV (2016) Modeling of network mechanisms of management in the conditions of organizational development. International Review of Management and Marketing 6(1):101–106

Kryshtanovych S, Kornieieva T, Malinovska O, Sokolik L, Bortnikova M (2022) SMART management of sustainable development of the region in the context of globalization. International Journal of Sustainable Development and Planning 17(6):1765–1772. https://doi.org/10.18280/ijsdp.170610

Kumar P, Dwivedi YK, Anand A (2021) Responsible Artificial Intelligence (AI) for Value Formation and Market Performance in Healthcare: the Mediating Role of Patient's Cognitive Engagement. Information Systems Frontiers. https://doi.org/10.1007/s10796-021-10136-6

Lee MK, Grgić-Hlača N, Tschantz MC, Carney M, Inkpen K (2020) Human-centered approaches to fair and responsible AI. Conference on Human Factors in Computing Systems – Proceedings 3375158. https://doi.org/10.1145/3334480.3375158

Li X, He J, Huang Y, Liu X, Dai J (2022) Predicting the factors influencing construction enterprises' adoption of green development behaviors using artificial neural network. Humanities and Social Sciences Communications 9(1):238. https://doi.org/10.1057/s41599-022-01253-x

Lobova SV, Alekseev AN, Litvinova TN, Sadovnikova NA (2020) Labor division and advantages and limits of participation in creation of intangible assets in industry 4.0: humans versus machines. Journal of Intellectual Capital 21(4):623–638. https://doi.org/10.1108/JIC-11-2019-0277

Lou Z, Zhang X, Wu WB (2023) High-dimensional analysis of variance in multivariate linear regression. Biometrika 110(3):777–797. https://doi.org/10.1093/biomet/asad001

Ministry of Natural Resources and Environment of the Russian Federation (2023). "Lukoil-Zapadnaya Sibir" expands the experience of developing the project "Improvement of the effectiveness of the business segment 'Exploration and production'". http://geoinform.ru/lukojl-zapadnaya-sibir-tirazhiruet-opyt-

razrabotki-proekta-povyshenie-effektivnosti-biznes-segmenta-geologorazvedka-i-dobycha/ (data accessed: 18.12.2022)
Maragno G, Tangi L, Gastaldi L, Benedetti M (2023) Exploring the factors, affordances and constraints outlining the implementation of Artificial Intelligence in public sector organizations. International Journal of Information Management 73:102686. https://doi.org/10.1016/j.ijinfomgt.2023.102686
Morimoto J (2022) Intersectionality of social and philosophical frameworks with technology: could ethical AI restore equality of opportunities in academia? Humanities and Social Sciences Communications 9(1):203. https://doi.org/10.1057/s41599-022-01223-3
Murugesan U, Subramanian P, Srivastava S, Dwivedi A (2023) A study of Artificial Intelligence impacts on Human Resource Digitalization in Industry 4.0. Decision Analytics Journal 7:100249. https://doi.org/10.1016/j.dajour.2023.100249
Nabavi E, Browne C (2023) Leverage zones in Responsible AI: towards a systems thinking conceptualization. Humanities and Social Sciences Communications 10(1):82. https://doi.org/10.1057/s41599-023-01579-0
Nakao Y, Strappelli L, Stumpf S, Regoli D, Gamba GD (2022) Towards responsible AI: a design space exploration of human-centered artificial intelligence user interfaces to investigate fairness. International Journal of Human-Computer Interaction. https://doi.org/10.1080/10447318.2022.2067936
Pirrera A, Giansanti D (2023) Human–machine collaboration in diagnostics: exploring the synergy in clinical imaging with artificial intelligence. Diagnostics 13(13):2162. https://doi.org/10.3390/diagnostics13132162
Polak P (2021) Welcome to the digital era—the impact of ai on business and society. Soc 58:177–178. https://doi.org/10.1007/s12115-021-00588-6
Popkova EG, Ekimova KV, Sergi BS (2020) Data set of balance of Russia's regional economy in 2005–2024 based on the methodology of calculation of "underdevelopment whirlpools". Data in Brief 31:105821. https://doi.org/10.1016/j.dib.2020.105821
President of Russian Federation (2022) National strategy of the development of AI for the period until 2030: decree dated 10.10.2019. http://publication.pravo.gov.ru/Document/View/0001201910110003 (data accessed: 18.12.2022)
President of the Russian Federation (2023) National strategy for the development of artificial intelligence for the period until 2030, adopted by the Decree dated 10 October 2019, No. 490 "On the development of artificial intelligence in the Russian Federation". https://www.economy.gov.ru/material/directions/fed_proekt_iskusstvennyy_intellekt/ (data accessed: 19.09.2023)
Rakova B, Yang J, Cramer H, Chowdhury R (2021) Where Responsible AI meets reality: practitioner perspectives on enablers for shifting organizational practices. Proceedings of the ACM on Human-Computer Interaction 5(CSCW1): 3449081. https://doi.org/10.1145/3449081
Rakowski R, Polak P, Kowalikova P (2021) Ethical Aspects of the Impact of AI: the Status of Humans in the Era of Artificial Intelligence. Soc 58:196–203. https://doi.org/10.1007/s12115-021-00586-8
RIA (2022) Rating of Russian regions by the quality of life – 2021. https://ria.ru/20220214/kachestvo_zhizni-1772505597.html (data accessed: 18.12.2022)
Robbins S (2020) AI and the path to envelopment: knowledge as a first step towards the responsible regulation and use of AI-powered machines. AI Society 35(2):391–400. https://doi.org/10.1007/s00146-019-00891-1
Saheb T, Saheb T (2023) Topical review of artificial intelligence national policies: a mixed method analysis. Technol. Soc. 74:102316. https://doi.org/10.1016/j.techsoc.2023.102316
Said N, Potinteu AE, Brich I, Schumm H, Huff M (2023) An artificial intelligence perspective: How knowledge and confidence shape risk and benefit perception. Comput. Hum. Behav. 149:107855. https://doi.org/10.1016/j.chb.2023.107855
Sambasivan N, Holbrook J (2019) Toward responsible AI for the next billion users. Interactions 26(1):68–71. https://doi.org/10.1145/3298735
Segal R, Bradley WP, Williams DL, Correa De Araujo Nunes R, Ng I (2023) Human-machine collaboration using artificial intelligence to enhance the safety of donning and doffing personal protective equipment (PPE). Infect. Control Hospital Epidemiol. 44(5):732–735. https://doi.org/10.1017/ice.2022.169
Sergi BS, Popkova EG, Bogoviz AV, Ragulina JV (2019) Costs and profits of technological growth in Russia. Tech, Smart Cities, and Regional Development in Contemporary Russia, 41–54. https://doi.org/10.1108/978-1-78973-881-020191005
Sobyanin S (2018) Strategy for the development of Moscow "Smart city – 2030". https://www.mos.ru/upload/alerts/files/3_Tekststrategii.pdf (data accessed: 18.12.2022)
Stahl BC (2023) Embedding responsibility in intelligent systems: from AI ethics to responsible AI ecosystems. Sci. Rep. 13(1):7586. https://doi.org/10.1038/s41598-023-34622-w
Stahl BC, Wright D (2018) Ethics and Privacy in AI and big data: implementing responsible research and innovation. IEEE Security Priv. 16(3):26–33. https://doi.org/10.1109/MSP.2018.2701164
Tahri Sqalli M, Aslonov B, Gafurov M, Nurmatov S (2023) Humanizing AI in medical training: ethical framework for responsible design. Front Artif Intellig 6:1189914. https://doi.org/10.3389/frai.2023.1189914
Tomašev N, Cornebise J, Hutter F, Schaul T, Clopath C (2020) AI for social good: unlocking the opportunity for positive impact. Nature Communications 11(1):2468. https://doi.org/10.1038/s41467-020-15871-z
Velinov E, Maly M, Petrenko Y, Denisov I, Vassilev V (2020) The role of top management team digitalization and firm internationalization for sustainable business. Sustainability (Switzerland) 12(22):9502. https://doi.org/10.3390/su12229502
Vetrò A, Santangelo A, Beretta E, De Martin JC (2019) AI: from rational agents to socially responsible agents. Digital Policy, Regulation and Governance 21(3):291–304. https://doi.org/10.1108/DPRG-08-2018-0049
Wamba-Taguimdje S-L, Fosso Wamba S, Kala Kamdjoug JR, Tchatchouang Wanko CE (2020) Influence of artificial intelligence (AI) on firm performance: the business value of AI-based transformation projects. Business Process Management Journal 26(7):1893–1924. https://doi.org/10.1108/BPMJ-10-2019-0411
Wearn OR, Freeman R, Jacoby DMP (2019) Responsible AI for conservation. Nature Machine Intelligence 1(2):72–73. https://doi.org/10.1038/s42256-019-0022-7
Wibisono E (2022) Multilevel governance and Smart Specialization in EU regions: an evidence-based critical review. European Journal of Government and Economics 11(2):234–250. https://doi.org/10.17979/ejge.2022.11.2.9004
Yang C, Bu S, Fan Y, Wang R, Foley A (2023) Data-driven prediction and evaluation on future impact of energy transition policies in smart regions. Applied Energy 332:120523. https://doi.org/10.1016/j.apenergy.2022.120523
Yigitcanlar T, Corchado JM, Mehmood R, Mossberger K, Desouza K (2021) Responsible urban innovation with local government artificial intelligence (Ai): A conceptual framework and research agenda. Journal of Open Innovation: Technology, Market, and Complexity 7(1):1–16. https://doi.org/10.3390/joitmc7010071
Zhai S, Liu Z (2023) Artificial intelligence technology innovation and firm productivity: evidence from China. Finance Research Letters 58:104437. https://doi.org/10.1016/j.frl.2023.104437
Zhao L (2023) International art design talents-oriented new training mode using human-computer interaction based on artificial intelligence. International Journal of Humanoid Robotics 20(4):2250012. https://doi.org/10.1142/S0219843622500128
President of the Russian Federation (2023) National strategy of the development of artificial intelligence in the Russian Federation for the period until 2030, adopted by the decree dated October 10, 2019 No. 490. URL: http://static.kremlin.ru/media/events/files/ru/AH4x6HgKWANwVtMOfPDhcbRpvd1HCCsv.pdf (data accessed: 17.10.2023)

Competing interests
The author declares no competing interests.

Ethical approval
This article does not contain any studies with human participants performed by any of the authors.

Informed consent
Informed Consent was not required as the study did not involve human participants.

Additional information
Correspondence and requests for materials should be addressed to Ksenia V. Ekimova.

Reprints and permission information is available at http://www.nature.com/reprints

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.