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HOW TO INCREASE THE READINESS OF UKRAINE'S INDUSTRY TO SMART TRANSFORMATIONS

Introduction. *Accelerated development of the smart industry based on the use of modern cyber-physical technologies, is the worldwide dominant trend that will determine the competitive positions of national economies in the upcoming years.*

Problem Statement. *Ukraine needs to improve its readiness for accelerated development of the smart industry (industry 4.0), insofar as its conventional industry undergoes a crisis, while the new smart industry has not yet received due attention from the government.*

Purpose. *To substantiate the measures for improving the readiness of the national industry for smart transformations in accordance with the current world trends in the development of cyber-physical production ecosystems.*

Materials and Methods. *Comparing the ratings of Ukraine, some other countries, and the world as a whole by the groups of indicators «institutions», «technologies», and «economy» characterizing the readiness of the industry for smart transformations.*

Results. *The industry of Ukraine has been established to retain, at least partially, its productive and innovative capabilities. The situation with the quality of basic economic institutions is more problematic. The toughest problems are a low overall level of the domestic economy development, and an unacceptable backlog in the development of R&D due to insufficient funding because of weak business demand for R&D products.*

Conclusions. *In the complex of measures to improve the readiness of Ukrainian industry for smart transformations, the greatest attention should be paid to increasing the business demand for R&D products. This requires transforming the short horizon of business planning, because of adverse influence of political cycle, to the long one by creating long-term development institutions based on the principles of independent regulatory agencies.*

Keywords: smart industry, cyber-physical ecosystem, R&D, institution, and horizon of business planning.

The fourth industrial revolution based on the development of cyber-physical systems and fusion of cutting-edge digital, physical and biological technologies is among the key drivers of revolutionary transformations of the world economy and changes in the hierarchy of world power centers [1] is [2, 66]. Its progress shows accelerating dynamics, as according to estimates of *McKinsey & Company* experts, till 2025 from 80 to 100% of the world manufacturing will be covered by *Industrial Internet of Things* (*IIoT*) [3, 55].

In this regard, a widespread conception of postindustrial economy, which gives priority to sphere of services, essentially losesits relevance. This is confirmed by the fact that today, the advanced economies are more and more strongly competing for the leadership in manufacturing goods and reshoring production assets and industrial facilities [4].

The reason is that the industry[1], namely, *manufacturing* as its main link is the key driving force of innovation in the modern world, which ensures a unique combination of technological progress, growing return and imperfect competition, which underlie the historical success of rich countries [6, 37]. The science is revived and technological capabilities are accumulated there where new industry emerges. The two mentioned factors define competitive ability of economy, including in the sphere of human wellbeing and national security.

This does not mean that the services lose their significance. However, not all services are equally necessary and important. Today, the most required are hi-tech services, for instance, information and communication ones that are incorporated into advanced cyber-physical production systems in which tangible goods and intangible services make up a whole. These developments make the distinction between industry and services less relevant as digital technologies are connected with industrial products and services into hybrid products that are neither goods nor services exclusively (smartphones, robotic cars, «smart» houses, etc.) [7, 20].

Therefore, advanced economies are talking about and intensively promoting the building of super smart society (as it is called in Japan) or «Society 5.0» rather than the postindustrial one [8, 13–15]). The formeris notable for merging physical space (real world) and cyberspace where innovations in science and technology play a leading role in ensuring well-balanced economic development and bringing wealth to people. The super smart society is characterized as follows: a society where various needs of society are finely differentiated and met by providing the necessary products and services in the required amounts to the people who need them when they need them, and in which all the people can receive high-quality services and live a comfortable, vigorous life that makes allowances for their various differences such as age, sex, region, or language[8, 13], with collaboration between industry, academy, and government being a precondition for it [8, 14].

Combining the global Internet with tangible things gives new opportunities for directly managing the physical world, including equipment, factories, and infrastructure, which constitute modern economic landscape. In the next 10 years, the Internet of Things revolution will dramatically alter manufacturing, energy, agriculture, transportation and other industrial sectors of the economy which, together, account for nearly two-thirds of the global gross domestic product (GDP)[9].

As a result of digitalization, these transformations can entail new redistribution of resources and markets of current full world [10]. Digital copies can be made at virtually zero cost and transmitted anywhere in the world almost instantaneously, each an exact replica of the original. These properties lead to some weird and wonderful economics as they can create abundance where there had been scarcity, not only for consumer goods, such as music videos, but also for economic inputs, such as certain types of labor and capital.The returns in such markets typically follow a distinct pattern — power law or Pareto curve, in which a small number of players reap a disproportionate share of the rewards. Network effects whereby a product becomes more valuable the more users it has, can also generate these kinds of winner-take-all or winner-take-most markets [11].

Naturally, these radical changes are very complicated, controversial, and high-risky processes. It seems the most tough problems will appear in employment and income distribution. In the near future, as a result of digitalization and automation of the economy, the labor markets will undergoradical transitions that can match or even exceed the scale of historical shifts out of agriculture and manufacturing. Scenarios suggest that by 2030, 75 million to 375 million workers (3 to 14% of the global workforce) will need to switch occupational categories [12, ii]. In the absence of policy intervention, the most likely outcome of

[1] In broad context, the industry (from Latin *Industria* — activity) includes all types of activities related to manufacture of goods and services [5].

automation is an increase in inequalities of wealth, income, and power. The economic dividends of automation are likely to flow to the owners of technologies and businesses, and the highly skilled [13, 3].

In general, all this means that studying the problems related to new industrial revolution should be of top priority, because those countries that cannot respond to challenges are at risk of being shot out of the world progress and will face more and more problems unless gain competitive advantages.

In Ukraine, the role of the smart industry (Industry 4.0) is determined by the fact that the conventional industry undergoes a deep crisis, whereas the smart industry has not received due attention from the government. So far, National Plan for the Development and Upgrade of Industry and Manufacturing Based on Industry 4.0. Technologies as a constituent of the concept of the development of digital economy and society of Ukraine for 2018–2020 [14] have been at the stage of drafting some legislative acts, while the recent trends in the development of domestic industry, unlike the global ones, are not encouraging [15]. Accordingly, all this substantiates measures to improve the readiness of national industry to smart transformations in line with the actual world trends in the development of cyber-physical production ecosystems, which are the subject of this research.

ASSESSMENT OF READINESS OF UKRAINE'S INDUSTRY TO SMART TRANSFORMATIONS

The opportunities for accelerated development of Ukraine's industry based on the «smart» principles are determined, firstly, by its real status that depends on the path of development (path dependence) and, secondly, on its readiness for transition in the period of smart digital future.

As for the previous path of industrial development, which has led to its current state, the situation is clear and has been repeatedly analyzed by national experts [16, 102]. The main result of the market reforms in Ukraine's industry over the last decades is massive deindustrialization (Figs. 1, 2).

Since the mid-1990s, Ukraine has significantly lost its position as world industrial leader. Unlike, for example, Germany (Europe) or Russia (Eurasia), Ukraine's output per capita is far behind the world average and this gap does not tend to reduction.

All this, in turn, affects the readiness of Ukraine's industry for the smart future. A number of indicators can be used to assess such readiness. Among the most important indicators in terms of the smart industry development, the most important are those related to institutional environment, technology, and economy (Fig. 3).

The general conclusion that can be drawn from the above is that, firstly, the main obstacles to the «smart» development of business in Ukraine, and the national industry as its part, is a poor development of the domestic economy, which determines the available financial and economic resources for the implementation of smart transformations, as well as unsatisfactory institutional environment conditioned by a low quality of the basic institutions and a moderate quality of those that affect the financial capacity of production development (easy access to loans and ease of paying taxes).

Secondly, despite the recent deindustrialization, the industry, at least, partially has retained its potential that manifests itself in a rather good (slightly higher than average) production complexity index.

Thirdly, the further successful development of the domestic industry based on the «smart» principles will not be easy, because the indices of innovation and network readiness are not high. It should be noted that Ukraine has good positions in the world in terms of education. However, firstly, this concerns mainly the humanitarian componentwhileit still has a scarcity of skilled technical specialists [17]. Secondly, these achievements are not converted into the R&D sphere, since their volume is unacceptably low. This means that the technical level of production is based on the use of developments of past years and, part-

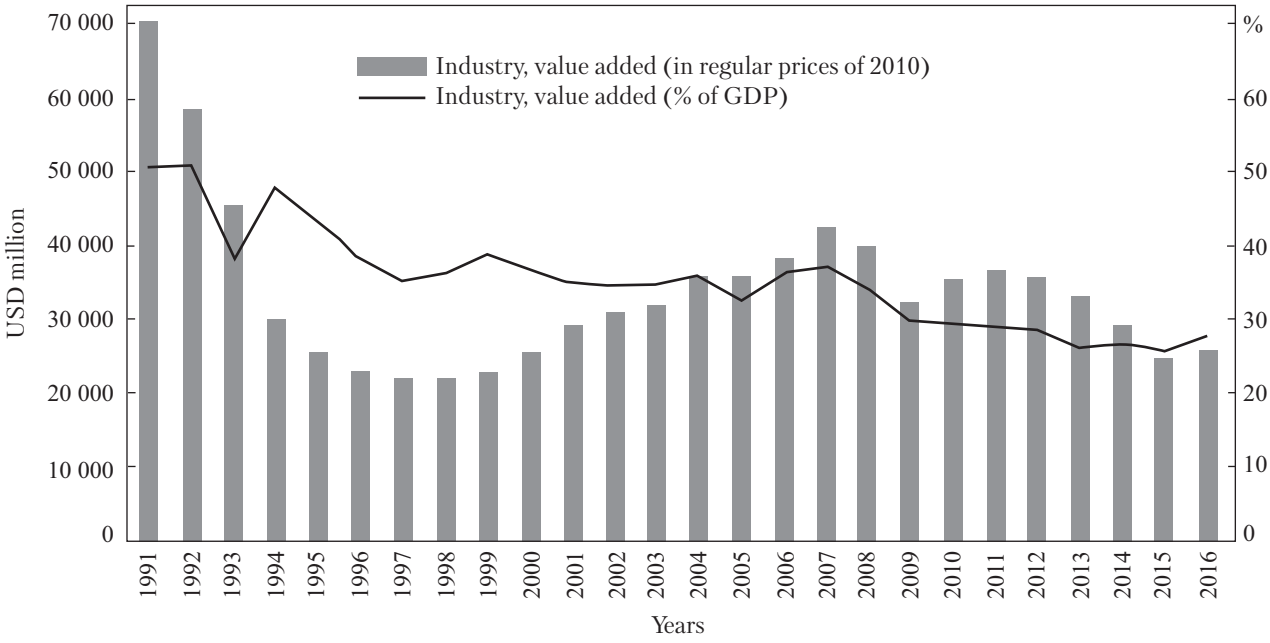

Fig. 1. Industrial output dynamics in Ukraine. Based on data of the World Bank. *World Development Indicators*. URL: Databank.worldbank.org (access: 21.11.2017)

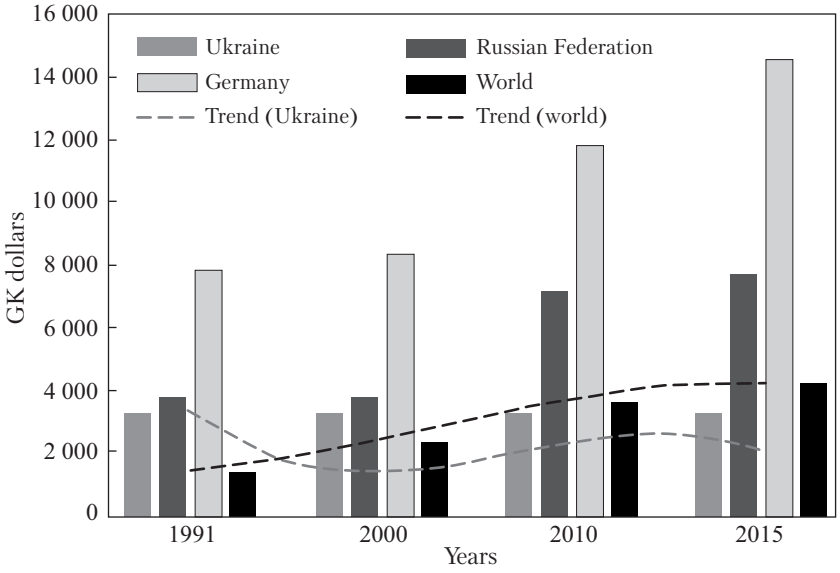

Fig. 2. Industry, value added per capita adjusted with PPP in some world countries. Based on data of the World Bank. *World Development Indicators*. URL: Databank.worldbank.org (access: 21.11.2017)

ly, on the transfer of foreign technologies, the best of which, as a rule, are not transferred to other parties, rather than on new Ukrainian R&D results[2].

[2] Ukraine is ranked 107th among 137 countries in terms of possession of state-of-the-art technologies, with the situation having shown an adverse trend in recent years [19].

Similar results have been received by experts of the World Economic Forum who used a set of indicators to estimate the future production capacity of the world countries. The indices are divided into 2 groups: the production structure and the production drivers. These data can be inter-

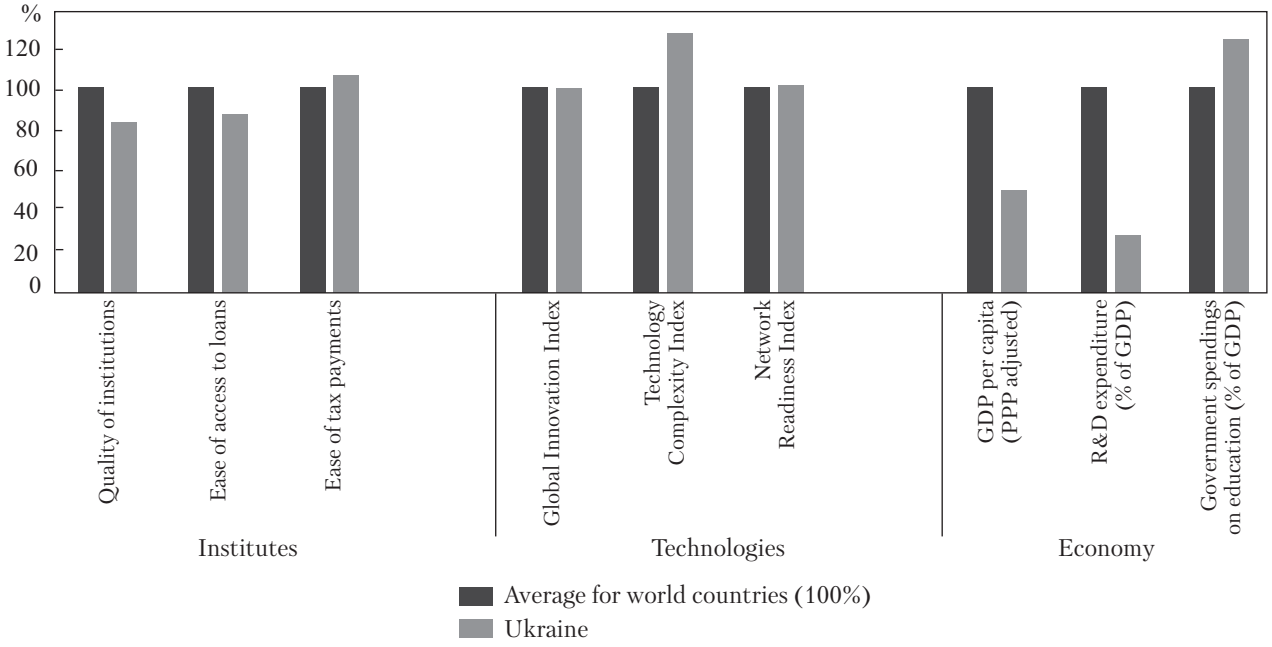

Fig. 3. Some indicators showing the readiness of Ukraine's industry to smart transformations. Based on data of Cornell University, INSEAD, and the World Intellectual Property Organization. *The Global Innovation Index 2017*: *Innovation Feeding the World*; Center for International Development at Harvard University. Atlas of economic complexity. *Country Complexity Rankings* (*ECI*). 2016.; The World Economic Forum. *The Global Competitiveness Report 2017—2018*; PwC, The World Bank Group. *Paying Taxes 2017*

preted in such a way that Ukraine is in the middle of the world countries, and the biggest problems (except for a very low GDP per capita, USD 2194) are related to institutional environment, technology, and innovation [18, 240].

This implies conclusions on the feasibility of implementing a set of measures in the institutional, technological, and economic spheres tofacilitateintensified development of smart industry.

MEASURES TO IMPROVE READINESS OF UKRAINE'S INDUSTRY TO SMART TRANSFORMATIONS

Institutional measures aim at cultivating special institutions for facilitation of smart transformations in the industry.

First of all, the public authorities should demonstrate their own interest in innovative way of Ukraine's development instead of rent-seeking and trying to strengthen their power based on economic benefits. To this end, as has been emphasized many times [20], a focused, consistent, and «long» national industrial policy is needed. It must be based on both on the development of national R&D capacity and on the use of «window of opportunities» to simulate and to localize the technological experience of more advanced countries, which become available now due to relatively low entry barriers at the stage of smart manufacturing formation.

The key to success of this policy should be public-private partnership (PPP), since neither the government nor the businessmen can solve the problems of the national industry single-handed. In particular, the government should involve the business in elaborating strategies for developing and implementing priority projects for the community (for example, the creation of sectoral road maps for «digital» transformations, the development of industrial parks, industrial technology centers, etc. [21, 40–42]) due to heightening the businessmen interest by opportunities of influencing the government policy, organizational sup-

port, easy access to financing, etc. A certain experience of such cooperation has already been acquired, for example, in drafting the Concept for the Development of Digital Economy and Society of Ukraine for 2018–2020 [14], which covers, in particular, the issues related to «Industry 4.0». Similar projects can be developed specifically for the industry.Their main ambition is the creation of ecosystems — interrelated networks of companies and knowledge institutions — around the core principles of Smart Industry such as automation, zero defect manufacturing, flexible production, chain collaboration, customer intimacy, value creation based on big data and on a number of core technologies such as 3D printing and robotics [22].

A favorable institutional environment in terms of easy access to loans and ease of paying taxes is also of crucial importance for a successful transition to the smart industry. At the same time, it's important to keep in mind that financial, credit, and fiscal instruments are not neutral in relation to the object of their application, but develop in a dialectical unity with the development of industry.

On the one hand, taxation and banking are determined by new technologies. Taxes and banking have changed dramatically when the production facilities for mass manufacture of equipment for radio, telephone, telegraph, telex, television, and the Internet appeared. For example, the world-famous *SWIFT* system (*Society for Worldwide Interbank Financial Telecommunications*) could not have appeared in the 19th century, since in that time no telecommunications existed at all; similarly, it would have been impossible to develop *BEPS* (*Action Plan on Erosion and Profit Shifting*), since there were no problems with taxation related to cross-border supply of digital goods and services at all.

On the other hand, the capital market improvements, which mitigated liquidity risk, were the primary cause of the industrial revolution. Many of the inventions already existed but required large injections and long-term commitment of capital, which was not possible without further development of financial markets [23, 76]. Today, advanced financial technologies (fintech) provide additional opportunities for the development of smart factories, for example, due to quick lending based on borrower image recognition; the blockchain technologies can radically change the financial statements and tax costs of business entities. However, in order to properly use the potential of these new opportunities and to create a favorable institutional environment for smart factories, it is necessary to focus joint efforts of government officials and entrepreneurs on synchronizing financial and technological innovations.

Equally important direction of public-private partnership should be to improve the regulatory framework of economic activities in the conditions of new industrial revolution. The development of smart industry and digital economy is hampered by the lack of basic definitions and regulations for robotics, unmanned vehicles, large data, blockchain technologies, etc. In connection with very knowledge-intensive production, a system for the protection of intellectual property rights through government support of patenting [21, 46], organization of the High Court on Intellectual Property [24], and so on needs further development. In a more general way, solving problems related to the development of smart industry in areas where technology is in contact with government regulation, requires the implementation of interdisciplinary research and the establishment of cooperation between engineers and legal experts, which aims at prompt resolution of problems arising starting with early stages of R&D process [25, 58].

Technological measures should be directed, first of all, towards the creation of a comprehensive broadband infrastructure for industry, since integrated, reliable, and high-quality communication networks are a key requirement for the development of Industry 4.0 [25, 45]. Therefore, it is important to accelerate the development of broadband Internet infrastructure both inside Ukraine and across borders between Ukraine and partner

countries. For this, it is advisable to develop a national plan for broadband access and construction of telecommunication infrastructures: fixed (main, distribution and local networks, points of traffic exchange, etc.), mobile (3G, 4G, radio and satellite technologies, Wi-Fi, etc.), and *LoRa* (*long range frequency*) for Internet of Things (sensors, etc.); as well as for coordination of efforts of the government and private providers in this field.

At the same time, it is necessary to develop appropriate national standards (compatibility, data exchange, service-oriented architecture, etc.) and/or to adapt international open standards in the field of cyber-physics systems (for example, *IEC 62541* that is the standard for the *OPC* unified architecture[3]). In this case, it is important to focus on establishing mechanisms for collaboration and information exchange based on *reference architecture* — ready infrastructure solutions that use proven configurations of environment, storage system, network, and virtualization [26]. These technologies are integrated and standardized, which enables to raise their productivity and reliability, as well as to speed up the implementation.

Since the value network in Industry 4.0 comprises several different companies with very different business models, the role of the reference architecture is to pull together these divergent approaches into one single, common approach. This will require the partners to agree on the basic structural principles, interfaces and data [25, 39].

The protection and safety of smart devices and equipment, computing devices and computer networks are critical to the success of intelligent manufacturing systems. Given the increasing scale of cybercrime in the world [27], as well as risks related to breach of industrial technologies (in nuclear power engineering, chemical industry, etc.), it is important to ensure that thecyber-physical systems do not pose a danger either to people or to the environment. At the same time, both production facilities and products and in particular the data and information they contain — need to be protected against misuse and unauthorized access. This will require, for example, the deployment of integrated safety and security architectures and unique identifiers, together with the relevant enhancements to training and continuing professional development content [25, 6]. It has been decided to createan organizational model of the National Cybersecurity System at the government level in Ukraine. This system will cover the whole economy, industrial *Security Operation Centers,* and industrial *Computer Emergency Response Team* [21, 83].

Socio-economic measures concern, first of all, the problems of accelerated development of R&D sphere. The fact is that intelligent production systems and products are becoming more sophisticated and knowledge intensive. At the same time, Ukraine is not yet ready to support them at the appropriate scientific and technical level. The total R&D expenditures in Ukraine for 2005–2015 amounted to only 0.62% of GDP while the average world level was 2.23% (3.6 times higher than in Ukraine). Taking into account the fact that Ukraine's purchasing power parity (PPP) is as about twice less as the world average, real expenditures on R&D in the country are about 7 times less than the world average. The same conclusions are true for the costs per researcher, as their amount per 1 million population is approximately equal to the world average (1,0 thousand people in Ukraine versus 1.3 thousand people in the world) (Table) [28].

For the money spent on them (the sum of current and capital costs), the Ukrainian researchers produce much more products than their colleagues in the world, on average, and even more than their colleagues in such advanced industrial countries as the USA, China, and Germany. However, this does not mean that national science as a whole works quite satisfactorily. The figures per one researcher in Ukraine (see Table) are markedly lower than the world average (except for ap-

[3] *OPC* (*Object Linking and Embedding for Process Control*) is open connectivity in industrial automation and the enterprise systems that support industry. Interoperability is assured through the creation and maintenance of open standards specifications

Some Indices of Science & Technology Development in World Countries

	Researches. Full-time equivalent per 1 million people (2005–2015)	Expenditure for R&D, % of GDP (2005–2015)	Average annual number of researchers, thousand (2005–2015)	Expenditure per researcher PPP, USD million
World	*1 278*	*2.23*	*9 511*	*0.263*
USA	4 232	2.79	1 367	0.352
China	1 177	2.10	1 623	0.257
Germany	4 431	2.88	366	0.288
Russia	3 131	1.13	452	0.090
Ukraine	1 006	0.62	45	0.045
Ukraine/world ratio	**0.79**	**0.28**	**0.0048**	**0.17**
	Return per researcher			
	Publications in scholarly research and engineering periodicals	Patent applications filed. Residents	Industrial design applications filed. Residents	High-technology exports, USD million
World	*0.23*	*0.196*	*0.089*	*0.226*
USA	0.30	0.211	0.017	0.112
China	0.25	0.597	0.340	0.306
Germany	0.28	0.129	0.123	0.518
Russia	0.08	0.065	0.006	0.015
Ukraine	0.16	0.050	0.095	0.031
Ukraine/world ratio	**0.69**	**0.26**	**1.07**	**0.14**
	Return on expenditure per researcher			
	Publications in scholarly research and engineering periodicals per USD 1 million)	Residents. Patent applications filed per USD 1 million	Residents. Industrial design applications filed per USD 1 million	High-technology exports per USD 1 million
Всього у світі	*0.87*	*0.745*	*0.337*	*0.859*
USA	1.20	0.600	0.047	0.319
China	0.96	2.323	1.323	1.190
Germany	0.96	0.450	0.429	1.800
Russia	0.88	0.723	0.065	0.164
Ukraine	3.56	1.119	2.114	0.684
Ukraine/world ratio	**4.07**	**1.50**	**6.27**	**0.80**

Based on data of the World Bank. World Development Indicators: Science and technology. Wdi.worldbank.org, 2017. URL: http://wdi.worldbank.org/table/5.13# [06.12.2017].

plications for industrial design right). However, even these results, if they are calculated per 1 million are rather high (except for high-tech exports). For example, one Ukrainian researcher per USD 1 million funding makes about 4 times more publications than the world average. This means that the expenditure of the country (the government and the private sector) per one scholarly research publication made by researcher is about four times lower than the world average.

In other words, the Ukrainian researchers still keep a rather good level of results without adequate funding. Neither in the USA nor in Germany nor in China the science does not work for such funding. And this is a real problem. The underfunding of science can turn into big losses for the society. This is on the one hand. On the other hand, relatively good (taking into account the funding factor) results of Ukraine in the field of science and technology are poorly transformed into real production. For example, China much more effectively utilizesits R&D capacity. In this country, hi-tech exports per one industrial design are almost three times higher than in Ukraine. This means that the existing national R&D potential works for the sake of foreign rather than for domestic industry.

Another problem of Ukraine, which has explicitly manifested itself in the light of international comparisons, is that in the leading world countries, the main source of R&D funding is private business, not the government. For example, in 2013, the share of private capital in R&D funding accounted for 67% in Germany; 69% in the USA; and 75% in China [29, 743–791]. It is the demand from business side, primarily, from the industry, that allows them to maintain a high level of R&D in these countries. That is why, modern industry is called the driver of innovation. Where there is demand there will be supply. In Ukraine, science is funded mainly by the state (48%). A significant part of the funds comes from abroad (22%). In comparison with industrial leaders, in Ukraine, business has a very little (29%) share in the R&D funding. This testifies to a poor demand for hi-tech developments from the private sector. Naturally, one could suggest that the supply from national science is far from the best one [30]. However, even in the case of the best supply, a sustainable demand for science from business requires a long-horizon planning. Otherwise (if it is limited to the duration of political cycle), the costs of innovation do not pay off, and the dominant business owners gain more profit from the use of government resources and rent-seeking rather than from risky innovations, which is often observed in practice.

Obviously, these unfavorable trends need to be changed. Using the levers of public-private partnership and the organizational and financial capabilities of the government it is necessary to consistently create favorable conditions for the restoration of the «factory» sector of science. Particular attention should be paid to special research aiming at developing the European research and innovation space, in particular in the area of open and interoperable digital solutions for the introduction and development of innovative ecosystems in the industrial sectors, as well as for the development and use of open standards and platforms for new products and services [21, 81].

It is likely that the smart industry will significantly transform job and skills profiles as a result of two trends. Firstly, traditional manufacturing processes characterized by a very clear division of labor will now be embedded in a new organizational and operational structure where they will be supplemented by decision-taking, coordination, control and support service functions. Secondly, it will be necessary to organize and coordinate the interactions between virtual and real machines, plant control systems and production management systems [25, 55].

All this will inevitably consolidate and accelerate the changes in demand in labor markets, while the response from the supply side is traditionally much slower. As a result, imbalances in the labor market will get pointed, which may lead to an increase in property inequality and further aggravation of social polarization in the society. This will adversely affect the stable development and long-term planning of labor markets. Therefore, the government needs to concentrate its efforts on enhancing assistance to employees during structural smart transformations in the form of support for professional training and retraining opportunities.

In this regard, the priority components of the reforms should be creating the national system of «digital» and *STEM* education, special training

for cyber-physical industries, and ongoing professional development; developing new approaches to on-the-job acquisition of knowledge and skills, including with use of digital teaching methods; creating and promoting «best practice networks» in the field of retraining, transfer of new knowledge and skills; and organizing the system for obtaining the target skills of the unemployed graduates in the field of ICT and engineering and their direct ties with industry (such as *The Academy Cube* in Germany [25, 56]) and others.

CONCLUSIONS

In order to leave the group of low-middle income countries and to be ranked up (according to the World bank classification) Ukraine needs a modern industry based on cyber-physical and other advanced technologies, which enables to utilize advantages of technological progress, growing return, and imperfect competition, which underlie historical success of advanced economies. The society with such an industry is more than a postindustrial society which conception inexplicitly counterpose the innovation-based economy and services to the industrial production. Moreover, the division into the services and the production loses its significance. Today, the advanced economies are building the smart cyber-physical society where tangible goods (hardware) and intangible services (software) are combined in production technologies and products and organically complement one another.

The analysis of national industry readiness to these smart transformations in terms of institutions, technology, and economy has shown that the situation differs for different indices, but as a whole, there is a certain potential for speeding up the industrial development has been retained. This means, that even in the view of some problems in the country, the situation is not hopeless. Despite the fact that during the years of independence Ukraine has almost completely lost the status of industrial country, its industry, at least, partially has been keeping the production and innovation capacities. More problematic is the situation with basic economic institutions. However, the toughest problems are caused by a poor development of national economy, which determines available financial and economic resources for the smart transformations as well as by inadmissible lag in the R&D development.

At the current stage, given the world trends towards speeding up science-intensive smart transformations in all spheres of social life, the national science seems to be the weakest link in terms of Ukraine's industry readiness to smart transformations. It must have a priority in the complex of measures for improving the quality of institutions, facilitating the technology development and economic relations.

This situation is explained by a very poor funding of science rather than by improper organization of work of Ukrainian researchers who are based on long traditions of scholarly research schools (although organizational innovations have been long-pending). The reason is not only insufficient attention on behalf of the government, but also a low demand for R&D from the business side. The latter is caused by a short-horizon planning that requires from business to give priority to fast profits due to the use of power and rent-seeking behavior instead of long-term innovations. The short-horizon planning is caused by strategic instability and social instability aggravating from revolution to revolution. The society that lives in the rhythm of short-term cycles of revolutionary transformations of policy and proprietorship cannot be stable and wealthy.It is a classic catch twenty-two situation. In order to break it, it is crucially important to put the development of economy and industry as its key component out of short-term political cycles generating instability and aggravating social inequality. To this end, the following is required:

a) long-term guaranteeing of proprietary rights, including intellectual property rights;

b) long-term PPP development strategies, including those for cyber-physical production, strategies for *STEM*-based staff retraining, and

strategies for combatting poverty and social inequality;

c) long-term institutions for development based on the principles of independent regulatory agencies [31], with rules for their operation and management having to be modified further than the powers of next-in-turn political authorities.

No decisive steps on this path have been made in Ukraine so far. However, Ukraine still has a chance to solve the problems of intensifying the social and economic development and getting into technological mainstream due to the windows of opportunities popping up in the time of changes in technological and economic paradigms [32, 14] and strengthening of institutional pressure by European democracies, in the view of Ukraine's focus on European integration. Time will tell, whether this chance is used. However, in the view of accelerating global cyber-physical transformations, this time is drawing on.

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ЯК ПІДВИЩИТИ ГОТОВНІСТЬ ПРОМИСЛОВОСТІ УКРАЇНИ ДО СМАРТ-ТРАНСФОРМАЦІЙ

Вступ. Прискорений розвиток смарт-промисловості, базованої на застосуванні сучасних кіберфізичних технологій, є домінуючою тенденцією у світі, яка у найближчі роки визначатиме конкурентні позиції національних економік.

Проблематика. Україні необхідно підвищити ступінь готовності до прискореного розвитку смарт-промисловості (Індустрії 4.0) зважаючи на те, що її традиційна індустрія знаходиться на сьогодні у кризовому стані, а нова «розумна» промисловість ще не отримала належної уваги з боку держави.

Мета. Обґрунтувати заходи з підвищення ступеня готовності національної промисловості до смарт-трансформацій відповідно до актуальних світових тенденцій розвитку кіберфізичних виробничих екосистем.

Матеріали й методи. Порівняння рейтингів України, низки інших країн та світу в цілому за групами індикаторів «інститути», «технології» й «економіка», які характеризують готовність промисловості до смарт-трансформацій.

Результати. Встановлено, що промисловість України, принаймні частково, зберігає свої виробничі та інноваційні можливості. Більш проблемною є ситуація з якістю базових економічних інститутів. А найбільш складним є питання низького загального рівня розвитку вітчизняної економіки, а також неприпустиме відставання у розвитку сфери науково-дослідних та дослідно-конструкторських робіт (НДДКР), що зумовлене недостанім фінансуванням через низький попит з боку бізнесу на науково-технічні розробки.

Висновки. У комплексі заходів з підвищення готовності промисловості України до смарт-трансформацій, найбільшу увагу потрібно приділити підвищенню бізнесового попиту на науково-технічні розробки. Для цього потрібно трансформувати короткий горизонт бізнес-планування, обумовлений негативним впливом політичного циклу, на довгий, шляхом створення довгострокових інститутів розвитку, що базуються на принципах незалежних регуляторних агентств.

Ключові слова: смарт-промисловість, кіберфізична екосистема, НДДКР, інститут, горизонт бізнес-планування.

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КАК ПОВЫСИТЬ ГОТОВНОСТЬ ПРОМЫШЛЕННОСТИ УКРАИНЫ К СМАРТ-ТРАНСФОРМАЦИЯМ

Введение. Ускоренное развитие смарт-индустрии, основанной на применении современных киберфизических технологий, является доминирующей тенденцией в мире, которая в ближайшие годы будет определять конкурентные позиции национальных экономик.

Проблематика. Украине необходимо повысить степень готовности к ускоренному развитию смарт-индустрии (Индустрии 4.0) учитывая, что ее традиционная промышленность находится сегодня в кризисном состоянии, а новая «умная» промышленность еще не получила должного внимания со стороны государства.

Цель. Обосновать меры по повышению степени готовности национальной промышленности к смарт-трансформациям в соответствии с актуальными мировыми тенденциями развития киберфизических производственных экосистем.

Материалы и методы. Сравнение рейтингов Украины, ряда других стран и мира в целом по группам индикаторов «институты», «технологии» и «экономика», характеризующих готовность промышленности к смарт-трансформациям.

Результаты. Установлено, что промышленность Украины, по крайней мере, частично сохраняет свои производственные и инновационные возможности. Более проблемной является ситуация с качеством базовых экономических институтов. А самый сложный вопрос — низкий общий уровень развития отечественной экономики, а также недопустимое отставание в развитии сферы научно-исследовательских и опытно-конструкторских работ (НИОКР), которое обусловлено недостаточным финансированием в связи с низким спросом со стороны бизнеса на научно-технические разработки.

Выводы. В комплексе мер по повышению готовности промышленности Украины к смарт-трансформациям, наибольшее внимание следует уделить повышению спроса бизнеса на научно-технические разработки. Для этого требуется трансформировать короткий горизонт бизнес-планирования, обусловленный негативным влиянием политического цикла, на длинный, путем создания долгосрочных институтов развития, основанных на принципах независимых регуляторных агентств.

Ключевые слова: смарт-промышленность, киберфизическая экосистема, НИОКР, институт, горизонт бизнес-планирования.