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QUALITY OF HUMAN CAPITAL OF DEVELOPING COUNTRIES: MEASURING AND MANAGEMENT

Abstract: *The goal is this paper is to study – thoroughly and systemically – the experience of developing countries in human capital management, determine its most perspective directions, and prepare the methodological recommendations for the most precise measuring and applied recommendations for the most effective management of human capital quality in developing countries. The originality of this paper is due to a new treatment of human capital quality – from the positions of the contribution to socio-economic development. According to a new treatment, an authors' methodology of evaluation of human capital quality in developing countries is developed. Its application allows proving the imperfection of the existing approach to the management of human capital quality in developing countries and low quality in 2020 (below 0.3 for all countries, and 0.07 on average). For developing countries in the period until 2030, it is recommended to focus on the most perspective directions: increase of the level of digital/technological skills (weight: 0.25), an increase of employee training (weight: 0.17), international experience (weight: 0.14), and increase of foreign highly skilled personnel (weight: 0.14). According to the optimistic scenario, the quality of human capital will grow in most directions in developing countries in the period until 2030, which will ensure the increase of output per worker by 37.06%, economic growth rate by 26.92%, the Global Competitiveness Index by 25.07%, and the Quality of Life Index by 13.23%.*

Keywords: *Quality of human capital; Development of education; Developing countries; Measuring of quality; Management of quality*

1. Introduction

In the conditions of the "knowledge economy, human capital has been established as a systemic and important element of economic activities. Acknowledgment of the key role of human capital in the economy raised the manageability of economic processes and systems through an increase of quality of human capital. However, instead of acceleration of the rate of socio-economic development, this caused an "institutional trap", which essence consists in a forced and comprehensive (in all directions at once) development of human capital, which decreases the effectiveness of its management and instead of acceleration, leads to a slowdown of the rate of economic systems' development.

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The economic essence of the described "institutional trap" consists of the following: implementation of each available direction of human capital quality management requires substantial investments. However, the return from investments among these directions is much differentiated. For example, the experience of countries of OECD (2021) shows that unemployment among the population with secondary education (upper below secondary) among the economically active population (aged 25 – 64) is 9.3% on average. Receipt of secondary vocational education (below secondary) allows reducing unemployment down to 5.4%, and higher education (tertiary) – down to 3.8%.

Therefore, an advantage in the form of the decrease of unemployment (and the related increase of quality of life and living standards, acceleration of economic growth, etc.) is much higher during the popularization of higher education as compared to alternative secondary vocational education. The experience of developed countries also demonstrates that digital competencies are in large demand in the labor market. Their mastering by employees allows companies for more active implementation of the leading technologies and ensures the increase of output per worker.

The problem is as follows: developing countries are opposed to developed countries, which have the largest digital competitiveness. While it is considered that Industry 4.0 is formed only in developed countries, developing countries develop digital competencies with their employees to a lesser extent (expecting a low return from digital competencies, due to limited possibilities of their practical application). Developing countries do not refuse their employees' mastering digital competencies, but do not make this practice widespread – i.e., they place investments, but refuse the return. Instead of digital competencies, developing countries popularize general and secondary vocational education, experience a larger return from investments in education in these spheres.

Due to this, the gap between the levels of development of human capital between developed and developing countries further grows. The following hypothesis is offered here: digital competencies in developing countries are in the same large demand as in developed countries. The existing approach to human capital quality management in developing countries (which envisages the primary focus on employees with the basic skills in the labor market with the insufficient attention to the leading – digital – skills) stimulates their underrun from developed countries by the level of human potential and decreases the return from investments in the development of human capital. There is a need for a new approach to the management of human capital quality in developing countries, which would ensure the primary implementation of the most effective directions of this management.

The goal of this paper is to study the experience of developing countries in human capital management, determine its most perspective (from the positions of the largest return from investments in education) directions, and develop the methodological recommendations for the most precise measuring and applied recommendations for the most effective (from the positions of return from investments) management of human capital quality in developing countries.

The originality of this paper is ensured by a new treatment of human capital quality – not from the positions of the level of its development in all available directions (the existing treatment), but from the positions of the contribution to socio-economic development, i.e., the scale of implementing the directions of human capital development that are in the largest demand in the economy (for maximizing the return from investments in education). The uniqueness of this paper consists in the systemic consideration of the experience of developing countries and development of the proprietary scientific and methodological approach to measuring and management of human capital quality in

developing countries according to its new treatment – on the most perspective directions, which are determined by the level of significance for socio-economic development.

This introduction is followed by the literature review and description of the research methodology and its results: 1) comparative analysis of the directions human capital quality management by the contribution to socio-economic development and selection of the most perspective directions; 2) assessment of the quality of human capital in developing countries in 2020 according to the proprietary methodology, from the positions of the return from investments in education; 3) Scenario analysis of the perspectives of human capital quality management in developing countries for the period until 2030.

In the Discussion section, we determine the target landmarks for the maximum improvement of capital quality management in developing countries for the period until 2030; i.e., we compile an optimistic scenario and substantiate its advantages, and determine the limitations of socio-economic development of developing countries based on human capital quality management. Conclusions sum up the research.

2. Literature Review

Quality – as a characteristic of human capital – is studied in the works Bogoviz (2020), Bogoviz et al. (2019a), Bogoviz et al. (2019b), Bratukhina et al. (2020), Cheglakova et al. (2020), Dewi et al. (2021), Fahrurrozi et al. (2021), Legowo et al. (2020), Lysova et al. (2020), Nabokikh et al. (2020), and Popkova and Giyazov (2021). The content analysis of the above works has shown that the quality of human capital is treated in them from the position of the level of its development in all available directions.

A drawback of the existing treatment of human capital quality is as follows: using it as a landmark, countries have to develop human capital in all directions at once, regardless of the demand in the economy, which reduces the effectiveness of education management (leads to a low return from the investments in education).

This problem is especially urgent in developing countries, since they are peculiar for a vivid deficit of investment resources. The attempts of developing countries to increase the return from investments in education lead to a refusal from employees' mastering the leading skills, which further increases their underrun by human potential from developed countries. That is why there is a need for an alternative approach to the treatment and management of the quality of human capital, which absence is the first research gap.

The experience of developing countries in the management of human capital quality is studied in the works Allenykh et al. (2019), Dun et al. (2020), Fokina (2020), Inshakova and Litvinov (2020), Karanina (2020), Katargin (2019), Nikolaichuk et al. (2019), Hierarchical synthesis et al. (2021), Popkova et al. (2021), Popkova and Sergi (2020), Popkova et al. (2020), Sillaste (2019), Smetanina (2020), Sozinova (2020), and Vanchukhina et al. (2019).

A large number and diversity of the existing works allow stating that the level of elaboration of the developing countries' experience in managing the quality of human capital is high. Nevertheless, the existing publications consider the experience of developing countries in a limited way, and these countries are studied separately. This has caused the fragmentary character of the study of the developing countries' experience in managing the quality of human capital (which is the second research gap) and the necessity for its systematization.

This paper is to fill the above two research gaps through a complex study of the experience of development of human capital in developing countries and the preparation of an alternative approach to the treatment, measuring, and management of its quality in

these countries, in view of their specifics, to maximize the return from investments in education.

3. Materials and methodology

In this paper, we offer an alternative treatment of the quality of human capital – from the positions of the contribution of human capital to socio-economic development, i.e., the scale of implementing the directions of development of human capital which are in the largest demand in the economy (to maximize the return from investments in education). As a result of systematization of the existing knowledge and statistical data, we distinguish four directions of human capital quality management:

- Direction 1 – development of the basic skills in the labor market: its indicators are Educational assessment PISA - Math, employee training, and higher education achievement;
- Direction 2 – internationalization of the labor market: its indicators are international experience and foreign highly-skilled personnel;
- Direction 3 – provision of gender neutrality of the labor market: its indicators are women with degrees and female researchers;
- Direction 4 – development of the leading skills of employees in the labor market: its indicators are total R&D personnel per capita, scientific and technical employment, and digital/technological skills.

According to the new treatment, we have developed a proprietary methodology of evaluating human capital quality in developing countries, which envisages the use of T.L. Saaty's hierarchy process and the following algorithm.

At the first stage, correlation analysis is used to determine the connection between the indicators of implementing the distinguished directions of human capital quality management (x) and the results of in the sphere of socio-economic development, the contribution to which is to be made by human capital (y): labor efficiency, economic growth rate, the Global Competitiveness Index, the Quality of Life Index, and ranking of happiness.

The indicators of implementing the distinguished directions of human capital quality management are measured in positions; and the indicators of the results in the sphere of socio-economic development are measured in percent and points. That's why we seek the negative coefficients of correlation. The absence of negative coefficients of correlation with all results demonstrates a low demand for the direction of human capital quality management in developing countries. Negative coefficients of correlation (r) with the results are summed up for each direction. A sum of the obtained values for all directions is found ($\sum r$). Then, the weights (weight coefficients: β) are calculated according to the formula: $\beta=r/(\sum r$. The sum of all weight equals one ($\sum\beta=1$).

At the second stage, the assessment of homogeneity (δ) takes place. For this, we determine the ratio of the best value (1st position) to the value of each indicator (x) according to the following formula: $\delta=1/x$. At the third stage, weighing takes place. The weighted values (λ) are found through determining the product of homogeneous values (δ) and weights (β) according to the following formula: $\lambda=\delta*\beta$. At the fourth stage, the hierarchical synthesis (IS) is performed. For this, we calculate the sum of all weighted values according to the following formula: $IS=\sum\lambda$. The treatment of the obtained values of IS is performed according to the following scale:

- $IS\geq0.8$: very high quality of human capital;
- $0.6\leq IS<0.8$: high quality of human capital;
- $0.3\leq IS<0.6$: moderate quality of human capital;

- IS<0.3: low quality of human capital.

We have created a sample of the top 10 developing countries by the value of the human development index in 2020 (Figure 1), which includes developing countries with the available values for other studied indicators.

The empirical data for the research are given in Tables 1-2.

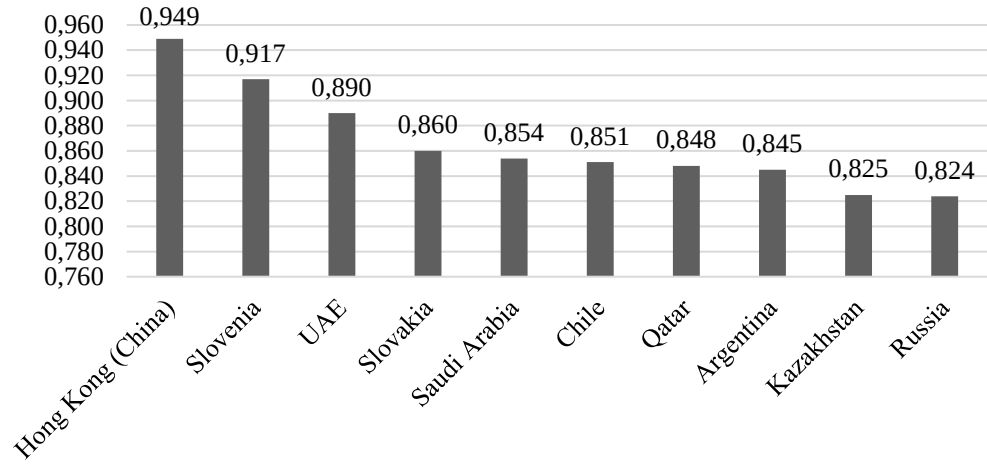

Figure 1. Sample of top 10 developing countries by the value of the human development index in 2020, points 1-100.
Source: compiled by the authors based on UNDP (2021).

Table 1. Results in the sphere of socio-economic development, the contribution to which is to be made by human capital in countries of the sample in 2020.

	Output per worker (GDP constant 2011 international $ in PPP)	Gross domestic product, constant prices, percent change (Economic growth rate, %)	Global Competitiveness Index 4.0	Quality of Life Index	Ranking of happiness, score
	y_1	y_2	y_3	y_4	y_5
Hong Kong (China)	118.705	4.289	83.1	99.34	5.295
Slovenia	82.608	3.710	70.2	168.20	6.462
UAE	98.205	3.092	75.0	156.03	6.458
Slovakia	68.993	4.675	66.8	149.68	6.519
Saudi Arabia	119.151	2.931	70.0	147.37	6.560
Chile	52.054	6.174	70.5	99.90	6.151
Qatar	123.661	2.357	72.9	154.58	-
Argentina	52.790	5.839	57.2	110.50	5.901
Kazakhstan	56.446	3.196	62.9	96.42	6.168
Russia	56.659	3.763	66.7	101.67	5.495

Source: compiled by the authors based on ILOSTAT (2021), International Monetary Fund (2021), Numbeo (2021), Sustainable Development Solutions Network (2021), World Economic Forum (2021).

Table 2. Indicators of implementing the given directions of human capital quality management in countries of the sample in 2020.

Country	Employees with basic skills in the labor market			Internationalization of the labor market		Gender neutrality of the labor market		Employees with leading skills in the labor market		
	Educational assessment PISA - Math	Employee training	Higher education achievement	International experience	Foreign highly-skilled personnel	Women with degrees	Female researchers	Total R&D personnel per capita	Scientific and technical employment	Digital/technological skills
	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
Hong Kong (China)	3	30	9	4	14	-	-	31	3	13
Slovenia	13	18	34	42	53	32	43	15	27	24
UAE	45	14	47	2	3	19	39	32	35	17
Slovakia	31	62	38	58	61	42	21	35	41	35
Saudi Arabia	58	34	36	11	13	37	52	-	-	15
Chile	49	47	43	19	8	45	36	52	47	42
Qatar	50	10	57	5	7	-	38	48	53	8
Argentina	56	53	37	30	60	29	2	42	56	49
Kazakhstan	47	21	1	36	31	1	3	51	46	55
Russia	29	55	5	61	55	3	23	24	43	46
Arithmetic mean	38.10	34.40	30.70	26.80	30.50	26.00	28.56	36.67	39.00	30.40
Standard deviation	18.56	18.77	19.01	22.08	24.27	16.84	17.53	12.67	16.10	17.04

* "-" – no data in the source. During the regression analysis, these cells are assigned the worst values among the given values (63rd position).
Source: calculated and compiled by the authors based on IMD (2021).

To test the offered hypothesis, we perform the scenario analysis of the perspectives of human capital quality management in developing countries for the period until 2030. For this, we use regression analysis to determine the dependencies of the results in the sphere of socio-economic development (y) on the directions human capital quality management (x), with which the negative coefficients of correlation were received. The formal model of this research is as follows:

$$y_i=a_i+\sum b_j*x_j \quad (1)$$

where y_i – results in the sphere of socio-economic development (i=1,…5);

a_i – constant (i=1,…5);

b_j – regression coefficient (j=1,…10);

x_j – direction of human capital quality management (j=1,…10).

Using the Monte Carlo method and based on arithmetic means and standard deviations, calculated in Table 2, we compile the forecasts of the change of the directions of human capital quality management for the period until 2030. For this, 100 random numbers are generated, and histograms of threir normal distribution are compiled. A pessimistic scenario envisages the selection of the most probable forecast values, and a realistic scenario envisages the selection of the best forecast values with the probability that exceeds 10% (i.e., very probable). The forecast values x are inserted in regression equation (1). Thus, we determine the

consequences for the results in the sphere of socio-economic development.

4. Results

4.1 A comparative analysis of the directions of human capital quality management by the contribution to socio-economic development and the selection of the most perspective directions

The comparative analysis of the directions of human capital quality management by the contribution to socio-economic development and the selection of the most perspective directions for assigning a weight coefficient to each direction (with the help of correlation analysis) is performed in Table 3.

As shown in Table 3, digital/technological skills demonstrate a negative correlation with output per worker (-95.33%), the Global Competitiveness Index (-77.95%), the Quality of Life Index (-62.27%), and the ranking of happiness (-15.895), i.e., almost with all results of in the sphere of socio-economic development (except for economic growth rate). The sum of negative values of the coefficients of correlation of digital/technological skills with all results of socio-economic development is as follows: -95.33-77.95-62.27-15.89=-251.45. The sum of negative coefficients of correlation for all directions is as follows: -995.51. The weight of digital/technological skills is as follows: -251.45/-995.51=0.25.

Table 3. Correlation between the directions of human capital quality management with the results of socio-economic development in developing countries of the sample in 2020, %.

Correlation, %	Educational assessment PISA - Math	Employee training	Higher education achievement	International experience	Foreign highly-skilled personnel	Women with degrees	Female researchers	Total R&D personnel per capita	Scientific and technical employment	Digital/technological skills
Output per worker (GDP constant 2011 international $ in PPP)	-14.33	-59.68	30.02	-69.35	-59.92	22.55	72.18	-16.07	-50.56	-95.33
Gross domestic product, constant prices, percent change (Economic growth rate, %)	-1.50	70.30	1.08	23.60	33.18	51.26	-37.80	18.51	10.51	52.79
Global Competitiveness Index	-54.04	-44.66	6.03	-58.08	-64.82	21.75	85.74	-24.56	-77.23	-77.95
Quality of Life Index	1.59	-40.07	67.14	-11.59	-3.80	40.85	65.02	-40.16	0.10	-62.27
Ranking of happiness	43.86	-23.00	66.37	-0.72	-6.46	55.15	52.59	5.38	35.34	-15.89
Sum of negative values	-55.54	-167.41	0	-139.73	-135.00	0	-37.80	-80.79	-127.79	-251.45
	Total: -995.51 (-55.54-167.41-139.73-135-37.8-80.79-127.79-251.45)									
Weight	0.06	0.17	0.00	0.14	0.14	0	0.04	0.08	0.13	0.25

Source: authors

Similarly, the weights for all other directions (and indicators) are calculated. As is shown in Table 3, higher education achievement and women with degrees do not demonstrate positive coefficients of correlation with any result; therefore, these indicators do not contribute to socio-economic development of developing countries. The ratio of arithmetic means and obtained weights for the indicators of human capital quality in developing countries of the sample in 2020 is shown in Figure 2.

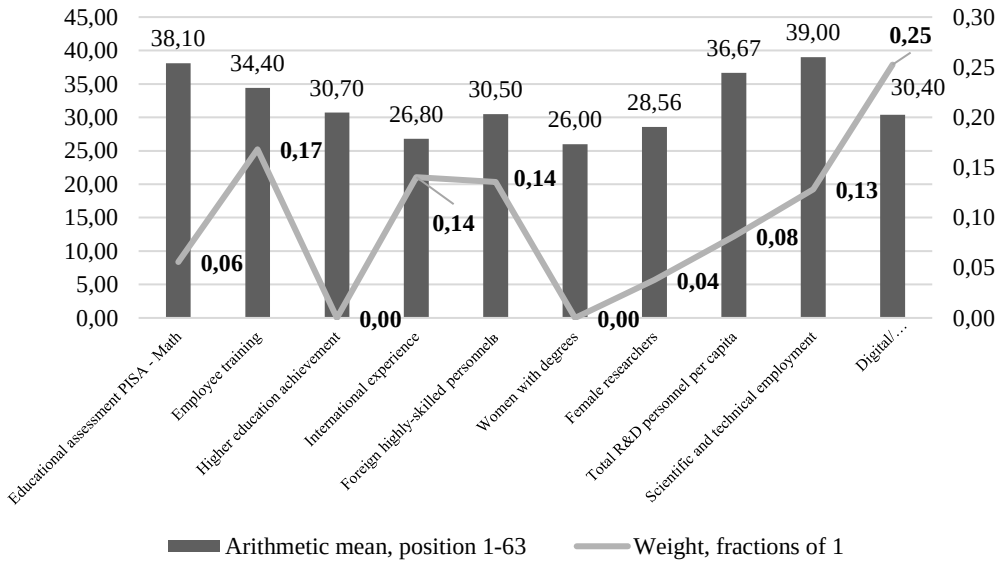

Figure 2. Ratio of arithmetic means and weights for the indicators of human capital quality in developing countries of the sample in 2020.
Source: authors

As shown in Figure 2, direction 4 – development of the leading skills of employees in the labor market is most significant in developing countries: the sum of weight coefficients of its indicators equals 0.46 (0.08+0.13+0.25). However, the arithmetic mean of the values of the indicators of human capital quality for this direction is the lowest one (out of four given directions) – 35.36th position ((36.67+39+30.40)/3). By the most significant (weight: 0.25) indicator – digital/technological skills – arithmetic mean equals 30,40th position, which, for example, is worse than the arithmetic mean for women with degrees (26th position), though their contribution (and weight) equal zero.

The second significant direction 2 is internationalization of the labor market; its weight equals 0.28. The arithmetic mean of the indicators for this direction is 28.65th position. The third significant direction 1 is development of the basic skills of employees in the labor market, its weight equals 0.22, arithmetic mean of the indicators – 34.40th position. The least significant direction 3 is the provision of gender neutrality of the labor market (weight: 0.04, i.e., almost zero), though arithmetic mean for this direction is the best among all four directions – 27.28th position.

Thus, the performed comparative analysis of the directions of human capital quality management by the contribution to socio-economic development has shown that the most perspective direction is development of the leading skills of employees in the labor market (direction 4). It has also been determined that developing countries pay more attention to an insignificant direction 3 – provision of gender neutrality of the labor

market – with small attention to the most perspective direction 1, which is a sign of the imperfection (low return from investments) of the practice of human capital quality management and which confirms the offered hypothesis.

4.2 Evaluation of the quality of human capital in developing countries in 2020 according to the proprietary methodology, from the positions of the return from investments in education

The evaluation of the quality of human capital in developing countries in 2020 – according to the proprietary methodology and from the positions of return from investments in education – based on the weight coefficients from Table 3 is performed in Tables 4-5.

Let us consider an example of calculations in Table 4. In Russia, digital/technological skills are at the 46th position in 2020 - $\delta=1/46=0.02$. Similarly, we calculate homogeneous values for other countries and indicators.

Let us consider an example of calculations in Table 5. In Russia, digital/technological skills in 2020 are assigned the value 0.02 ($\delta=0.02$) during the evaluation of homogeneity, and the weight of this indicator in Table 3 is assessed at 0.25 ($\beta=0.25$).

Then, $\lambda=\delta*\beta=0.02*0.25=0.054$. Similarly, the weighted values for other countries and indicators are calculated.

Table 4. Evaluation of homogeneity

Country	Educational assessment PISA - Math	Employee training	Higher education achievement	International experience	Foreign highly-skilled personnel	Women with degrees	Female researchers	Total R&D personnel per capita	Scientific and technical employment	Digital/technological skills
Hong Kong (China)	0.33	0.03	0.11	0.25	0.07	0.02	0.02	0.03	0.33	0.08
Slovenia	0.08	0.06	0.03	0.02	0.02	0.03	0.02	0.07	0.04	0.04
UAE	0.02	0.07	0.02	0.50	0.33	0.05	0.03	0.03	0.03	0.06
Slovakia	0.03	0.02	0.03	0.02	0.02	0.02	0.05	0.03	0.02	0.03
Saudi Arabia	0.02	0.03	0.03	0.09	0.08	0.03	0.02	0.02	0.02	0.07
Chile	0.02	0.02	0.02	0.05	0.13	0.02	0.03	0.02	0.02	0.02
Qatar	0.02	0.10	0.02	0.20	0.14	0.02	0.03	0.02	0.02	0.13
Argentina	0.02	0.02	0.03	0.03	0.02	0.03	0.50	0.02	0.02	0.02
Kazakhstan	0.02	0.05	1.00	0.03	0.03	1.00	0.33	0.02	0.02	0.02
Russia	0.03	0.02	0.20	0.02	0.02	0.33	0.04	0.04	0.02	0.02

Source: authors

Hierarchical synthesis for Russia is calculated in the following way:

$IS=\sum\lambda=0.0021+0.0031+0+0.0023+0.0025+0+0.0017+0.0033+0.0030+0.0054=0.02$.

Hierarchical synthesis for all developing countries of the sample in 2020 is demonstrated in Figure 3.

Table 5. Weighted values.

Country	Educational assessment PISA - Math	Employee training	Higher education achievement	International experience	Foreign highly-skilled personnel	Women with degrees	Female researchers	Total R&D personnel per capita	Scientific and technical employment	Digital/technological skills
Weight	**0.06**	**0.17**	**0.00**	**0.14**	**0.14**	**0.00**	**0.04**	**0,08**	**0,13**	**0,25**
Hong Kong (China)	0.0200	0.0057	0.0000	0.0350	0.0100	0.0000	0.0006	0.0026	0.0433	0.0192
Slovenia	0.0046	0.0094	0.0000	0.0033	0.0026	0.0000	0.0009	0.0053	0.0048	0.0104
UAE	0.0013	0.0121	0.0000	0.0700	0.0467	0.0000	0.0010	0.0025	0.0037	0.0147
Slovakia	0.0019	0.0027	0.0000	0.0024	0.0023	0.0000	0.0019	0.0023	0.0032	0.0071
Saudi Arabia	0.0010	0.0050	0.0000	0.0127	0.0108	0.0000	0.0008	0.0013	0.0021	0.0167
Chile	0.0012	0.0036	0.0000	0.0074	0.0175	0.0000	0.0011	0.0015	0.0028	0.0060
Qatar	0.0012	0.0170	0.0000	0.0280	0.0200	0.0000	0.0011	0.0017	0.0025	0.0313
Argentina	0.0011	0.0032	0.0000	0.0047	0.0023	0.0000	0.0200	0.0019	0.0023	0.0051
Kazakhstan	0.0013	0.0081	0.0000	0.0039	0.0045	0.0000	0.0133	0.0016	0.0028	0.0045
Russia	0.0021	0.0031	0.0000	0.0023	0.0025	0.0000	0.0017	0.0033	0.0030	0.0054

Source: authors.

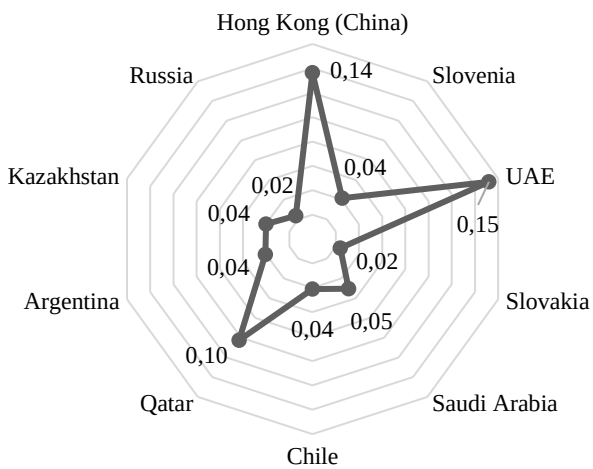

Figure 3. Hierarchical synthesis
Source: authors

According to the obtained values of hierarchical synthesis, the quality of human capital in all developing countries of the sample in 2020 is low (less than 0.3 for all countries). The highest quality of human capital among countries of the sample is observed in the UAE (0.15) and Hong Kong (0.14), as well as Qatar (0.10). Low quality is due to the following: during human capital management in developing countries, the main attention is paid to insignificant directions with insufficient attention to the most perspective and significant directions.

4.3 Scenario analysis of the perspectives of human capital quality management in developing countries for the period until 2030

To determine the perspectives of human capital quality management in developing countries for the period until 2030, we perform scenario analysis. Based on the data from Table 1-2, we find the regression dependencies of the results in the sphere of socio-economic development (y) on the directions of human capital quality management, with which the negative coefficients of correlation were obtained:

$$\begin{cases} y_1=114.79-0.28x_2+0.05x_4+0.305+0.85x_8-0.36x_9-1.69x_{10} \\ y_2=5.11-0.01x_1-0.02x_7 \\ y_3=87.47-0.13x_1+0.07x_2+0.07x_4-0.23x_5-0.02x_8-0.10x_9-0.18x_{10} \\ y_4=145.93-0.68x_2+0.64x_4+0.59x_5+0.55x_8-1.68x_{10} \\ y_5=4.05+0.02x_2-0.0002x_4+0.003x_5+0.03x_{10} \end{cases} \quad (2)$$

According to the system of equations (2), ranking of happiness (y_2) cannot be optimized by means of human capital quality management in developing countries, since there are no statistically significant (b_1 at x_4=0.0002 moves toward zero) negative coefficients of regression. Based on arithmetic means and standard deviations from Table 2, we use the Monte Carlo method to create the following histograms of normal distribution of the forecast values of the indicators of human capital quality in developing countries for the period until 2030 (Figures 4-7).

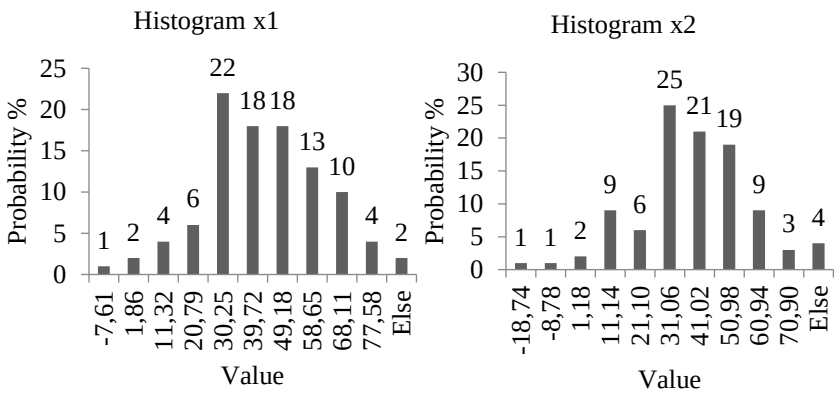

Figure 4. Histograms of normal distribution of the forecast values of the indicators of human capital quality: x_1 and x_2
Source: authors

As shown in Figure 4, the most probable and the lowest of the forecast values with the probability that exceeds 10% - x_1 and x_2 – coincide. Therefore, in the case of the pessimistic and the realistic scenarios, the educational assessment PISA – Math (x_1) in developing countries of the sample will be at the 30.25th position (on average) with the probability of 22% (by 2030). Employee training (x_2) will be at the 31.06th position with the probability of 25%.

As shown in Figure 5, in the case of the pessimistic scenario, international experience (x_4) will be at the 28.43rd position with the probability of 18%, and in the case of the realistic scenario – at the 20.20th position with the probability of 11%. In the case of the pessimistic scenario, foreign highly skilled

personnel (x_5) will be at the 36.08th position with the probability of 25%, and in the case of the realistic scenario – at the 8.48th position with the probability of 11%.

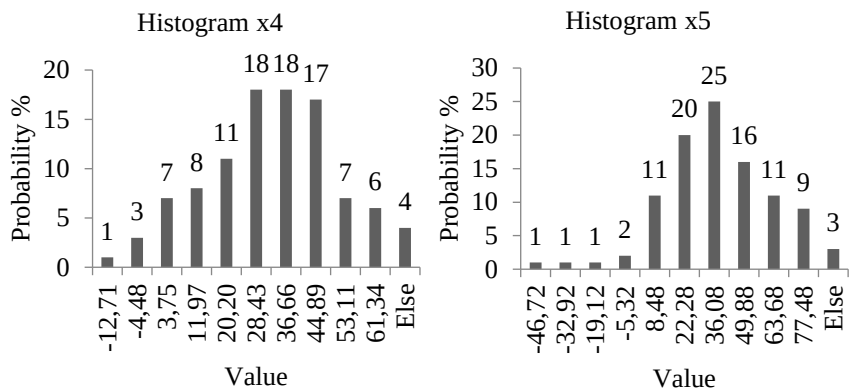

Figure 5. Histograms of normal distribution of the forecast values of the indicators of human capital quality: x_4 and x_5
Source: authors

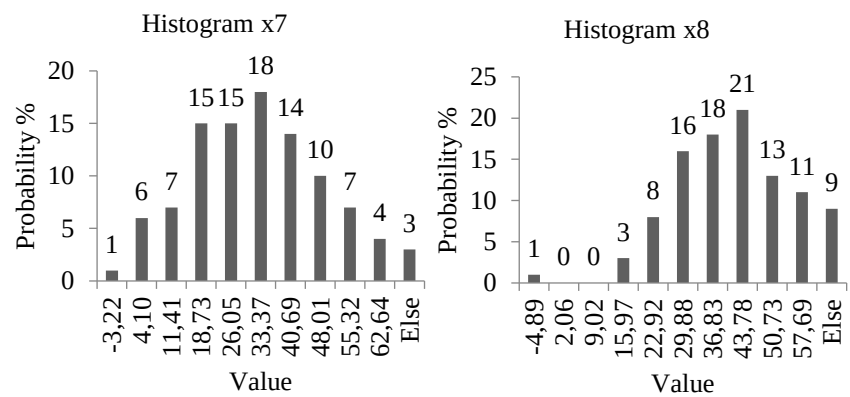

Figure 6. Histograms of normal distribution of the forecast values of the indicators of human capital quality: x_7 and x_8
Source: authors

As shown in Figure 6, in the case of the pessimistic scenario, female researchers (x_7) will be at the 33.37th position (probability - 18%); in the case of the realistic scenario – at the 18.73rd position (probability - 15%). In the case of the pessimistic scenario, total R&D personnel per capita (x_8) will be at the 43.78th position (probability of 21%); in the case of the realistic scenario – at the 29.88th position (probability - 16%).

As shown in Figure 7, in the case of the pessimistic scenario, scientific and technical employment (x_9) will be at the 36.12th position (probability - 20%); in the case of the realistic scenario – at 29.07th position (probability - 12%). In the case of the pessimistic scenario, digital/technological skills (x_{10}) will be at the 32.60th position (probability - 19%); in the case of the realistic scenario – at the 10.32nd position (probability - 14%).

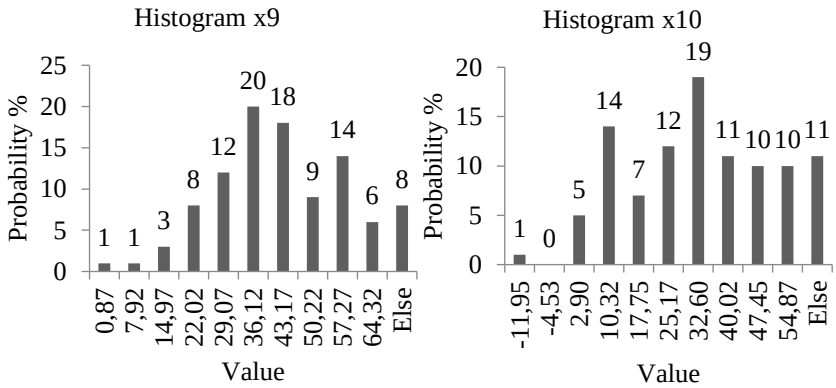

Figure 7. Histograms of normal distribution of the forecast values of the indicators of human capital quality: x_9 and x_{10}.
Source: authors

The obtained forecast values (x) are inserted in the system of equation (2), which allows evaluating the consequences of human capital quality management for socio-economic development of developing countries for the period until 2030, based on the pessimistic (Figure 8) and realistic (Figure 9) scenarios.

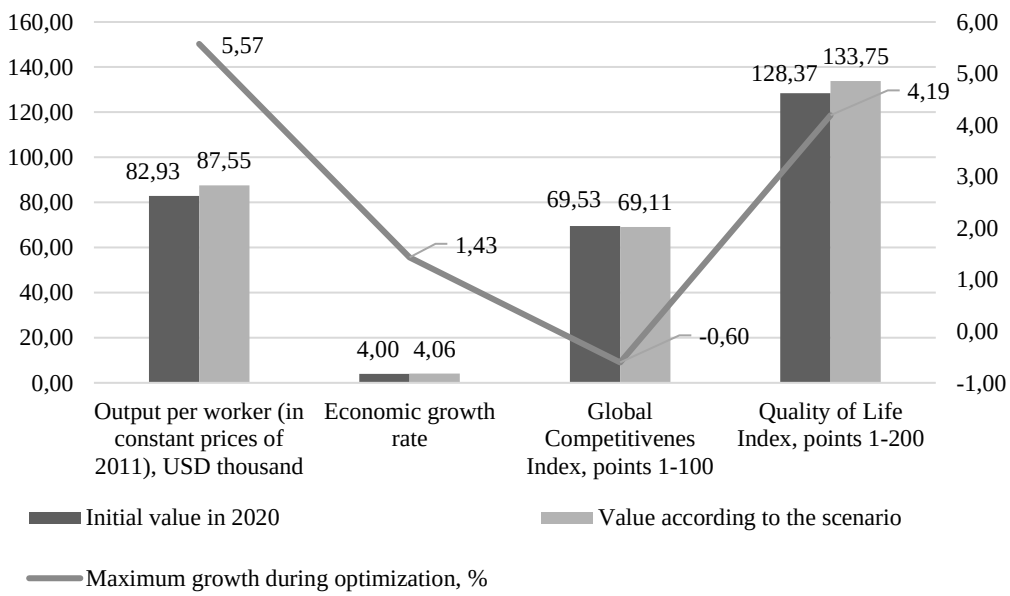

Figure 8. The consequences of human capital quality management for the socio-economic development of developing countries for the period until 2030, according to the pessimistic scenario
Source: authors

As shown in Figure 8, in the case of the pessimistic scenario, the quality of human capital will reduce in most directions in developing countries in the period until 2030. This will lead to the following:

- increase of output per worker from USD 82.93 thousand to USD 87.55 thousand (by 5.57%);
- increase of economic growth rate from 4% to 4.06% (by 1.43%);
- reduction of the Global Competitiveness Index from 69.53 points to 69.11 points (by 0.60%);
- increase of the Quality of Life Index from 128.37 points to 133.75 points (by 4.19%).

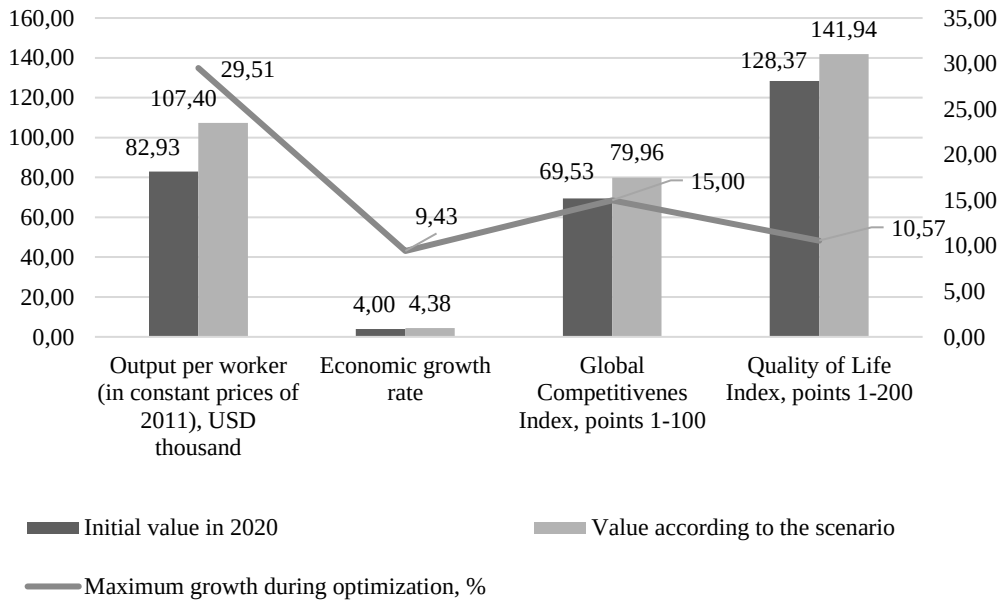

Figure 9. The consequences of human capital quality management for the socio-economic development of developing countries for the period until 2030, according to the realistic scenario

Source: authors

As shown in Figure 9, in the case of the realistic scenario, the quality of human capital will grow in most of the directions in developing countries in the period until 2030. This will lead to the following:

- increase of output per worker from UAS 82.93 thousand to USD 107.40 thousand (by 29.51%);
- increase of economic growth rate from 4% to 4.38% (by 9.43%);
- increase of the Global Competitiveness Index from 69.53 points to 79.96 points (by 15%);
- increase of the Quality of Life Index from 128.37 points to 141.94 points (by 10.57%).

Evaluation of the quality of human capital in developing countries in the case of the pessimistic and realistic scenarios, according to the proprietary methodology, is performed in Table 5.

As shown in Table 5, in the case of the pessimistic scenario, the quality of human capital in developing countries in the period until 2030 will equal 0.03, and in the case of the realistic scenario – 0.06.

Table 5. Evaluation of the quality of human capital in developing countries in case of the pessimistic and realistic scenarios.

Evaluation of quality	Pessimistic scenario		Realistic scenario	
	Assessment of homogeneity	Weighted values	Assessment of homogeneity	Weighted values
Educational assessment PISA - Math	0.03	0.00	0.03	0.00
Employee training	0.03	0.01	0.03	0.01
International experience	0.04	0.00	0.05	0.01
Foreign highly-skilled personnel	0.03	0.00	0.12	0.02
Female researchers	0.03	0.00	0.05	0.00
Total R&D personnel per capita	0.02	0.00	0.03	0.00
Scientific and technical employment	0.03	0.00	0.03	0.00
Digital/technological skills	0.03	0.01	0.10	0.02
Hierarchical synthesis	-	0.03	-	0.06

Source: authors.

Since quality equals 0.07 on average in 2020, it is possible to state that if there is no targeted optimization (development in the most perspective directions), the quality of human capital, instead of the expected growth, will reduce even in the case of growth of investments in education. This emphasizes the critical necessity for optimization.

5. Discussion

For the maximum improvement of human capital quality management in developing countries for the period until 2030, it is recommended to improve Educational assessment PISA - Math, employee training, international experience, foreign highly-skilled personnel, female researchers, total R&D personnel per capita, scientific and technical employment, and digital/technological skills up to the 1st position. In this case, the quality of human capital in developing countries will reach its maximum – i.e., 1 – which is the optimistic scenario (Figure 10).

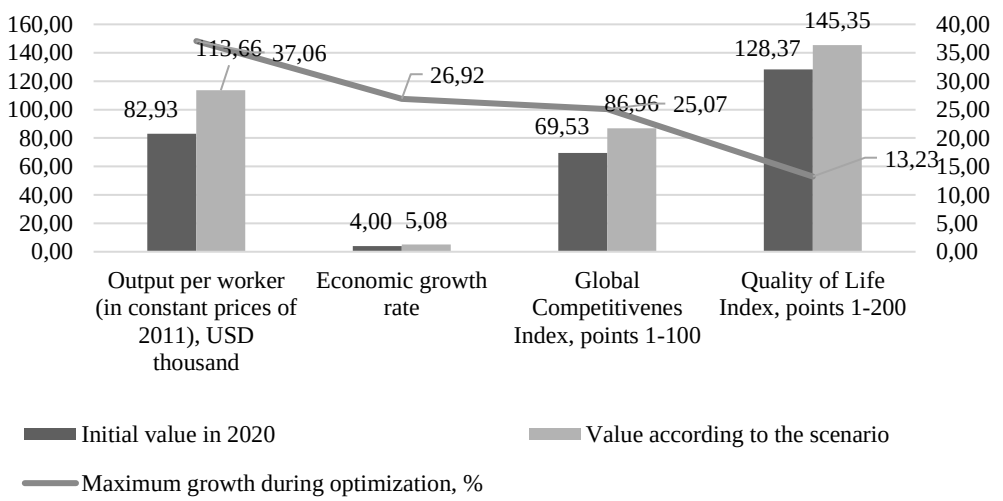

Figure 10. The consequences of human capital quality management for the socio-economic development of developing countries for the period until 2030, according to the scenario
Source: authors

As shown in Figure 10, in the case of the optimistic scenario, the quality of human capital will grow in most of the directions in developing countries in the period until 2030. This will lead to the following:

- increase of output per worker from USD 82.93 thousand to USD 113.66 thousand (by 37.06%);
- increase of economic growth rate from 4% to 5.08% (by 26.92%);
- increase of the Global Competitiveness Index from 69.53 points to 86.96 points (by 25.07%);
- increase of the Quality of Life Index from 128.37 points to 145.35 points (by 13.23%).

It should be noted that simultaneous maximum progress in all directions at once cannot be achieved. That is why it is recommended that developing countries in the period until 2030 focus on the most perspective directions, namely: increase of digital/technological skills (weight: 0.25), increase of employee training (weight: 0.17), international experience (weight: 0.14), and increase of foreign highly skilled personnel (weight: 0.14).

6. Conclusion

Thus, the research results have shown that digital competencies are in high demand in developing countries, being the most significant manifestation of the quality of human capital (their weight is the largest among all manifestations – 0.25). The most perspective direction is development of the leading skills of employees in the labor market (direction 4, weight – 0.46), but this direction is poorly developed (35.36th position). Developing countries pay more attention to the insignificant direction 3 – provision of gender neutrality of the labor market – which significance is almost zero (0.04), and the average position is higher than in other directions – 27.28th. This is a sign of the imperfection (low return from investments) of the existing approach to managing the quality of human capital (the hypothesis has been proved).

A logical result of the determined problem is the low quality of human capital in all developing countries of the sample in 2020 (less than 0.3 for all countries and 0.07 on average). The highest quality of human capital among countries of the sample is observed in the UAE (0.15), Hong Kong (0.14), and Qatar (0.10). That is why there is a need for a new approach to managing the quality of human capital in developing countries, which would ensure the primary implementation of the most effective directions of this management.

The new approach should be based on an alternative (authors') treatment of the quality of human capital – from the positions of the contribution of human capital to socio-economic development. i.e., the scale of implementing the directions of development of human capital which are in the highest demand in the economy (to maximize the return from investments in education). According to the new treatment, we have developed a proprietary methodology of evaluation of human capital quality in developing countries.

The performed scenario analysis of the perspectives of human capital quality management in developing countries for the period until 2030 has shown that in case of the pessimistic scenario, the quality of human capital in developing countries in the period until 2030 will equal 0.03, and in case of the realistic scenario – 0.06, i.e., it will further decrease. This emphasizes the critical necessity for optimization. In case of the optimistic scenario, the quality of human capital will grow in most of the directions in developing countries in the period until 2030, which will ensure the increase of output per worker by 37.06%, economic growth rate - by 26.92%, the Global Competitiveness Index - by 25.07%, and the Quality of Life Index – by 13.23%.

It is recommended that developing countries in the period until 2030 focus on the most

perspective directions, namely: increase of digital/technological skills (weight: 0.25), an increase of employee training (weight: 0.17), international experience (weight: 0.14), and increase of foreign highly skilled personnel (weight: 0.14).

It should be noted that even in the case of the optimistic scenario (the maximum quality of human capital), the limitations of the socio-economic development of developing countries include the increase of output per worker up to USD 113.66 thousand, economic growth rate – up to 5.08%, the Global Competitiveness Index – up to 86.96 points, and the Quality of Life Index – up to 145.35 points. Taking into account the determined limitation of the contribution of human capital quality to the socio-economic development of developing countries, further studies should dwell on the search for additional sources of accelerating this development.

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