AFRICA 4.0 AS A PERSPECTIVE SCENARIO FOR NEO-INDUSTRIALIZATION IN THE 21ST CENTURY: GLOBAL COMPETITIVENESS AND SUSTAINABLE DEVELOPMENT

Prof. Elena G. Popkova, Dr. Lubinda Haabazoka and Prof. Yulia V. Ragulina

[1]Plekhanov Russian University of Economics, Moscow, Russia
[2]Director of the University of Zambia Graduate School of Business, Zambia
[3]Head of compliance and controlling Department, Center of Management of the Department of Industry of Economics, RUDN University, Moscow, Russia

ABSTRACT: *Purpose: The article studies the perspectives of involvement of African countries in the global Fourth industrial revolution based on breakthrough technologies of Industry 4.0. Design/methodology/approach: The methods of imitation modeling, trend analysis, regression, correlation analysis, variation analysis, and scenario analysis were used for determining the future scenarios of development of African countries for periods of up to 2030. The sources of statistical data for the research included secondary data from the IMF and the World Bank. Findings: It is substantiated that the most perspective scenario is neo-industrialization, which has been conducted in recent years by the most progressive countries of the European, American, and Asia-Pacific regions of the world. This scenario will ensure global competitiveness and sustainable development of African countries in the long-term. Originality/value: As a result, the authors develop a conceptual model of Africa 4.0 and offer the algorithm of neo-industrialization of African countries based on breakthrough technologies of Industry 4.0. The article opens a wide field for further scientific research, which should be devoted to adapting the conceptual model of Africa 4.0 to the national specifics of certain African countries for maximization of effectiveness of its practical application.*

KEYWORDS: Fourth Industrial Revolution, Breakthrough Technologies, Africa 4.0, Industry 4.0, Neo-Industrialization

JEL Code: Q01, O14, O31, O32, O33, O38, O55.

INTRODUCTION

Modern Africa entered a new age of globalization, in which its integration into the global economic system as a perspective participant that seeks its own interests and possesses the unique opportunities for growth and development takes place. The most important priorities in this process are increase of global competitiveness and provision of sustainable development. Globalization of modern Africa takes place against the background of the Fourth industrial revolution, which covered most countries of the world.

According to the latest (as a result of 2018) rating of global digital competitiveness ("World Digital Competitiveness Ranking"), the African region remains untouched by the Fourth industrial revolution. The only country of the region that is present in the rating is South

Africa - 49th position among 63 countries, with 56.876 points out of 100 (IMD, 2019). In the course of globalization, countries of Africa won't be able to remain aside from the global tendency. The current scientific and practical problem of the modern economics is selecting the optimal method of Africa's accession to the Fourth industrial revolution.

The most progressive countries of the European, American, and Asia-Pacific regions of the world (firstly, countries of the OECD – Germany, the USA, and Japan) have been implementing the model of neo-industrialization in recent years (2012-2018). This envisages transition to Industry 4.0, connected to ubiquitous dissemination of the breakthrough technologies of the Fourth technological mode. It is expected that they will be able to start production of hi-tech products in all spheres of economy and develop and use it as a growth pole (a source of acceleration of economic growth).

At the same time, a lot of developing countries (e.g., BRICS) have more restrained models of participation in the Fourth industrial revolution, which envisage digital modernization of economy. Within this model, the breakthrough technologies (e.g., AI and the Internet of Thins), which belong to the Fourth technological mode, are implemented in certain – hi-tech – spheres that are unified into Industry 4.0. Digital modernization of other spheres envisages implementation of technologies of the Third technological mode (e.g., cloud technologies, RFID-technologies, and broadband Internet).

Thus, implementation of the models of participation in the Fourth industrial revolution is inadmissible, as instead of growth of global competitiveness and provision of its sustainable development it may lead to opposite results – depletion of national resources with impossibility of development of effective production of hi-tech products, absence of sale in domestic market, and crisis of overproduction. Countries of Africa have to develop their own model, which take into account the current needs and specific features of the economy. The purpose of this paper is to study the perspectives of involvement of African countries in the global Fourth industrial revolution based on breakthrough technologies of Industry 4.0.

MATERIALS AND METHOD

The perspectives of development of African countries in the modern economic conditions for provision of their global competitiveness and sustainable development are discussed in multiple works of the modern authors: Batuo et al. (2018), Efremenko et al. (2017), Ndaguba and Hanyane (2019), Tiruneh et al. (2017), and Wamboye and Sergi (2019). The conceptual foundations and practical experience of various countries in the sphere of implementing the breakthrough technologies of Industry 4.0 are studied in detail in the works Bogoviz (2019), Popkova (2019), Popkova and Sergi (2019), Popkova et al., (2019), and Rajput and Singh (2019).

At the same time, it should be noted that the objects of the research in these works are primarily countries of the European, American, and Asia-Pacific regions of the world. The issues of participation of African countries in the Fourth industrial revolution are poorly studied in the existing publications and remain unsolved.

In this paper, the authors use the methods of imitation modeling, trend, regression, and correlation analysis, variation analysis, and scenario analysis for determining the future

scenarios of development of African countries until 2030. The selection of data includes information for all countries of Africa. The analyzed indicators are as follows

- − Global competitiveness index (the World Economic Forum);
- − Sustainable development index (the International Institute for Sustainable Development);
- − Growth Rate of GDP in constant prices according to the IMF;
- − GDP per capita according to the IMF;
- − Total volume of investments according to the IMF;
- − Innovations index according to the WIPO;
- − Sectorial structure of gross added value according to the World Bank.

All indicators are analyzed based on the 2018 data; certain indicators (with available information) are analyzed based on the data of their dynamics for 2000-2022 (the data for 2019-2022 are forecasted data). The initial statistical data are given in Tables 1 and 2.

Table 1. Indicators of Socio-Economic Development of African Countries in 2018.

Country	Global competitiveness index, 1-7	Sustainable development index, points 1-100	Growth rate of GDP in constant prices, %	GDP per capita, USD	Total volume of investments, % GDP	Innovations index, points 1-100
	y_1	y_2	x_1	x_2	x_3	x_4
Angola	n/a	49.6	1.528	4,627.096	7.308	n/a
Benin	n/a	49.0	6.032	813.496	27.354	n/a
Botswana	4.30	n/a	4.188	7,543.525	31.863	n/a
Burkina Faso	n/a	50.9	6.339	681.47	17.654	18.95
Burundi	3.21	49.8	n/a	n/a	n/a	n/a
Cabo Verde	3.76	n/a	n/a	n/a	n/a	n/a
Cameroon	3.65	55.8	4.297	1,250.993	20.578	n/a
Central African Republic		37.7	5.03	439.516	17.894	n/a
Chad	2.99	42.8	2.418	802.156	20.872	n/a
Democratic Republic of the Congo	3.27	43.4	3.451	473.991	13.076	n/a
Republic of Congo	n/a	52.4	8.826	1,980.551	18.724	n/a
Cote d'Ivoire	n/a	55.2	n/a	n/a	n.a	19.96
Equatorial Guinea	n/a	n/a	-5.098	13,258.96	42.724	n/a
Eritrea	n/a	n/a	3.646	988.471	6.672	n/a
Eswatini	n/a	n/a	n/a	n/a	n/a	n/a
Ethiopia	n/a	53.2	7.51	889.181	35.274	n/a
Gabon	n/a	n/a	2.661	7,559.919	36.495	n/a
Gambia	3.61	51.6	3.497	503.361	16.537	n/a
Ghana	3.72	n/a	9.164	1,617.693	25.738	24.52
Guinea	3.47	52.1	4.896	553.961	17.02	20.71

Guinea-Bissau	n/a	n/a	5	711.75	12.361	n/a
Kenya	3.98	56.8	5.753	1,681.247	19.916	31.07
Lesotho	3.20	51.5	2.359	1,308.384	15.342	n/a
Liberia	n/a	48.3	5.345	508.919	n/a	n/a
Madagascar	3.40	45.6	4.814	418.647	18.169	24.75
Malawi	n/a	50.0	5	338.202	12.147	n/a
Mali	n/a	n/a	4.73	848.597	19.451	n/a
Mauritius	n/a	64.5	4.014	10,054.75	22.562	n/a
Mozambique	2.89	50.7	5.5	406.191	70.736	23.06
Namibia	3.99	n/a	4.846	5,355.723	23.426	28.03
Niger	n/a	n/a	5.528	426.473	43.003	20.57
Nigeria	3.30	47.5	1.893	2,434.924	12.807	22.37
Rwanda	4.35	56.1	6.8	776.223	24.752	26.54
Sao Tome and Principe	n/a	n/a	5.5	1,743.059	28.028	n/a
Senegal	n/a	57.2	7.005	1,027.718	26.962	33.19
Seychelles	3.80	n/a	3.407	16,332.05	33.495	n/a
Sierra Leone	3.20	49.1	6.633	668.833	18.79	n/a
South Africa	4.32	n/a	1.569	5,662.045	19.271	35.13
South Sudan	n/a	49.6	-1.085	342.02	17.701	n/a
Tanzania	3.71	55.1	6.924	1,100.183	27.915	28.07
Togo	n/a	52.0	5.3	615.193	24.632	n/a
Uganda	3.70	54.9	5.753	666.621	30.045	25.32
Zambia	3.52	53.1	4.023	1,385.797	38.159	20.66
Zimbabwe	3.32	58.8	-1.509	1,054.339	15.284	23.15
Direct average	3.59	51.48	4.34	2,496.31	23.87	25.06
Standard deviation	0.41	5.21	2.71	3,672.90	11.77	4.75
Coefficient of variation, %	11.35	10.11	62.38	147.13	49.34	18.95

Source: compiled by the authors based on International Institute for Sustainable Development (2019), International Monetary Fund (2019), WIPO (2019), World Economic Forum (2019).

Table 1 shows that each statistical indicator lack information for a lot of countries of Africa. The average level of global competitiveness of the economies of African countries in 2018 is rather low – 3.59 points out of 7. The coefficient of variation constitutes 11.35%, which shows rather high homogeneity of the selection. The average value of the index of sustainable development in African countries in 2018 is also low – 51.48 points out of 100. The coefficient of variation constitutes 10.11%, which shows rather high homogeneity of the selection. Average growth rate of GDP in constant prices in African countries in 2018 is moderate, constituting 4.34%. The coefficient of variation constitutes 62.38%, which shows heterogeneity of selection of data for this indicator.

Average level of GDP per capita in African countries in 2018 is low – USD 2,496.31. The coefficient of variation constitutes 147.13%, which shows heterogeneity of selection of data for this indicator. Average total volume of investments into economies of African countries in 2018 is rather high – 23.87% of GDP. The coefficient of variation constitutes 49.34%, which shows heterogeneity of selection of data for this indicator. Average value of the innovations index in African countries in 2018 constitutes 25.06 points out of 100, which allows characterizing the innovative activity of these countries as low. The coefficient of variation constitutes 18.95%, which shows rather high homogeneity of the selection of data for this indicator.

Table 2. Sectorial Structure Gross Added Value that is Created in African Countries in 2018, %.

Country	Agriculture	Industry	Manufacturing	Services
	x_5	x_6	x_7	x_8
Angola	n/a	n/a	n/a	n/a
Benin	22	21	12	46.9
Botswana	2	30	5	58.7
Burkina Faso	28	21	6	42.0
Burundi	36	15	9	n/a
Cabo Verde	6	19	8	61.3
Cameroon	15	24	15	52.7
Central African Republic	40	15	7	39.3
Chad	49	15	3	33.5
Democratic Republic of the Congo	20	42	20	34.1
Republic of Congo	7	54	8	38.5
Cote d'Ivoire	20	27	13	41.6
Equatorial Guinea	2	56	25	40.7
Eritrea	n/a	n/a	n/a	n/a
Eswatini	n/a	n/a	n/a	n/a
Ethiopia	2	24	13	60.4
Gabon	6	45	7	43.0
Gambia	17	12	5	65.8
Ghana	17	24	6	52.2
Guinea	16	33	11	40.7
Guinea-Bissau	49	13	11	32.3
Kenya	32	17	48.1	45.4
Lesotho	5	33	16	52.6
Liberia	34	12	3	53.6
Madagascar	21	17	n/a	48.4
Malawi	26	14	9	52.4
Mali	38	23	n/a	36.7

Mauritius	3	18	12	66.9
Mozambique	22	18	9	54.2
Namibia	7	28	11	58.4
Niger	40	16	6	39.0
Nigeria	21	22	9	55.8
Rwanda	31	16	6	46.4
Sao Tome and Principe	11	15	7	71.4
Senegal	15	21	11	53.8
Seychelles	2	11	6	71.0
Sierra Leone	60	5	2	32.4
South Africa	2	26	12	61.5
South Sudan	n/a	n/a	n/a	n/a
Tanzania	30	26	6	37.5
Togo	41	17	4	29.8
Uganda	25	20	8	47.1
Zambia	7	36	8	52.7
Zimbabwe	10	22	8	56.3
Direct average	20.93	23.08	10.13	48.90
Standard deviation	15.24	11.11	7.83	11.14
Coefficient of variation, %	72.85	48.16	77.22	22.79

Source: compiled by the authors based on World Bank (2019).

Table 2 shows that statistical data for certain countries are absent. The average share of agriculture in the structure of gross value that is created in African countries in 2018 constitutes 20.93%. The coefficient of variation constitutes 72.85%, which shows heterogeneity of selection of data for this indicator. The average share of Industry in the structure of gross value that is created in African countries in 2018 constituted 23.08%. The coefficient of variation constitutes 48.16%, which shows heterogeneity of selection of data for this indicator.

The average share of Manufacturing в structure of gross value that is created in African countries in 2018 constituted 10.13%. The coefficient of variation constitutes 77.22%, which shows heterogeneity of selection of data for this indicator. The average share of the service sphere in the structure of gross value that is created in African countries in 2018 constitutes 48.90%. The coefficient of variation constitutes 22.79%, which shows heterogeneity of selection of data for this indicator.

RESULTS

The Current Tendencies of Development of the African Countries

Let us study the tendencies of development of African countries in 2000-2022 (the data for 2019-2022 are forecast of the IMF specialists) (Figures 1-3).
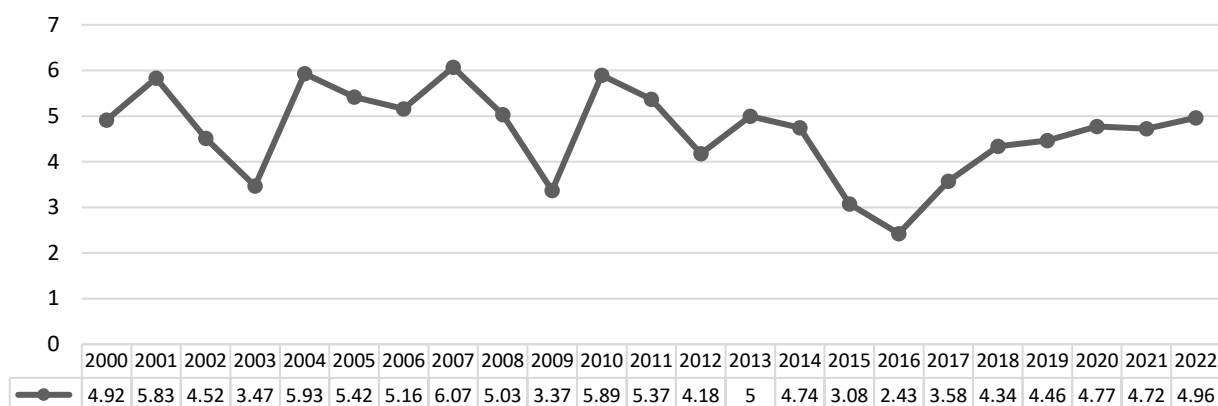

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	4.92	5.83	4.52	3.47	5.93	5.42	5.16	6.07	5.03	3.37	5.89	5.37	4.18	5	4.74	3.08	2.43	3.58	4.34	4.46	4.77	4.72	4.96

Figure 1. Dynamics of Average Growth Rate of GDP in Constant Prices in African Countries in 2000-2022, %.

Source: calculated and compiled by the authors based on International Monetary Fund (2019).

Figure 1 shows that average growth rate of GDP in constant prices in African countries in 2000-2022 is peculiar for high volatility. The general trend of this indicator is downward – decrease of its value in 2018 (4.34%) as compared to 2000 (4.92%) constituted 11.78%. Its slight (4.96%) increase is expected by 2022.
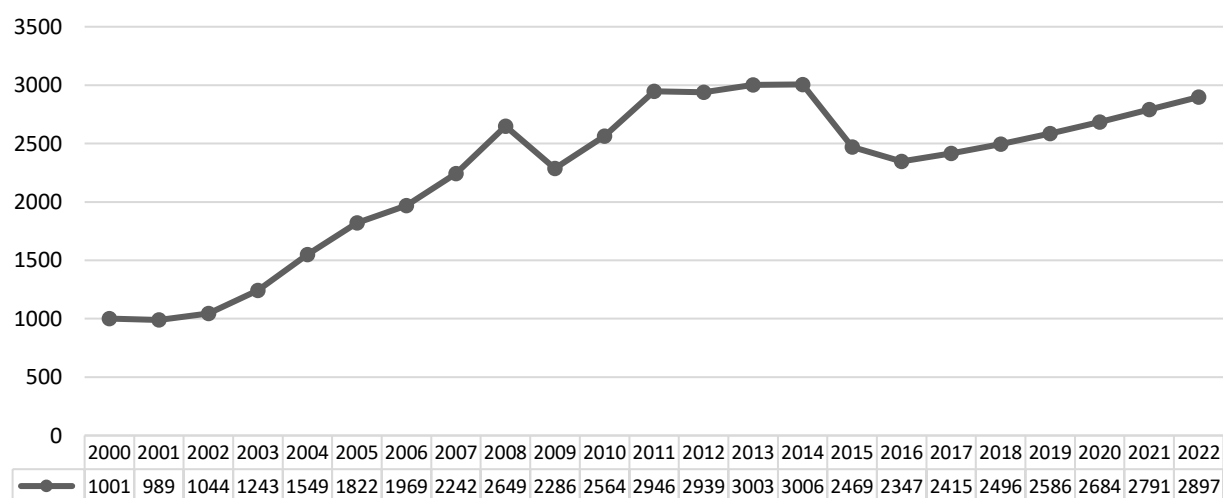

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	1001	989	1044	1243	1549	1822	1969	2242	2649	2286	2564	2946	2939	3003	3006	2469	2347	2415	2496	2586	2684	2791	2897

Figure 2. Dynamics of Average GDP per capita in African Countries in 2000-2022, USD

Source: calculated and compiled by the authors based on International Monetary Fund (2019).

Figure 2 shows that average GDP per capita in African countries in 2000-2022 is peculiar for vivid upward trend. Its value in 2018 (USD 2,496) grew by 1.5 times as compared to 2000 (USD 1,001). Its further growth by 16% is expected by 2022.
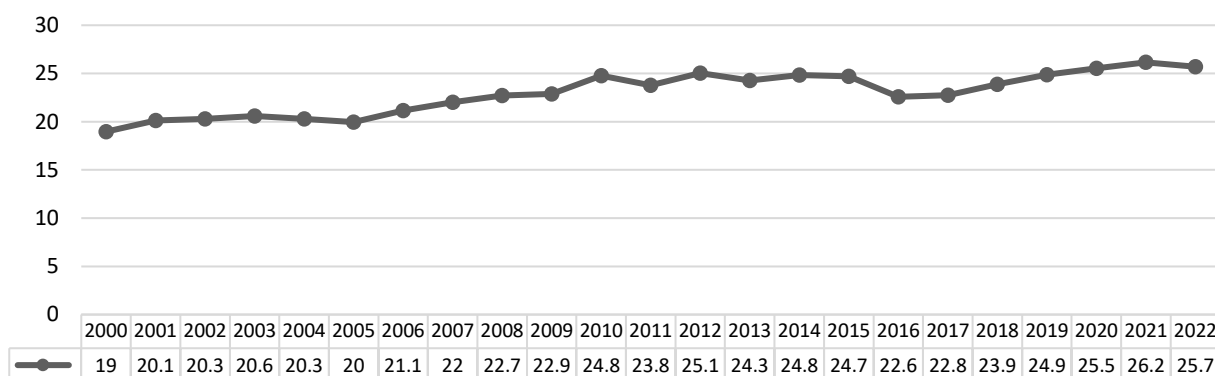
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	19	20.1	20.3	20.6	20.3	20	21.1	22	22.7	22.9	24.8	23.8	25.1	24.3	24.8	24.7	22.6	22.8	23.9	24.9	25.5	26.2	25.7

Figure 3. Dynamics of Average Aggregate Volume of Investments into Economies of African Countries in 2000-2022, % of GDP.

Source: calculated and compiled by the authors based on International Monetary Fund (2019).

Figure 1 shows that average aggregate volume of investments into economies of African countries in 2000-2022 is peculiar for slight upward trend. Its growth in 2018 (23.9% of GDP), as compared to 2000 (19% of GDP), constituted 25.78%. Its slight growth by 7.53% is expected by 2022 (25.7% of GDP).

Average sectorial structure of gross added value that is created in African countries in 2018, is presented in Figure 4.
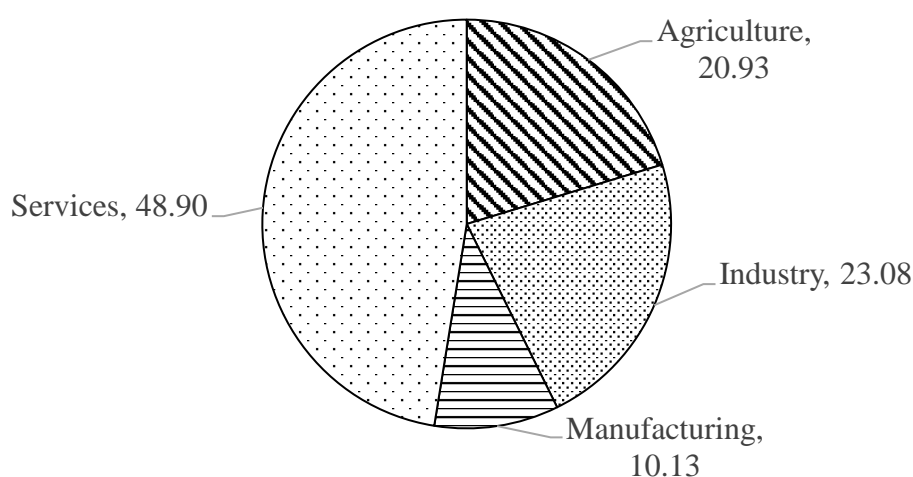
Figure 4. Average Sectorial Structure of Gross Added Value that is Created in African Countries in 2018.

Source: calculated and compiled by the authors based on World Bank (2019).

Figure 4 shows that African countries were peculiar for post-industrial direction in 2018 – specialization in the service sphere, which share in the structure of created gross added value constituted 48.90%. The share of industry constituted 23.08%, the share of manufacturing – 10.13% (aggregate share of industry constituted 33.21%). The share of agriculture constituted 20.93%. On the whole, the sectorial structure of gross added value that is created in African countries in 2018 could be called well-balanced, as there's no vivid domination of the service sphere. This allows developing the production specialization in any direction, including in industry.

For determining the position of African countries in the modern global economic system and determining their specifics, we find the ratio of average values of the indicators of socio-economic development of African countries in 2018 to average values of the indicators of developed countries (OECD) (Figure 5).
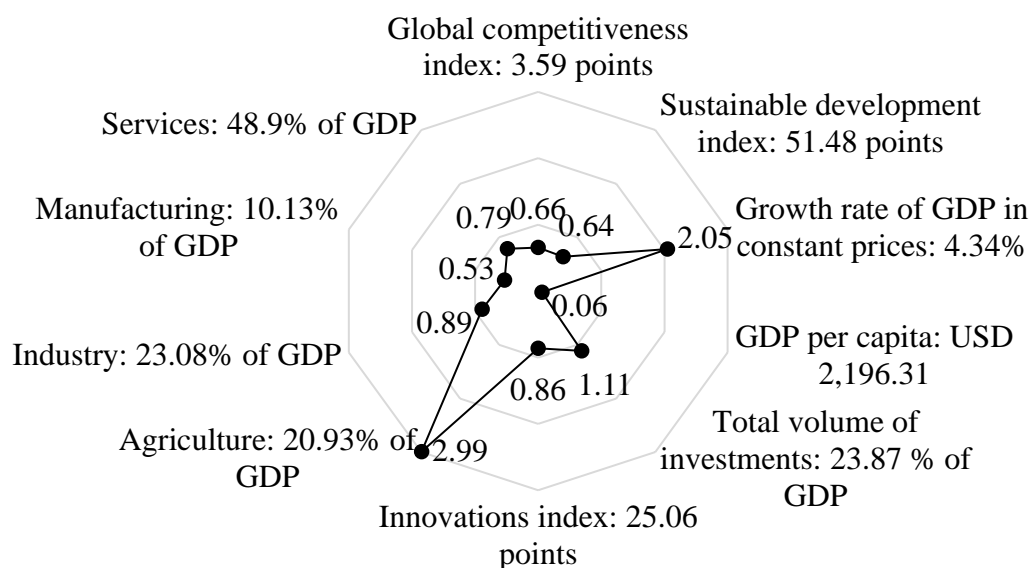
Figure 5. Ratio of Average Values of the Indicators of Socio-Economic Development of African Countries in 2018 to Average Values of the Indicators of Developed Countries (OECD).

Source: calculated and compiled by the authors based on International Institute for Sustainable Development (2019), International Monetary Fund (2019), WIPO (2019), World Bank (2019), World Economic Forum (2019).

Figure 5 shows that countries of Africa are behind the developed countries (OECD) as to the level of GDP per capita (0.06), the level of sustainable development (0.64), global

competitiveness (0.66); the difference as to the level of innovative activity (0.86%) is lowed. At the same time, countries of Africa show higher growth rate of GDP in constant prices (2.05) and total volume of investments into economy (1.11). The share of agriculture in the structure of gross added value that is created in African countries is higher than in developed countries (2.99); the share of industry is similar (0.89); and the share of the service sphere (0.79) and manufacturing (0.53) is lower.

Future Scenarios of Development of the African Countries until 2030

Let us determine the most significant factors of global competitiveness and sustainability of development of African countries in 2018. For that we calculate the coefficients of auto-correlation of dependent variables (y_1, y_2) with independent variables $(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8)$ based on the data of Tables 1 and 2. The obtained results are given in Table 3.

Table 3. Autocorrelation of the Indicators of Socio-Economic Development of African Countries in 2018.

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
y_1	0.0447	0.0933	0.1423	0.3441	-0.1520	0.1891	0.0699	0.2121
y_2	0.1779	-0.3775	-0.0738	0.1563	0.2075	-0.0333	0.1555	-0.0059

Source: calculated by the authors.

Table 3 shows that growth rate of GDP in constant prices performs slight positive influence on the level of global competitiveness and sustainability of development of African countries. The influence of GDP per capita is contradictory – its growth slightly increases global competitiveness but decreases sustainability of development of African countries a lot. The influence of the volume of investments, agriculture, the service sphere, and industry is also substantial. Increase of the volume of manufacturing stimulates slight growth of global competitiveness and vivid sustainable development of African countries.

The most significant factor that shows the largest connection with global competitiveness of African countries in 2018 is innovative activity – coefficient of autocorrelation $ry_2x_4=0.3441$. Let us perform the regression and dispersion analysis of dependence of global competitiveness of African countries on their innovative activity in 2018 and compile a model of paired linear regression of the type $y_1=£+\beta*x_4$ (Table 4).

Table 4. Regression and Dispersion Analysis of Dependence of Global Competitiveness of African Countries on their Innovative Activity in 2018.

Regression statistics	
Multiple R	0.3441
R^2	0.1184
Adjusted R-square	0.0974
Standard error	7.4334
Observations	44

Dispersion analysis

	df	SS	MS	F	Significance F
Regression	1	311.7368	311.7368	5.6417	0.0222
Residue	42	2320.7252	55.2554		
Total	43	2632.4620			

	Coefficients	Standard error	t-statistics	P-Value	Lower 95%	Upper 95%
£	1.3472	1.4161	0.9514	0.3469	-1.5105	4.2049
β	0.2124	0.0894	2.3752	0.0222	0.0319	0.3928

Source: calculated by the authors.

According to the results of the regression analysis (Table 4), we have the following regression model: $y_1=1.3472+0.2124*x_4$. The compiled model allows stating that growth of innovative activity of African countries by 1-point leads to increase of the level of their global competitiveness by 0.2124 points in 2018. However, the obtained value $R^2=0.1184$ shows weak connection between the studied indicators – the change of the level of global competitiveness of African countries in 2018 only by 11.84% is explained by the change of the level of their innovative activity.

The observed value of f-criterion (5.6417) does not exceed the table value, which, with α=0.05, k_1=m=1 and k_2=n–m–1=44–1–1=42, constitutes 4.08 – which shows statistical significance of the obtained regression equation. This is confirmed by verification with the help of t-criterion, which observed value (2.3752) does not exceed the table value, which, with p=0,05 and n-2=44-1=42, constitutes 2.018. The obtained results show the necessity for increasing the level of innovative activity of African countries for growth of their global competitiveness.

For determining the most preferable scenario of innovative development of African countries let us analyze the dependence of the level of their innovative activity on the volume of hi-tech

export in 2018. The initial data for this is given in Table 5, and the results of regression and dispersion analysis in Table 6.

Table 5. Volume of Hi-Tech Export in African Countries in 2018.

Country	Volume of hi-tech export, USD thousand	Country	Volume of hi-tech export, USD thousand
	x_9		x_9
Angola	n/a	Lesotho	n/a
Benin	n/a	Liberia	n/a
Botswana	49,682.76	Madagascar	4,754.27
Burkina Faso	n/a	Malawi	n/a
Burundi	237.96	Mali	2,164.48
Cabo Verde	n/a	Mauritius	26,573.5
Cameroon	28,690.44	Mozambique	32,059.25
Central African Republic	n/a	Namibia	14,734.53
Chad	n/a	Niger	n/a
Democratic Republic of the Congo	n/a	Nigeria	18,192.6
Republic of Congo	84,282.67	Rwanda	n/a
Cote d'Ivoire	n/a	Sao Tome and Principe	321.24
Equatorial Guinea	n/a	Senegal	9,468.67
Eritrea	n/a	Seychelles	62,598.41
Eswatini	n/a	Sierra Leone	1.35
Ethiopia	n/a	South Africa	1,817,259.05
Gabon	n/a	South Sudan	n/a
Gambia	n/a	Tanzania	15,651.17
Ghana	39,603.96	Togo	557.55
Guinea	n/a	Uganda	7,081.46
Guinea-Bissau	n/a	Zambia	35,952.67
Kenya	45,768.89	Zimbabwe	n/a

Source: compiled by the authors based on World Bank (2019).

Table 6. Regression and Dispersion Analysis of Dependence of Innovative Activity of African Countries on the Volume of their Hi-Tech Export in 2018.

Regression statistics	
Multiple R	0.3182
R-square	0.1012
Normed R-square	0.0798
Standard error	12.1627
Observations	44

Dispersion analysis

	df	SS	MS	F	Significance F
Regression	1	699.8430	699.8430	4.7309	0.0353
Residue	42	6213.1165	147.9313		
Total	43	6912.9595			

	Coefficients	Standard error	t-Stat	P-Value	Lower 95%	Upper 95%
£	8.9119	1.8675	4.7720	0.0000	5.1431	12.6808
β	0.000015	0.0000	2.1751	0.0353	0.0000	0.0000

Source: calculated by the authors.

The data from Table 4 show weak connection between the studied indicators – innovative activity of African countries growth by 0.000015 points with growth of the volume of their hi-tech export by USD 1,000. Deep regression analysis is not required in this case, as connection between the indicators is very weak, and their close connection is logical. Therefore, the scenario of digital modernization that is connected to innovative development of only hi-tech spheres of economies of African countries, will not allow ensuring the systemic effect, connected to growth of their global competitiveness and sustainable development.

The most preferable scenario of participation of African countries in the Fourth industrial revolution is the alternative scenario, which envisages neo-industrialization (transition to Industry 4.0 of all spheres of economy). For quantitative characteristics of scenarios with the help of statistical indicators we use regression dependencies of indicators $y_1, y_2, x_1, x_2, x_3, x_5, x_6, x_7, x_8$ on indicator x_4. Though these dependencies are not statistically significant at the level $\alpha=0.05$ they allow for assessment of the change of the statistical indicators in case of increase of the level of innovative development of African countries (Figure 6).
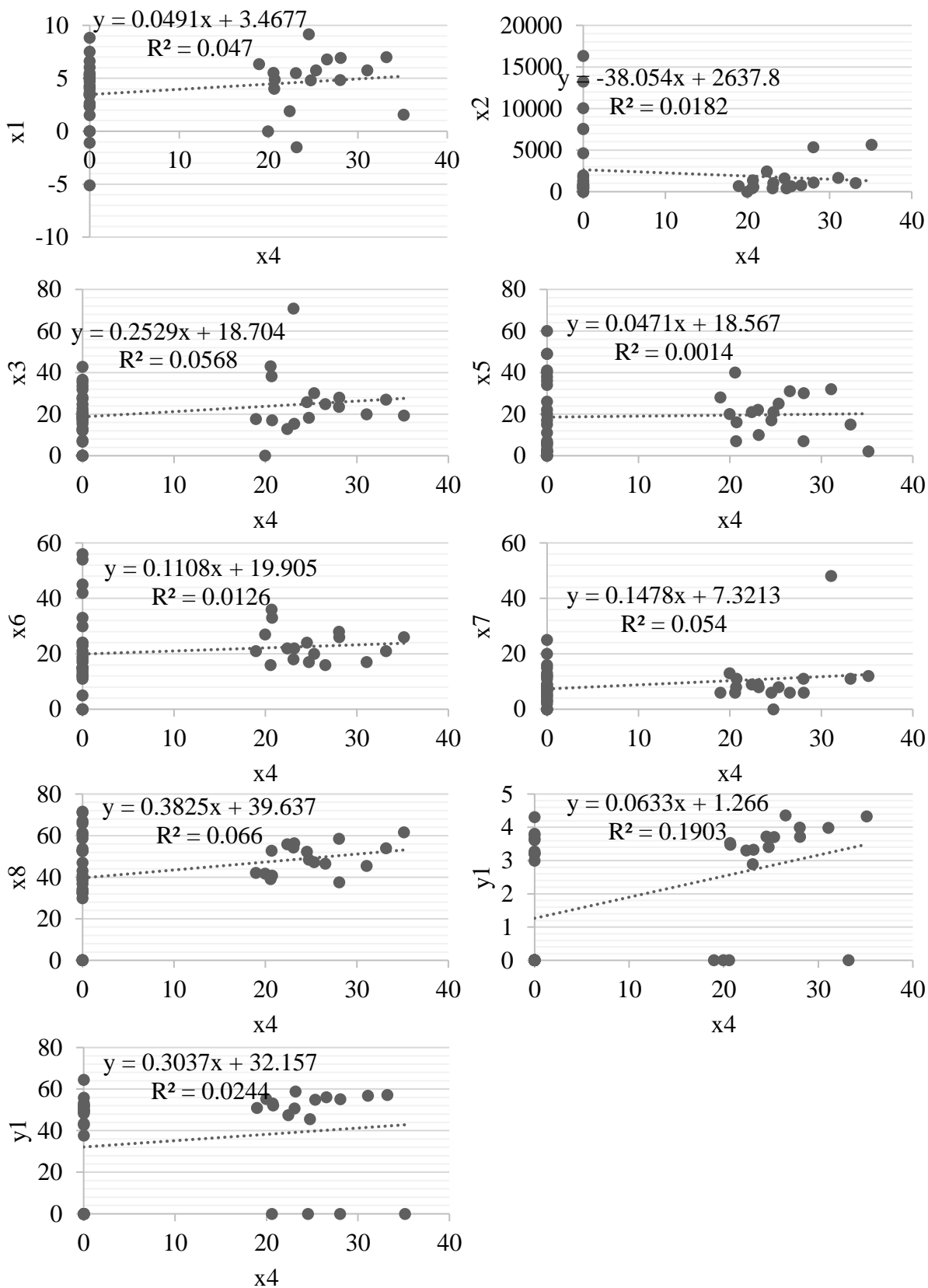
Figure 6. Regression Curves that Reflect Dependence of the Statistical Indicators on the Level of Innovative Development of African Countries in 2018.

Source: calculated and compiled by the authors.

Let us put the values of the indices of innovations into the obtained models of paired linear regression. Within the scenario of digital modernization the value of this index will be close to the level of developing countries (33.16 points), and within the scenario of neo-industrialization to the level of developed countries (59.86 points). The following characteristics of the alternative scenarios of African countries' participation in the Fourth industrial revolution were obtained (Table 7).

Table 7. Characteristics of the alternative scenarios of African countries' participation in the Fourth industrial revolution until 2030.

Indicators	Value in 2018	Values of the indicators within the alternative scenarios of African countries' participation in the Fourth industrial revolution					
		Scenario of digital modernization			Scenario of neo-industrialization		
		value	growth (absolute)	growth, %	value	growth (absolute)	growth, %
Innovations index points	25.06	33.16	8.10	32.32	59.86	34.80	138.87
Growth rate of GDP in constant prices, %	4.34	5.10	0.76	17.42	6.41	2.07	47.62
Share of agriculture, %	20.93	20.13	-0.80	-3.83	21.39	0.46	2.18
Share of industry, %	23.08	23.58	0.50	2.16	26.54	3.46	14.98
Share of manufacturing, %	10.13	12.22	2.09	20.65	16.17	6.04	59.61
Share of service sphere, %	48.90	52.32	3.42	7.00	62.53	13.63	27.88
Total volume of investments, % of GDP	23.87	27.09	27.09	113.49	33.84	33.84	141.78
GDP per capita, USD	2,496.31	1,375.93	-1,120.38	-44.88	359.89	-2,136.42	-85.58
Global competitiveness index, points	3.59	3.37	-0.22	-6.27	5.06	1.47	40.81
Sustainable development index, points	51.48	42.23	-9.25	-17.97	50.34	-1.14	-2.22
Essence of the scenario	-	selective innovative development, limited by hi-tech spheres of industry			systemic innovative development of economy with the infrastructure-building role of industry		
Existing experience of scenario realization	-	developing countries			developed countries		

Source: calculated and compiled by the authors.

The data from Table 7 show that within the scenario of digital modernization the value of the global competitiveness index of African countries reduces as compared to the 2018 level, and within the scenario of neo-industrialization increases by 40.81%. However, GDP per capita reduces within both scenarios – as well as the sustainable development index – as forecasting was conducted with all other conditions being equal. For preventing the reduction of the values of these indicators it is necessary to take special measures within the model of neo-industrialization.

Africa 4.0 as the Optimal Scenario: Policy Implications

The following conceptual model of Africa 4.0 was developed (Figure 7). It takes into account the specifics of African countries that are connected to contradictory influence of innovative development of their economies on global competitiveness (positive, direct influence) and on sustainability of their development (negative, reverse influence) (Figure 7).
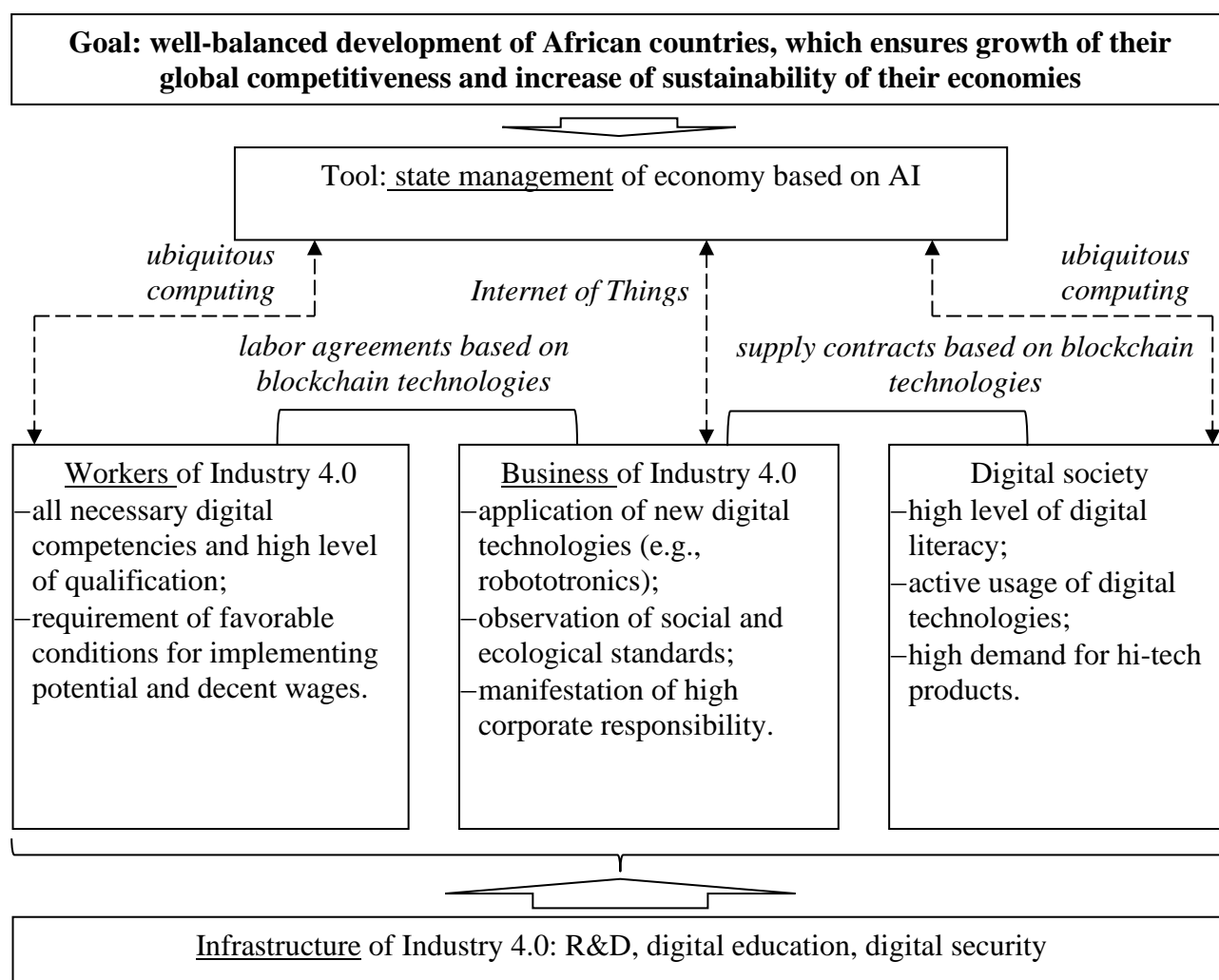

Figure 7. The conceptual model of Africa 4.0.

Source: compiled by the authors.

As is seen from Figure 7, the offered model is aimed at well-balanced development of African countries, which ensures growth of their global competitiveness, and increase of sustainability of their economies. The tool of implementing the set goal is state management of economy on the basis of AI. The basis of economy is Industry 4.0 – production, distribution, and consumption with the usage of new digital technologies. It is based on specialized infrastructure – R&D that is aimed at creation and adaptation of new digital technologies to various economic operations, digital education, which allows developing digital competencies and ensures high level of qualification of the employees of Industry 4.0, and digital security, which ensures loyalty (trust) of business and society to digital technologies.

The central subject of economy is business of Industry 4.0, which specific features are application of new digital technologies (e.g., robototronics), observation of social and ecological standards, and manifestation of high corporate responsibility. State management of business is automatized on the basis of the Internet of Things. Another subject of economy is employees of Industry 4.0, who possess all necessary digital competencies and high level of qualification and set requirements of favorable conditions for implementing the potential and decent wages. Their labor relations with business have the contractual basis with the help of blockchain technologies, which allow preventing the development of the shadow economy.

A subject of economy is also the digital society (consumers), which specific features are high level of digital literacy, active usage of digital technologies, and high demand for hi-tech products. Their relations with business (connected to products supply) also have the contractual basis with the help of blockchain technologies, which allow preventing the development of the shadow economy. State management by the employees and society (consumers) is automatized on the basis of ubiquitous computing.

The following algorithm has been developed for successful and crisis-free neo-industrialization of African countries based on breakthrough technologies of Industry 4.0 (Figure 8).
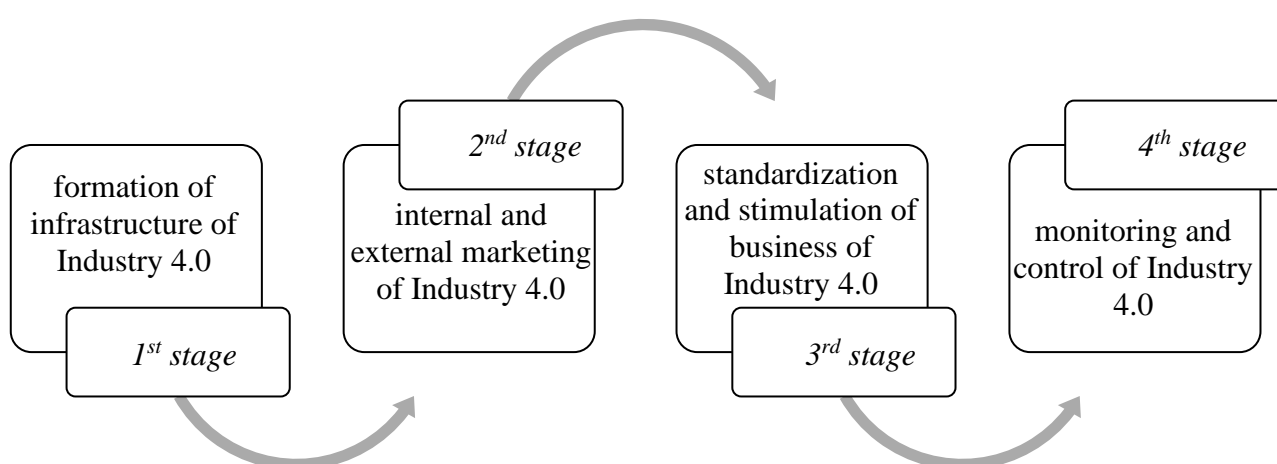

Figure 8. Algorithm of neo-industrialization of African countries based on breakthrough technologies of Industry 4.0.

Source: compiled by the authors.

As is seen from Figure 8, the offered algorithm is implemented in four consecutive stages. The first stage envisages formation of the infrastructure of Industry 4.0 via modernization of the system of science and education and development of the system of provision of digital security. The second stage envisages internal and external (global) marketing of Industry 4.0 of African countries for formation of demand for their hi-tech products.

The third stage envisages standardization (adoption of social and ecological standards) and stimulation (e.g., tax) of business of Industry 4.0, which value should depend on the level of corporate social and ecological responsibility. The fourth stage envisages monitoring and control of achievement of the set goals. It is offered to use the estimate (planned) values of the indicators of socio-economic development of African countries until 2030 within this scenario.

CONCLUSION

Thus, as a result of the research it is determined that the perspectives of involvement of African countries in the global Fourth industrial revolution based on breakthrough technologies of Industry 4.0 are connected to their neo-industrialization. This scenario envisages full-scale transition to economies of African countries to Industry 4.0 and is preferable (as compared to selective digital modernization in the sphere of hi-tech spheres of industry), as only it allows increasing the level of innovative development of economies of African countries, which is necessary for growth of their global competitiveness.

An important specific feature of African countries, which differentiates them from developed and developing countries in other regions of the modern global economy, is contradictory influence of innovative development on their economies, which stimulates the growth of its global competitiveness with simultaneous reduction of sustainability of development. That's why in this work the model of neo-industrialization, which is implemented by the modern developed countries, is adapted to the determined specifics of African countries.

This model envisages standardization and stimulation of corporate social and ecological responsibility of business of Industry 4.0. This will allow achieving growth of global competitiveness and increase of sustainability of development of economies of African countries until 2030. The offered model is to be implemented in stages according to the specially developed algorithm, which allows preventing a crisis of production and social and ecological crisis in African countries in the process of their neo-industrialization.

It should be concluded that the level of differentiation of socio-economic development of African countries is rather high. That's why the model neo-industrialization of these countries is inexpedient. It is recommended to adapt the offered conceptual model of Africa 4.0 to the national specifics of separate African countries for maximization of the effectiveness of its practical application.

REFERENCES

Batuo, M., Mlambo, K., Asongu, S. (2018). Linkages between financial development, financial instability, financial liberalisation and economic growth in Africa. Research in International Business and Finance, 45, p. 168-179

Bogoviz, A.V. (2019). Industry 4.0 as a new vector of growth and development of knowledge economy. Studies in Systems, Decision and Control, 169, p. 85-91.

Efremenko, I.N., Haabazoka, L., Larionov, V.A. (2017). Development of the international monetary system conditions of globalization. European Research Studies Journal, 20(3), p. 269-279.

IMD business school (2019). World Digital Competitiveness Ranking 2018. URL: https://www.imd.org/wcc/world-competitiveness-center-rankings/world-digital-competitiveness-rankings-2018/ (data accessed: 01.04.2019).

International Institute for Sustainable Development (2019). The 2018 SDG Index and Dashboards Report. URL: http://sdgindex.org/reports/2018/ (data accessed: 04.04.2019).

International Monetary Fund (2019). World Economic Outlook Database. URL: https://www.imf.org/external/pubs/ft/weo/2017/01/weodata/weoselgr.aspx (data accessed: 04.04.2019).

Ndaguba, E.A., Hanyane, B. (2019). Stakeholder model for community economic development in alleviating poverty in municipalities in South Africa. Journal of Public Affairs, 19(1),e1858.

Popkova, E.G. (2019). Preconditions of formation and development of industry 4.0 in the conditions of knowledge economy. Studies in Systems, Decision and Control, 169, p. 65-72.

Popkova, E.G., Sergi, B.S. (2019). Will Industry 4.0 and Other Innovations Impact Russia's Development? Exploring the Future of Russia's Economy and Markets 34-42, Emerald Publishing.

Popkova, E.G., Ragulina, Y.V., Bogoviz, A.V. (2019). Fundamental differences of transition to industry 4.0 from previous industrial revolutions. Studies in Systems, Decision and Control, 169, p. 21-29.

Rajput, S., Singh, S.P. (2019). Connecting circular economy and industry 4.0. International Journal of Information Management, 49, p. 98-113.

Tiruneh, E.A., Wamboye, E., Sergi, B.S. (2017). Does productivity in Africa benefit from advanced countries' R&D? Technology Analysis and Strategic Management, 29(7), p. 804-816.

Wamboye, E., Sergi, B.S. (2019). Exploring the nature, motives, and implications of foreign capital in Africa. World Development Perspectives, 2(1), p. 28-34.

WIPO (2019). Global Innovation Index 2018. URL: https://www.wipo.int/publications/ru/details.jsp?id=4330 (data accessed: 04.04.2019).

World Bank (2019). World Development Indicators: Structure of output. URL: http://wdi.worldbank.org/table/4.2 (data accessed: 04.04.2019).

World Economic Forum (2019). The Global Competitiveness Report 2017–2018. URL: http://www3.weforum.org/docs/GCR2017-2018/05FullReport/TheGlobalCompetitivenessReport2017–2018.pdf (data accessed: 04.04.2019).