Lecture Notes in Networks and Systems 129

Elena G. Popkova
Bruno S. Sergi *Editors*

Scientific and Technical Revolution: Yesterday, Today and Tomorrow

Springer

Lecture Notes in Networks and Systems

Volume 129

The series "Lecture Notes in Networks and Systems" publishes the latest developments in Networks and Systems—quickly, informally and with high quality. Original research reported in proceedings and post-proceedings represents the core of LNNS.

Volumes published in LNNS embrace all aspects and subfields of, as well as new challenges in, Networks and Systems.

The series contains proceedings and edited volumes in systems and networks, spanning the areas of Cyber-Physical Systems, Autonomous Systems, Sensor Networks, Control Systems, Energy Systems, Automotive Systems, Biological Systems, Vehicular Networking and Connected Vehicles, Aerospace Systems, Automation, Manufacturing, Smart Grids, Nonlinear Systems, Power Systems, Robotics, Social Systems, Economic Systems and other. Of particular value to both the contributors and the readership are the short publication timeframe and the world-wide distribution and exposure which enable both a wide and rapid dissemination of research output.

The series covers the theory, applications, and perspectives on the state of the art and future developments relevant to systems and networks, decision making, control, complex processes and related areas, as embedded in the fields of interdisciplinary and applied sciences, engineering, computer science, physics, economics, social, and life sciences, as well as the paradigms and methodologies behind them.

**** Indexing: The books of this series are submitted to ISI Proceedings, SCOPUS, Google Scholar and Springerlink ****

More information about this series at http://www.springer.com/series/15179

Elena G. Popkova · Bruno S. Sergi
Editors

Scientific and Technical Revolution: Yesterday, Today and Tomorrow

Springer

Editors
Elena G. Popkova
Moscow State Institute
of International Relations
Plekhanov Russian University
of Economic
Moscow, Russia

Bruno S. Sergi
University of Messina
Messina, Italy

Harvard University
Cambridge, MA, USA

ISSN 2367-3370 ISSN 2367-3389 (electronic)
Lecture Notes in Networks and Systems
ISBN 978-3-030-47944-2 ISBN 978-3-030-47945-9 (eBook)
https://doi.org/10.1007/978-3-030-47945-9

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Introduction

The process of digital transformations is long and multistage, and its consequences are accumulative and multiplicative. The first digital technologies which appeared in the late twentieth century were accessible for a limited number of people; their advance laid a marketing foundation for the Fourth Industrial Revolution as a means of meeting the growing needs of the consumer society.

Subsequently, the mass distribution of simple (unintellectual) digital technologies—computer equipment, handheld devices, the Internet which eventually became high-speed and broadband—made it possible to form an advanced frame of mind with the representatives of great masses of population in the first decade of the twenty-first century.

This period was followed by a wave of the mass distribution of high technologies aimed at achieving high performance—intelligent assistance for making cut-and-dried solutions—and cyber security—cloud technologies and block chain technology (distributed ledger technology)—as well as at more extensive automation of certain business processes: production processes—by means of 3D printing, distributive processes—by means of RFID technologies, logistic processes—by means of SCM technologies, and communication processes—by means of CRM technologies.

At this stage which may be considered to be finished at the end of the second decade of the twenty-first century, there was a re-thinking of the role of engineering and technologies in people's lives, which came to the fore. To date, the openness of the popular majority of both developed and developing countries to high technologies, loyalty to them has been achieved; in addition, their great value and benefit for society and the economy have been acknowledged and recognized.

In 2020—at the beginning of the third decade of the twenty-first century—one may talk of the beginning of a new stage of the Fourth Industrial Revolution. It is expected that the impending stage will be associated with new outstanding scientific discoveries and technical inventions and will ensure the mass distribution of groundbreaking technology innovations of Industry 4.0. The transition to the Fourth Technological Mode will make it possible to form a "smart" economy in which

automation will reach the peak, and the boundaries between human and artificial intelligence may eventually be erased.

On the threshold of the impending new wave of the Fourth Industrial Revolution, critical analysis and system research of the future of mankind, as well as the development of recommendations for managing this future, constitute a topical issue of contemporary science. The consequences of the transition to Industry 4.0 are so unpredictable that they require that modern scientists not only have research abilities, but also creative thinking. The contours of the future are blurred: A technocratic society, which will be dominated by intelligent machines, may be formed, and a model of a social market economy based on social values and interests may be implemented in practice.

Therefore, the Fourth Industrial Revolution is a logical consequence of the scientific and technological progress in the twenty-first century. The relationship of the past, the present, and the future is absolutely clearly visible in it. This book is the result of a collective study of this process, its scientific reflection, and is reflective of a system view of its dynamics and future prospects, and also offers comprehensive recommendations on the organization and management for using the latest opportunities of the scientific and technological progress for the sake of mankind.

The book includes the most knowledge-intensive and creative papers which were reported and discussed at the 12th international scientific and practical conference, organized by the Institute of Scientific Communications. The conference "Artificial Intelligence: Anthropogenic Nature vs. Social Origin" took place during December 5–7, 2019, in Krasnoyarsk, Russia.

The target audience of the book consists of academic researchers and independent experts who study the social and human aspects of the Fourth Industrial Revolution and the associated transition to the digital economy and Industry 4.0, as well as the creators of the legal framework of this process and its participants—entrepreneurs, managers, employees and consumers.

The book has a logical structure and contains research findings in the following conceptual sections:

- "Intelligent" technologies and artificial Intelligence: promising directions of application in the present-day economy;
- Digital transformations of modern economic and social systems;
- Social environment of the Fourth Industrial Revolution and its consequences for mankind;
- Regulatory framework of the Fourth Industrial Revolution: experience and prospects;
- Effects of the Fourth Industrial Revolution on the environment: climatic change and "green" prospects of the digital economy;
- Financing of the Fourth Industrial Revolution and the prospects for improving the investment attractiveness of the digital economy.

Conference

The conference was organized by the Institute of Scientific Communications (Volgograd) in cooperation with the Siberian Federal University (Krasnoyarsk) and the Krasnoyarsk regional fund for supporting scientific and technological activities (Krasnoyarsk).

Contents

Digital Transformations of Modern Economic and Social Systems

“Intelligent” Technologies and Artificial Intelligence: Promising Directions of Application in Present-Day Economy

Overview of Promising Educational Services for a "Green" Digital Future: Online, Lifelong and Distance Learning

Darima A. Kozhanova[1(✉)], Oxana M. Makhalina[2], and Kirill A. Kirilin[3]

[1] Gorno-Altaisk State University, Gorno-Altaisk, Russia
darima.murzagulo@mail.ru
[2] State University of Management, Moscow, Russia
moxanam@mail.ru
[3] Altai State University, Barnaul, Russia
kirilink@bk.ru

Abstract. Purpose: The aim of the work is to review promising educational services of "green" digital future and to develop conceptual models of online, lifelong, distance learning aimed at mastering "green" competencies on the EdTech platform.

Design/methodology/approach: The authors apply a regression analysis method used to identify the contribution of the digital education index (EdTech), calculated by the IMD when compiling the digital competitiveness index (the "knowledge" index), to the formation of the education index (duration of studies in years), calculated by the UNDP when compiling the human development index. In order to obtain as informative and reliable results as possible, the top 10 countries in terms of the level of development of the "green" economy in 2019 according to the Dual Citizen rating were selected as targets for the study.

Findings: The results of the study showed that digital education - EdTech - can make a significant contribution to building a "green" digital future, as it will allow mass mastering of "green" competencies, distinguishing individual and corporate learning, taking into account the requirements and priorities of all stakeholders.

Originality/value: It has been proved that currently, as of 2019, due to EdTech's failure to realize its potential for sustainable development, digital education is not contributing to education and training for a "green" digital economy, even in the top 10 "green" economies. Developed and presented conceptual models of educational services for a "green" digital future, delivered in the form of online, lifelong and distance learning, will solve this problem.

Keywords: Promising educational services · "Green" digital future · Online learning · Lifelong learning · Distance learning · Digital education (EdTech)

JEL Code: D91 · E01 · F42 · F43 · F64 · Q01 · Q15 · O31 · O32 · O33 · O38 · Q56 · Q57 · O13 · O41 · O43 · O44 · O47

E. G. Popkova and B. S. Sergi (Eds.): ISC 2019, LNNS 129, pp. 1449–1455, 2020.
https://doi.org/10.1007/978-3-030-47945-9_158

1 Introduction

There is an "institutional trap" to achieving sustainable development goals. The essence of the trap is that environmental protection values were formed throughout the 20th century and by the beginning of the 21st century have become widely shared and supported. Social values have received a wide response in the business environment, expressed through the annual publication of corporate environmental responsibility reports, first by the largest shareholder companies in the industry, then by companies of all sizes, legal forms and industries. With the readiness of society and business, governments around the world began to tighten environmental norms and standards for resource and energy consumption, and sustainable development goals were adopted internationally.

However, without the necessary educational support, people are not fully aware of their ability to participate in responsible consumption, and with a lack of "green" people (workers capable of applying environmentally sound technologies and capable of creating environmental innovations), corporate responsibility practices are very restrained and "small-scale". As "green" practices are voluntary initiatives by people and businesses, they suffer from a lack of funding, which is mainly directed towards technological upgrading, which prevents private investment in the development and delivery of "green" education courses.

The state also suffers from a budget deficit and therefore cannot place public orders for the creation of these courses, the training of "green" personnel and the implementation of regional programs of "green" literacy of the population, similar to the financial and digital literacy programs, actively implemented in recent years. Since the availability of "green" competences cannot guarantee a modern employee either a better chance of employment or additional income, the following requirements are imposed on educational services that ensure the mastering of these competences.

Firstly, it is price availability that should be noted. These educational services must be low cost because the cost may not pay off. In the absence of a government order, obtaining educational services on a contractual (market) basis should be beneficial for universities and therefore not available to the general public. The traditional form of providing educational services for mastering "green" competences makes them elitist. Secondly, consumers are often interested only in the educational services themselves and the competences acquired as a result of their "green" competences, and therefore no diploma is required. Therefore, the mastering of these competences should be possible in self-study.

Thirdly, "green" technologies are being improved as a result of scientific and technological progress, so continuous learning is needed to constantly master new technologies in order to realize the fullest potential for sustainable development. Fourthly, many workers are interested in acquiring "green" competencies, but cannot combine traditional education with work even by correspondence and evening classes. In other words, a flexible individual learning schedule should be available. All these requirements are met by digital education - EdTech. Already today, online, lifelong and distance education is provided on the EdTech platform.

This is the basis for our hypothesis that the "institutional trap" of the impossibility of achieving sustainable development goals with a lack of "green" competencies and the inaccessibility of educational services to master them can be overcome by developing EdTech in a "green" direction. The aim of the work is to review promising educational services for a "green" digital future and to develop conceptual models of

online, lifelong, distance learning aimed at mastering "green" competencies on the EdTech platform.

2 Materials and Method

The literature review found that selected issues for the future development of the "green" economy are reflected in works by Frolov et al. (2017), Morozova et al. (2019), Popkova et al. (2014), Popkova et al. (2016), Pozdnyakova et al. (2017), and future scenarios for the digital economy are discussed in studies by Belik et al. (2020), Petrenko and Shevyakova (2019), Popkova (2019), Popkova and Sergi (2020), Popkova and Gulzat (2020a), Popkova and Gulzat (2020b), Popkova et al. (2018), Popkova and Zmiyak (2019), Popkova and Sergi (2019), Ragulina (2019a), Ragulina et al. (2019b), Sergi (2019), Sergi et al. (2019), Stolyarov et al. (2020). However, the contribution of education and promising educational services to a "green" digital future are not identified—this work is intended to fill this gap.

To verify this hypothesis, the paper uses the regression analysis method to identify the contribution of the digital education index (EdTech) calculated by the IMD when compiling the digital competitiveness index (the "knowledge" index) to the education index (duration of studies in years) calculated by the UNDP when compiling the human development index.

Since there are no separate statistics on "green" education in order to obtain as informative and reliable results as possible, the top 10 countries in terms of the level of development of the "green" economy in 2019 according to the Dual Citizen rating (2020) have been selected as targets for the study. Initial statistics and the result of its processing as a regression model are presented in Fig. 1.

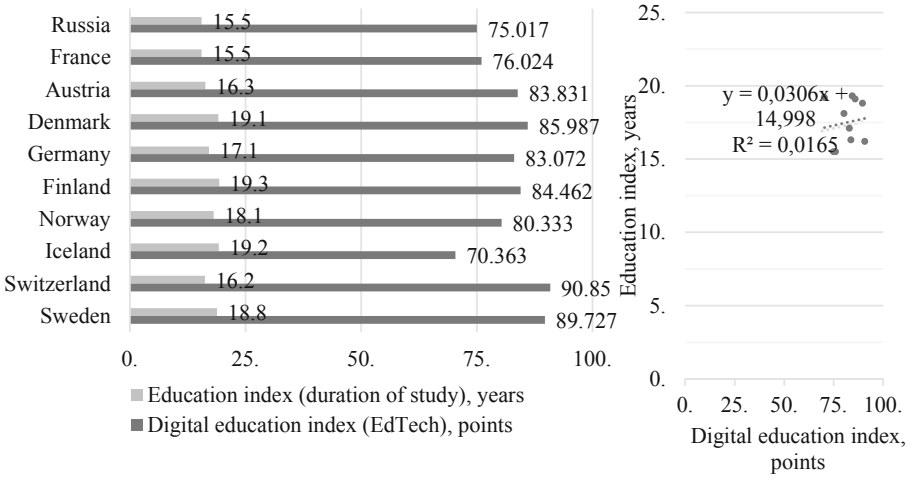

Fig. 1. Education statistics (y) and EdTech (x) and regression relation y = F(x) in the top 10 "green" countries of the economy in 2019 Source: compiled and calculated by the authors based on Dual Citizen (2020), IMD (2020).

According to Fig. 1, the highest level of digital education (EdTech) in 2019 is in Switzerland (90.85 points) and Sweden (89.727 points), with the highest level of education as a duration of study is in Finland (19.3 years) and Iceland (19.2 years). Even in the top 10 countries in terms of the level of development of the "green" economy in 2019 the dependence of the level of education on the development of EdTech is very small, but it exists, which is most important in the context of this study.

Thus, according to the obtained equation of paired linear regression, when the value of digital education index increases by 1 point, the value of education index increases by 0.0306 year, the correlation of indicators is 1.65%. Therefore, new conceptual models of educational services within the framework of EdTech are in demand to implement a "green" digital future, in which digital education will increase the availability of education to "green" competences.

3 Results

In this study, the following 3 conceptual models of educational services for a "green" digital future have been developed in EdTech in various forms: online learning (Fig. 2), lifelong learning (Fig. 3) and distance learning (Fig. 4).

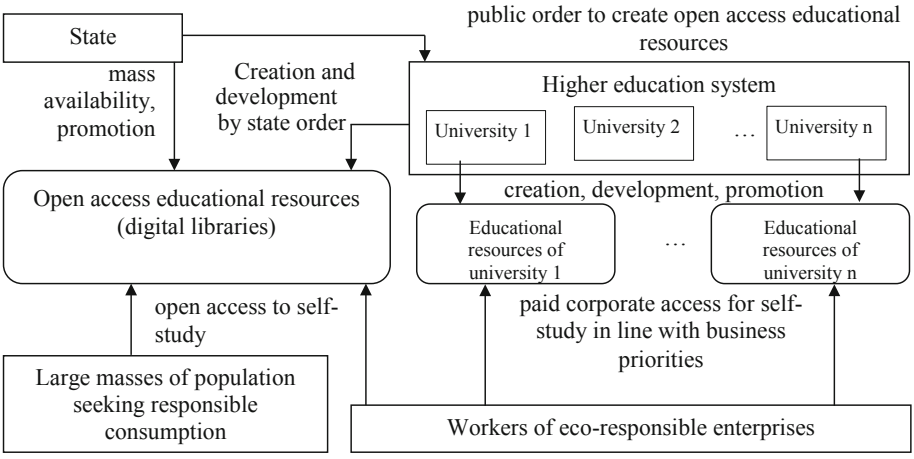

Fig. 2. The conceptual model of educational services for a "green" digital future, provided in the form of online learning Source: designed and compiled by the authors.

As shown in Fig. 2, in the model of online learning, the state places a state order to the system of science and higher education to create educational resources (digital libraries) of open access. Open educational resources are freely available for self-study by the general public seeking responsible consumption. The state provides mass availability and promotes these resources.

In addition, employees of environmentally responsible enterprises can access (paid by the business) educational resources of different universities for self-study in accordance with environmental priorities of the business. Paid educational resources are created, developed and promoted by each university separately. This provides them with an additional source of income, while the population has ample and flexible opportunities to learn different "green" competencies.

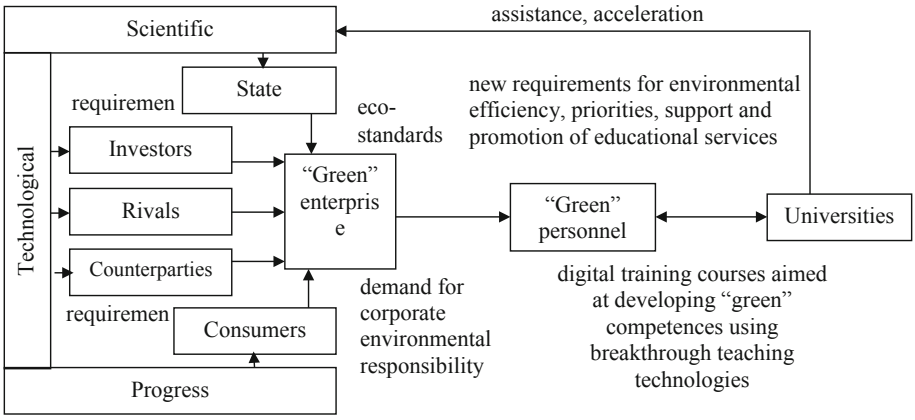

Fig. 3. Conceptual model of educational services for a "green" digital future, provided in the form of lifelong learning Source: designed and compiled by the authors.

Figure 3 shows that under the influence of scientific and technological progress all market players are placing increasing demands on the corporate environmental responsibility of "green" enterprises, including investors, counterparties, competitors, as well as consumers with a higher demand for eco-efficient products, and the government with a hardening of environmental standards.

In response to the new challenges of the market, the "green" company sets new requirements to environmental efficiency, priorities, provides support and incentives for educational services to "green" personnel. They, in turn, take digital training courses on the basis of universities aimed at developing "green" competencies using breakthrough training technologies. Universities promote and accelerate scientific and technological progress, a new wave of which launches the next cycle of the described algorithm, so that "green" learning is carried out throughout life.

Figure 4 shows that in the form of distance learning, employees can both receive individual distance education and target (paid by the enterprise) corporate distance learning for all employees. Distance learning is followed by a diploma in higher education or advanced training. Ecologically responsible company cooperates or participates in a partnership (for example, on the basis of a cluster) with the university, as well as produces incentives for "green" personnel distance learning—material through the value of salary and bonuses, and non-material through career development, depending on the competitiveness of the employee, determined from the position of possession of "green" competences.

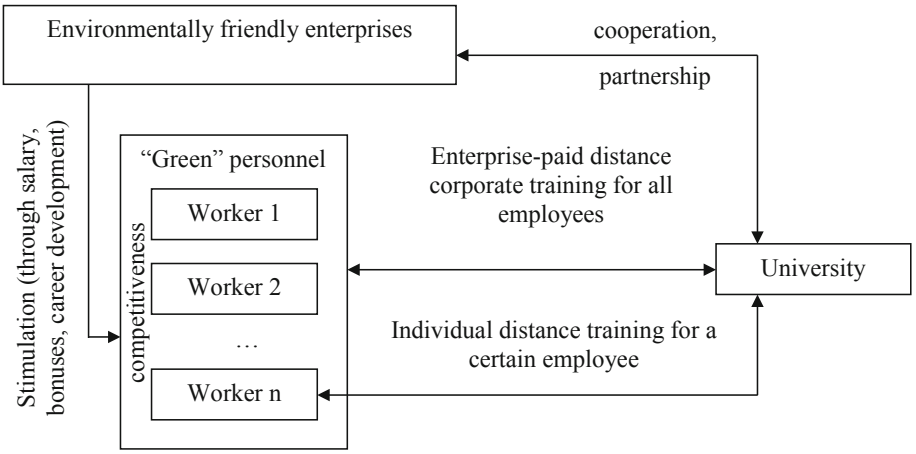

Fig. 4. Conceptual model of educational services for a "green" digital future provided in the form of distance learning Source: designed and compiled by the authors.

4 Conclusion

The results of the study showed that digital education - EdTech - can make a significant contribution to building a "green" digital future, as it will allow mass mastering of "green" competencies, distinguishing individual and corporate learning, taking into account the requirements and priorities of all stakeholders. Currently, as of 2019, due to EdTech's failure to realize its potential for sustainable development, digital education is not contributing to education and training for a "green" digital economy, even in the top 10 green economies. Developed and presented conceptual models of educational services for a "green" digital future, delivered in the form of online, lifelong and distance learning, will solve this problem.

References

Belik, E.B., Petrenko, E.S., Pisarev, G.A., Karpova, A.A.: Influence of technological revolution in the sphere of digital technologies on the modern entrepreneurship. Lecture Notes in Networks and Systems, vol. 91, pp. 239–246 (2020)

Dual Citizen: The Global Green Economy Index (2020). https://dualcitizeninc.com/global-green-economy-index/index.php#interior_section_link. Accessed 07 Jan 2020

Frolov, D.P., Popkova, E.G., Strekalova, A.S., Marushchak, I.V.: Strategic planning of regional ecological development: adaptation of Elinor Ostrom's principles in Russia. Contributions to Economics, pp. 39–45 (2017). (9783319552569)

IMD: World Digital Competitiveness Ranking 2019 (2020). https://www.imd.org/wcc/world-competitiveness-center-rankings/world-digital-competitiveness-rankings-2019/. Accessed 06 Jan 2020

Morozova, I.A., Popkova, E.G., Litvinova, T.N.: Sustainable development of global entrepreneurship: infrastructure and perspectives. Int. Entrep. Manage. J. **15**(2), 589–597 (2019)

Petrenko, E.S., Shevyakova, A.L.: Features and perspectives of digitization in Kazakhstan. Studies in Computational Intelligence, vol. 826, pp. 889–899 (2019)

Popkova, E.G.: Preconditions of formation and development of industry 4.0 in the conditions of knowledge economy. Studies in Systems, Decision and Control, vol. 169, no. 1, pp. 65–72 (2019)

Popkova, E.G., Sergi, B.S.: Human capital and AI in industry 4.0. convergence and divergence in social entrepreneurship in Russia. J. Intell. Cap. (2020). In press, 2020

Popkova, E.G., Dubova, Y.I., Yakovleva, E.A., Azarova, N.A., Titova, E.V.: Role of ecological marketing in formation and development of ecological cluster. Asian Soc. Sci. **10**(23), 1–8 (2014)

Popkova, E.G., Gulzat, K.: Technological revolution in the 21st century: digital society vs. artificial intelligence. Lecture Notes in Networks and Systems, vol. 91, pp. 339–345 (2020a)

Popkova, E.G., Gulzat, K.: Contradiction of the digital economy: public well-being vs. cyber threats. Lecture Notes in Networks and Systems, vol. 87, pp. 112–124 (2020b)

Popkova, E.G., Morozova, I.A., Litvinova, T.N.: Transformational processes in the media system under industry conditions 4.0: future outlines and perspectives (reflections on the article by Alexander P. Sukhodolov, DSc. In Economics, Professor and Irina A. Kuznetsova, Ph.D. in Engineering, Associate Professor "Designing the mass media as a homeostatic system by means of automation engineering: Basic concepts, structure, components")".Theor. Pract. Issues J. **7**(1), 145–154 (2018)

Popkova, E.G., Shakhovskaya, L.S., Abramov, S.A., Natsubidze, A.S.: Ecological clusters as a tool of improving the environmental safety in developing countries. Environ. Dev. Sustain. **18** (4), 1049–1057 (2016)

Popkova, E.G., Zmiyak, K.V.: Priorities of training of digital personnel for industry 40: social competencies vs technical competencies. Horizon **27**(3–4), 138–144 (2019)

Popkova, E.G., Sergi, B.S. (eds.): Digital Economy: Complexity and Variety vs Rationality. Springer International Publishing, Heidelberg (2019)

Pozdnyakova, U.A., Popkova, E.G., Kuzlaeva, I.M., Lisova, O.M., Saveleva, N.A.: Strategic management of clustering policy during provision of sustainable development. Contributions to Economics, pp. 413–421 (2017). (9783319454610)

Ragulina, Y.V.: Priorities of development of industry 4.0 in modern economic systems with different progress in formation of knowledge economy. Studies in Systems, Decision and Control, vol. 169, pp. 167–174 (2019a)

Ragulina, Y.V., Alekseev, A.N., Strizhkina, I.V., Tumanov, A.I.: Methodology of criterial evaluation of consequences of the industrial revolution of the 21st century. Studies in Systems, Decision and Control, vol. 169, pp. 235–244 (2019b)

Sergi, B.S. (ed.): Tech, Smart Cities, and Regional Development in Contemporary Russia. Emerald Publishing Limited, Bingley (2019)

Sergi, B.S., Popkova, E.G., Bogoviz, A.V., Litvinova, T.N.: Understanding Industry 4.0: AI, the Internet of Things, and the Future of Work. Emerald Publishing Limited, Bingley (2019)

Stolyarov, N.O., Petrenko, E.S., Serova, O.A., Umuralieva, A.S.: The digital reality of the modern economy: new actors and new decision-making logic. Lecture Notes in Networks and Systems, vol. 87, pp. 882–888 (2020)

UNDP: Human development report 2019 (2020). http://hdr.undp.org/sites/default/files/hdr2019.pdf. Accessed 06 Jan 2020

Conclusion

The scientific and technological revolution of the late 20th century - early 21st century is logical, its stages are interrelated in a cohesive way, but its consequences are unpredictable. On the one hand, formation of the digital economy will solve a large variety of topical issues of mankind. Digital medicine will ensure complete coverage of world population with medical services, early disease detecting and curing most ailments; high-tech production sector will make it possible to produce goods and services for meeting even the most exclusive needs, and the innovative approach to farming will make it possible to solve the problem of world hunger.

On the other hand, the transition to Industry 4.0 implies new risks and threats. They are safety-related, as it is necessary to ensure safety in a new environment – digital environment, and by means of advanced – "intelligent" technologies, with social adaptation to permanent changes, as well as finding ways to maintain the balance and stability of economic systems in a global economic environment characterized by unprecedented dynamism.

Scenarios of development of the digital economy and Industry 4.0 described in the book will make it possible to reduce the degree of uncertainty and prepare for the upcoming changes in a timely manner, and the proposed theoretical and practical recommendations will make it possible to make the scientific and technological revolution controllable and harmonize it in accordance with development priorities of mankind.

Finally, regard must be paid to the fact that, although the book answers many topical questions of society and the economy, new topical issues were discovered as a result of studies. In particular, the established unidimensional view of the scientific and technological progress gives rise to the fair scientific criticism and needs enhanced reasoning or revision.

Economic systems are characterized by cyclic development. Therefore, the isolated consideration of the Fourth Industrial Revolution leads to its limited interpretation and prevents us from assessing its long-range consequences. Based on the fundamental principles and empirical observations of the Theory of Business Cycles, it appears that the current stage of development of the world economic

E. G. Popkova and B. S. Sergi (Eds.): ISC 2019, LNNS 129, pp. 1737–1738, 2020.
https://doi.org/10.1007/978-3-030-47945-9

system associated with the Fourth Industrial Revolution is the stage of expansion of the long-wave cycle (conjuncture cycles also known as K-waves, developed by N. Kondratiev).

Hence, a new world crisis should become a logical end of the revolution in the long-term. Searching for its sources – social, anthropogenic and environmental – currently deserves high attention for preventing the probable future crisis. It is recommended to dedicate further research to this scientific inquiry.

Author Index

E. G. Popkova and B. S. Sergi (Eds.): ISC 2019, LNNS 129, pp. 1739–1744, 2020.
https://doi.org/10.1007/978-3-030-47945-9