DOI: 10.61954/2616-7107/2023.7.4-4 *ISSN 2616-7107*

UDC 005.336
JEL: O11, O30

ASSESSMENT OF CHINA'S MACRO-READINESS FOR INTEGRATED INNOVATIVE MANAGEMENT TECHNOLOGIES EMPLOYMENT

Xiaoqing Guo
Simon Kuznets Kharkiv National University of Economics,
Kharkiv, Ukraine
ORCID iD: 0000-0003-2804-2918

Iryna Chmutova
Simon Kuznets Kharkiv National University of Economics,
Kharkiv, Ukraine
ORCID iD: 0000-0001-7932-7652

Iryna Sochynska-Sybirtseva
Central Ukrainian National Technical University,
Kropyvnytskyi, Ukraine
ORCID iD: 0000-0002-1046-8403

Maryna Karpunina
Classic Private University,
Zaporizhzhia, Ukraine
ORCID iD: 0000-0002-4270-3447

*Corresponding author:
Email: chmutova_i@ukr.net

Received: 28/07/2023
Accepted: 15/12/2023

DOI:10.61954/2616-7107/2023.7.4-4

Introduction. Economic entities should constantly apply various forms of innovation, including managerial and organizational innovations, to ensure the processes of developing and acquiring adaptive capacity. One of these innovations is integrated management technologies covering several interacting heterogeneous technological, economic, organizational, social, and psychological processes or several management functions.

Aim and tasks. The study aims to elaborate a procedure for assessing a country's macro-readiness to apply integrated innovative management technologies and qualitatively characterise its level.

Results. An assessment of macro-readiness to apply integrated innovative management technologies was conducted using the case of China. In order to obtain a generalized evaluation of the country's macro-readiness to apply integrated innovative management technologies, synthetic taxonomic indicators based on readiness components and a general synthetic indicator were generated. The synthetic human capital and research indicator changed from low (0.243) in 2016 to high (0.647) in 2020. The same trend is inherent in the synthetic indicator of ICT availability and use, which increased from 0.367 to 0.920, and in the synthetic indicator of institutional and business environment, which increased from 0.310 to 0.876. Although it has improved from 0.205 to 0.451, the synthetic indicators of financial resources and development have not yet reached a high level.

Conclusion. The suggested procedure for assessing macro-readiness to apply integrated innovative management technologies is based on constructing a synthetic indicator of readiness, combining the taxonomic indicators of human, digital, financial, and institutional readiness. This procedure, implying the determination of their qualitative levels, enables us to determine a country's readiness to support business entities' adoption of new management technologies. The assessment of China's readiness for applying integrated innovative management technologies using the developed approach revealed that the ICT component is the best developed, while the financial component is the most underdeveloped.

Keywords: management, readiness, technology, innovation, synthetic indicator.

1. Introduction.

Political and social processes have influenced modern economic systems worldwide. The external environment is characterized by poor predictability, high dynamism, and limited resources for development. These factors increase the complexity of economic entities' functioning, regardless of their ownership form and business scope. To ensure adaptive capacity development and acquisition, economic entities should constantly apply various forms of innovation, including managerial and organizational innovation. One of the varieties of these innovations is integrated management technologies covering several interacting heterogeneous technological, economic, organizational, social, and psychological processes, or several management functions (Chmutova, 2014). When introducing innovative management technologies, one should consider that an organization's readiness to adopt a new technology has a significant impact on the effectiveness of this process. It should be noted that readiness is primarily determined by macro factors: the innovative susceptibility of the country, the ability to create new technologies (including management technologies), the level of institutional development, financial security, the use of information and communication technologies, and the availability of qualified personnel (Plaksiuk et al., 2023).

Although adopting integrated management technologies is attracting increasing academic and practical interest, assessing readiness for their application at the national level remains a new area of research. Since integrated management technologies are perceived as organizational innovations (Bernardo, 2014), this article studies innovation readiness models and the possibilities of their modification to determine the level of macro-readiness for adopting and using integrated innovative management technologies (IIMTs).

Adapting Li and Kassem's (2019) definition of the objectives of the given study, macro-readiness for the IIMT application was defined as the country's ability to support the application of new management technologies by economic entities, i.e., to be in a state where policies, processes, and systems are robust enough to withstand the new system adoption.

2. Literature review.

Applying new technologies in different fields of activity, including management, is a research subject that arouses the practical interests of business entities. Recently, the direction towards determining readiness (organizational, innovative, and managerial) to use technologies and its assessment has also been developed.

Generally, the term "readiness" measures the ability to master any new technology before its adoption (Bendi, 2017). Due to the fact that the introduction of IIMTs is an innovative process, innovation readiness assessment models can also be used to determine the level of readiness to adopt IIMTs.

Contemporary researchers have used different approaches to assess innovation readiness. For instance, with regard to service innovation, Akhtar et al. (2021) identify two components of readiness: a strategic position conducive to innovation (strategic financing and risk sensitivity) and the expansion of structural capabilities to implement innovations (innovation catalysts, that is, innovation managers who search for innovative concepts and implement them in practice, strategic collaboration, innovation knowledge, and IT knowledge). Setiawan et al. (2018) assessed innovation readiness from a different perspective and defined it in terms of the innovation life cycle phases: idea, detailing, completion, competition, and change/closure, each of which is assessed in terms of technology, market, organization, partnership, and risk.

Bendi (2017) theoretically substantiates a combined model of readiness, which evaluates it in the aspect of personnel (skills, culture), business processes, technology (including information) and the final product, based on the analysis of numerous existing models. Four factors were empirically identified: operational challenges, strategy, planning, and effectiveness. This approach will enable the evaluation and comparison of the process of new technology introduction at the strategic and operational levels, and define problem areas and opportunities for further development or change.

Akunyumu et al. (2020) also determined similar components of innovation readiness (people, project, process, and technology) and suggested assessing the project rather than the product. In this case, the people element focuses on the readiness of the organization's human resources. According to the organizational readiness theory, the amount of worthiness and commitment demonstrated by each organization's personnel is an important prerequisite for any innovative effort. The project element considers design-related issues and problems when assessing compliance with the customer requirements. The process component refers to procedures and processes such as risk management, project planning, communication management, and other related procedures. An organization's ability to implement advanced knowledge and technology is represented by its technological components.

Webster and Gardner (2019) developed the institutional readiness model that does not contradict technological readiness but embeds it in a broader social and technical framework. This model takes into account aspects such as the need to create a new technology for a certain institutional structure, the strategic focus, the usefulness of the new technology, determination of the personnel required for its implementation, and possible exploitation problems followed by its application on an ongoing basis.

When assessing innovation readiness, Rosen (2018) interprets it as a combination of business readiness (innovation viability evaluation with regard to its conformity with the existing business, company's capabilities, and resources), user (estimation of interest and willingness to purchase the innovation), and technology (innovation feasibility estimation based on technical complexity and novelty). This emphasizes the need to consider both external and internal factors affecting a company to evaluate the potential of the innovation to become successful.

First, an internal analysis should be performed with regard to the following three factors: resources, processes, and values. Resources become values and are aligned with the company's capabilities through processes (Grant, 2016), and the way decisions and priorities are made is determined by the company's strategy and values.

To evaluate the external environment, the author suggests using Porter's five forces theory: industry competition, threat from new competitors, pressure from suppliers, consumer pressure, and threat from substitute products (Porter, 2008).

To measure readiness for innovation, Lokuge and Sedera (2014) suggest using the "A VICTORY" model evaluating resources availability (Ability), values and culture (Value), detailed understanding of change (Information), external and internal conditions (Circumstances), time (Timing), motivation to perceive innovation (Obligation), resistance to change (Resistance), reward mechanism for innovation activity (Yield).

As seen from the abovementioned approaches, when assessing readiness to innovate, researchers mainly focus on the internal parameters of the organization. External factors are analyzed only in the approaches of Rosen (2018), Lokuge and Sedera (2014), and there is no detailed description of the procedure of such analysis. Considering the analyzed points of view, it is reasonable to assess macro-readiness for the application of IIMTs according to the following components:

1. Human capital and research. New technologies in a country are perceived to the extent that business structures and the population have the skills to use them productively. The ability to conduct research, which is a prerequisite for innovative technological development, was also assessed.

2. The availability and use of information and communication technology (ICT), digital security, and data privacy, as the effective functioning of well-established management technologies, cannot be achieved without the use of ICT.

3. Financial resources and development. The formation of new technologies requires financing, so ease of access to credit resources and investment process intensity is important.

4. Institutional and business environment in terms of business and institutional development and regulatory impact effectiveness for new technology adoption.

In addition to assessing the macro-readiness components, it is necessary to determine and interpret the level using all components qualitatively.

Generalization of existing models of innovation readiness evaluation has shown that they are not suitable for assessing macro-readiness for integrated management technology implementation without proper modification and adaptation because they are designed for a different organizational scale and are not related to the factors determining the readiness to use new technologies at the macro level.

3. Aim and tasks.

The study aims to elaborate a procedure for assessing the country's macro-readiness to apply integrated innovative management technologies and qualitatively characterise its level.

4. Methodology.

In the research process, the following methods were used: theoretical generalization – to define the particular features of the existing approaches to the evaluation of different readiness types; analysis and synthesis – to identify the assessment components of readiness to implement the IIMTs based on the existing models; comparative analysis – to compare parameters in the context of readiness components used in international ratings; taxonomic analysis – to calculate the synthetic indicator of the country's readiness to use the IIMTs.

The use of the taxonomic analysis method is stipulated by the diversity and ambiguity of the economic phenomena and processes under study. It conditions the difficulty of their accurate and exhaustive assessment using a system of often multidirectional indicators that should be summarized and analyzed to make balanced managerial decisions. The taxonomic method has a powerful arsenal of systematization algorithms and is designed to solve this problem.

The taxonomic indicator construction method is widely used in economic evaluation and has significant advantages (Yankovyi et al., 2021). It enables to completely reduce the multidimensional space of characteristics and comparatively evaluate the economic object's functioning and development in dynamics with regard to the selected standard.

In addition, this method provides tools for comprehensive functioning and development analysis and management and allows for the construction of generalizing characteristics of the system development level. The taxonomic method is based on standard selection and its optimal parameter (coordinates) comparison with the parameters of vectors of all other research objects. Object ranking is based on the Euclidean distance, where the lowest distance corresponds to the highest object ranking. When applying the taxonomic indicator, a data matrix composed of standardized features was used. Standardization eliminates the dimensionality of both the cost and natural indicators (Bavar et al., 2023).

The taxonomic indicator can acquire a value in the interval [0; 1] and is interpreted as follows: the closer the taxonomic indicator value is to 1, the greater the development level of an individual object (process, phenomenon). With the help of such an indicator, it is possible to assess the average level of the statistical item value characterizing a phenomenon or process achieved in a certain period or at a certain moment (Syrvetnyk-Carij and Duljaba, 2019) as well as to compare certain objects (in this study, with reference to the periods when the country was characterized by a certain development value of the components of readiness to use IIMTs).

The taxonomically calculated synthetic indicators for each component of a country's readiness for IIMTs applications are summarized in the overall readiness index using the arithmetic mean (Fig.1).

The scale needs to be determined when considering the qualitative characterization of the obtained synthetic indicator values (high, medium, and low). One approach is to use the golden mean method, in which all changes occur at 38.2% and 61.8%, respectively. The scale was generated by successively multiplying the difference between the maximum and minimum scale values (component 1) by 0.382 and 0.618, respectively, and then subtracting each of the resulting sums from the maximum. This enables to obtain the scale value where changes are most likely to occur according to the golden mean method.

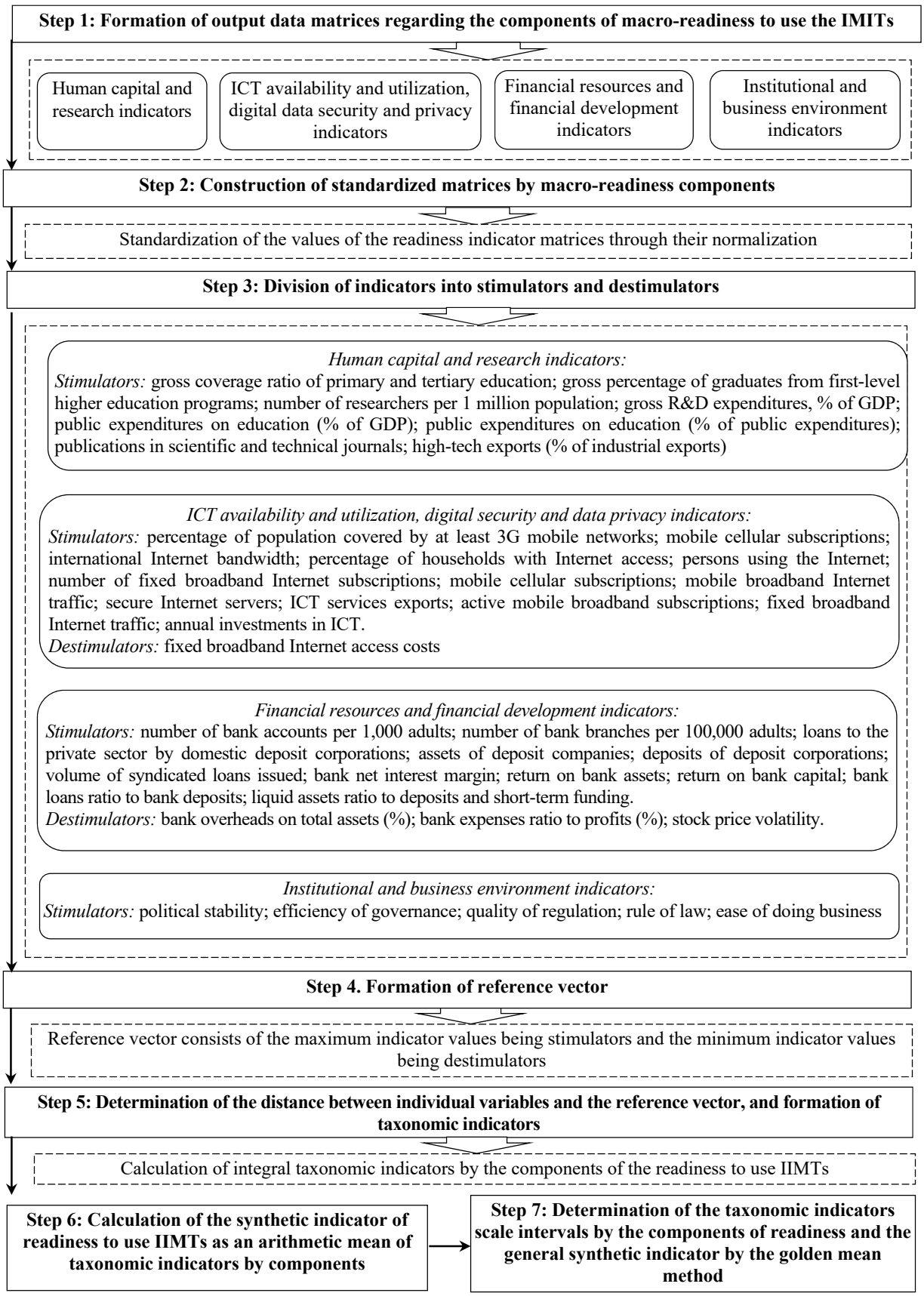

Fig. 1. Sequence of building a synthetic indicator of the country's macro-readiness to apply the IIMTs.

Source: developed by the authors.

Thus, the range of [0; 0.382] corresponds to a low level, the range of [0.382; 0.618] corresponds to a medium level, and the range of [0.618; 1] corresponds to a high level of the country's readiness to use IIMTs both for each component and as a whole.

According to the scheme presented in Fig. 1, the first stage implies building a matrix of indicators by the readiness components: human capital and research; ICT availability and use, digital security and data privacy; financial resources and financial development; institutional and business environment.

Then, according to the defined taxonomic analysis algorithm, a standardized matrix is created. The standardization procedure is used in many multivariate statistical methods and involves input data normalization in order to make factor measurement attributes dimensionless (Syrvetnyk-Carij and Duljaba, 2019). As a result, the average values for each studied attribute are zero and the variance is one (1).

$$Z_{ij} = \frac{y_{ij} - \overline{y_i}}{s_i}, \quad (1)$$

where Z_{ij} is the standardized value; y_{ij} is the average value; S_i is the standard deviation.

At the next stage of the taxonomic method application, the procedure of attribute stimulators and destimulators differentiation is carried out.

This differentiation is the basis for the construction of a developmental standard representing the point P_0, with coordinates: $Z_{01}, Z_{02}, \ldots, Z_{0n}$.

This approach allows revealing whether the development is evenly carried out, which indicators are stable and which are less stable, what is the gap between the reference value and other indicators (2-3).

The distance between the individual point-one and the point P_0, which represents the development standard, is denoted as C_{io} and is calculated by the formula (4).

$$z_{os} = max\, z_{rs}, \text{ when S} \in \text{I}, \quad (2)$$

$$z_{os} = min\, z_{rs}, \text{ when S} \notin \text{I}, \quad (3)$$

Where I is the set of stimulants, Zrs is the standardized value of trait S for unit r.

$$C_{io} = \left[\sum_{s=1}^{n} (z_{is} - z_{os})^2\right]^{\frac{1}{2}}, \quad (4)$$
(i=1,…,w).

The obtained distances serve as initial values for calculating the local indicators level (5-8):

$$d_i^* = \frac{C_{i0}}{C_0} \quad (5)$$

$$C_0 = \overline{C_0} + 3S_0 \quad (6)$$

$$S_0 = \sqrt{\frac{1}{w}\sum_{i=1}^{w} (C_{i0} - \overline{C_0})^2} \quad (7)$$

Where w is the number of objects,
C_{i0} is the distance from the i-th object to the reference,
$\overline{c_0}$ is the average distance between the objects and the reference,
S_o is the standard deviation of distances,
d_i^* is the taxonomic indicator of the development level.

$$\overline{C_0} = \frac{1}{w}\sum_{i=1}^{w} C_{i0}, \quad (8)$$

In practice, the modified index (9) is more often used, increasing at large values of stimulators and decreasing at small ones:

$$d_i = 1 - \frac{C_{i0}}{C_0} = 1 - d_i^* \quad (9)$$

5. Results.

The components of macro-readiness for the IIMTs application are human capital and research; ICT availability and use, digital security and data privacy; financial resources and financial development; and institutional and business environment. Individual indicators for assessing these components are found in global indices and rankings.

Thus, the human capital and research component is represented by the corresponding sub-index in the Global Innovation Index (GII) and the Global Talent Competitiveness Index (GTCI). The ICT availability and use, digital security and data privacy is reflected in the Global Innovation Index (GII) and the Network Readiness Index (NRI). Financial development is characterized by the Financial Development Index (FDI), while crediting and investment are separate components of the Global Innovation Index, which also includes assessments of the institutional and business environment component.

The macro-readiness for the IIMTs implementation was evaluated in compliance with the international indices using the example of China (Table 1), which continued its movement towards the top 10 innovators in 2022, reaching the 11th place in the world (Dutta et al., 2022).

Based on the above data, it can be observed that over the past four years, China has improved its position in the human capital and research sub-index of the Global Innovation Index in terms of both point appraisal and ranking, rising from the 25th to the 20th place.

Meanwhile, its greatest strengths are its score in the Program for International Student Assessment in Reading, Mathematics and Science (PISA) and its QS World University Ranking positions. Low academic mobility is one of its weaknesses. The Global Talent Competitiveness Index also reflects the country's strengthening position, with China rising from 45th to 36th during the period examined. In 2022, China's Global Talent Competitiveness Index had its highest-ever score of 51.04. Talent development is the biggest strength driven by the formal education quality and the understanding of the importance of lifelong learning. At the same time, there is a need to improve further such index components as talent attraction, which is, in particular, possible through labour migration (Hutsaliuk et al., 2020). This is caused by the country's low external openness, adversely affecting its attractiveness to businesses and people.

The overall ICT sub-index of the Global Innovation Index, considering both access to and use of ICTs, demonstrates positive dynamics. The score has increased from 74.5 in 2019 to 86.7 in 2022, and the rank has increased by 26 positions.

Table 1. China's IIMTs macro-readiness indicators by international indices.

Indicator / sub-index / index	2019		2020		2021		2022	
	rate	rank	rate	rank	rate	rank	rate	rank
Human capital and research component								
GII Human Capital and Research sub-index	47,6	25	49,4	21	50,6	21	53,1	20
Global Talent Competitiveness Index	45,44	45	49,64	42	45,84	37	51,04	36
ICT availability and use, digital security and data privacy component								
GII ICT sub-index	74,5	46	75,8	45	79,4	34	86,7	20
Network Readiness index	57,63	41	58,44	40	65,62	29	68,83	23
Financial resources and financial development component								
Financial Development Index	0,629	n/a	0,672	n/a	n/a	n/a	n/a	n/a
GII Credit indicator	45,3	43	53,1	25	51,7	26	44,7	25
GII Investment indicator	42,2	64	37,1	66	35,9	44	28,7	26
Institutional and business environment component								
GII Institutions sub-index	64,1	60	64,6	62	64,4	61	64,8	42

Source: based on Dutta et al. (2019, 2020, 2021; 2022; Dutta and Lanvin (2019, 2020, 2021; 2022); Lanvin and Monteiro (2019, 2020, 2021, 2022) and The World Bank (2022).

China shows a steady improvement in the Network Readiness Index from 57.63 in 2019 to 68.83 in 2022, indicating increasing levels of technology, ICT use, governance, and impact on the economy and living standards. Continuous improvements in these components indicate that the country's readiness for a digital economy and networked society is strengthening. The weakest element in a country's ICT development is the governance component stipulated by weak legislative privacy protection and ICT regulatory environment development.

Regarding the Financial Development Index, it should be noted that it is calculated by the International Monetary Fund for the period from 1980 to 2020, and the indicators for 2021-2022 are not available in the database. The overall trend shows a gradual improvement in China's financial development, from 0.258 in 1982 to 0.672 in 2020. Meanwhile, one weakness is its access to financial markets and institutions, which could be an impetus to develop appropriate managerial influences to improve this area.

Judging by the GII crediting and investment indicator dynamics, China continues to develop its financial system by increasing its credit volumes. However, investment assessments reveal fluctuations and volatility, which may indicate the need for more investments to stimulate economic development and support innovative projects. One can also use suggestions (Prokopenko et al., 2021) to refocus investment flows to achieve sustainable development goals.

The institutional environment in China is developing steadily, resulting from the country's movement from 60th place in 2019 to 42nd place in 2022. Simultaneously, the regulatory environment shows a slight decrease in rates, which may indicate regulatory challenges and complexities. The ease of setting up a business and the bankruptcy procedure reflect some fluctuations in rates, but they generally show an upward trend.

In general, in terms of all components of IIMTs application readiness, it can be stated that its level in the country is sufficient. To obtain a generalized evaluation of macro-readiness to use IIMTs, a synthetic indicator was developed, the value of which can be used to determine its level and trace its dynamics.

For this purpose, a list of separate indicators characterizing the components of readiness was defined: human capital and research, ICT availability and use, digital security and data privacy, financial resources and financial development, and institutional and business environments.

The readiness component indicators were formed mainly from those used in international indices and supplemented with indicators from the World Bank database, UNESCO Institute for Statistics (2022) online database, and World Telecommunication/ICT Indicators Database (ITU, 2022). The most significant characteristics reflecting the state of the IIMTs application readiness components were selected while ensuring compliance with the criteria of complete and adequate information display. In this case, preference was given to quantitative indicators that had a lower level of subjectivity compared to qualitative indicators and indicators obtained from the surveys. The only exception was the institutional and business environment component because it is impossible to quantitatively evaluate political stability, governance efficiency, and quality of regulation, as well as the rule of law and ease of doing business. Therefore, survey data presented in the World Bank database were used.

The availability of indicators was of great importance in the indicator systems formation, as not all indicators are available in international databases, making calculations impossible. There is also the issue of processing missing data. According to the approach used in the construction of most international indices, an indicator with unavailable data is excluded from the evaluation (Dutta et al., 2019; Dutta et al., 2020; Dutta et al., 2021; Dutta et al., 2022; Lanvin and Monteiro, 2019; Lanvin and Monteiro, 2020; Lanvin and Monteiro, 2021; Lanvin and Monteiro, 2022). At the same time, data from previous years were often used to construct the 2022 rankings.

For example, in the 2022 Global Innovation Index, the estimates of expenditure on education, number of researchers, and expenditure on R&D are based on the 2020 data, while enrollment in higher education and entry mobility in higher education are based on the 2019 data (the Global Innovation Index, 2022).

In the 2022 Network Readiness Index, annual investments in telecommunication services as well as the number of secure Internet servers were considered for 2020, and online access to financial accounts was considered for 2017 (Dutta and Lanvin, 2022).I t is more correct to form synthetic indicators based on the generalization of the relevant individual indicators for the same period. Taking into account the abovementioned, the following list of indicators of the country's readiness to use IIMTs was formed in the context of the components for 2016-2020 (Table 2).

Table 2. List of indicators by components of China's readiness to use the IIMTs.

Indicator by readiness component	Representation in international index/database	2016	2017	2018	2019	2020
Human capital and research component						
Tertiary education inbound mobility rate (%)	GII	0,313	0,356	0,397	0,428	0,448
Tertiary education outbound mobility ratio (%)	UIS	1,975	2,104	2,220	2,256	2,167
Gross enrolment ratio, primary to tertiary education (%)	UIS	77,456	78,793	80,274	82,533	85,316
Gross graduation ratio from first degree programs in tertiary education (%)	UIS	31,323	32,944	33,658	33,576	35,293
Number of researchers per million inhabitants	GII, GTCI	1196,688	1224,782	1307,121	1471,254	1584,865
GERD as a percentage of GDP	GII	2,100	2,116	2,141	2,245	2,407
Government expenditure on education (% of GDP)	GII	3,794	3,667	3,542	3,540	3,570
Government expenditure on education (% of government expenditure)	WDI	11,885	11,589	10,759	11,230	10,530
Scientific and technical journal articles	GTCI, WDI	436078,81	468045,33	531109,87	610458,55	669744,30
High-technology exports (% of manufactured exports)	GTCI, WDI	30,243	30,907	31,545	30,817	31,276
ICT availability and use, digital security and data privacy component						
Percentage of the population coverage with minimum 3G mobile networks	GII, ITU	98	98	99	100	100
Mobile cellular telephone subscriptions	GII, ITU	1364934000	1469882500	1649301700	1746238000	1718411000
International internet bandwidth (bit/s) per internet user	GII, ITU	15000	28000	29000	35000	44000
Percentage of households with internet access	GII, ITU	56	60	65	72	78
Individuals using the Internet (% of population)	GII, WDI	53,2	54,3	59,2	64,08	70,05
Fixed broadband internet subscriptions per 100 inhabitants	ITU	23	28	29	32	34
Mobile cellular subscriptions (per 100 people)	WDI	97,363867	104,22659	116,3882	122,81329	120,596188
Mobile broadband internet traffic	NRI, ITU	9,6	21	53	88	120
Secure Internet servers (per 1 mln people)	NRI, WDI	47,596538	207,64925	443,51279	729,738696	948,458649
ICT services exports (% of service exports, BoP)	NRI, WDI	12,203465	12,606755	12,854228	14,3016972	17,0321612
Active mobile broadband access subscriptions	ITU	973558000	1177694000	1334229000	1386740700	1364966000
Fixed broadband internet traffic (GB per subscription)	ITU	430	3100	1800	1300	2700
Fixed-broadband Internet package cost (PPP $)	ITU	28	7,9	7,9	7,2	7,1
Annual investment in telecommunication services, $ bn	NRI, ITU	66	49	50	53	59
Financial resources and financial development component						
Bank accounts per 1,000 adults	GFD, FDI	22,25	25,55	29,18	33,21	36,45
Bank branches per 100,000 adults	GFD, FDI	8,81	8,81	8,88	8,86	8,79
Private credit by domestic deposit money banks, (% of GDP)	GFD, FDI	156,22	154,88	157,81	165,39	182,87
Deposit money banks' assets, % of GDP	GFD, FDI	179,28	181,11	186,57	196,54	218,74
Financial system deposits, % to GDP	GFD, FDI	56,04	56,87	52,05	50,56	53,40
Syndicated loan issuance volume, % of GDP	GFD, FDI	1,43	1,16	0,94	4,53	1,24
Bank net interest margin (%)	GFD, FDI	2,28	2,33	2,15	2,23	2,30
Bank overhead costs to total assets (%)	GFD, FDI	0,88	0,87	0,81	0,82	0,80
Bank return on assets (%, after tax deduction)	GFD, FDI	0,96	0,99	0,90	0,90	0,85
Bank return on equity (%, after tax deduction)	GFD, FDI	13,21	13,45	11,71	11,21	10,25
Bank cost to income ratio (%)	GFD, FDI	33,43	32,13	31,53	30,80	30,32
Bank credit to bank deposits (%)	GFD, FDI	278,78	272,36	303,19	327,09	342,44
Liquid assets to deposits and short-term funding (%)	GFD, FDI	13,94	12,38	19,28	20,55	19,63
Stock price volatility	GFD, FDI	36,42	17,76	13,10	19,95	20,09
Institutional and business environment component						
Political stability	GII, WGI	-0,50	-0,23	-0,30	-0,26	-0,33
Governance efficiency	GII, WGI	0,38	0,44	0,52	0,56	0,68
Quality of regulation	GII, WGI	-0,30	-0,16	-0,22	-0,29	-0,19
Rule of law	GII, WGI	-0,31	-0,24	-0,17	-0,24	-0,08
Ease of doing business	DB	63,10	64,60	65,20	74,00	77,90

Explanation of indicators: GII – the Global Innovation Index; UIS – UNESCO Institute for Statistics; GTCI – the Global Talent Competitiveness Index; WDI – World Development Indicators (World Bank, 2022); ITU – World Telecommunication/ICT Indicators Database; NRI – Network Readiness Index; FDI – Financial Development Index; GFD – Global Financial Development Database (World Bank); WGI – The Worldwide Governance Indicators (World Bank); DB – Ease of Doing Business Index (Doing Business (World Bank)).

Source: based on The World Bank (2022); UNESCO Institute for Statistics (2022); ITU (2022).

The values of synthetic indicators by readiness components calculated by the taxonomic method as well as the general synthetic indicator of China's readiness to implement the integrated innovative management technologies and their qualitative level are presented in Table 3, the dynamics of values is shown in Fig. 2.

Table 3. Values and levels of the synthetic indicator and components of China's readiness to use the IIMTs.

Year	Synthetic indicator by readiness components								General synthetic indicator	Level
	Human capital and research	Level	ICT availability and use, digital security and data privacy	Level	Financial resources and financial development	Level	Institutional and business environment	Level		
2016	0,243	L	0,367	L	0,205	L	0,310	L	0,281	H
2017	0,424	M	0,517	M	0,305	L	0,572	M	0,454	M
2018	0,485	M	0,638	H	0,365	L	0,651	H	0,534	M
2019	0,605	M	0,758	H	0,519	M	0,625	H	0,627	H
2020	0,647	H	0,920	H	0,451	M	0,876	H	0,723	H

Explanation of indicators: H – high; M – medium; L – low.

Based on the calculations performed, the examined period showed a significant change in the qualitative level of a country's readiness to adopt and use IIMTs. Thus, in 2016, all components were characterized by a low development level. In 2017, it transformed into a medium level for all components except the financial component, and in 2018-2020, the medium level changed to a high level.

The graph shows that during the examined period, the country's readiness to apply IIMTs increased by components and general.

The most developed component during the entire study period was ICT. This means that the availability and coverage of internet connections and digital services will ensure the effective functioning of IIMTs. The weakest part of IIMTs' application readiness is financial development, which increased slightly in 2019 and reached a medium level but declined in 2020, likely caused by the COVID-19 pandemic. Simultaneously, this level is sufficient for IIMT applications. As shown in Fig. 3, almost all components had values higher than the threshold for the high level in 2020.

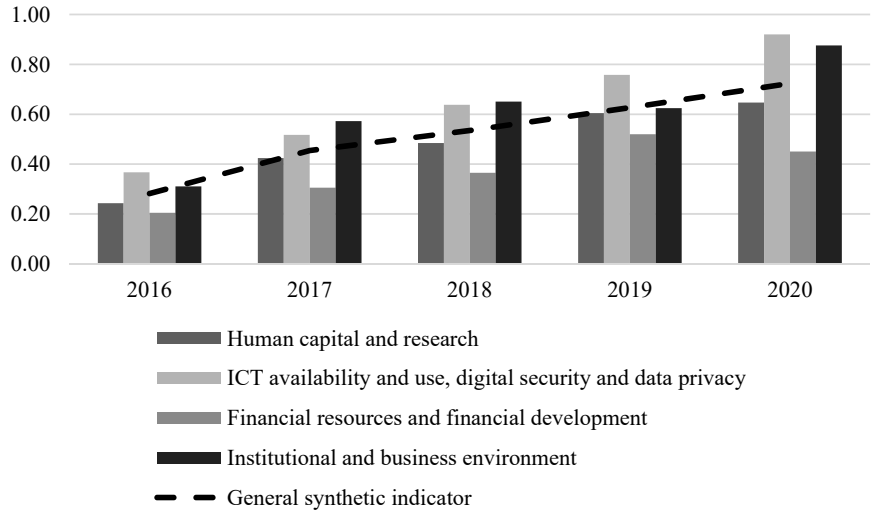

Fig. 2. Dynamics of synthetic indicator and indicators of China's readiness to use IIMTs.

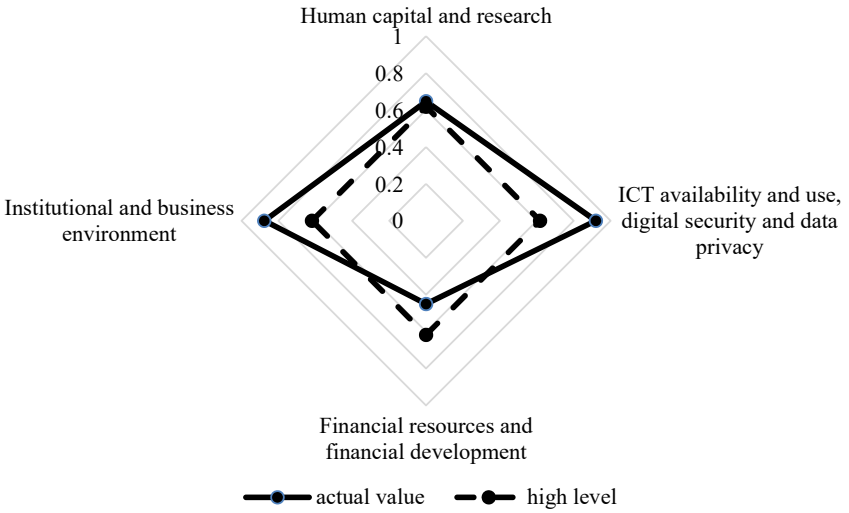

Fig. 3. Development level of the components of China's readiness to use the IIMTs in 2020.

Based on the calculated synthetic indicator, it is possible to draw conclusions concerning the development of the components of the country's readiness to use IIMTs by one generalized attribute, which shows the direction and scale of changes in the processes described by a set of input attributes characterizing the readiness development status and level.

6. Conclusions.

Therefore, considering the suggested components of macro-readiness for the application of IIMTs (human capital and research; ICT availability and use, digital security, and data privacy; financial resources and financial development; institutional and business environment) will enable a comprehensive evaluation of countries' readiness for the introduction and application of innovative management technologies.

Based on the analyzed international indices and rankings, we can see the following trends in terms of the components of China's readiness to apply IIMTs:

1. There is a sufficient macro-readiness level in human capital development evidenced by the strengthening of the country's position both in the Global Innovation Index and the Global Talent Competitiveness Index, according to which China has risen from 45th to 36th place and obtained the highest rate of 51.04 in 2022 in the last four years.

2. The availability and use of information and communication technologies have improved significantly, and the Network Readiness Index rose from 57.63 in 2019 to 68.83 in 2022. The country has achieved high access to ICTs and the effective use of these technologies, promoting the development of a digital society and improving the interaction between the government, citizens, and businesses. The need to improve the legislative protection of privacy and to develop an ICT regulatory environment requires further attention.

3. The country shows positive dynamics in financial institutions and financial market functioning, with the Financial Development Index increasing from 0.258 in 1982 to 0.672 in 2020. This indicates the need for significant effort to create an efficient and sustainable financial system. The weakness is poor access to financial markets and institutions, which could be an impetus to developing appropriate management influences to improve this area.

4. There are positive trends in the institutional and business environment stemming from the country's movement from 60th place in 2019 to 42nd place in 2022 with regard to the Institutions sub-index of the Global Innovation Index. Simultaneously, the business environment is improving, which is reflected in easier start-up and bankruptcy procedures. This contributes to the development of entrepreneurship and attracts investments.

Synthetic indicators of macro-readiness to apply integrated innovative management technologies in China in terms of components are characterized by positive dynamics. Thus, the synthetic human capital and research indicators changed from low (0.243) in 2016 to high (0.647) in 2020. The same trend is inherent in the synthetic indicator of ICT availability and use, which increases from 0.367 to 0.92, and the institutional and business environment development indicator, which increases from 0.310 to 0.876. Although the synthetic indicator of financial resources and development has improved from 0.205 to 0.451, it is yet to reach a high level.

The suggested procedure for assessing macro-readiness to apply integrated IIMTs is based on constructing a synthetic readiness indicator that combines human, digital, financial, and institutional taxonomic indicators. This implies the determination of the macro-readiness qualitative levels according to the golden mean rule, and enables the identification of the actual level of the country's readiness to support the introduction of the latest management technologies. The procedure for evaluating China's readiness to apply IIMTs revealed considerable positive changes in the country's readiness level.

REFERENCES

Akhtar, N., Altalhi, H., Ahmed, A., Mustafa, F., & Meraj, M.A. (2021). Service Innovation Readiness of Health Institutions during COVID-19: A Perspective from the Kingdom of Saudi Arabia. Journal of Asian Finance, Economics and Business, 8, 375–386 https://doi.org/10.13106/jafeb.2021.vol8.no8.0375

Akunyumu, S., Fugar, F.D.K., Adinyira, E., & Danku, J.C. (2021). A review of models for assessing readiness of construction organisations to innovate. Construction Innovation, 21, 2, 279-299. https://doi.org/10.1108/CI-01-2020-0014

Bavar, M. S., Naderan, A., Saffarzadeh, M. (2023). Evaluating the spatial effects of environmental influencing factors on the frequency of urban crashes using the spatial Bayes method based on Euclidean distance and contiguity. Transportation Engineering. 12, 1-13. https://doi.org/10.1016/j.treng.2023.100181

Bendi, D. (2017). Developing an offsite readiness framework for Indian construction organisations, Doctoral dissertation, University of Salford.

Bernardo, M. (2014). Integration of management systems as an innovation: a proposal for a new model. Journal of Cleaner Production, 82, 132-142. http://dx.doi.org/10.1016/j.jclepro.2014.06.089

Chmutova, I. M. (2014). Implementation stages of financial management system technologies in banking. Bulletin of Odessa National University, 3/4, 116–120.

Dutta, S., & Lanvin, B. (eds.) (2019). The Network Readiness Index 2019: Towards a Future-Ready Society. Washington D.C., USA.

Dutta, S., & Lanvin, B. (eds.) (2020). The Network Readiness Index 2020: Accelerating Digital Transformation in a post-COVID Global Economy. Washington D.C., USA.

Dutta S., & Lanvin B. (eds.) (2021). The Network Readiness Index 2021: Shaping the Global Recovery. How digital technologies can make the post-COVID world more equal. Washington D.C., USA.

Dutta S., & Lanvin B. (eds.) (2022). The Network Readiness Index 2022: Stepping into the new digital era. How and why digital natives will change the world. Washington D.C., USA.

Dutta, S., Lanvin, B., Leon, R.V., & Wunsch-Vincent S. (eds.) (2022). Global Innovation Index 2022: What is the future of innovation-driven growth? Geneva. World Intellectual Property Organization.

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (eds.) (2019). Global Innovation Index 2019: Creating Healthy Lives – The Future of Medical Innovation. Ithaca, Fontainebleau, and Geneva. World Intellectual Property Organization.

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (eds.) (2020). Global Innovation Index 2020: Who Will Finance Innovation? Ithaca, Fontainebleau, and Geneva. World Intellectual Property Organization.

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (eds.) (2021). Global Innovation Index 2021: Tracking Innovation through the COVID-19 Crisis. Geneva. World Intellectual Property Organization.

Grant, R. M. (2016). Contemporary Strategy Analysis: Text and Cases Edition, 9th Edition. John Wiley & Sons.

Hutsaliuk, O., Smutchak, Z., Sytnyk, O., Krasnozhon, N., Puhachenko, O., & Zarubina, A. (2020). Mass labour migration in the vector of international tourism as a determinant sign of modern globalization. Turismo: Estudos & Práticas (UERN), Mossoró/RN, Caderno Suplementar, 3.

ITU. (2022). https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx

Kuznetsova, N.B. (2022). Konkurentospromozhnist talantiv Ukrainy u svitovykh reitynhakh. Socio-Economic Problems of the Modern Period of Ukraine, 153 (1), 45-53. https://doi.org/10.36818/2071-4653-2022-1-7

Lanvin, B., & Monteiro, F. (eds.) (2019). The Global Talent Competitiveness Index 2019. Entrepreneurial Talent and Global Competitiveness, Fontainebleau.

Lanvin, B., & Monteiro, F. (eds.) (2020). The Global Talent Competitiveness Index 2020. Global Talent in the Age of Artificial Intelligence, Fontainebleau.

Lanvin, B., & Monteiro, F. (eds.) (2022). The Global Talent Competitiveness Index 2022. The Tectonics of Talent: Is the World Drifting Towards Increased Talent Inequalities? Fontainebleau.

Lanvin, B., & Monteiro, F. (eds.) (2021). The Global Talent Competitiveness Index 2021. Talent Competitiveness in Times of COVID, Fontainebleau.

Li, J., & Kassem, M. (2019). A roadmap to achieving readiness for macro adoption of distributed ledger technology (DLT) in the construction industry. Proceedings of the Creative Construction Conference 2019, p.2-7. https://doi.org/10.3311/CCC2019-001

Lokuge, S., & Sedera, D. (2014). Enterprise systems lifecycle-wide innovation readiness. PACIS-2014 Proceedings, 335.

Plaksiuk, O. Horvathova, V., & Yakushev, O. (2023). Human capital as a factor increasing the efficiency and competitiveness of an enterprise. Academy Review, 1 (58), 160-174. https://doi.org/10.32342/2074-5354-2023-1-58-12.

Porter, Michael E. (2008). The Five Competitive Forces That Shape Strategy. Special Issue on HBS Centennial. Harvard Business Review, 86, 1, 78–93.

Prokopenko, O., Toktosunova, C., Sharsheeva, N., Zablotska, R., Mazurenko, V., & Halaz, L. (2021). Prospects for the Reorientation of Investment Flows for Sustainable Development under the Influence of the COVID-19 Pandemic. Problemy Ekorozwoju, 16(2), 7-17. http://doi.org/10.35784/pe.2021.2.01

Rosen, J. (2018). Evaluating Innovation Readiness – A Case Study. Master of Science Thesis TRITA ITM-EX 2018:578 KTH Industrial Engineering and Management Machine Design. Stockholm.

Setiawan, A., Sulaswatty, A., Meliana, Y., & Haryono, A. (2018). Innovation Readiness Assessment toward Research Commercialization: Case of Surfactants for Food Processing. International Journal of Innovation, 6(2), 180-193. http://dx.doi.org/10.5585/iji.v6i2.291

Syrvetnyk-Carij, V.V. & Duljaba, N.I. (2019). Taxonomic analysis as an instrument of detection opportunities for effective management of economic potential trade enterprise consumer cooperation. Global and National Problems of the Economy, 9, 419-423.

The World Bank. (2022). DataBank. https://databank.worldbank.org

UNESCO Institute for Statistics. (2022). http://data.uis.unesco.org

Webster, A. & Gardner, J. (2019) Aligning technology and institutional readiness: the adoption of innovation, Technology Analysis & Strategic Management, 31, 10, 1229-1241. https://doi.org/10.1080/09537325.2019.1601694

Yankovyi, V., Koval, V., Dudka, T., & Bykhovchenko, V. (2021). Statistical assessment of project economic priority in company's investment management. Revista Gestion de las Personas y Tecnologia, 42, 98-119. https://doi.org/10.35588/gpt.v15i42.5284