

The Framework for Resilient Industry

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The Framework for Resilient Industry: A Holistic Approach for Developing Economies

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INVESTOR IN PEOPLE

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Foreword

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In an era marked by rapid globalisation and unprecedented technological advancements, the challenges faced by developing economies in creating resilient industries have become increasingly complex. The framework for resilience in industry is not a mere aspiration; it is a necessity that must be embraced if these economies are to thrive in the face of various disruptions, be they economic, environmental, or social in nature.

The Framework for Resilient Industry: A Holistic Approach for Developing Economies is a timely and comprehensive guide that explores the intricacies of building resilience in industrial sectors. This book delves into the fundamental principles, strategies, and practical applications necessary for fostering sustainable and adaptive industries that can withstand shocks, adapt to changing circumstances, and emerge stronger than before.

Authored by a distinguished group of scholars, practitioners, and experts, this volume offers invaluable insights into the multifaceted nature of resilience in developing economies. Drawing from diverse perspectives and real-world case studies, the book presents a holistic framework that encompasses the economic, environmental, social, and technological dimensions of industry resilience. It goes beyond a narrow focus on individual sectors or isolated interventions, emphasising the interconnectedness of various factors and the need for a comprehensive approach.

The authors of this book recognise that resilience is not a one-size-fits-all concept. It requires a nuanced understanding of the unique challenges faced by different countries and regions, as well as the capacity to tailor strategies and policies accordingly. Throughout the chapters, the contributors delve into the complexities of different industries and explore the interplay between global trends and local contexts. By doing so, they provide policymakers, industry leaders, and researchers with a valuable toolkit for navigating the complexities of resilience building.

One of the key strengths of this book is its interdisciplinary approach. By bringing together perspectives from economics, environmental science, sociology, engineering, and other relevant fields, the authors shed light on the interconnectedness of various aspects of industry resilience. This interdisciplinary lens is crucial for addressing the systemic challenges that developing economies face, as it encourages a holistic understanding and facilitates collaboration across sectors and disciplines.

The Framework for Resilient Industry also emphasises the role of innovation and technological advancements in fostering industry resilience. From embracing digital transformation to promoting sustainable practices, the authors explore how cutting-edge technologies and innovative solutions can enhance the adaptive capacity of industries. They highlight the importance of fostering an ecosystem that nurtures entrepreneurship, encourages research and development, and promotes collaboration between academia, industry, and government.

While this book provides a robust theoretical framework for understanding industry resilience, it also offers practical guidance for implementing resilience-building strategies. The authors draw on real-world examples, best practices, and lessons learned from diverse contexts to illustrate how countries and industries have successfully navigated turbulent times. By doing so, they offer actionable insights that can be tailored to specific circumstances, enabling policymakers and practitioners to make informed decisions and take effective action.

As we embark on a future marked by uncertainty and volatility, it is imperative that we adopt a forward-thinking approach to industry development in developing economies. *The Framework for Resilient Industry: A Holistic Approach for Developing Economies* provides an invaluable resource for individuals and organisations committed to building sustainable, adaptive, and robust industries. It serves as a guiding light, illuminating the path towards a future where industries are not only economically successful but also socially inclusive and environmentally sustainable.

I commend the authors for their dedication and expertise in tackling this complex topic, and I am confident that their work will contribute significantly to the discourse on industry resilience. I encourage readers from all backgrounds to engage with this book, as it offers profound insights, actionable strategies, and inspiring examples that can shape the trajectory of industry development in the years to come. May this book serve as a catalyst for transformative change and empower developing economies to overcome challenges and embrace the opportunities that lie ahead.



Preface

The book title *The Framework for Resilient Industry: A Holistic Approach for Developing Economies* (ESFIRM 11) talks about the historical background of the Indian industry and its present status. It also talks about the contemporary issues and challenges that impede the resilience of Indian industries. As far as the Indian industry is concerned, India lacks large industries due to a weak micro small medium enterprises (MSME) structure. The contemporary status of the *MSME* in India cannot be called developed. It is evident that the structure of the industries in India is very fragile and lacks flexibility and resilience to absorb any external shock, viz. the COVID-19 pandemic that shook the core of the Indian industry is one such shock that has affected the health of the industries in the economy.

Compared with the global status of the industries, developing economies with abundant labour, such as India, Pakistan, Bangladesh, and Sri Lanka, are some countries that lack capital. These economies can be safely categorised as capital deficit economies; on the contrary, economies with abundant capital, such as the United States, the United Kingdom, a significant part of Europe, and Japan, have lost very little value during the global pandemic. It is a question of resilience and what separates these and developing economies. The answer is reasonable dependence on technology and mechanisation of the production process. On the other hand, India's lack of mechanisation of the industries, usage of obsolete technologies, increasing energy production costs, population burden, etc., are some impediments to resilience in Indian industry.

The determining factors for a resilient industry in an economy are a developed chain of small and medium industries or supportive industries, production of clean energy, availability of credit and network of large banks, human capital and training, and risk management of the industries, legal and policy aspect of the industries, flexible system, equilibrium rate of technology adoption, and risk of unemployment creation through the adoption of technology in production.

The book intends to benefit the policymakers, industrialists, and governments, both state and central, through efficient analysis of the states based on their input–output combinations for policy making. Academia will be highly benefited from this discourse on the resilient industry.

The book can become a reference document for developing economies to identify the strategies that can help these economies reach the full potential of industries. The book attempts to identify a suitable model for Indian industries that can be adopted as a working model to achieve this goal.

The book mainly covers:

- Historical background of Indian industry (pre-colonial era).
- Contemporary status of MSMEs.
- Status, issues, and challenges with large industries.
- The way forward to clean energy: a revolution in clean energy production.
- Issues related to credit availability for industries and potential prospects.
- Human capital formation and impediments.
- Risk management of the industries and related policies.
- Formulation of flexible industrial systems and its possible determinants.
- Challenges in technology adoption: factors impeding mechanisation of the Indian industries.
- Future of Indian industries amid the global chaos.

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Chapter 1

Clustering National Innovation Capability: Positioning of Ukraine

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Abstract

Introduction: Today the ability of nations to develop and implement innovations is core for their international competitiveness. Ukraine is striving for innovation progress; however, its innovation performance is relatively low. The research problem is to find the bottlenecks, affecting Ukraine's innovation capability.

Purpose: This study aims to research the national innovation capability profiles, based on cluster analysis, to develop an understanding of drivers and threats for the innovation capability of Ukraine.

Need of the study: The knowledge-based economy, which had already turned into one of the most efficient developmental models of the 21st century, became a key driver of international competitiveness for the leading developed countries due to their progressive structural shifts towards the growth of high-technology manufacturing and knowledge-intensive sectors. These trends are significant to capture for the sake of increasing the innovation capability of the economy of Ukraine.

Methodology: The study is based on the *K*-means clustering method, which is employed for identifying 10 country clusters based on the indicators of their R&D and innovation activities, which allowed us to assess the

innovation capability of Ukraine in comparison with 140 countries of the world. Data selection and normalisation were based on the *2019 Global Competitiveness Report* indicators.

Findings: The study showed that Ukraine's innovation capability problems are typical for most developing countries and are prevalently connected to low R&D expenditures, patent applications, and international co-invention activities. Most countries, except for the technologically developed ones, follow the so-called 'passive technological learning' strategies, which usually result in low economic productivity.

Practical implications: Several innovation policy implications have been developed for the government of Ukraine based on the cluster analysis results and accounting for the problems of the national innovation system (NIS).

Keywords: Innovation capability; national innovation system; innovation capability profile; innovation policy; cluster analysis; K-means clustering method; international competitiveness

JEL classifications: O31; O38; O57

Introduction

Modern competitive national economic development models are prevalently based on the generation, commercial exploitation, and diffusion of new knowledge and technologies. This triggers vivid scientific interest in comparative studies of the ability of nations to develop, adapt, and implement innovations, which is core for the competitiveness not only of the developed countries but also for the rest of the world because new goods and services, production technologies, and equipment contribute to the growth of labour productivity and quality of life in any country.

Innovation is currently one of the core drivers of international competitiveness. However, Ukraine's modern economic model is mainly based on traditional industrial sectors related to the third and fourth techno-economic paradigms (TEP) (Fuks, 2009, p. 33). In contrast, the current 5th and emerging 6th TEP sectors remain relatively embryonic, high-technology manufacturing export share is usually low, and technology imports dependence is evident. Thus, an in-depth study of the factors of innovation capability of nations might be appropriate to create the innovation capability profile of Ukraine (innovation capability profile in this study is viewed as an analytical graphic representation in the form of a radar chart of the national (or average for the cluster) innovation capability indicators, normalised into 1–100 scale, which is used to visualise national innovation capability components) and compare it to other nations' profiles to understand its

advantages and shortcomings, which would allow elaborating on recommendations to boost the national innovation capability.

Aim of the Study

With the start of the 21st century, the world entered the era of the Fourth Industrial Revolution. The stage of comprehensive implementation of information and communication technologies is gradually being replaced by the era of new frontier technologies, like artificial intelligence, the Internet of things, big data, blockchain, robotics, 5G mobile communications, 3D printing, drones, gene engineering, and nanotechnology. This is accompanied by the merging of technologies, products, industries, infrastructure, and transformation of the economic structure, which can have significant consequences for increasing inequality both between and within countries in terms of the level of well-being and other dimensions of human development. In these circumstances, it is essential to assess the ability of countries to master advanced technologies and implement related technological and organisational innovations.

Ukraine is evaluated in several international rankings of national innovation potential and innovation capability. Some of the most well-known ones are The Global Innovation Index (WIPO, 2022), The Bloomberg Innovation Index (Bloomberg, 2021), The Global Talent Competitiveness Index (INSEAD, 2022), The European Innovation Scoreboard (European Commission, 2022), A Frontier Technologies Readiness Index (UNCTAD, 2022), as well as The Global Competitiveness Index (GCI; WEF, 2019), which includes Innovation Capability Pillar and evaluates most of the countries of the world, based on several critical dimensions of national economic development (Fig. 1.1).

The dynamics of Ukraine's positions in the six abovementioned international innovation capability rankings during the last 6–9 years allows us to conclude that innovation capability indices are pretty stable, and there are no progressive breakthroughs regarding innovative activities growth (see Fig. 1.1). Fundamental strengths of the innovative performance of Ukraine are usually correlated with the availability of well-trained human capital, the population's coverage level by tertiary education, as well as results of scientific research. However, weak state institutions, an unfavourable environment for the growth of innovative businesses, and an unfriendly financial system create obstacles to the commercialisation of innovations, therefore limiting their impact on economic growth.

According to the Ukrainian Institute of Scientific and Technical Expertise and Information (2021), the low efficiency of innovative activities in Ukraine was caused by a reduction in domestic R&D funding, which triggered a decrease in the attractiveness of the research system for young scientists, low concentration of researchers, insufficient level of innovation infrastructure, weak protection of intellectual property rights, low patent activity, and deterioration of the ability to export high-value goods. At the same time, the strengths of the NIS of Ukraine include high knowledge and technological results, innovative interconnections, human capital and research, opportunities to attract talent, market and regulatory opportunities, creativity, and penetration of high technologies and skills.

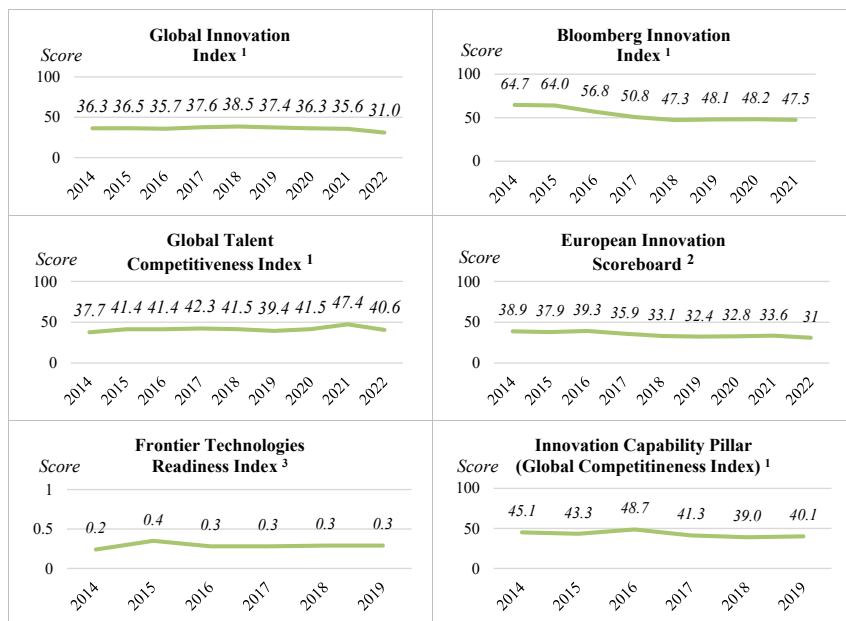


Fig. 1.1. Scores of Ukraine in Global Innovation Capability Rankings.

Source: Developed by the authors based on Global Innovation Index (Cornell University, INSEAD, & WIPO, 2014, 2015, 2016, 2018, 2019, 2020; WIPO, 2021, 2022), Bloomberg Innovation Index (Bloomberg, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021), Global Talent Competitiveness Index (INSEAD, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022), European Innovation Scoreboard (European Commission, 2020, 2022), A Frontier Technologies Readiness Index (UNCTAD, 2022), and GCI (WEF, 2014, 2015, 2016, 2017, 2018; 2019).

Notes:

¹The scores of the Global Innovation Index, Bloomberg Innovation Index, Global Talent Competitiveness Index, as well as Innovation Capability Pillar of the CGI vary according to a scale of 0–100.

²The relative values of the European Innovation Scoreboard are calculated as country scores divided by the European Union (EU) score and multiplied by 100.

³Values of a Frontier Technologies Readiness Index vary between 0 and 1.

Human resources are still the most vital dimension of Ukraine in most rankings. However, the slow development of an innovative ecosystem attractive to researchers and engineers and the limited budget funding for research and education can destroy this advantage for our country in the future.

Under martial law conditions, Ukraine's innovative potential is being significantly affected. After 24 February 2022, since the Russian Federation launched a full-scale war against Ukraine, in the conditions of massive missile attacks and active hostilities in the East and South of Ukraine, most of the businesses, in

particular, those located in the frontline or temporarily occupied territories, were forced to stop their activities. Some enterprises have moved production facilities to the country's western regions, but economic losses are still huge. On the other hand, the extreme war-time conditions mobilise and activate the Ukrainian IT businesses, which are flexible. Moreover, the sanctions introduced by Ukraine and its foreign partners against Russian companies serve as an instrument of global resistance against the aggression and free a niche for Ukrainian innovators in the global innovation market. International financial assistance and investment support for projects reviving Ukraine's economy create opportunities for reformatting Ukraine's NIS.

Because of this, the study of Ukraine's positioning in the innovative global environment allows not only to analyse the internal potential for innovation development of a country in comparison with other nations but also to identify potential directions for building innovation capability through the study of best practices of the other countries. Thus, the main aim of this study is to conduct comparative research of national innovation capability profiles based on cluster analysis, to develop an understanding of drivers and threats for the innovation capability of Ukraine.

Literature Review

The term 'innovation capability' (or its widespread synonym – 'innovation capacity') has been widely used since the 1980s by researchers in the sphere of economics, geography, and innovation policy (Neely & Hii, 1998; Pavitt, 1980; Suarez-Villa, 1993). According to Furman et al. (2002), 'national innovation capacity is the economic and political potential of creating a flow of commercially viable innovations, which determines the country's ability to produce and commercialise new technologies in the long run'. Other authors point out, that national innovative capacity is the ability to develop and commercialise 'new-to-the-world' technologies, products, and business organisations (Gans & Stern, 2003).

A national economy's level of innovation capability is determined by a system of factors, including the quality of the common innovation infrastructure, cluster-specific innovation environment, and the quality of linkages between these two elements. In their seminal work (Furman et al., 2002), the authors developed an econometric model, where national innovation capacity is calculated as an expected number of patent applications of a particular country to the US Patent Office per 1 million population, depending on the group of indicators, which approximate the three abovementioned factors. The following indicators approximated national common innovation infrastructure: aggregate employed research and development (R&D) personnel, R&D expenditures, openness to international trade and investment (survey score), the strength of protection for intellectual property rights (IPR) (survey score), the share of gross domestic product (GDP) spent on higher education, the stringency of antitrust policies (survey score), and per capita GDP. The following indicators approximated cluster-specific innovation environment: percentage of R&D funded by private industry and relative concentration of innovative output in chemical, electrical, and mechanical United States Patent and Trademark Office (USPTO) patent classes. The third factor,

reflecting the quality of interaction between industrial clusters and the common innovation infrastructure of a country, which is usually provided by various technology transfer intermediaries (primarily by universities), was assessed via the percentage of R&D performed by universities and a survey on the strength of national venture capital markets. The results of their analysis show that no single factor is decisive in creating a favourable innovation environment. To significantly increase the innovation capacity of the national economy, joint development of the entire system of determinants of the innovation process is required. Thus, we support the position of [Gans and Stern \(2003\)](#), who insist that ‘achieving a higher level of innovative capacity requires attention to all aspects of the innovation system’.

National innovation capability is a complex phenomenon that no single factor can explain. Thus, a complex of interrelated determinants, reflected in the concept of a NIS, should be considered. Theoretical foundations of the NIS approach have been laid by [Lundvall \(1992\)](#), [Freeman \(1995\)](#), and [Nelson \(1993\)](#), who focussed on the study of the nature of the relationships between the actors of the innovation process within national economies, as well as the impact of formal and informal rules of conduct on the flow of technology and information between them. [Freeman \(1995\)](#) defined the NIS as the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies. Proponents of the NIS concept assume that innovation and technological development result from a complex system of relationships between NIS actors – businesses, think tanks, and government. In contrast to the traditional linear model of innovation ([Godin, 2006](#)), it is believed that the overall innovation efficiency (or innovation capability) of the economy depends not only on the efficiency of individual actors of the innovation process (research institutes, innovative enterprises, etc.) but also on the nature of their interaction in creating and disseminating new knowledge.

As mentioned above, innovation capability is a complex phenomenon requiring a systemic research methodology. Econometric modelling of innovation capability usually limits itself to the selection of a single indicator (e.g. number of patent applications per 1 million population of a specific country, as in [Furman et al., 2002](#)) to approximate the whole phenomenon, although authors themselves realise the existing limitations ([Furman et al., 2002](#); [Gans & Stern, 2003](#)). Other approaches are based on calculating complex innovation indices, which are used for ranking the countries ([Cornell University, INSEAD, & WIPO, 2020](#); [European Commission, 2020](#); [WEF, 2019](#)). However, a country’s position in the global innovation ranking alone reveals neither its innovation system’s structural problems nor innovation capability profile similarities and differences between countries.

Research Questions

1. Into which clusters can the criterion of innovation performance group countries?
2. What are the characteristic features of the cluster to which Ukraine belongs?

3. What are the significant differences between the clusters of innovative leaders, least innovative countries, and the cluster to which Ukraine belongs?
4. What innovation policy implications derive from the cluster analysis?

Hypothesis

H1. The *K*-means clustering approach allows identifying country clusters with unique features based on innovation performance indicators.

H2. Analysing country clusters based on the innovation performance indicators allows us to identify the factors of national innovative capability not for a single country but for a group of countries with comparable characteristics.

H3. Ukraine belongs to a cluster of countries with low innovation capability.

H4. Ukraine's innovation performance is low because of uneven national innovation capability factors development.

These ideas are essential not only for Ukraine but also for the world community. Because of the active digital welfare state policy developments in Ukraine (the state in a smartphone), the need for economic resilience in the conditions of the Russian–Ukrainian war, as well as the challenges of post-war reconstruction, the government of Ukraine needs to have a sufficiently broad rationale for determining strategic priorities of ensuring the economic security for Ukraine, based on the innovative ideas. Ukraine's international partners, such as the EU, the United States of America, the United Kingdom of Great Britain and Northern Ireland, and others, provide active support to Ukraine in its resistance against the military aggression of the Russian Federation, particularly in technical, financial, economic, political, and informational areas. The guarantee of further sustainable economic development of Ukraine, based on the accelerated implementation of innovations, would create strong foundation and strategic advantages for extending cooperation with the international partners in the post-war period.

Methodology

As mentioned above, the research hypothesis is that Ukraine's innovation performance is low because of uneven development of the national innovation capability factors. In order to verify the abovementioned hypothesis, the research methodology includes several interlinked stages.

At first, the groups of countries are defined via cluster analysis techniques based on the commonalities in the set of their innovation capability indicators. The *K*-means clustering technique is used for the 141 countries (Table 1.4) using 11 innovation capability indicators as clustering criteria.

Data mining, selection, and normalising for the first stage of the research (cluster analysis) is based on the indicators presented in the annual global competitiveness report by World Economic Forum (WEF, 2019, pp. 46–609). Its advantage

lies in combining hard data, deriving from official national statistical offices, with the soft data, obtained as a result of the global Executive Opinion Survey (which is a part of each annual global competitiveness report by the WEF), highlighting attitudes of independent respondents to the relevant national innovation environments and trends. The indicators used for cluster research are the following: growth of innovative companies; companies embracing disruptive ideas; state of cluster development; international co-inventions; multi-stakeholder collaboration; scientific publications, based on *H*-index; patent applications; R&D expenditures; research institutions; buyer sophistication; and trademark applications (WEF, 2019).

The indicator 'growth of innovative companies' is measured as a response to the survey question: 'In your country, to what extent do new companies with innovative ideas proliferate?' (1 = not at all; 7 = to a great extent) (WEF, 2019, p. 624). The indicator 'companies embracing disruptive ideas' is measured as a response to the survey question: 'In your country, to what extent do companies embrace risky or disruptive business ideas?' (1 = not at all; 7 = to a great extent) (WEF, 2019, p. 624). The indicator 'state of cluster development' is measured as a response to the survey question: 'In your country, how widespread are well-developed and deep clusters (geographic concentrations of firms, suppliers, producers of related products and services, and specialised institutions in a particular field)?' (1 = non-existent; 7 = widespread in many fields) (WEF, 2019, p. 624). The indicator 'international co-inventions' is measured as the number of patent family applications with at least one co-inventor located abroad per million population, filed in at least two of the major five offices in the world (the European Patent Office, the Japan Patent Office, the Korean Intellectual Property Office, the State Intellectual Property Office of the People's Republic of China, and the United States Patent and Trademark Office) (WEF, 2019, p. 624). The indicator 'multi-stakeholder collaboration' is calculated as the average score of the three survey questions: 'In your country, to what extent do people collaborate and share ideas within a company?', 'In your country, to what extent do companies collaborate in sharing ideas and innovating?' and 'In your country, to what extent do business and universities collaborate on research and development?' (1 = not at all; 7 = to a great extent) (WEF, 2019, p. 624). The indicator 'scientific publications' is calculated as the number of publications and their citations, expressed via the *H*-index at the country level (WEF, 2019, p. 624). The indicator 'patent applications' is calculated as the sum of the patent family applications filed in at least two of the major abovementioned five offices in the world per million population (WEF, 2019, p. 624). The 'R&D expenditures' indicator is expressed as a percentage of GDP (WEF, 2019, p. 624). The indicator 'research institutions prominence' is calculated as the sum of the inverse ranks of all research institutions in a country included in the SCImago Institutions Rankings (Scimago Institutions Rankings, 2019; WEF, 2019, p. 624). The indicator 'buyer sophistication' is measured as a response to the survey question: 'In your country, on what basis do buyers make purchasing decisions?' (1 = based solely on the lowest price; 7 = based on sophisticated performance attributes) (WEF, 2019, p. 624). The indicator 'trademark applications' is calculated as the number of trademark applications per million population (WEF, 2019, p. 624).