

# CROSS-COUNTRY ANALYSIS OF COMPETITIVENESS TOWARDS INNOVATION POTENTIAL ASSESSMENT FOR INDUSTRIALS

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## ABSTRACT

The global competitiveness report reveals cross-regional and cross-country disparities, and the innovation development of industrials shows how difficult it is to build and support competitiveness at a high level and increase innovation potential. The bibliometric analysis proves the diversity of the studies in the field and the increasing trend in paper production. The lack of understanding of the link between different levels of competitiveness and the need to monitor and forecast innovative development necessitated the cross-country benchmarking of industrials' innovation potential. The offered methodology is a seven-stage algorithm of innovation potential assessment, based on an existing GCI methodology modified to reveal innovation development differences, and tendencies for particular industries. The ranking was performed for major industrial countries to reveal the gaps in innovative activities and develop catch-up strategies.

**Keywords:** analysis, subindex, competitiveness, industrials, machine-building, cross-country analysis, bibliometric analysis, innovation potential.

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## INTRODUCTION

The globalization rate, and the acceleration of the 4.0 and 5.0 industry transformations, the gap between poor and rich countries, visible earlier (Jiang, & Probst, 2017), has become bigger, especially the exogenous shock caused by COVID-19. Economic entities of different types have urgent needs for forming a new basis for competitiveness and innovations to compete globally. While the latest machine-building trends are disrupting the industry, some countries are left behind. According to the research of Maslyak and Dakhno (2003), as well as according to economic geography data (Geografiya mashinobuduvannya svitu, 2019), the countries which are major manufacturers of machine-building products are the USA, Germany, France, Japan, UK, China, Russian Federation, Ukraine, and Brazil. Many studies focused on the nexus between innovations, economic growth, and development of certain industries (for instance, IT or ICT technologies (Pradhan et al., 2019). The contributing role of the industrial sector in GDP and economic growth is a well-developed topic (Stereov & Rosillo, 2019). There are two unanswered questions: identifying the 'innovation potential' of an entity or a country and increasing the chances of this entity in the global competitive game. Achieving this goal may be hampered by a lack of resources or global crises, inflation, national currencies instability, and countries' financial dependence on world donors. There should be geopolitical concerns among local difficulties, the predominance of leading countries' technologies, local governments' crises, and so on. Given this, it is necessary to introduce economic monitoring of the industrials' innovation activity to analyze their ability to generate innovative outcomes and implement innovative technologies.

## LITERATURE REVIEW

Innovation potential is still a puzzle for a researcher. Ever since Schumpeter, the discussions about the source and nature of innovations have not subsided. In Schumpeter's works, innovations were considered as a new combination related to a new product, new quality, a new production technology, a new market, a new source of supply of raw materials, or implementing the new organization in an industry (Hagedoorn, 1996). While these

postulates were criticized, they became a line of research for prominent scholars, such as Ansoff (Ansoff's Matrix) and Abell (strategic windows theory). The seminal work by C. Christensen that coined disruptive innovations has pushed strategists to think about the game-changers – firms or entities that can enter the market with an idea that will vanish the traditional way of thinking. The question set by many researchers is why some entrepreneurs, companies or countries are more innovative than others. According to (Fagerberg, 2004) the cross-national differences in growth performance can be explained by the innovative performance of these countries and regions. While one flow of academic thought is concentrated on the differences between technological development labeled as the cross-country "technology gap" (Fagerberg, 2004), another type of research is devoted to highlighting the innovation as an evolutionary, non-linear and interactive process (Tödtling & Trippl, 2005) applied to the national level (Edquist, 2001).

To explain the antecedents of possible innovations development, scholars and practitioners use widely the term "innovation potential" as well as the similar term "entrepreneurial innovativeness" (Koellinger, 2008). The previous studies revealed that innovative entrepreneurship varies across countries, and empirical data showed that in highly developed countries, innovative activities are more likely dominant among the entrepreneurs than imitative activities (Koellinger, 2008). The term "innovation potential" is not new (Nauwelaers, & Reid, 1995), but lately it has become a trend in cross-country analysis (Kotenko et al., 2021). Based on new insights and evidence on the nature and functioning of country economic systems and their capabilities for economic growth, "innovation potential" differences can explain the fragmented, disproportional development of similar regions in the EU and regional disparities between them (Shvindina et al., 2019). We understand the innovation potential as a difference between the system's current state in terms of innovation performance and its potential outcomes based on existing innovative capabilities. That may explain the recent successful catch-up in technology and income in Asian countries that involved innovations and radical changes. However, solid bibliometric research should be done in this field to

understand and frame the comprehensive model of innovation potential assessment. Therefore, the literature review was constructed as bibliometric research to reveal top contributors in innovation potential literature, main trends, and key terms network. The literature review then was divided into two big topics: the innovative development of countries and the innovation potential of industrials as two different and interrelated topics.

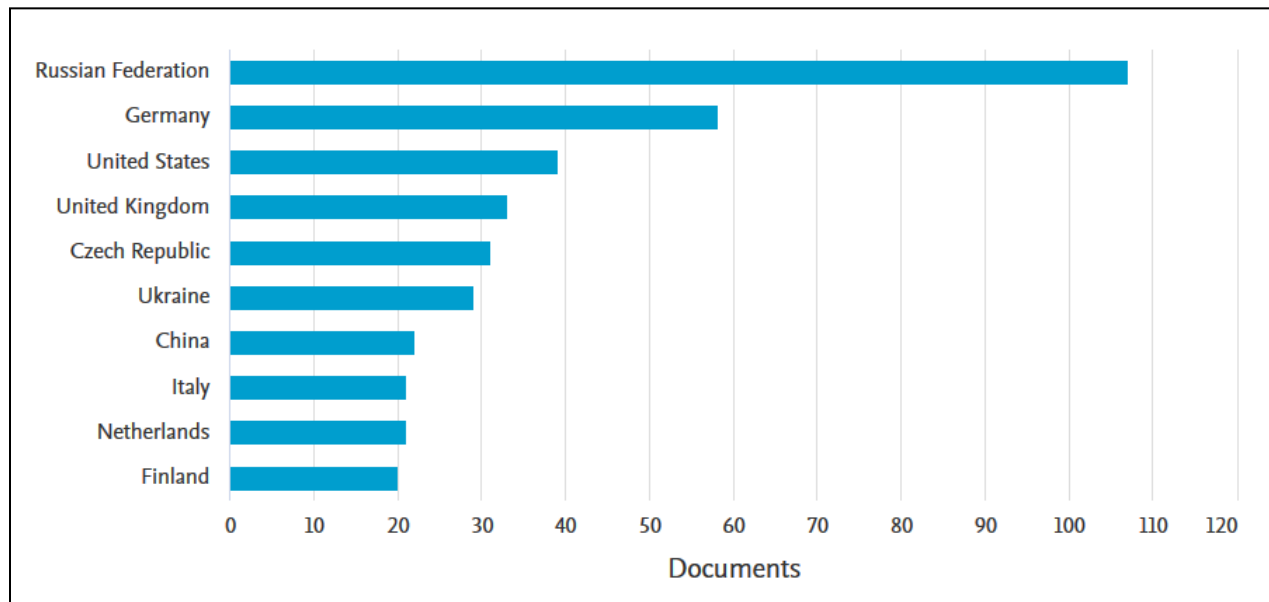
### Analysis of recent research and publications. Bibliometric Analysis in the field of study.

The bibliometric approach is an operable toolbox that allows analyzing any research area, identifying the leading trends and most influential authors, and finding the connections between keywords and fields of research. One of the most pioneering works is the study of Fahimnia, Sarkis, and Davarzani (Fahimnia et al., 2015), who performed a remarkable investigation of green supply chain management as a separate direction in research and offered the roadmap for further investigation in this field. The term 'bibliometrics' was originally

introduced by (Pritchard, 1969), but lately this type of research has expanded to many different fields, including tourism studies (Soliman et al., 2021) or multidisciplinary research linked to a particular field (Shvindina, 2019), particular for sustainable innovations (Bilan et al., 2020) and proved to be an effective tool in literature review studies.

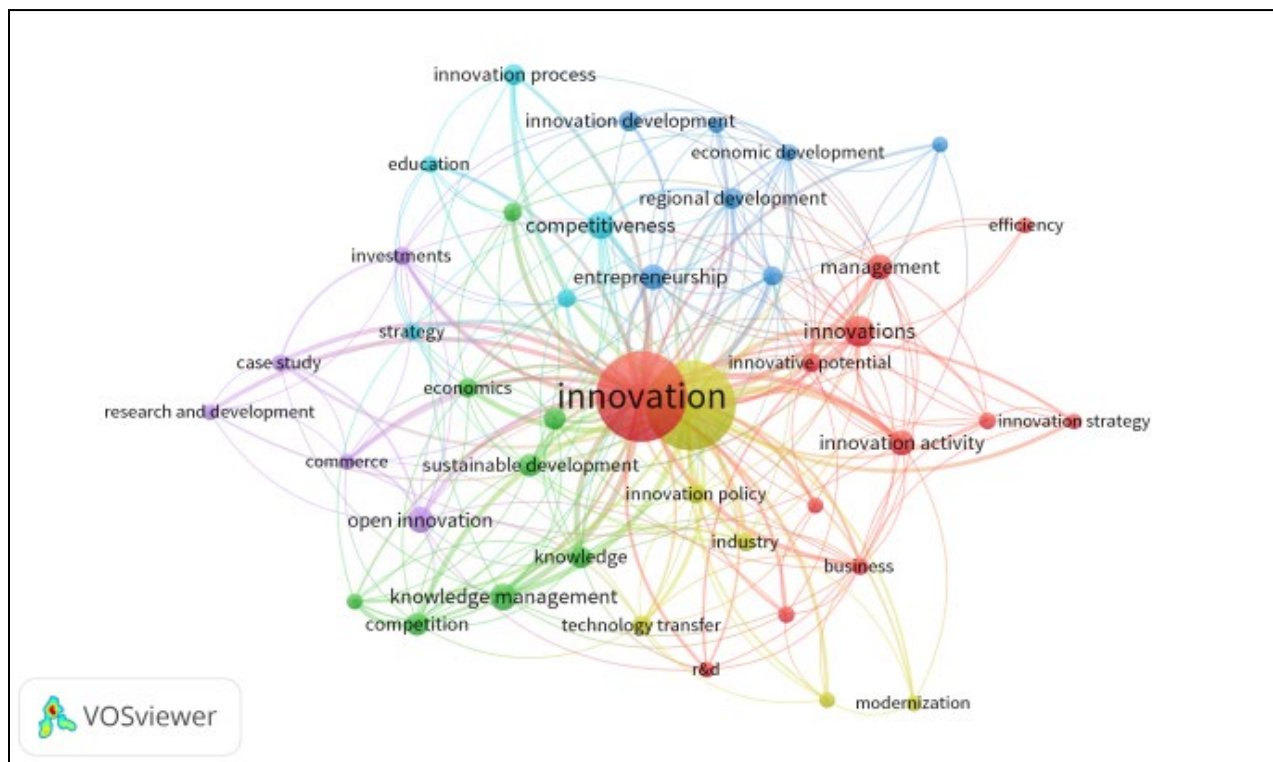
Using the keywords' innovation potential' in searching 'Article title, Abstract, Keywords' revealed 941 documents in the period 2010-2021. Refining results that include only articles (not books or conference materials) ended with 519 documents. The preliminary analysis of the results showed the main countries that are highly interested in the development of the research area, as indicated in Figure 1.

VOSviewer software has proven to be an effective visualization tool (Van Eck, Waltman, 2013) and has been chosen for this study to perform the links between keywords and terms used in the research field. The papers selected at the previous stage allowed for the presentation of the network as follows (Fig. 2).



**Figure 1:** TOP-10 countries, authors from which are contributors to the field.

Source: Scopus Database, constructed by authors for the keyword' innovation potential', 519 documents, 2010-2020).



**Figure 2:** The visualization of the keywords network in the field of research.

Source: Constructed by authors via VOSviewer for the keyword 'innovation potential' (Input data: 519 documents, 2010-2020, Scopus Database, refined).

The bibliometric analysis resulted in seven clusters or topics of the research that we may use for distinguishing the flows in academic studies using the significance of the most frequent term. As a result, we can suggest that at least six research areas are interconnected: competitiveness and entrepreneurship (light blue); regional development (dark blue); innovative potential (red); technological transfer (yellow); knowledge management (green); and open innovation (purple).

Among the top contributors (according to the Scopus database), that we should mention are works by Meier, Roy, and Seliger (Meier et al., 2010), who investigated industrial product-service systems evolution and the perspective of their use for business models, sustainability contribution, risk management, knowledge management, design, development and delivery ploys. The conceptualization of innovation was presented in (De Massis et al., 2016) using the cases of family businesses and the successful cases of innovation growth. The innovation potential is highly discussed in studies devoted to the distributed inference of the innovation, particularly estimation over complex networks (Kar & Moura, 2013).

The innovation potential studies are linked to cutting-edge technologies such as nanotechnology (Fraceto et al., 2016), nanobiosensor industry (Robinson et al., 2013), nanostructured AI (Murashkin et al., 2016), as well as start-ups in general and their development in times of COVID crises (Kuckertz et al., 2020),

The innovations may occur at the city level (Kourtit et al., 2012), in the regions and their periphery (Fitjar, & Rodríguez-Pose, 2011; Ivanova, & Kordos, 2017)). The investigations of innovation potential may be focused on Europe in general (Marrocu et al., 2013) or certain emerging economies (for instance, the economy of India (Kafouros & Forsans, 2012)). The innovation potential research varies in scale - from the cluster's development within the innovations in Ukraine (Kachala, & Kovalchuk, 2015) to a global cross-country study comparing developed and developing countries (Wu et al., 2018).

**Recent findings in the research of the innovation development of countries.**

Another dimension of the current study is the innovative development of industrialized countries, which includes developed and developing ones. Regarding this matter, the study of the innovation potential of less developed European countries of the Mediterranean region for the period 2000–2012 years should be mentioned. This study was carried out by Ramzi and Salah (2018), who identified negative factors of innovative development.

Researchers Wignaraja, Krueger and Touzon (2016) studied the productivity of manufacturing networks, profits, and innovative production at Malaysian and Thailand companies through evaluating the technological capabilities index.

Technology transfer was considered by Ciborowski and Skrobska (2020), as well as the impact of the transfer on the economic activity of industrial enterprises using the method of soft modeling and research of innovative changes in the European Union countries.

Another work was accomplished by Özak, who studied the position of countries in the evolution of innovations, the distance of pre-industrial technological borders, and the formation of cross-cultural cooperation between countries, which influences the creation of a favorable innovation climate, high productivity, and economic development in the country (Özak, 2018).

The stakeholder approach was the focus of research by Carayannis and Papadopoulos (2011), particularly the link between stakeholders' participation in the innovations and the innovative development of the country (the US as a case).

Gkypali, Kounetas, and Tsekouras (2019) investigated the link between country competitiveness, technology gaps, and level of industrial development, considering the technology gaps in the industrial system of European Union countries and the impact of it on competitiveness.

Another stream of research is an investigation of tax relief for innovative companies and tax regulation in the investment market in Ukraine (Kobushko & Kobushko, 2015).

### **Recent findings in the research of innovative potential of the countries' industrial system.**

Another dimension of the literature review is devoted to the studies related to industrial development and their innovation potential.

Freitas, Clausen, Fontana, and Verspagen (2011) studied the issues of formal and informal external linkages of machine-building firms of Sweden, Norway, the Netherlands, and the United Kingdom in the innovation process and revealed that different innovation strategies lead to different mixes of external actors and that "some differences exist across countries" (p. 113).

The cost-benefit analysis of government programs aimed at subsidizing industry in Sweden was conducted by Carlsson, Eliasson, and Sio (2018). The scholars established the correlation between government support for the industry and the stagnation of the Swedish economy.

Barzotto, Coro, Mariotti, and Mutinelli (2019) studied the use of national labor resources by foreign industrial companies that are producers of innovative products in Italy. The issues of international labor migration and its features in the United States were studied by Kazakis and Fajian (2017). The researchers identified the gender pay gap in various sectors of the economy.

The phenomenon of deindustrialization development and, as a consequence, the outflow of foreign capital from the chemical industry and chemical engineering was covered by Lopez (2017), who proved the need for state regulation of Colombia's chemical industries producing intermediate goods.

The study of export opportunities of the industrial complex of the world through the formation of mathematical models in the economy was conducted by Bayar (2017), who developed aggregate models at the global level, and country, sector, and firm levels.

The study conducted by D. Kovalin, A. Moiseyev, R. Lavrynenko (2018) on the impact of global economic sanctions on the innovative work of machine-building enterprises in the Russian Federation should be considered, as well as Brexit, which was an unexpected exogenous shock for countries dependent on UK economy (Kordos, 2019).

**Unresolved issues.** Considering the findings mentioned above and the observed disproportions in innovative development of

industrials between countries, as well as the lack of understanding of the link between different levels of competitiveness, the idea of benchmarking of industrials' innovation potential in a cross-country perspective is offered.

## METHODOLOGY

**Research methods.** To assess the innovation potential of the world's major manufacturers of machine-building products, the analysis of the global competitiveness index of the world, which was conducted by Schwab (2019), was used in combination with an approach to an understanding of competitive elements formed by Kononenko (1998). In the current study, the methodology is modified towards innovational potential assessment only. In order to do that, subindexes were selected from the 7th, 8th, 9th, 11<sup>th</sup>, and 12th pillars of GCI (Schwab, 2019) related to innovations production and implementation. Using the offered methodology, the assessment of innovation potential for countries - the major manufacturers of machine-building products (industrials) - and using Sturges formula enables the grouping of the countries by their ranks. This express method is a simplified approach comparatively to GCI; however, it enables balanced decision-making by different stakeholders at different levels in business, as well as by policymakers for regional and national programs aimed to support the industrials' development.

### Assessment procedure.

The assessment procedure has eight stages. At the first stage, a list of indicators is formed, which characterize the components of innovation potential by subindexes in the pillars "Interaction and diversity", "Research and development", "Commercialization", "Business dynamism", "Labor market", "Product market" and "Financial system". These subindexes (please see Table 1) were selected by their relatedness to the main characteristics of the markets/products/innovation development in industrial countries using the findings of previous studies.

The second stage contains the arraying of innovation indicators values, making the matrixes of their ranked values ( $R_i$ ) and their weights ( $w_i$ ) for all selected countries (Table 2). It

is worth noting that the weight of each indicator ( $w_i$ ) is determined by experts using the method of the "Analysis of Hierarchy" by Saati with the assistance of experts, group of specialists, and scientists from Sumy State University, Sumy National Agrarian University (Ukraine), and researchers from Henan University of Science and Technology (China) and Bingham University (Nigeria).

At the third stage, a weighted value of the innovation indicators is defined for each country using the approach (Kononenko, 1998):

$$Rank = \sum_i (R_i \cdot w_i) \quad (1)$$

where  $Rank$  is a weighted value of the innovation indicators for the given country;  $R_i$  is the ranked value of the  $i$ -th innovation indicator for the given country;  $w_i$  is the weight of the  $i$ -th innovation indicator for the given country.

At the fourth stage, the competitiveness of county in the field of innovation is defined as the normalized weighted value of the innovation indicators for the given country, using the approach (Kononenko, 1998):

$$CCI = \frac{Rank_O - Rank}{Rank_O - Rank_L} \quad (2)$$

where  $CCI$  is the competitiveness of the given country in the field of innovation;  $Rank$  is the weighted value of the innovation indicators for the given country;  $Rank_O$  is the  $Rank$  of outsider-country (biggest one);  $Rank_L$  is the  $Rank$  of leader-country (smallest one).

The fifth stage involves determining the level of risk-taking acceptance in business, which affects the innovative activity of enterprises in the countries – major manufacturers of machine-building products, offered earlier (Taraniuk et al., 2019):

$$RTC = \frac{ER_c}{ER_p} \quad (3)$$

where  $RTC$  is the risk-taking capacity of business in the given country;  $ER_c$  is the attitude to the entrepreneurial risk at current state ( $c$  means "current") in the given country;  $ER_p$  is the attitude to an entrepreneurial risk at the potentially maximum level ( $p$  means "peak").

The sixth stage attempts to determine the level of enterprises' use of disruptive innovative ideas that can positively affect the innovative

development of countries and help increase the innovation potential of the country as a whole:

$$DCI = \frac{DI_c}{DI_p} \quad (4)$$

where  $DCI_i$  is the level of use of disruptive innovative ideas by companies in the given country;  $DI_c$  is the level of use of disruptive ideas at the  $c$ -th (current) state in the given country;  $DI_p$  is the level of use of disruptive (innovative) ideas at the  $p$ -th (maximum) value.

At the seventh stage, the level of innovation potential of the country – major producer of machine-building products - is determined by the formula:

$$IP = CCI \cdot RTC \cdot DCI \quad (5)$$

where  $IP$  is the level of innovation potential of the given country.

The eighth, final stage is a final ranking using the Sturges formula that enables grouping the countries by level of innovation potential:

$$k_{IP} = \frac{IP_{max} - IP_{min}}{1 + 3,322lgN} \quad (6)$$

where  $k_{IP}$  is the Sturges range step, which characterizes the range of criteria values of the indicator of innovation potential;  $IP_{max}$  is the maximum value of the innovation potential;  $IP_{min}$  is the minimum value of the innovation;  $N$  – number of countries, objects of evaluation.

After determining the levels of innovation potential of the countries – main producers of machine-building products, - conclusions were made about the leading countries and outsiders of innovation development.

## RESULTS AND PRESENTATION OF KEY RESEARCH FINDINGS

### The assessment of the innovation potential.

When assessing the innovation potential of the world's main industrials, the input information is taken from the global competitiveness index report performed in 2019, conducted by Schwab (2019) and relevant research by Maslyak and Dakhno (2003). Based on the input information of the first stage of the evaluation, the indicators that characterize the innovation potential of the countries, global industrial producers, are presented as the system of subindexes in blocks (Tables 1-2).

**Table 1:** Innovation indicators, inputs

Name of block and subindex	Symbol	Unit
Interaction and diversity		
12.01 Diversity of workforce	$X_1$	conventional unit
12.02 State of cluster development	$X_2$	conventional unit
12.03 International co-inventions	$X_3$	score
12.04 Multi-stakeholder collaboration	$X_4$	conventional unit
Research and development		
12.05 Scientific publications	$X_5$	score
12.06 Patent applications (per 1 million population)	$X_6$	conventional unit
12.07 R&D expenditures (% GDP)	$X_7$	conventional unit
12.08 Research institutions prominence (1-100)	$X_8$	score
Commercialization (related to innovations)		
12.09 Buyer sophistication (1-7)	$X_9$	conventional unit
12.10 Trademark applications (per 1 million population)	$X_{10}$	score
Business dynamism (related to innovations)		
11.01 Cost of starting a business (% Gross national income per capita)	$X_{11}$	conventional unit
11.07 Growth of innovative companies	$X_{12}$	conventional unit
Meritocracy and incentivization (related to innovations)		
8.09 Reliance on professional management (1-7)	$X_{13}$	conventional unit
Market of innovations (Competition & Financial support related to innovations)		
7.02 Extent of market dominance	$X_{14}$	conventional unit
9.05 Market capitalization (% GDP)	$X_{15}$	conventional unit

Source: compiled by authors from the (Schwab, 2019),

**Table 2:** Assessment of the subindexes of innovation potential of the countries, major producers of machine-building products, displayed as value / rank / weight (standardized units)

Indicator	USA	Germany	France	Japan	United Kingdom (UK)	China	Russian Federation (RF)	Ukraine	Brazil	
Interaction and diversity, CCI <sub>1</sub>										
X <sub>1</sub>	value	5.5	5.3	4.5	4.0	5.3	4.4	4.9	4.6	4.4
	rank	1	2	6	9	3	7	4	5	8
	weight	0.06	0.06	0.06	0.06	0.06	0.07	0.06	0.07	0.07
X <sub>2</sub>	value	5.5	5.4	4.7	5.1	5.0	4.6	3.4	3.5	3.9
	rank	1	2	5	3	4	6	9	8	7
	weight	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.07
X <sub>2</sub>	value	12.39	21.4	11.44	5.1	12.44	0.9	0.68	0.53	0.31
	rank	3	1	4	5	2	6	7	8	9
	weight	0.06	0.06	0.06	0.06	0.06	0.07	0.06	0.06	0.06
X <sub>2</sub>	value	5.4	5.2	4.5	4.7	4.9	4.4	4.0	3.8	3.7
	rank	1	2	5	4	3	6	7	8	9
	weight	0.07	0.07	0.07	0.06	0.06	0.06	0.07	0.06	0.06
Research and development, CCI <sub>2</sub>										
X <sub>5</sub>	value	2088	1131	1027.7	919.3	1289	1289	503.3	229.3	493.3
	rank	1	3	4	5	2	2	7	9	8
	weight	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.06
X <sub>6</sub>	value	143.99	292.1	145.94	490.35	101.76	14.46	3.81	1.56	1.56
	rank	4	2	3	1	5	6	7	9	9
	weight	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
X <sub>7</sub>	value	2.7	2.9	2.9	3.1	1.7	2.1	1.1	0.4	1.3
	rank	3	2	2	1	6	5	8	9	7
	weight	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
X <sub>8</sub>	value	4.06	0.8	1.23	1.23	1.23	2.84	0.4	0.04	0.25
	rank	1	4	3	3	3	2	7	9	8
	weight	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Commercialization (related to innovations), CCI <sub>3</sub>										
X <sub>9</sub>	value	5.1	4.7	4.3	5.0	4.7	4.5	4.5	4.5	3.6
	rank	1	3	6	2	4	5	5	5	7
	weight	0.06	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.06
X <sub>10</sub>	value	2947.1	8745.5	5700.8	1959.8	6560.1	1577.9	437.57	744.4	749.7
	rank	5	3	8	9	1	6	9	9	4
	weight	0.06	0.06	0.06	0.07	0.07	0.06	0.06	0.06	0.06
Business dynamism, meritocracy & incentivization (related to innovations), CCI <sub>4</sub>										
X <sub>11</sub>	value	1.0	6.7	0.7	7.5	0.0	0.4	1.1	0.6	5.0
	rank	5	8	4	9	1	2	6	3	7



Table 2: Continued

	weight	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.07
X <sub>1</sub> <sub>2</sub>	value	5.6	5.1	4.6	4.6	4.9	4.4	3.7	3.6	4.2
	rank	1	2	5	4	3	6	8	9	7
	weight	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.07
X <sub>1</sub> <sub>3</sub>	value	5.7	5.3	5.1	5.7	5.3	4.5	4.0	4.1	4.5
	rank	1	3	5	2	4	6	9	8	7
	weight	0.06	0.06	0.06	0.07	0.07	0.06	0.06	0.06	0.07
Market of innovations, CCI <sub>5</sub>										
X <sub>1</sub> <sub>4</sub>	value	5.2	5.2	4.6	5.6	4.6	4.5	3.7	3.6	3.8
	rank	3	3	5	1	4	6	8	9	7
	weight	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
X <sub>1</sub> <sub>5</sub>	value	150.3	53.9	93.2	113.1	111.7	70.2	38.9	4.0	38.6
	rank	1	6	4	2	3	5	7	9	8
	weight	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07

Source: constructed by authors, using (Schwab, 2019) – for values; (Maslyak et al., 2003; and experts' evaluation) – for ranks/weights of the indicators.

The second stage of evaluating the ranking matrix of innovation indicators, which determines the value of the rank of each indicator ( $R_i$ ) and its weight ( $w_i$ ), involved the expert groups from institutions of Ukraine, China, and Nigeria. First, the weights of indicators of innovation potential for the countries, global industrial producers, and major manufacturers were computed using MS Office Excel to determine the exposition of the hierarchy of indicators  $X_1$ - $X_{15}$  and their weight using the method of "Hierarchy Analysis" by Saati (Pererva, 2019). As a result, the range of products of the correlation of indicators  $X_1$ - $X_{15}$  [0.00006 – 12288] and the range of weight of indicators  $X_1$ - $X_{15}$  [0.06 - 0.07] was revealed (Table 2). Such values characterize a fairly large sample of indicators  $X_1$ - $X_{15}$  and their geometric mean value in the range [0.99 - 1.00], which reduces the range of obtained values of weights of indicators  $X_1$ - $X_{15}$ , without losing the adequacy of the model. It is also worth mentioning that the ratio of consistency (RC) of this assessment between expert groups was calculated and had a range of values [0.148 - 0.153] (14.8 - 15.3%) for the observed countries, which corresponds to its acceptable value  $RC \leq 10$ -20% (Kulchytska, 2018), and therefore the hierarchical model is adequate.

The results of the next stages (3-7) of the innovation potential assessment for the selected countries are presented in Table 3.

It was revealed that the same countries that have a high global competitiveness index have high values of innovation potential (Table 3). For instance, United States leadership is proved ( $IP = 1.00$ ), and Ukraine is the outsider ( $IP = 0.00$ ) with the poorest weighted ranking (Rank = 7.93) and the level of competitiveness ( $CCI = 0.00$ ) compared with the USA ( $CCI = 1.00$ ).

The eighth stage of assessing involves calculating the intervals of criteria values of the country's innovation potential (IP) using the Sturges formula. The range of criteria for the innovation potential of the countries is calculated by the formula (6) and equals  $k_{IP} = 0.25$  (Table 4) that allows designing the four-dimensional basis for the final evaluation and further decision-making.

**Table 3:** The results for Innovation Potential (IP) assessment, outputs

Parameters	USA	Germany	France	Japan	UK	China	RF	Ukraine	Brazil
Weighted value of the innovation indicators (Rank)	2.07	2.91	4.38	3.88	3.41	5.31	7.46	7.93	7.58
Competitiveness of country in the field of innovation (CCI)	1.00	0.86	0.61	0.69	0.77	0.45	0.08	0.00	0.06
Attitude to an entrepreneurial risk (ER <sub>c</sub> ), (ER <sub>p</sub> = 5.6) (Schwab, 2019, subindex No 11.05)	5.6	4.8	4.2	4.2	4.9	4.5	4.2	4.7	4.1
The level of perception of entrepreneurial risk or risk-taking capacity (RTC)	1.0	0.9	0.8	0.8	0.9	0.8	0.8	0.8	0.7
Companies embracing disruptive ideas (DI <sub>c</sub> ), (DI <sub>p</sub> =5.1) (Schwab, 2019, subindex No 11.08)	5.1	4.8	4.1	3.9	4.6	4.2	3.6	3.4	3.8
The level of use of disruptive innovative ideas by companies (DCI)	1.0	0.9	0.8	0.8	0.9	0.8	0.7	0.7	0.7
<b>Innovation potential (IP) (cross-country ranking)</b>	<b>1.00</b> (1)	<b>0.69</b> (2)	<b>0.37</b> (5)	<b>0.40</b> (4)	<b>0.61</b> (3)	<b>0.30</b> (6)	<b>0.04</b> (7)	<b>0.00</b> (9)	<b>0.03</b> (8)
(For comparison)									
Global Competitiveness Index (score / place)	84 (2)	82 (7)	79 (15)	82 (6)	81 (9)	74 (28)	67 (43)	57 (85)	61 (71)

As results show, among the countries selected for the analysis by their specialization in industrial production, there are: one leader (USA), four engines (Germany, France, UK, and Japan), fair performer (China), and outsiders, which include Ukraine, Russian Federation, and Brazil. According to its value, our assumptions about the innovation potential are presented in Table 4, but the representative analysis is performed in Figure 3.

Among the findings, we should mention the big contribution of the RTC (risk-taking capacity) and DCI (level of use of disruptive innovative ideas) into the innovation potential level of the selected countries. The level of entrepreneurial risk perception or willingness to take risks and act proactively in business may be explained by the influence of the national culture (Kreiser et al., 2010), and might be culturally preconditioned. However, there are some other barriers, such as using outdated technology and

avoiding personnel training, that may lead to low innovation dynamic. There is a hidden source in 'talent adaptability' (Schwab, 2019, p. 7) that also requires a well-functioning labor market and means an ability of the workforces to contribute to innovations and disruptive ideas. And, as a result of an imbalance between economic growth and talent development, China may also be in danger.

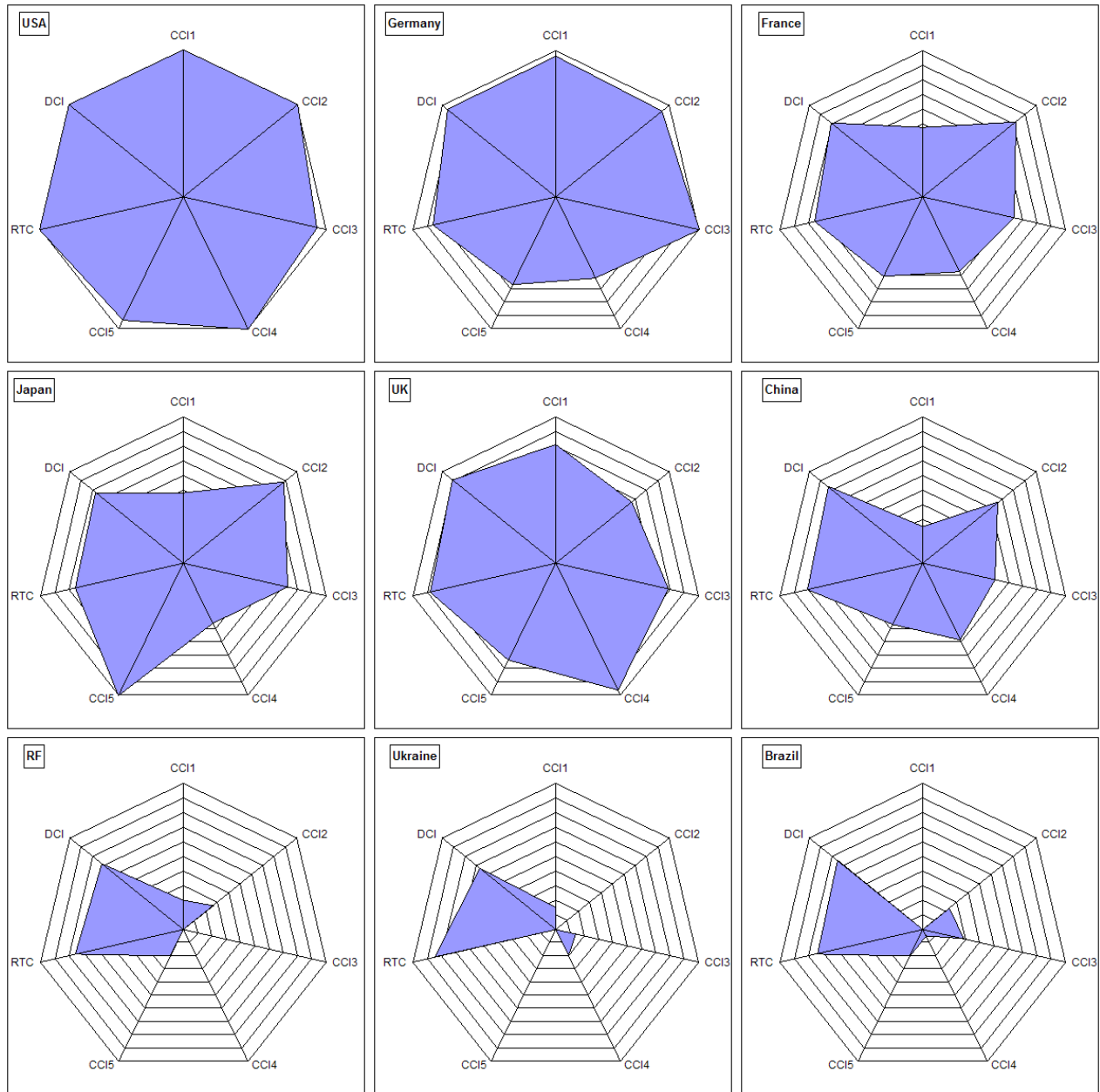
**Table 4:** The final evaluation criteria of the innovation potential level of the countries - world's major manufacturers of machine-building products

IP	Characteristics $IP_i$ according to the criteria range	Group
$0.75 \leq IP \leq 1.0$	The country's innovation potential is excellent. It characterizes the country's ability to be a leader in innovations, diversity, R&D, market extension, the country that launches the new trends, offers advanced technological processes, production upgrades, and dominates globally in the markets.	Leader: the USA
$0.50 \leq IP < 0.75$	The innovative potential of the country is good. It characterizes the country that has sufficient institutional and financial support of innovative development, good performance in R&D, despite of moderate risk-taking capacity (France, Japan) or high costs of starting a new business (Japan).	Innovation Engines: Germany, United Kingdom, Japan, France
$0.25 \leq IP < 0.50$	The innovative potential of the country is fair. It characterizes the country that has certain barriers in R&D, moderate or low interactions with international stakeholders for co-invention and co-marketing, business dynamism should be supported by professional management (meritocracy), and market development is far from modern trends.	Fair performer: China
$0.00 \leq IP < 0.25$	The innovative potential of the country is poor. It means a low level of interactions towards new ideas, their commercialization, poor start-up support infrastructure, and low business dynamism, as well as an absence of meritocracy and low market capitalization.	Outsiders: Russian Federation, Brazil, Ukraine

Source: authors' work.

Focusing on financial development may lead to an imbalance between technological integration and human capital investments, reflecting in a low level of business dynamism, meritocracy and incentivization (i.e., Russian Federation). Despite

the fact that Russian Federation was the leader in Eurasia by GCI in 2019, according to IP ranking, it is an outsider.



**Figure 3:** The visualization of the IP and its parameters for each country.

Source: authors' work.

This proves again that the subindexes selection may play a significant role in the evaluation process and understanding of future strategies for improvements. The limitation of this study is the specialization of the countries and the preselection of the indexes that, in our opinion, must be targeted as vectors for further development in the innovation sphere. The best practices should be considered too. For instance, if comparing GCI to the IP ranking, we should also mention Singapore as the country that ranks first in terms of infrastructure, health, labor market

functioning, and financial system ('Interaction and diversity'), without any industrials in the ecosystem.

## DISCUSSION

The offered methodology is a modified global competitiveness evaluation approach aimed at understanding particular aspects of competitiveness. It is a tool for decision-making by various stakeholders, including international investors, corporations, technopolises,

technology parks, innovation incubators, businesses, governments, local authorities, and other concerned stakeholders at the state and regional levels. The offered benchmarking enables the vectors development identification and partner detection for investments in industrials development. Particular decisions can also be made based on the offered approach, for example, in the sphere of marketing management (Taraniuk et al., 2018). Moreover, there is the possibility of preliminary investment evaluation in different spheres based on the level of the country's innovation potential.

The catch-up strategies may include improvements within the following fields:

- reinforcement of 'Interaction and diversity' aspects that include the balance between human capital investments and financial support of cluster development, as well as cooperation in R&D between countries/clusters, and business hubs co-creation. This strategy is recommended to implement for China, Russian Federation, Ukraine, and Brazil.
- improvements in R&D, namely direct and indirect investments, both private and public, in R&D, institutional support, and funding for scientific outcomes (papers, patents). This strategy is strongly recommended for Ukraine in the first place, and for the Russian Federation and Brazil as well. Japan demonstrates the best practice.
- strengthening the commercialization means finding ways to increase buyer sophistication and trademark applications. Here a 'value for money' approach should be implemented; best practices may be borrowed from successful countries. For instance, Luxembourg was a leader in 'Commercialization' in 2019, and it is well known for high employment rates in knowledge-intensive activities and knowledge-intensive services exports; Germany and Ireland are the exporters of high-tech products and services (Lipkova, & Braga, 2016). It is strongly recommended to expand the markets for the products with added value for the countries where this indicator is very low - Russian Federation, Ukraine, and Brazil.
- to speed up business dynamism and scale up the innovative companies, which means decreasing administrative barriers of starting the business, tax relief for start-ups, beneficial conditions for business angels and certain

types of companies, like it is already done in Portugal, Belgium, France, Germany, Ireland, UK, etc.

Additional measures may include cross-country collaboration, joint R&D projects (i.e., COSME, Horizon 2020), cross-border cooperation in industrial production.

The risk-taking capacities are extremely unlikely to be changed, as far as they are culturally determined. That may be explained by uncertainty avoidance (Hofstede, 2011), or it can be related to many cultural variables and manifest themselves in business activities (Kreiser et al., 2010), and in consumer behavior (Koç & Boz, 2017; Koç et al., 2019). However, precisely this indicator is closely related to willingness to finance start-ups (Pukala et al., 2018), and transparency in innovative business (Zakutniaia & Hayriyan, A. 2017).

Another discussion may be launched in a field of types and system of financial support for SMEs as a factor of business dynamism (Musa et al., 2017), or public and private partnership to support financial activity in the country (Kozmenko & Vasyl'yeva, 2008; Rizwan, Semenog, 2017), and therefore, economic growth. Additionally, economic growth and innovations should be implemented within sustainable development goals, and sustainability is another flow of discussion in related studies (Starchenko et al., 2021).

## CONCLUSION AND RECOMMENDATION

The methodology for assessing the innovation potential of the countries has been modified by regrouping the subindexes of GCI related to innovations and introducing additional indicators of risk-taking capacity (RTC) and the level of using disruptive ideas (DCI) by companies. That enabled the design of a seven-parameter evaluation system to gain insights into vectors of further development of innovation potential for selected countries. The leaders and outsiders were identified, and the criteria base of innovation potential of the countries enabled grouping them in several levels. The innovation potential (IP) assessment is highly related to the GCI on the one hand; on the other, it gives additional insights into the further strategies design towards a balance between innovation potential vectors. The catch-up strategies for industrials upgrading is a highly discussed topic (Xu et al., 2018; Artyukhova et al.,

2021), and the limitation of this research is lack of details in a sphere of best practices in upgrading the country's R&D process, its ability to reallocate resources, and improve the productivity, innovation commercialization and global competitiveness. However, the authors identified the gaps in development and disparities between countries, major manufacturers of machine-building products, developed the ploys and recommendations to increase the potential using a step-by-step comparison between subindexes and best practices analysis.

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