The Industry Innovation Index

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1. Introduction

Innovation isn't just about research papers and R&D budgets anymore; it's the game-changer driving economic progress and fierce competitiveness in specific industries. The definition of innovation has expanded beyond the confines of R&D laboratories and published scientific papers. It encompasses a broader spectrum, including social, business model, and technical innovation. Innovation is an increasingly significant determinant of firm performance across a wide variety of industries.[1] It has been demonstrated that firm innovation - including products and services, culture, management and processes - provides firms with a notable competitive advantage,[2] in addition to contributing to the competitiveness of the industry in which they operate. Both academic and corporate research have consistently demonstrated the positive impact of systemic innovation on firm-level performance as well as industry-level performance. It is increasingly evident that firms driven by innovation record stronger financial firm performance.[3]

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[1] Fariborz Damanpour, 'Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators', *The Academy of Management Journal* 34, no. 3 (September 1991): 555–90, https://doi.org/10.2307/256406; Junying Zhong and Marko Nieminen, 'Resource-Based Co-Innovation through Platform Ecosystem: Experiences of Mobile Payment Innovation in China', *Journal of Strategy and Management* 8, no. 3 (2015).

[2] Andrew M. Hess and Frank T Rothaermel, 'When Are Assets Complementary? Star Scientists, Strategic Alliances, and Innovation in the Pharmaceutical Industry', *Strategic Management Journal* 32, no. 8 (2011), https://doi.org/10.1002/smj.916; Gautam Ahuja, Curba Morris Lampert, and Vivek Tandon, 'Moving Beyond Schumpeter: Management Research on the Determinants of Technological Innovation', *The Academy of Management Journal* 2, no. 1 (2008): 1–98, https://doi.org/10.1080/19416520802211446.

[3] Nina Rosenbusch, Jan Brinckmann, and Andreas Bausch, 'Is Innovation Always Beneficial? A Meta-Analysis of the Relationship Between Innovation and Performance in SMEs', *Journal of Business Venturing* 26, no. 4 (2011): 441–57, https://doi.org/10.1016/j.jbusvent.2009.12.002; Neil Robert Anderson, Kristina Potočnik, and Jing Zhou, 'Innovation and Creativity in Organizations: A State-of-the-Science Review, Prospective Commentary, and Guiding Framework', *Journal of Management* 40, no. 5 (2014), https://doi.org/10.1177/0149206314527128.

As the digital economy becomes pervasive, innovation is more relevant than ever for creating and capturing firm value leading to industrial growth. The digital economy provides exciting new opportunities and tough challenges for firms hoping to profit from innovation.[4] In this sense, innovation is the currency of the Fourth Industrial Revolution,[5] defined as the latest transformation of the global economy characterized by the "fusion of technologies that is blurring the lines between the physical, digital and biological spheres".[6]

Many mainstream approaches fail to understand innovation over time, and instead conceptualize innovation as an event and not a process. Today, the definition of an innovative company should not only focus on measuring outputs (e.g. patent and financials), but also capture an organizations' qualities as the whole, and whether the organization has the adequate leadership, culture, processes and partnerships to sustain long-term innovation. An innovative firm fosters a culture of innovation that permeates throughout its workforce and amongst processes at all levels. Crucially, innovation is made possible by welcoming and integrating the digital technologies of the Fourth Industrial Revolution.

Innovation is often assumed to be disruptive, technology-based changes. However, disruptive innovation is only one piece of the puzzle. In fact, most innovation occurring in companies is an everyday process and much more incremental by nature. These two different kinds of innovation result from different processes within the firm. To this end, innovative companies create space for both incremental innovation and disruptive innovation. They understand that first-order innovations require a strong support system and secondary-level innovation. Furthermore, an innovative company understands its environment and thrives within it.

Portulans Institute's Industry Innovation Model is an innovative analytical tool which aims to find and determine metrics and methods that could better capture the richness of innovation in specific industries. It aims to measure the local productivity in terms of innovation across all industries. While the Industry Innovation Model acknowledges the intrinsic diversities and complexities in any economy's industry innovation structure, it offers a dual-layered analytical approach, differentiating between general and individual innovation ecosystems. The general category focuses on the economy-wide innovation ecosystem, which influences every local industry across the country's multifaceted regions. The individual category focuses on the unique ecosystems nested within organizations. These organizational

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[4] David J. Teece, 'Business Models and Dynamic Capabilities', *Long Range Planning* 51, no. 1 (July 2017), https://doi.org/10.1016/j.lrp.2017.06.007; Constance E. Helfat and Ruth Raubitschek, 'Dynamic and Integrative Capabilities for Profiting From Innovation in Digital Platform-Based Ecosystems', Working Paper (Turk School of Business, January 2018), https://ssrn.com/abstract=3122046.

[5] Michael Hanley, 'These Are the Most Innovative Companies in the World', World Economic Forum, 29 August 2016, https://www.weforum.org/agenda/2016/08/are-these-the-most-innovative-companies-in-the-world-this-is-what-the-market-says/.
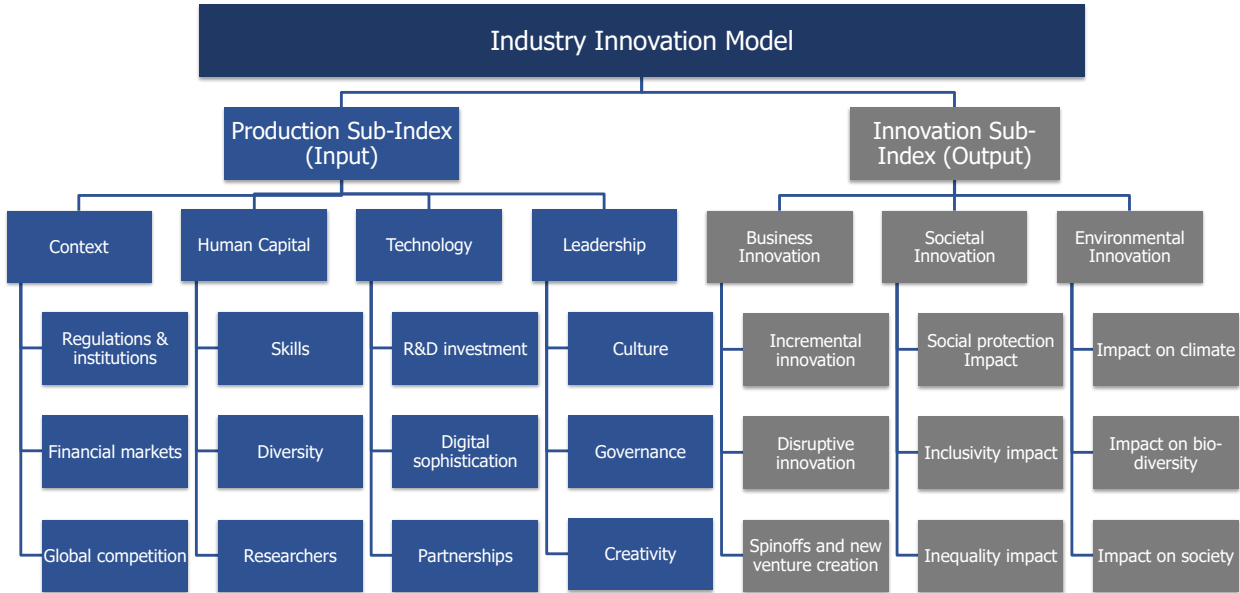
[6] Klaus Schwab, 'The Fourth Industrial Revolution: What It Means, How to Respond', World Economic Forum, 14 January 2016, https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/.

ecosystems, predicated on the foundational general ecosystem, are molded to suit specific industries, and form the backbone of the country's innovation environment. The model distinguishing between incremental and disruptive innovation, in addition to the processes and characteristics that usually lead to them, is critical for understanding the innovative capacity of a firm in the Fourth Industrial Revolution.

2. Structure and Methodology

The Industry Innovation Model follows an index-oriented methodology. Individual indicators are systematically combined not only to derive a global index value, but to formulate index values for crucial components of the innovation ecosystem. It is constructed using two sub-indices. **The Production Sub-Index (Input)** captures elements of the ecosystem that enable innovative activities. The **Innovation Sub-Index (Output)** measures innovation outputs resulting from innovative activities within the industry. The overall Industry Innovation score is the average of the Input and Output Sub-Indices. Figure 1 shows the basic structure of the Industry Innovation Model.

Figure 1: Structure of the Industry Innovation Model

Both the input and the output sub-indices are constructed using pillars capturing crucial aspects of the innovation ecosystem.

3. Pillars of Industry Innovation

The Production Sub-Index (Input)

The Production Sub-Index contains four input or 'enabler' pillars: Context, Human Capital, Technology, and Leadership. The production pillars quantify the level of policy support, the caliber of governance, and the sufficiency of infrastructure and investment in industry innovation. Additionally, these pillars

scrutinize whether available human capital and technology are innovation-focused, evaluate the persistent efforts towards resource development to back innovation, and analyze the direction and commitment of leadership for innovation. The components of the input pillars also assess the degree of investment in innovation-related activities and the extent of collaboration and engagement with stakeholders within the industry innovation ecosystem.

Pillar 1: Context Pillar

An environment that attracts business and fosters growth through a solid governance structure, legal protections and economic incentives is essential for innovation. The Context pillar measures the state of the innovation ecosystem by compiling indices on such elements in three areas: Regulations and institutions; Financial markets; and Global competition. In particular, the index of Regulations and institutions compiles quantitative indicators measuring the policy environment for doing business, regulatory quality, and the quality of the government's online services. It also focuses on institutional aspects such as the perceived political and legislative landscape affecting the industry/organization. Financial markets are assessed through indicators focusing on the financial stability of industry, including market capitalization, domestic credit to private sector, FDI net inflows and survey questions on healthy financial performance of firms. The global competition component of the Context Pillar assesses FDI regulatory restrictiveness, degree of financial globalization, the extent of market dominance, domestic market scale and survey question that judges the effectiveness of organizations in monitoring and mitigating global economic risks and the organization's overall market share.

Pillar 2: Human capital Pillar

The Human Capital Pillar focusses on the level and standard of skills, diversity, and research activity which are determinants of an industry's innovation capacity. The skills component assesses education, training, and learning with indicators like workforce with tertiary education; skills matching; knowledge-intensive employment; and ease of finding skilled employees. It tries to capture whether the culture within the industry encourages learning and continuous improvement. The Diversity component assesses whether industry has an inclusive workforce and if the leadership is committed to diversity through indicators measuring the percent of females employed w/advanced degrees, the migrant stock, and the level of tertiary inbound mobility. Finally, the "researchers" component of the Human Capital Pillar captures the focus of human capital on research activities through indicators such as the number of researchers employed in the economy; the percent of research talent in business, the rankings of local universities; and whether there exists a pipeline to promote new ideas and research.

Pillar 3: Technology Pillar

Access to technology is a key enabler for any innovation. The Technology Pillar measures R&D investment or resource allocation, Digital sophistication or digital capabilities and technology partnerships or collaborations for technology. The R&D investments measures gauge the amount and nature of resources invested in R&D activities through indicators like R&D expenditure by governments and higher education, gross expenditure on R&D, high-tech imports, and survey question on R&D collaboration and R&D investment effectiveness. The digital sophistication parameters measure how well data and digital technologies are leveraged for innovation by assessing the degree of e-participation, robot density, and imports of ICT services. The partnership indices assess whether the industry follows a collaborative approach for developing new and innovative ideas through partnerships with startups and other firms, using variables such as the level of intellectual property payments and joint venture/strategic alliance

deals and indices of university-industry R&D collaborations, joint venture formation, and the level of cluster development. These factors measure the degree to which there are tools in place for knowledge sharing and transfer.

Pillar 4: Leadership Pillar

Leadership is the last pillar of the Productive sub-index. The Leadership of an organization plays an important role in the innovation initiatives within the firm and can define the culture, instill strong governance, and promote creativity and innovation within the organization. Culture as an element of leadership assesses how efficiently leaders create a culture that is empowering and collaborative within their organizations. The degree to which an ecosystem contributes to such a culture is measured through indices of "brain" retention, delegation of authority, labor-employer cooperation, youth inclusion, and employee development. Survey questions also assess the frequency with which new leaders are brought in to renew the organization's talent pool; employee's involvement in change; and the level of decision-making freedom the firm grants employees. The governance element of the Leadership Pillar assesses whether organizations employ professional management practices, benchmark innovation along with other corporate targets, and ensure fundamental labor rights while providing risk-taking incentives. Finally, the creativity element of the pillar assesses how open leadership is to experiments and out-of-the-box ideas. It measures the use of virtual professional and social networks and attracting external talent and a assesses whether the leaders are dedicated to continuous learning and have the flexibility for different decision-making styles to promote innovation.

The Innovation Sub-Index (Output)

The Innovation Sub-Index includes three pillars: business innovation, societal innovation, and environmental innovation. Thus, it aspires to quantify not only the impact of innovation on business operations, but also its broader ramifications on society and the environment. These softer, often overlooked aspects of innovation deserve attention and prioritization as they contribute to sustainable development.

Pillar 5: Business Innovation

Business innovation pillar focuses on innovation in products, services, and new ventures. The first element of this pillar is "incremental innovation", which focuses on value creation through the introduction of innovative methods to provide existing services, products, and processes. It can be assessed through patents by origin, intellectual property receipts, number of trademarks, ICT services exports and high-tech exports. At the organizational level, it can be measured by whether the firm has an innovation policy, how frequently they engage in co-creation and co-development activities, and how quickly they implement new processes.

The "disruptive innovation" element of the pillar delves on value creation through the adoption of new methods and ideas, including new products and services. It is assessed by measuring creative goods exports, AI scientific publications, government promotion of investment in emerging technologies and whether firms maintain a portfolio of groundbreaking innovations and initiatives. Spinoffs and new venture creation captures innovative collaboration between entities including mechanisms to form new organizations and to develop alternative business processes. It is assessed through venture capital

received, finance for startups and scaleups, number of unicorns, quick conversion of ideas into marketable products/services and whether the organization invests resources in new opportunities.

Pillar 6: Societal Innovation

Societal innovation focuses on the softer social aspects of innovation, accessing its impact on the growth and well-being of society. This measure seeks to assess the social impact of innovation in each industry. While these are not the traditional components of innovation, they are important for the sustainable development of the industry/sector. The "social protection impact" measure of this pillar gauges the extent of support and protection to individuals and communities in times of need through social protection and pension coverage. Survey questions assess whether industries update their rules for social protection and whether organizations in the sector fulfill their corporate social responsibilities to create significant impact. The inclusivity impact assesses whether formalized measures are taken by the firms to increase inclusivity by increasing tolerance of minorities and immigrants, improving social mobility, and reducing the socioeconomic gap in digital payments. Inequality impact measures both the general impact on income inequality as well as actions in individual industries/sectors to reduce inequality by improving leadership opportunities for women, gender parity in high-skilled jobs and women's economic opportunity.

Pillar 7: Environmental Innovation

Like societal innovation, environmental innovation is another key element for sustainable development. It focuses on the actions taken towards the protection of natural resources and other public goods and spaces and delves on the innovative methods that the various sectors/industries follow and implement for preserving the environment. Environmental impact assesses the impact on the climate, includes steps towards reducing emissions and becoming carbon-neutral (use of affordable and clean energy; waste management; industry effectiveness in understanding opportunities from green initiatives). Impact on biodiversity assesses steps towards preserving biodiversity (ISO 14001 and environmental protection index). Finally, the impact on society assesses factors affecting human health, safety and urban sustainability (urban safety and sustainability; universal health coverage; and assessing whether industries are effective in sensing the impact of its activities on human health).

4. Technical Notes

The Industry Innovation model has two sub-indices, and the scores are calculated as below:

The Production Sub-Index (Input): Containing four input pillars is the simple average of the first four pillars, namely, Context, Human capital, Technology, and Leadership.

Innovation Sub-Index (Output): Containing three areas of innovation outputs, is the simple average of the last three pillars, namely, Business innovation, Societal innovation, and Environmental innovation.

The overall Industry Innovation score would be the average of the Input and Output Sub-Indices.

Each pillar consists of three sub-pillars. Each sub-pillar score is derived from the weighted arithmetic average of its individual variables. Subsequently, the Pillar Score is derived using a simple arithmetical average of the sub-pillar scores.

Data used to Construct and Evaluate the Input and Output Indices: The Industry Innovation model includes indicators, which fall into three categories:

1. Hard Data (quantitative/objective/hard data)

The variables based on hard data were drawn from a variety of public sources, such as the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the International Labour Organisation (ILO), SDG Database, the World Bank, the OECD, and The Conference Board. Most variables were already scaled at their source and therefore did not need to be re-scaled.

2. Indices (composite indicators/index data)

The variables measured as indices come from sources such as the World Bank (the World Governance Indicators and the Women, Business and the Law report series) and Transparency International. They also come from other composite indicators such as the Social Progress Index, the Global Innovation Index (Cornell, INSEAD, and the World Intellectual Property Organisation), and the Environmental Performance Index (Yale University and Columbia University).

There are two main concerns about using 'indices within an index': (1) doubts over its methodology to derive a single score, and (2) the risk of duplicating variables. Despite these concerns, the PI team determined that the gains outweighed the down- sides, as there are certain phenomena that are best captured by a multi-dimensional index. To address these concerns, only indices that transparently indicate their methodology and are widely well received were included in the model. Additionally, to avoid double-counting, only indices with a narrow focus were selected.

3. Survey Data (survey/qualitative/subjective/soft data)

The variables based on survey data were mainly extracted from the World Economic Forum's Executive Opinion Survey and from Gallup World Poll. Qualitative information tends to provide the most current assessment of certain areas related to innovation for which hard data either do not exist or have low country coverage.

Treatment of Series with Outliers: Potentially problematic indicators with outliers that could polarize results and unduly bias the rankings are treated according to the pre-set rules listed below, as per the recommendations of the JRC-COIN.

Normalization: The indicators are then normalized into the [0, 100] range, with higher scores representing better outcomes. Normalization is undertaken according to the min–max method, where the "min" and "max" values were the minimum and maximum indicator sample values, respectively. Index and survey data are exceptions; the original series range of values are kept as min and max values. The following formulas are applied:

Goods: $\dfrac{\text{industry value} - \text{min}}{\text{max} - \text{min}} \times 100$

Bads: $\dfrac{\text{max} - \text{industry value}}{\text{max} - \text{min}} \times 100$

5. About PI

Founded in 2019, Portulans Institute (PI) is an independent non-profit, nonpartisan research and educational institute based in Washington DC. PI is a tax exempted organization (501c3) according to USA Law. Our areas of expertise include technology competitiveness, innovation readiness, and people and global talent. Our mission is:

- To develop cross-community knowledge and dialogue on how people, technology, and innovation contribute to sustainable and inclusive growth.
- To inform policymakers, by producing independent, rigorous metrics and data-based research.
- To collaborate with private sector leaders in driving a business agenda that invests in people, technology, and innovation for a prosperous shared future.
- To host and co-organize events and conferences on the above issues affecting human-centric sustainable economic prosperity.

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