Modeling the Influence of the Inclusive Factor on Work Activity: Cognitive Aspect

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Abstract: In the work, a comparative cognitive modeling of two variants of the labor activity system is carried out in a generalized form: the currently active variant and with inclusive specifics. The main concepts of people's labor activity that affect GDP growth are combined into subsystems based on STEP groups of the macroenvironment. The IGLA computer Decision Support System (DSS) was used for modeling. It is shown that the modification of the labor activity system due to the inclusive component increases the confidence index (consonance) to the fuzzy cognitive matrix and insignificantly changes other key parameters of the system. In particular, the main nodes of influence on the target factor – GDP per capita - change slightly. In both considered variants, the depreciation of fixed assets has the greatest negative impact on the target factor. However, the modeled version with an inclusive component in social production provides an increase in the rate of GDP growth per capita by involving potential and capable creative resources of workers in economic relations. The significance of the work carried out lies in the fact that the possibility of modifying the system of human labor activity has been demonstrated in order to test the possibilities of managing its characteristics and to identify the degree of conservatism of system parameters. In conditions of exhaustion of resources of extensive growth of human capital, it is fundamentally important to explore new opportunities to increase the sustainability of society and the efficiency of the national economy. In particular, this can be realized by involving underutilized human resources in the labor activity through the use of inclusive approaches.

1 INTRODUCTION

The dominant trend of people's labor activity in our time is the rapid growth of the share of human capital (HC) in the national wealth of the largest developed and developing economies of the world [1, 2]. Therefore, for the sustainable economic development of the country, it is very important to study not only the established patterns and peculiarities of workers' work, but also the phenomena of inclusive potential in social and socio-personal personalized manifestations.

The scientific category "inclusion", as a theoretical and methodological problem of integrating people with disabilities into productive activities [3-5], is considered by us in the field of increasing the sustainability of society and the development of the country's human capital. The problem of more complete use of professional competencies of people with disabilities for the purpose of resource provision of the labor market acquires a measurable form in models of inclusive development of the economy and education [6, 7].

The works [8, 9] present the experience of economic and mathematical modeling of labor trends on the example of Russia using the method of cognitive modeling. The specifics of this work were aimed at adapting the labor market to the growing demands of globalization and uncertainty. GDP per capita was chosen as the target parameter, although now focusing only on this parameter is no longer sufficient for the comprehensive socio-economic

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development of a country or region. This was done due to the fact that at present, in the conditions of the imposed sanctions, Russia is particularly faced with the task of developing effective medium-term mechanisms to ensure the country's financial independence, restore growth rates, and increase confidence in industry institutions aimed at the effective use of human capital.

At the same time, the most important trend in the growth of the economy of the fourth industrial revolution into the fifth is to increase the sustainability of society's development, in particular, through the use of a system-inclusive concept. The purpose of this research is to study the cognitive model of social development, the stability of which is increased due to inclusively oriented elements.

The main objective of the work is to model the inclusive mechanism of patterns of human labor activity and a comparative analysis of prognostics and assessments of factors affecting the development of human capital.

2 METHODOLOGY

At the first (conceptual) level, a systematic approach is used as the main methodology in this work [10, 11], with its properties and features (integrity, totality, divisibility of the whole into parts, the presence of stable connections between parts, organization, interaction with the external environment, emergence), which allows not only to identify connections, but also to rank them according to the significance of their impact on the entire system of labor activity, taking into account the changed socio-economic conditions and policies.

Since the system of labor activity is complex, dynamic, but at the same time weakly structured, its civilizational behavior can be described at the local level of the established causal relationships of objective practical reality using expert information.

At the second level (mathematical), the study uses a mathematical method – static modeling of system behavior, using a technique proposed by American researcher Axelrod R. [12] and characterized by the fact that the model of the studied complex socio-economic system is created based on expert opinions about its structure, subsystems and connections of Fuzzy Cognitive Map (FCM) [13-14]. To form a cognitive map and model the patterns of people's labor activity, the authors used a computer Decision Support System "IGLA" [15-17]..

3 RESULTS

The initial version of the cognitive matrix of labor activity is presented in [8, 9], and the corresponding matrix is in table 1 in quartiles.

Table 1: Fuzzy cognitive matrix FCM-1, quartiles.

	The concepts influenced																					
Influencing concepts	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
1. Human capital										3												
2. The level of the personnel education	3				3		2											-1				
3. Motivation for education		3		2																		
4. Business education					3		2															
5. Labor productivity										3												
6. Infrastructure	1				3																	
7. Innovative activities								3														
8. Scientific and technological progress					3														3			
9. R&D								3			1								1			
10. GDP per capita						3						-3										2
11. Natural resources										3											2	
12. Depreciation of fixed assets			-3		-3					-3												
13. Macroeconomic stability							2							3				-2				3
14. Financial institutions and markets							3					-2										
15. Expenditure on scientific activities									3													
16. Globalization						2	2													-3		
17. Expenditure on the HVE system		3																				
18. Unemployment rate			2							-2												
19. Strategic programs						2						-3			3		3					3
20. Cross-country barriers										-3						-3						-3
21. Expenditure on the defense capacity									2				3									
22. Social and labor institutions	3					2												-2				

When developing a new version of the FCM-2 system of economic dynamics, focused on inclusive development [3-5], eight concepts that had a relatively weak impact on the system were removed from the FCM-1 cognitive matrix. Instead of them, six new concepts have been added to the system, which take into account the human factor to a greater extent, in particular inclusive economic development, entrepreneurship activity, the role of professional communities and mass education. Taking into account the changes taking place in society at the present time, the factor of efficiency of public administration has also been added. The level of change in the composition of FCM concepts was about 33%, that is, it was not radically changed, but significantly. The changes made are presented in table 2, and the corresponding cognitive matrix FCM-2 is presented in table 3 in quartiles..

Figure 1, 2 shows alpha slices of the mutually positive impact of the concepts of labor activity for FCM-1 and FCM-2 at the cut-off level of 75%. It can be seen that of the six concepts added, only the concept of "Inclusive Development" entered the alpha section (75%), that is, the remaining five have a relatively weak impact on the system.

The main nodes of direct positive influence on the target factor (GDP per capita) are the same in both variants: human capital, labor productivity, natural resources.

Table 2: Variants of labor activity concepts.

Excluded from FCM-2	Added in FCM-2
Social	
Business education	Continuing education
	Quality of secondary education
Technological	
R&D	
Economic	
Macroeconomic stability	Professional communities
Expenditures for science	Entrepreneurship activity
Globalization	Inclusive economic development
Unemployment level	
Political	
Cross-country barriers	Efficiency of public administration
Defense expenditures	

Table 3: Cognitive matrix of inclusively oriented development FCM-2.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Human capital			**2**							**3**							**2**			**2**
2	Personnel education level	**3**					**3**		**2**										**1**		
3	Incentives for education		**3**		**2**																
4	Continuing education	**2**					**2**														
5	Quality of secondary education	**2**	**2**																		
6	Labor productivity										**3**										
7	Infrastructure	**1**					**3**					**1**									
8	Innovative activity						**2**			**3**											
9	Progress in science and technology						**3**											**2**			
10	GDP per capita					**1**		**3**					**-3**		**1**					**2**	
11	Natural resources										**3**					**2**					
12	Depreciation of fixed assets			**-3**			**-3**				**-3**	**-1**									
13	Financial institutions and markets								**3**				**-2**			**2**					
14	Expenditures for the HVE		**3**																		
15	Entrepreneurship activity						**1**		**2**		**1**	**1**					**-1**				
16	Inclusive economic development	**2**				**2**															
17	Strategic programs							**2**	**1**				**-3**		**3**		**3**		**2**	**3**	
18	Efficiency of public administration	**1**				**1**								**2**		**2**					
19	Social and labor institutes	**3**			**2**			**2**									**3**				
20	Professional communities		**2**		**2**								**-1**			**-1**		**2**		**2**	

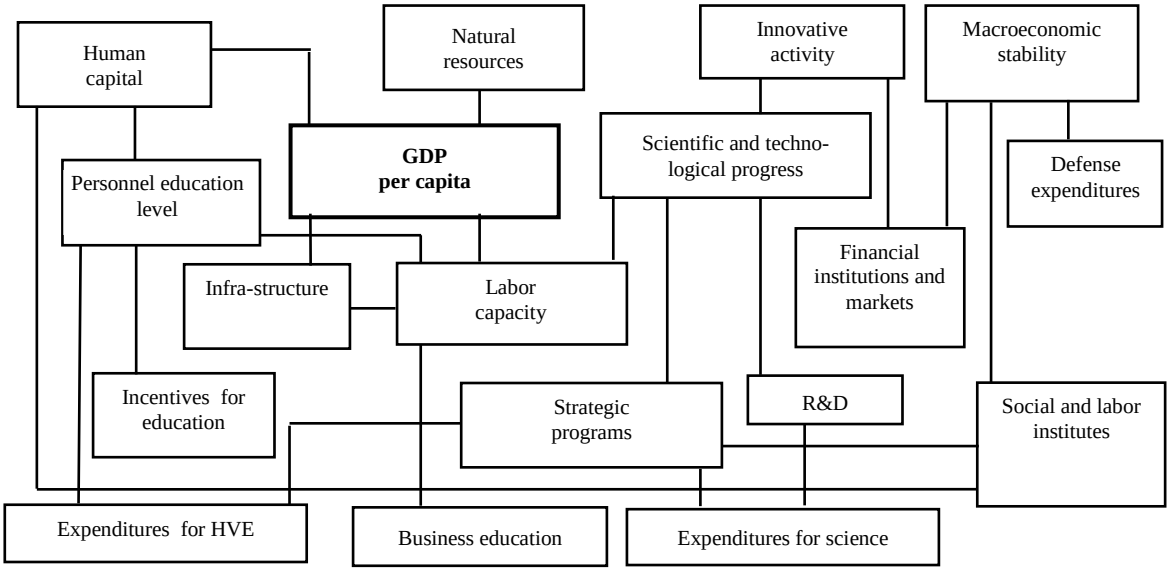

Figure 1: Alpha cross-section of mutually positive influence of FCM-1 concepts.

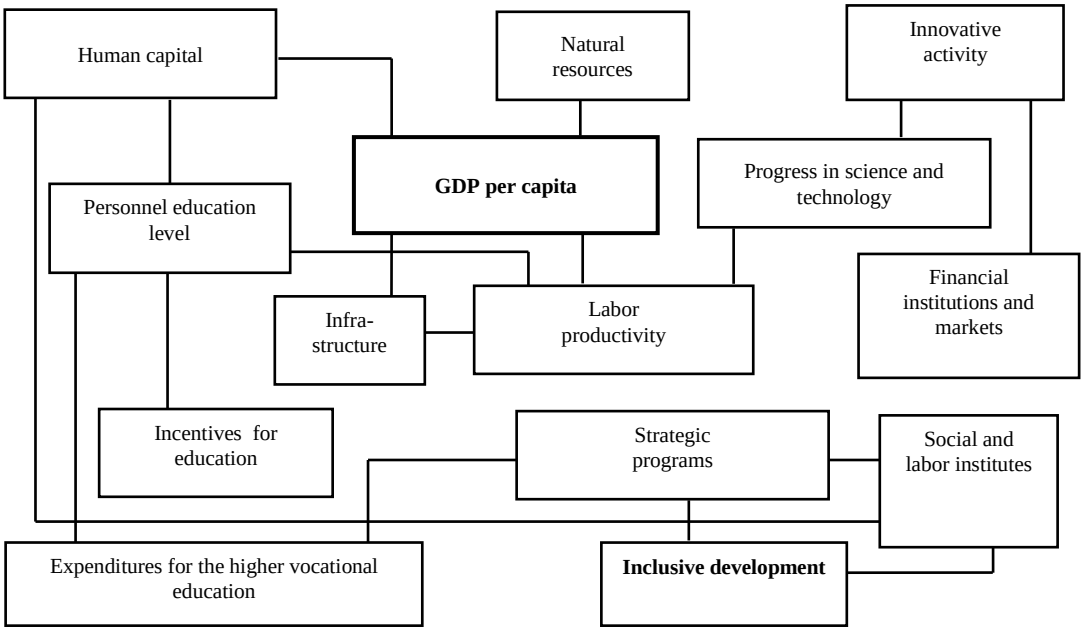

Figure 2: Alpha cross-section of mutually positive influence of FCM-2 concepts.

However, of the two nodes of negative influence in the second variant, only "depreciation of fixed assets" remains, and "cross-country barriers" have been excluded from the system. Also, the main nodes of direct influence on human capital remain unchanged. Inclusive development and other newly added concepts have a relatively weak impact. Innovative activity still influences the target factor through scientific and technological progress and labor productivity. Among the factors that have the greatest positive impact on the system, in variants 1 and 2, almost the same concepts are: "GDP per capita" (47%), "labor productivity" (48-46%), "strategic programs" (44-46%), "human capital" (41-43%).

Of the new factors, only "inclusive economic development" reached the level of 31% and "personnel education" increased from 39 to 41%.

A comparison of the impact consonance (confidence level) for two variants of the labor

activity system showed that FCM-2 is characterized by a noticeably higher level of consonance – the average level is 81% versus 74% for FCM-1. For FCM-2, only entrepreneurship activity was characterized by a low consonance (the impact on the system was 49%, the impact of the system on the concept was 39%). For FCM-1, the lowest consonance corresponded to educational concepts: incentives for education – 47%, business education – 49%, staff education – 53%. The alpha slice of the FCM-1 mutual consonance for the 90% slice level is shown in figure 3, and for FCM-2 – in figure 4 (96% cutoff level). Despite the increase in the cut-off level from 90 to 96%, 70% of concepts entered the alpha section of FCM-2, while only 59% entered the alpha section of FCM-1, which characterizes a higher level of confidence in FCM-2.

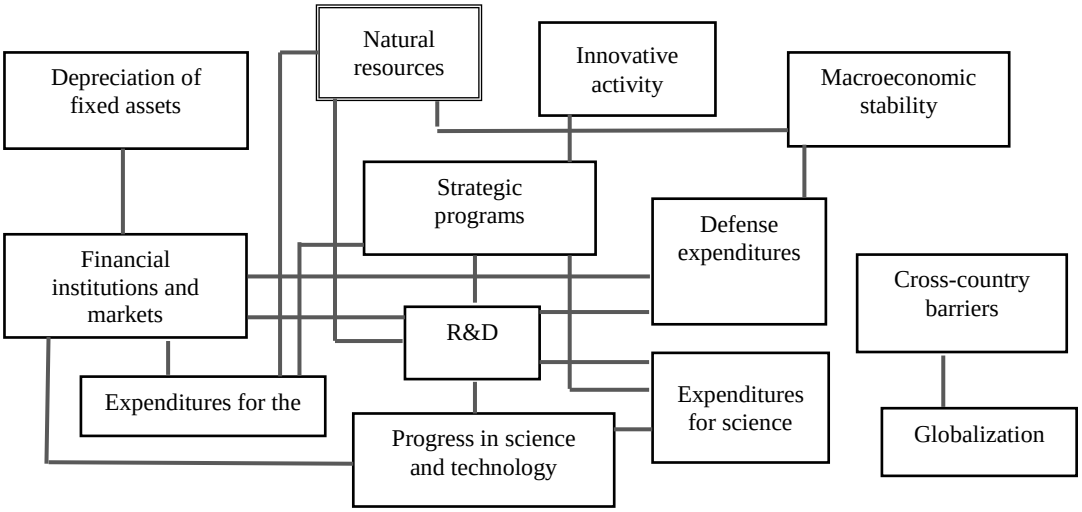

Figure 3: Alpha cross-section of mutual consonance FCM-1 (level – 90%).

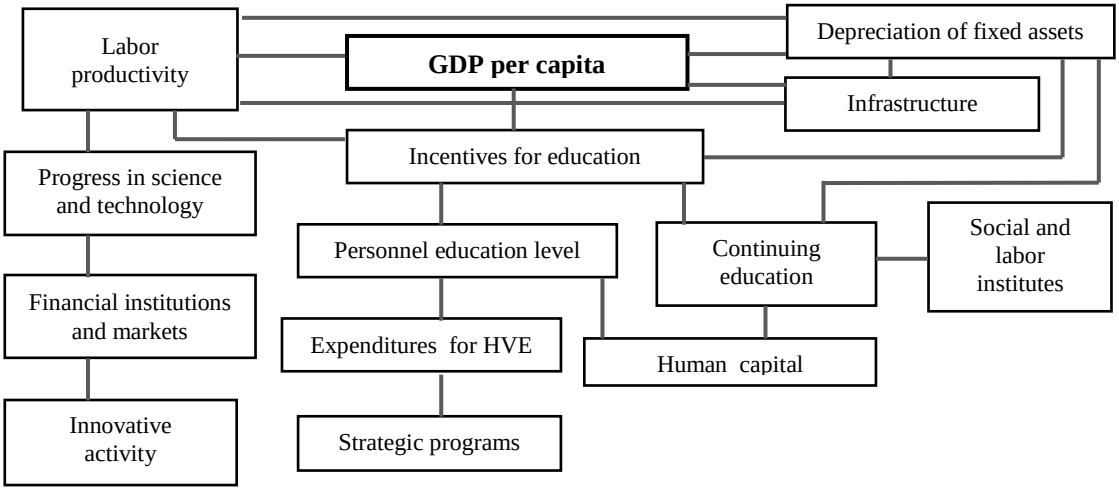

Figure 4: Alpha cross-section of mutual consonance FCM-2 (level – 96%).

A comparison of the alpha slices of the consonance for the two variants of the system shows that they are fundamentally different. The positive difference between FCM-2 is that the target concept (GDP per capita) and such important concepts as labor productivity and human capital are among the concepts with high confidence. Trust in educational concepts has increased dramatically.

The strength of the connection of direct (and indirect) positive influence on the target factor (GDP per capital) in the considered variants is presented in table 4.

Here C is the influence of the concept on the system, S is the influence of the system on the concept. Table 4 shows that in a number of key parameters, the impact of the system on FCM-2 concepts increases significantly compared to FCM-1 (GDP per capita – 7%, human capital – 2% and labor productivity – 3%).

This allows us to conclude that the development of the labor activity system with inclusive specifics is faster than the initial one. Given the exponential nature of GDP per capita growth, this change may have a significant impact on long-term periods..

Table 4: System indicators of cognitive maps.

concepts	FCM-1			FCM-2		
	C, %	S, %	S–C, %	C, %	S, %	S–C, %
Human capital	14	**32**	18	29	**34**	5
Natural resources	22	6	-16	21	11	-10
GDP per capita	17	**35**	18	23	**42**	19
Infrastructure	13	30	17	18	34	16
Labor productivity	14	**39**	25	19	**42**	23
Personnel education level	21	27	6	31	31	0
Incentives for education	20	27	7	27	28	1
Progress in science and technology	27	29	2	26	22	-4
Social and labor institutes	12	29	17	30	23	-7
Strategic programs	30	24	-6	39	26	-13
Innovative activity	23	26	3	23	25	2
Depreciation of fixed assets	-22	-33	-11	-29	-37	-8
Inclusive development				19	20	1

The impact on the system of such an indicator as natural resources is twice as great as the impact of the system on the concept, which corresponds to the capacity of Russian natural resources. The impact of the system on the concept of "strategic programs" is less than the reverse impact, which reflects the relative weakness of the relevant institutions of society.

In both versions of the model, the depreciation of fixed assets has the greatest negative impact on the target factor (GDP per capita).

The study shows that a moderate change in the composition of the system does not lead to a radical change in its basic properties from the point of view of the static characteristics of the cognitive model, but may lead to a change in the level of confidence in a number of concepts of the system and accelerate the growth of the target parameter of GDP per capita.

4 DISCUSSION

The study used only one factor of inclusive development directly, although concepts such as improving education and entrepreneurship activity also indirectly positively affect inclusive development. In the future, it is necessary to model the concepts of inclusive influence more systematically.

In the present paper, a static cognitive model is investigated. In the future, it is necessary to conduct a study of the dynamic behavior of the FCM-2 model.

The work [18] shows that one of the most powerful factors contributing to inclusive development is the international competition of countries striving for world leadership. In the future, it is necessary to include this concept in an inclusive cognitive model. This will contribute to restoring the influence of the international factor on the development of the FCM-2 system, instead of the concepts of "globalization" and "intercountry barriers" excluded in comparison with FCM-1.

5 CONCLUSIONS

A comparative cognitive modeling of two variants of the implementation of the system of human labor activity, as applied to Russia, differing in global (FCM-1) and inclusive (FCM-2) specifics with a difference of about 33 percent of the concepts, was carried out.

The key concepts of the STEP subsystems of the macroenvironment that affect the level of GDP per capita are identified, with an emphasis on the efficiency of the use of human capital and labor productivity. Using the IGLA Decision Support System, fuzzy cognitive matrices were constructed that characterize the established cause-and-effect relationships in the systems under consideration.

The main nodes of direct positive influence on the target factor (GDP per capita) are identified, which do not differ in the two options considered: human capital, natural resources and labor productivity. The depreciation of fixed assets has the greatest negative impact on the value of GDP.

The analysis of the consonance (level of trust) of the two variants of the system showed that the inclusive version of FCM-2 has a higher consonance

– 81% compared to 74% in FCM-1, and in the second variant there is a higher confidence in the key concepts of the system. A comparison of the two options for the implementation of labor activity systems showed that they do not differ fundamentally at the level of key system connections, but the inclusive option has a higher level of consonance.

The study found that the need to develop an inclusive economy is potentially beneficial to all participants in social production and serves to develop the professional and personnel component of society.

REFERENCES

Korchagin, Y.A., 2005. Rossiyskiy chelovecheskiy kapital: faktor razvitia ili degradatsii? [Russian human capital: a factor of development or degradation?]: Monograph. pages 27.

Koritsky, A.V., 2013. Vliyanie chelovecheskogo kapitala na ekonomicheskiy rost [Influence of human capital on economic growth]: Training. 244 pages.

Spence, M., 2011. The Next Convergence: The Future of Economic Growth in a Multispeed World. New York: Farrar, Straus and Giroux.

Avdokushin, E.F., Ivanova, V.N., 2014. Inklyuzivnoe razvitie: osnovnye napravleniya, bazovye predposylki i vozmozhnye ogranicheniya. *Voprosy novoj ekonomiki*, 3(31).

Andrievskaya, V.B., 2015. Effektivnost' gosudarstvennogo upravleniya, kak neobhodimaya predposylka inklyuzivnogo rosta ekonomiki. Problemy sovremennoj ekonomiki. *Idei i idealy*, 1(23), 2.Melnik, M. S., Orekhov, V.D., Pricina, O. S., 2018. Simulation of trends and legislation of labor activities in russia: cognitive approach. *Economic problems and legal practice*, 3. pages 94–101.

Prichina, O., Piel, H., Solodukha, P. Orekhov, V., 2019. Investigation of Managed External- and Intercoming Processes in Conditions of Global and Uncertainty. *Economic and Social Development* (Book of Proceedings). 34th International Scientific Conference on Economic and Social Development. pages 860–872.

Meadows, D. H., 2008. Thinking in Systems. *Chelsea Green Publishing.* pages 213.

Kachala, V.V., 2018. Obshchaya teoriya sistem i sistemnyj analiz. Goryachaya liniya-Telekom. 432 pages.Axelrod, R., 1976. The Structure of Decision: Cognitive Maps of Political Elites. Princeton. NJ: Princeton University Press.. 404 pages.

Kosko, B., 1986. Fuzzy Cognitive Maps. *International Journal of Man-Machine Studies*, 1. pages 65–75.

Avdeeva, Z. K., Kovriga, S. V., Makarenko, D. I., 2007 Cognitive Modeling Approach to Control of Semi-Structured Systems (Situations). *Managing Large Systems*, 16. pages 26–39.

Korostelev, D.A., Lagerev, D.G., Podvesovsky, A.G., 2008. Decision support system based on fuzzy cognitive models "IGLA". In: Proceedings of the Conference in 3 volumes, 3. pges 329-336.

Podvesovsky, A.G., Lagherov, D.G., Korostelev, D., 2018. SSDM " IGLA". Certificate of the Industry Fund of Algorithms and Rosstat Programs, 50200701348.

Podgorskaya, S.V., Podvesovskii, A.G., Isaev, R.A., Antonova, N.I., 2019. Fuzzy cognitive models for socio-economic systems as applied to a management model for integrated development of rural areas. *Business Informatics*, 13, 3. pages 7–19.

Kosorukova, I.V., Kukharenko, O.G., Orekhov, V.D., Piel, H., Karanashev, A.H., 2021. Benefits and drivers of inclusive human capital development. Laplage em Revista (International), 7, 3B. pages 337-355.