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Metrics and indicators in assessing innovation and entrepreneurial ecosystems: a comparative analysis of GII and GEM

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Abstract

Purpose – This study aims to examine how aligning development strategies with the specific characteristics of regional innovation ecosystems can foster inclusive and sustainable growth, using global innovation and entrepreneurship metrics in a policy-oriented, non-causal comparative perspective.

Design/methodology/approach – A qualitative, exploratory comparative analysis based on secondary data from GII and GEM, linked to the OECD Better Life Index across eight countries of varying income levels to support contextual interpretation rather than ranking or causal inference.

Findings – GII and GEM offer complementary perspectives, revealing that countries with different profiles can exhibit valuable practices when indicators are interpreted contextually and jointly, helping to identify distinct "ecosystem logics" and trade-offs between innovation capacity, entrepreneurial dynamics and well-being outcomes.

Research limitations/implications – This study provides insights into strategic alignment, although with limitations due to the reliance on secondary indicators and the absence of deeper historical, political and socio-cultural case evidence; moreover, the fast-evolving nature of ecosystems may affect the stability of observed patterns.

Practical implications – Policymakers should adapt global indicators to local contexts and use combined metric readings (GII–GEM–well-being) to design targeted interventions, improving innovation strategies and address societal challenges effectively.

Social implications – This study accentuates the need for evidence-based public policies, such as those supported by data from GII and GEM. This can assist policymakers in targeting resources more effectively in areas needing development, thereby enhancing public policies and social infrastructure.

Originality/value – Proposes an integrated conceptual framework connecting innovation, entrepreneurship and social impact, offering policy-relevant insights for ecosystem development by reframing how global indices are interpreted together to inform place-based strategy (rather than producing new rankings).

Keywords Innovation ecosystem, Innovation indicators, Entrepreneurial ecosystem, Innovation policy

Paper type Research paper

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1. Introduction

While several innovative and entrepreneurial ecosystems seek to replicate Silicon Valley, reproducing it may not always be the best approach. Since each region has unique characteristics and needs, therefore, development planning must be adapted to the identity of each regional innovation ecosystem (Feldman *et al.*, 2022). In today's competitive global landscape, countries foster innovation, create new enterprises and entrepreneurs and attract talent, startups and investments in their ecosystems through differentiated and place-based strategies rather than uniform models.

Recent studies emphasize that countries must strategically leverage their unique strengths and capabilities to enhance global competitiveness. According to the latest reports from the Global Innovation Index [World Intellectual Property Organization (WIPO), 2023] and the Global Entrepreneurship Monitor (Hill *et al.*, 2024), countries increasingly rely on customized innovation policies and entrepreneurship frameworks tailored to regional contexts and highlight the critical role entrepreneurial attitudes and societal impacts play in achieving sustainable economic growth.

Countries with competitive advantage must ensure growth under sustained development internationally. Therefore, creating conditions for an efficient national innovation ecosystem is essential for economic growth and global competitiveness (Kovačević *et al.*, 2021; Prokop *et al.*, 2021; Stojanović *et al.*, 2022). According to Cantwell (2005) and Yu *et al.* (2021), countries that differentiate themselves create conditions that offer more opportunities for competition. This is achieved through national policies and a knowledge-driven economy, including growth rates and benchmarking to assess innovation capacity. However, despite widespread use of innovation indicators, there is limited consensus on interpreting global metrics to inform ecosystem policies.

Companies gather data from various aspects of their businesses, customers, competitors and markets to gain a competitive edge and win markets. They analyzed these data to devise effective strategies that lead to sustainable competitive advantages and improved performance (Eidizadeh *et al.*, 2017; Lopes and Farinha, 2018). Using strategic management based on data, companies can improve their performance by focusing on parameters that are within their control and can be properly monitored (Chatzoglou and Chatzoudes, 2018). A similar data-informed logic can be applied at the ecosystem level, allowing innovation and entrepreneurial ecosystems to grow and mature through strategic interpretation rather than mechanical replication of benchmarks.

Indices and rankings for innovation and entrepreneurship are useful indicators for evaluating various parameters and guiding development strategies and plans. Examples include the Global Innovation Index (GII), which measures innovation performance in 132 countries based on R&D and technological development, and the Global Entrepreneurship Monitor (GEM), which assesses entrepreneurship performance by examining entrepreneurial behaviors and attitudes. These indices were developed by highly reputable organizations, such as the World Intellectual Property Organization (WIPO) for the GII and Babson College for the GEM. Despite their extensive use, these indices are often applied independently, limiting their ability to capture the multidimensional nature of innovation and entrepreneurial ecosystems.

This paper emphasizes these indicators because they serve as key references for governments, private and public institutions and businesses, and are regularly cited in scientific publications.

However, their policy relevance depends less on ranking positions and more on contextual and comparative interpretation across institutional, entrepreneurial and societal dimensions.

According to Rovere *et al.* (2021), identifying metrics and indicators is an important database for public policy development to support innovation strategies for entrepreneurs and small enterprises. While different metrics are needed for each sector, GII measures innovative entities or enterprises, whereas GEM assesses human entrepreneurial competencies. This distinction highlights their complementarity rather than substitutability, reinforcing the need for integrated analytical approaches.

Companies collaborate with academic researchers for regional development, but evaluating ecosystem performance remains challenging. Quantitative measurements are used but valuing intangibles like seed-stage startups, trademarks and patents is difficult. Measuring societal impacts of innovation is demanding. As a result, policy decisions frequently rely on partial indicators that fail to reflect ecosystem complexity. However, refining measures can aid managers in decision-making and in planning public policies, enterprises and ecosystem strategies to achieve optimal outcomes.

The Oslo Manual (OECD/Eurostat, 2018) is the reference for innovation indicators, which defines concepts and definitions for measuring business innovation activities, capabilities and knowledge flows. This manual separate innovation from the lengthier process in the innovation chain. According to Smith (2005) and Muller *et al.* (2005), selecting appropriate metrics is essential for assessing returns on innovation investments. Traditional indicators, such as the number of startups alone, may therefore fail to capture ecosystem efficiency and societal impact.

Social innovation measurement tools are essential for local analyses that impact society positively. These tools assess the effects of ecosystems on well-being and environmental sustainability, as reflected in the OECD Better Life Index (OECD, 2020a). The UN Sustainable Development Goals (SDGs) (Jensen, 2022) highlight that sustainable indicators extend beyond climate and natural environments to encompass actions aimed at improving indicators in areas such as poverty reduction, health and well-being, education, gender equality, innovation, infrastructure, reduced inequalities, sustainable consumption and production, strong institutions and partnerships and the overall impact of strategies and actions on all indicators (Székely and Knirsch, 2005). Yet, these societal dimensions are rarely integrated into innovation and entrepreneurship ecosystem assessments. The objective of this study is to propose and apply a comparative framework that integrates GII, GEM and OECD indicators to assess national innovation and entrepreneurial ecosystems. It seeks to answer the following research questions: What are the complementarities and contrasts between GII and GEM in evaluating ecosystem performance? How can the inclusion of societal well-being metrics enhance policy interpretation and application?

Given the global scope and comparative intent of this research, the study is deliberately theoretical, exploratory and non-causal, relying on secondary data from the GII, GEM and OECD Better Life Index to provide a comparative and integrative assessment of innovation and entrepreneurial ecosystems.

The framework integrates GII indicators, focused on systemic conditions, institutional environment, technological infrastructure and innovation outputs with GEM metrics, emphasizing entrepreneurial behaviors, attitudes and motivations. Rather than producing rankings or causal claims, this approach enables a macro-level analytical reading of ecosystem configurations. This approach combines perspectives for macro-level analysis and policy insights without primary data collection, enabling policymakers to understand the relationships between innovation inputs, entrepreneurial activities and societal outcomes for informed decisions toward sustainable growth.

2. Innovation and entrepreneurial ecosystems

Although innovation and entrepreneurship ecosystems differ in their objectives, they share the common goal of fostering growth and success. While the innovative ecosystem focuses on technological advancements and economic stability, the entrepreneurial ecosystem is centered on the growth and development of entrepreneurs. Both are important for achieving positive outcomes and impacts on society. It is possible to see in Table 1, by Rovere *et al.* (2021), the similarities and differences of these ecosystem approaches.

Countries have made efforts to increase their innovative investments and enhance their competitiveness. However, these investments may not necessarily achieve the development goals that aim to benefit society. This misalignment is known as the "innovation paradox" (Jovanović *et al.*, 2022). Several researchers have attempted to develop methods and tools to overcome this paradox by examining innovation and entrepreneurial system indicators (Ács *et al.*, 2014; Feldman *et al.*, 2022; Liguori *et al.*, 2018; Muller *et al.*, 2005; Sohn *et al.*, 2016; Vélez-Cuartas *et al.*, 2022).

This study draws on secondary data from the GII, GEM and OECD Better Life Index to enable a comparative and contextual analysis of innovation and entrepreneurial ecosystems across countries. Countries were selected to reflect variation in income levels, innovation capacity and ecosystem maturity, allowing for illustrative cross-country comparison rather than statistical generalization. This methodology is appropriate and widely accepted for policy-oriented research aiming to map trends, identify best practices and generate theoretical insights.

Figure 1 presents our integrated conceptual framework, linking indicators from GII and GEM to systematically assess the efficiency and effectiveness of ecosystems. The framework categorizes indicators into three dimensions: inputs: infrastructure, human capital, institutions and market conditions (GII), activities: entrepreneurial attitudes, behaviors, motivations, and startup creation (GEM) and outputs and impacts: knowledge creation, technology outputs, entrepreneurial growth and societal well-being indicators from both indices. Indicators were grouped into inputs, activities and outputs/impacts to facilitate structured comparison and interpretation across ecosystems. This categorization does not imply linear causality but serves to organize multidimensional information in a policy-relevant manner.

By clarifying our methodological approach and highlighting the rationale for country selection, this framework provides a foundation for cross-national comparison. The study

Table 1. Main similarities and differences between innovation and entrepreneurship ecosystem approaches (Rovere *et al.*, 2021)

Roles	Entrepreneurial ecosystem (EE)	Innovation ecosystem (IE)
Main focus	Entrepreneur (individual level): focuses on the person and the context created by it	Organizations (entities level): focus on the entities' dynamic capacities to determine the center of capitalist transformations
Institutional context	Both use the systemic perspective, looking for institutional importance and highlighting external forces that influence the economic aspects	
	Emphasis on formal institutions	Has a more balanced emphasis on formal institutions (laws and regulations) and informal ones (social and cultural standards)
Government role	Has a marginal role as a promoter of incentives	Has a complementary but active role, taking the lead that involves high risks and deep technological changes

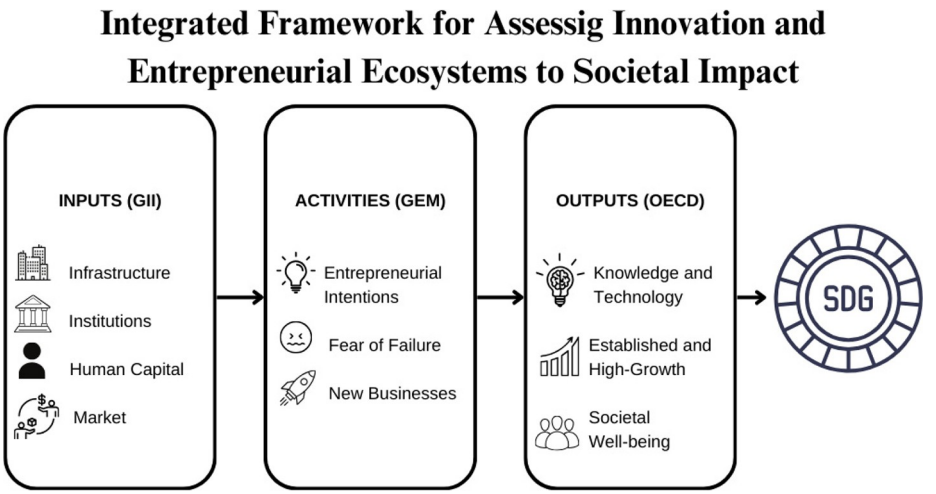

Figure 1. Conceptual framework integrating GII, GEM and OECD Better Life Index to assess innovation ecosystems across inputs, activities and societal impacts

recognizes its qualitative nature and intentionally avoids inferential statistics, instead focusing on contextual policy interpretation and singular ecosystem dynamics. Given the reliance on secondary indicators and cross-sectional data, the analysis focuses on identifying patterns and complementarities rather than testing hypotheses or estimating effect sizes. This choice is consistent with the exploratory aims of the study and with prior research using global innovation metrics.

The GII (World Intellectual Property Organization (WIPO), 2023) stresses the growing importance of technological adaptability, especially in response to recent global disruptions. Similarly, the recent GEM (Hill *et al.*, 2024) highlights the critical role entrepreneurial attitudes and societal impacts play in achieving sustainable economic growth. Overall, the methodological approach prioritizes interpretability, comparability and policy relevance over precision estimation, making it suitable for strategic reflection by policymakers and ecosystem stakeholders.

3. Innovation and entrepreneurial ecosystems monitors

Innovation developments, in their various dimensions, are depicted by the variables measured over a given period, and these measures help to understand the dynamics from linear to nonlinear processes (Bund *et al.*, 2013). Innovation can be difficult to measure, especially in scientific research and early-stage startups. In these cases, there may not be many tangible things to go on, and there may be more reliance on intangible resources. (Smith, 2005).

The innovation ecosystem includes economic, social, political and organizational components and involves the development of new products and processes (Edquist, 2005). According to da Silva *et al.* (2022), performance measurement is important for innovation system settings and for evaluating measurement models that align with the appropriate ecosystem performance.

Additionally, according to Jovanović *et al.* (2022), a suitable measure is essential for effectively evaluating the performance of the triple helix. While OECD indicators could be useful, they present challenges when applied for R&D and patents in the university,

government and business sectors. However, separate values make it difficult to assess a country's overall performance. Examining multidimensional parameters can provide insights into a country's impact on its performance.

Patents and spinoffs are critical components of the R&D innovation system and triple-helix entities. While patents are essential for protecting intellectual property, spinoffs are a means to transfer knowledge between universities and businesses. However, academic spinoff founders face a dilemma in deciding whether to focus on the future market and customer needs or prioritize efficient intellectual property management (Ferri *et al.*, 2019).

The triple helix model emphasizes technological advancement, knowledge sharing and intellectual capital transfer through innovation and collaboration, primarily between industry and universities, with patents resulting from research findings (Rajalo and Vadi, 2017; Szücs, 2018). The authors identified that technology transfer measurement performance exhibited low levels of efficiency and many barriers (Belitski *et al.*, 2019; Chau *et al.*, 2017; Villani *et al.*, 2017).

To meet their third mission, universities must integrate an entrepreneurial model, expand their offerings to include entrepreneurship training and create startups based on research and scientific advancement (Caputo *et al.*, 2022). Although intellectual property (IP), which includes inventions, literary and artistic works, designs, symbols, names and images used in commerce or technological transfer, spinoff performance may not be as efficient and requires ongoing monitoring and adjustments to improve its positive societal impact (Caputo *et al.*, 2022; Dabić *et al.*, 2022; Ferri *et al.*, 2019; Fiorentino *et al.*, 2022).

Monitoring and supplying strategies for different actors in an innovative and entrepreneurial ecosystem's growth requires an understanding of the importance of various parameters (Rabelo Neto *et al.*, 2024). Additionally, it is necessary to determine the most suitable ranking and metrics for local, regional and national ecosystem development. Achieving accuracy in these metrics requires the combination of system-level indicators with relevant indicators. Subsections 3.1 and 3.2 aim to identify and explain, in general, the main values of both indexes, the GII and GEM, and try to understand the potential and relevant features of these metrics.

3.1 Global Innovation Index

The GII from the WIPO is based on technological progress and adoption, human capital, investments, knowledge and others and is composed by seven pillars (Dutta *et al.*, 2022), as listed in Global Innovation Index general pillars (Dutta *et al.*, 2022):

- Global innovation index pillars
- Institutions
- Human capital and research
- Infrastructure
- Market sophistication
- Business sophistication
- Knowledge and technology outputs
- Creative outputs

The institution's pillar has two political, three regulatory and two business dimensions by Dutta *et al.* (2022), as listed in Table 2. Human capital and research pillars have five educational dimensions, three tertiary education dimensions and four R&D dimensions. The infrastructure pillar has four ICT, three general infrastructure and three ecological

sustainability dimensions. The market sophistication pillar includes three credit dimensions; four investment dimensions; and three trade, diversification and market-scale dimensions. Business sophistication has five knowledge workers, five innovation linkage and five knowledge absorption dimensions. Knowledge and technology outputs consist of five knowledge creation, five impact and four diffusion dimensions. The creative pillar has four intangible assets, five creative goods and services and four online creativity dimensions.

The institutional pillar evaluates a country's general risks, governance and workers' employment on political and regulatory topics using country risk scores, World Bank governance indicators and employer reports. The business environment subtopic examines public policies for business and entrepreneurship and the culture index from World Economic Forum data and the GEM. Policymakers have argued that innovation can be boosted through policy tools, and some have studied the consequences of various policy actions. Research shows that R&D tax credits and skilled immigration are the most effective policy tools for fostering innovation in the long and short term, respectively. Huergo and Moreno (2017) found that public policies and funding have a greater influence on SMEs than on large companies, and participating in multiple programs does not increase R&D in large firms. The impact of public policies varies with the company size.

The human capital and research pillar (Table 3) analyzes government investments and public policies in education from primary school to tertiary education. For example, expenditure on education at the secondary level, PISA ranking up to the tertiary education level and researchers, university ranking and expenditure on R&D by the government and companies.

Tertiary educational institutions are crucial in fostering innovative ecosystems as they play a vital role in attracting talent to compensate for the absence of strong educational institutions. By improving the quality of labor and transferring technologies to industry, higher education acts as an engine for an innovation ecosystem. Moreover, entrepreneurial university missions have now been incorporated into recent approaches. In addition, the importance of secondary education in influencing creativity and innovation development is growing in different ecosystems, such as STEAM education.

The infrastructure pillar (see Table 4) includes topics such as mobile network coverage, household internet access, individual internet usage, the E-Government Development Index, electricity production, logistics performance and gross capital in inventories and acquisitions. The ecological topic analyzes GDP per total energy supply, environmental health, ecosystem vitality and the number of ISO 14001 environmental certificates. Purchasing power parity (PPP) is used to compare economic productivity, standards or specific values between countries.

Table 2. Global Innovation Index institutions' pillars (Dutta *et al.*, 2022)

Institutions index pillar	
Political environment	Political and operational stability
	Government effectiveness
Regulatory environment	Regulatory quality
	Rule of law
	Cost of redundancy dismissal
Business environment	Policies for doing business
	Entrepreneurship policies and culture

Table 3. Global Innovation Index of human capital and research pillars (Dutta *et al.*, 2022)

Human capital and research index pillar	
Education	Expenditure on education (% GDP)
	Government funding, student secondary level (and GDP)
	School life expectancy (years)
	PISA scales in reading, math and science
	Pupil-teacher ratio, secondary
Tertiary education	Tertiary enrolment (% gross)
	Graduates in science and engineering (%)
	Tertiary inbounding mobility (%)
Research and development (R&D)	Researchers (FTE/mn pop.)
	Gross expenditure on R&D (% GDP)
	Global corporate R&D investors, TOP 3 (mn US$)
	QS university ranking, TOP 3

Table 4. Global Innovation Index infrastructure pillars (Dutta *et al.*, 2022)

Infrastructure index pillar	
Information and communication technologies (ICTs)	ICT access index
	ICT use
	Government online service
	E-participation
General infrastructure	Electricity output (GWh/mn pop.)
	Logistic performance
	Gross capital formation (% GDP)
Ecological sustainability	GDP/unit of energy use
	Environment performance
	ISO 14001 environment certificates/billion PPP$ GDP

Commer *et al.* (2018) and Khan *et al.* (2020) found that ICT investments are crucial for environmental sustainability in developed countries, but not in developing countries. They concluded that ICT has the potential to protect against environmental degradation, supporting policies that encourage ICT investments in developing countries to improve environmental sustainability.

The market sophistication pillar (Table 5) evaluates the financial conditions for starting and growing entrepreneurship startups as assessed by finance experts via the GEM. Financial corporations provide funding to the private sector through microfinance institutions, and the market value is calculated based on share prices, outstanding shares, venture capital investments, effective interest rates, manufacturing subsectors and GDP adjusted for purchasing power parity.

This pillar focuses on investment access and trade in the technology industry, and various models cater to the different stages of maturity, risk and the needs of innovator companies. These models include public investment, venture capital, corporate venture capital, angel or business investors, crowdfunding and accelerators. Among the challenges faced by startups, accessing the capital market is one of the most frequently cited, and traditional investors such as lenders or banks may find innovative startup assets less attractive because of their intangible nature. Specific investor models are often the main option for startups.

Table 5. The market sophistication pillar of the Global Innovation Index (Dutta *et al.*, 2022)

Market sophistication index pillar	
Credit	Finance for startups and scale-ups
	Domestic credit to private sector (% GDP)
	Loans from microfinance (% GDP)
Investment	Market capitalization (% GDP)
	Venture capital investors (deals/bn PPP$ GDP
	Venture capital recipients (deals/bn PPP$ GDP)
	Venture capital received, value (% GDP)
Trade, diversification and market scale	Applied tariff rate, weighted avg. (%)
	Domestic industry diversification
	Domestic market scale (bn PPP$)

Understanding a new company's stage, goals and requirements is important. It is not just about securing financial investments, but also obtaining expertise and support. Because different stages of companies demand varying levels of maturity, they often lack development in areas such as business models, departments and human resources beyond just funding (Annamalaisami, 2022; Bessiire *et al.*, 2018; DeGennaro, 2012; Rossi *et al.*, 2022). Venture capitalists' access to cover spinoff investments and the gap between the university's technology transfer office and theirs pose challenges (Festel *et al.*, 2015).

The business sophistication pillar (Table 6) evaluates various aspects, such as employee and firm training programs, R&D expenditures, female employment, university–business collaborations, patent filings, intellectual property payments and foreign direct investment inflows. The range of subtopics and references from databases such as the World Economic Forum, International Labor Organization, World Bank, UNESCO, OECD, WIPO, IMF, UN and World Trade Organization are covered in this pillar. The subtopics related to intellectual property and its effects on business development are complex and require proof of their impact on economic growth. In addition, the knowledge and technology output pillar encompass a diverse set of subtopics, including knowledge creation through IP production.

Table 6. Global Innovation Index business sophistication pillars (Dutta *et al.*, 2022)

Business sophistication pillar	
Knowledge workers	Knowledge-intense employment (%)
	Firms offering formal training (%)
	GERD performed by business (% GDP)
	GERD financed by business (%)
	Females employed w/advanced degrees (%)
Innovation linkages	University-industry R&D collaboration
	State of cluster development and depth
	GERD financed by abroad (% GDP)
	Joint venture/strategic alliance deals/bn PPP$ GDP
	Patent families/bn PPP$ GDP
Knowledge absorption	Intellectual property payments (% total trade)
	High-tech imports (% total trade)
	ICT services imports (% total trade)
	FDI net inflows (% GDP)
	Research talent (% in business)

According to Sweet and Eterovic Maggio (2015), a study of IP rights (IPR) in 94 countries showed that IPR increases economic levels and impacts innovation systems. However, its effect is more pronounced or restricted in countries with higher levels of development, and it has a non-significant impact on the economies of developing countries. Power and Reid (2021) analyzed the performance of startups using different IP strategies and found that these strategies can be converted into advantages and improve performance in certain contexts.

Analyzing Table 7, it includes resident patents at both the national and regional levels as well as PCT and utility model applications. It evaluated various aspects, including the number of scientific and technical articles published, citations received, GDP growth per employed person, new business density, computer software spending, ISO 9001 certificates, high and medium-tech manufacturing outputs, intellectual property usage fees, the economic complexity index based on export diversity and complexity, the percentage of high-tech trades and ICT service exports.

International patent systems play a vital role in fostering innovation and development. While it stimulates knowledge diffusion, other factors such as financing and infrastructure are crucial for turning patents into successful innovations, as per Hall (2022). However, developing countries have invested heavily in intellectual property through patent protection, but this has not led to increased productivity and economic performance, as per C. Sweet and Eterovic (2019).

The creative output pillar, depicted in Table 8, assesses the top 15 intangible assets for each economy, number of trademarks and industrial design applications, global brand values as a percentage of GDP, creative services exports, national film production, entertainment and media market per capita, printing and media output, creative goods exports and domain usage, as well as the number of pushes received in the world's largest source code repository, GitHub and global mobile app downloads.

Crosling *et al.* (2014) noted a strong correlation between the creative learning system (CLE), quality of education system (QES) and innovative capacity (IC). Creative thinking is crucial to improving competitiveness and sustainable development. It serves as an engine and accelerator of innovation in ecosystems. This pillar aims to view creative outputs in various dimensions such as trademarks, brands, industrial design and market entertainment. However, the impact of the creative process on the innovation ecosystem is far-reaching and

Table 7. Global Innovation Index knowledge and technology output pillars (Dutta *et al.*, 2022)

Knowledge and technology outputs pillar	
Knowledge creation	Patents by origin/bn PPP$ GDP
	Patent cooperation treaty (PCT) by origin/bn PPP$ GDP
	Utility models by origin/bn PPP$ GDP
	Scientific and technical articles/bn PPP$ GDP
	Citable documents H-index
Knowledge impact	Labor productivity growth (%)
	New businesses/th pop. 15–64
	Software spending (% GDP)
	ISO 9001 quality certificates/bn PPP$ GDP
	High-tech manufacturing (%)
Knowledge diffusion	Intellectual property receipts (% total trade)
	Production and export complexity
	High-tech exports (% total trade)
	ICT services exports (% total trade)

Table 8. Global Innovation Index creative output pillars (Dutta *et al.*, 2022)

Creative outputs pillar	
Intangible assets	Intangible asset intensity, top 15 (%)
	Trademarks (origin/bn PPP$ GDP)
	Global brand value, top 5,000 (% GDP)
	Industrial designs (origin/bn PPP$ GDP)
Creative goods and services	Cultural and creative services exports (% total trade)
	National feature films/mn pop. 15–69
	Entertainment and media market/th pop. 15–69
	Printing and other media (% manufacturing)
	Creative goods exports (% total trade)
Online creativity	Generic top-level domains (TLDs)/th pop. 15–69
	Country-code TLDs/th pop. 15–69
	GitHub commit pushes received/mn pop. 15–69
	Mobile app creation/bn PPP$ GDP

requires a deep and amplified vision, considering the foundation of creative learning education and its processes across different outputs in various fields.

3.2 Global Entrepreneurship Monitor

The GEM research entrepreneurship ecosystems through attitude and perception survey data, like the GII, and represents a network of national teams. This index suggests that new market opportunities, productivity increases and employment creation can be achieved without promoting innovation. However, fostering an entrepreneurial culture and sustainable ecosystems is crucial. The GEM addresses societal challenges, such as the UN SDGs, by solving local problems and prioritizing sustainable growth (Hill *et al.*, 2022).

The GEM collects data through the Adult Population Survey (APS) and GEM. APS examines the characteristics, motivations and aspirations of potential entrepreneurs and their social attitudes toward entrepreneurship. GEM categorizes entrepreneurial activities into three clusters: nascent entrepreneurs, new business owners and established business owners. The second GEM survey is the National Expert Survey (NES), which includes at least 36 national experts who answered an online survey about the entrepreneurial environment in that economy. The GEM originally covered 24 topics without segmentation, but we separated them into six groups (Tables 9 to 14).

New entrepreneurs must make decisions in the pre-startup phase and face various challenges, referred to as the "Valley of Death" (Kim *et al.*, 2018; Salamzadeh and Kawamorita Kesim, 2015). According to Gbadegeshin *et al.* (2022), this stage is characterized by difficulties in funding, bureaucracy, governance, technology development or commercialization and lack of support. These challenges can lead to fear of failure and uncertainty among new entrepreneurs (Costa *et al.*, 2023). The psychological, economic and cultural environments, as well as family support, play a significant role in the learning process and can influence the likelihood of success or failure.

Entrepreneurs face various challenges and require resources at different stages of their journeys. Gbadegeshin *et al.* (2022) identified team building, technology development, funding and collaboration as the main challenges during the pre-startup stage, such as business formalization, and learning from failures during this stage can also be difficult. Atherton (2007), Gielnik *et al.* (2014) and Lerner (2016) analyzed entrepreneurs' motivation, behavior and engagement in initiating their entrepreneurship journey. Nascent

Table 9. Global entrepreneurship monitoring topics (Group 1) (Hill *et al.*, 2022)

Indicator	Definition
Knowing a startup entrepreneur	Percentage of adults aged 18–64 who personally know at least one person who has started a business in the past two years
Ease of starting a business	Percentage of adults aged 18–64 who agree that it is easy to start a business in their country
Fear of failure rate (opportunities)	Percentage of adults aged 18–64 who agree that they see good opportunities but would not start a business for fear it might fail
Nascent entrepreneurship rate	Percentage of adults aged 18–64 who are currently nascent entrepreneurs, i.e. are actively involved in setting up a business they will own or co-own; this business has not yet paid salaries, wages or any other payments to the owners for more than three months
New business ownership rate	Percentage of adults aged 18–64 who are currently owner-manager of a new business, i.e. who own and manage a running business that has paid salaries, wages or any other payments to the owners for more than three months, but not for more than 42 months (3.5 years)

Table 10. Global entrepreneurship monitoring topics (Group 2) (Hill *et al.*, 2022)

Indicator	Definition
Perceived opportunities	Percentage of adults aged 18–64 who agree that they see good opportunities to start a business in the area where they live
Perceived capacities	Percentage of adults aged 18–64 who agree that they have the required knowledge, skills and experience to start a business
Total early-stage entrepreneurial activity (TEA)	Percentage of adults aged 18–64 who are either a nascent entrepreneur or owner-manager of a new business, i.e. the proportion of the adult population who are either starting or running a new business
Business services	Percentage of TEA in business services
Consumer services	Percentage of TEA in consumer services

Table 11. Global entrepreneurship monitoring topics (Group 3) (Hill *et al.*, 2022)

Indicator	Definition
Entrepreneurial employee activity (EEA)	Percentage of adults aged 18–64 who, as employees, have been involved in entrepreneurial activities such as developing or launching new goods or services, or setting up a new business unit, a new establishment or a subsidiary, in the last three years
The motive for starting a business: "to make a difference in the world"	Percentage of TEA who agree that a reason for starting their business is "to make a difference in the world"
The motive for starting a business: "to build great wealth or very high income"	Percentage of TEA who agree that a reason for starting their business is "to build great wealth or a very high income"
The motive for starting a business: "to continue a family tradition"	Percentage of TEA who agree that a reason for starting their business is "to continue a family tradition"
The motive for starting a business: "to earn a living because jobs are scarce"	Percentage of TEA who agree that a reason for starting their business is "to earn a living because jobs are scarce"

Table 12. Global entrepreneurship monitoring topics (Group 4) (Hill *et al.*, 2022)

Indicator	Definition
Established business ownership rate (EBO)	Percentage of adults aged 18–64 who are currently owner-managers of an established business, i.e. who are owning and managing a running business that has paid salaries, wages or any other payments to the owners for more than 42 months (3.5 years)
High growth expectation entrepreneurial activity	Percentage of adults aged 18–64 starting or running a new business (TEA) who expect to employ six or more people five years from now
Internationally oriented entrepreneurial activity	Percentage of adults aged 18–64 involved in TEA who anticipate 25% or more revenue coming from outside their country
Product/services impact (local/national/global)	Percentage of adults aged 18–64 involved in TEA having products or services that are either new to the area, new to their country or new to the world
Technology/procedures impact (local/national/global)	Percentage of adults aged 18–64 involved in TEA having technology or procedures that are either new to the area, new to their country or new to the world

Table 13. GEM factors analyzed in economic growth by entrepreneurial conditions (Gomes *et al.*, 2023)

Economic growth	Groups	Entrepreneurial conditions
GDP per capita	*H1*	Cultural and social norms
	H2	Internal market dynamics
	H3	Physical and services infrastructure
		R&D transfer
		Taxes and bureaucracy
	H4	Basic school entrepreneurial education and training
		Governmental programs
		Post-School entrepreneurial education and training
		Commercial and professional infrastructure
		Financing for entrepreneurs
	H5	Internal market openness
		Governmental support and policies

Table 14. Global entrepreneurship monitoring topics (Group 5) (Hill *et al.*, 2022)

Indicator	Definition
Digitalization rate	Percentage of TEA who expect their business to use more digital technologies to sell their product or service in the next six months
Social impact rate	Percentage of TEA who agree they always consider social implications when making decisions about the future of their business
Environmental impact rate	Percentage of TEA who agree they always consider environmental implications when making decisions about the future of their business
Business exit rate	Percentage of adults aged 18–64 who have exited a business in the past 12 months, either by selling, shutting down or otherwise discontinuing an owner/management relationship with that business

entrepreneurs have a strong desire to make their business real and tangible, but exhibit behaviors such as uncertainty, inertia, hyperactivity, attentional variability, unreal goal intentions and quick decisions by impulse.

Entrepreneurs' success is influenced by their motivation, personality traits and behavioral competencies. However, teaching these soft skills is challenging in entrepreneurial ecosystems. Universities play a crucial role in addressing this by implementing innovative educational methods that not only develop hard skills but also foster the development of soft skills in individuals. According to Creigh-Tyte and Clay (1998), some authors contest the effectiveness of entrepreneurship training programs and criticize traditional courses. Additionally, many defend contemporary education methods by focusing on a wide range of skills, the development of personal characteristics and specific behaviors.

Gomes *et al.* (2023) analyzed the relationship between environmental and business factors in 37 OECD countries using the GEM model and the NES of the GEM. The authors examined 12 variables, focusing on the economic impact of entrepreneurship in high- and upper-middle-income countries. In upper-middle-income countries, reducing taxes and bureaucracy can have positive effects on economic growth, whereas cultural and financial support for entrepreneurship is beneficial in high-income countries. Based on their findings, Gomes *et al.* (2023) recommend that political decision-makers in upper-middle-income countries should improve post-school entrepreneurial education and reduce taxes and bureaucracy, while high-income countries should focus on primary and secondary school entrepreneurial education and government support programs.

Digital transformation in enterprises is essential for expanding beyond national boundaries, which is stimulated by various policies (Strange *et al.*, 2022). Although the process presents challenges, it positively affects traditional companies' international strategies and competitiveness. IoT, AI, robotic automation, cloud computing, big data analytics, blockchain, additive manufacturing and 3D printing are digital technologies that companies have adopted or developed to solve problems and improve market performance. According to the OECD (Cass-Beggs *et al.*, 2017), technology integration will shape digital transformation in the next decade, impacting business and society. Countries face challenges including fragmented internet access, platform concentration and job displacement. Cybersecurity concerns will grow with digital development, requiring governments to adapt policies accordingly.

Cass-Beggs *et al.* (2017) highlight the potential of digital technologies to enhance sustainable development and achieve SDGs. The GEM assesses social and environmental impact indicators, whereas the OECD Better Life Index and SDGs are important tools for monitoring and promoting innovation and entrepreneurship ecosystem development. Public policies play a crucial role in ensuring that economic, environmental and social responsibilities are shared among all entities in society. The OECD report (OECD, 2020b) emphasizes that effective public policies should focus on improving people's well-being, not just economic growth. According to Székely and Knirsch (2005), companies often treat sustainable initiatives as isolated activities that are not integrated into their business strategy. Therefore, it is important to link these initiatives to specific indicators and measurements to demonstrate the impact of corporate social responsibility on a company's internal structure and organizational management.

4. Comparison and assessment between ecosystems

Evaluating a country's innovation and entrepreneurship performance requires understanding its ecosystem characteristics. Insights from ecosystem inhabitants are valuable, as they possess knowledge of regional traits, political evolution, economic dimensions, development

level and cultural history. Their understanding enables them to identify actions for ecosystem development.

Evaluating national innovation ecosystems requires comparative analysis beyond country-level descriptions. While ecosystems reflect unique institutional and socio-economic conditions, valuable insights emerge from analyzing countries across shared dimensions. This section applies the framework to compare eight countries using GII and GEM indicators to identify patterns and trade-offs in innovation and entrepreneurship performance.

Countries were grouped by income level and ecosystem maturity to enable structured comparison rather than ranking. High-income ecosystems (Switzerland, the USA, South Korea, Israel) are contrasted with upper-middle-income (Chile, Brazil, South Africa) and lower-middle-income contexts (India) to examine how institutional strength, entrepreneurial culture and policy orientation interact differently across development stages.

Integrating the GII in innovation and GEM how tools for understanding a country's entrepreneurial environment and promoting new business creation. By combining these metrics, ecosystem members can develop effective strategies for entrepreneurial behavior and business development. The GII examines the factors that encourage and support new technologies, enterprises and entrepreneurs, whereas the GEM provides insights into the attitudes and intentions of potential entrepreneurs.

4.1 Switzerland

Switzerland ranks first in the GII and excels in the pillars of knowledge and technology outputs, and institutions, while showing low performance in business and market sophistication. The country stands out in knowledge creation, online creativity and business environment, but lags in trade, diversification and market scale. In the GEM, Switzerland ranks second in "Industry" (42.2% of businesses in business services) and third in Entrepreneurial Employee Activity. The country's low performance is seen in Entrepreneurial Intentions (Rank 31). The main motivations for entrepreneurs are "To make a difference" (Rank 16) and "Build great wealth" (Rank 29).

Although GII ranks high in many pillars and subpillars, it is important to note that it can still influence "Policies for doing business" and "Government effectiveness" to provide a safe environment for entrepreneurs. This can be reflected in the GEM category "Fear of failure (opportunity)" and "Entrepreneurial Employee Activity" among the best indicators. The higher levels of "Knowledge and technology outputs" and "Knowledge creation" in GII can also reflect influence in the GEM high indicator "Industry" (42.2% TEA in business services).

Based on the study by Derindag *et al.* (2021), Switzerland's ecosystem relies on minimal government intervention in private business and market relations. This creates a competitive environment for the technologies. The authors highlight Switzerland's ranking in global innovation and emphasize high R&D investment as a percentage of the GDP. Additionally, they recognize the ecosystem's strength in promoting partnerships among companies, universities and foreign institutions.

4.2 United States of America

The USA ranks second in GII and excels in "market sophistication" (Rank 1), "business sophistication" (Rank 3) and "knowledge and technology outputs" (Rank 3). However, it performs poorly in "Infrastructure" (Rank 19). The subpillars with the best positions are "Trade, diversification, and market scale" (Rank 1), "Research and development (R&D)"

(Rank 2) and "Knowledge impact" (Rank 2). Meanwhile, the subpillars with the worst performance were "Tertiary education" (Rank 48) and "Education" (Rank 44).

Similar to Switzerland, the USA has strong connections between university-industry, venture capital and knowledge and technology outputs. However, attitudes and perceptions of entrepreneurship in GEM do not reflect this, and there is a low impact on government policies and entrepreneurial programs. This leads to low entrepreneurial education in schools and contributes to the low performance in the GII subpillars "Institutions" and "Education" in the "Human capital and research" pillar.

According to Wessner (2005), there is a myth about the government's support for industry R&D, which suggests that increased public and private investments in research will lead to greater commercialization and strengthen US companies' competitiveness in the global market. However, the authors argue that the innovation process is nonlinear, as many discoveries occur through trial-and-error learning cycles and have serendipitous elements.

4.3 Republic of Korea (South Korea)

The Republic of Korea, ranked sixth in the GII, has the best performance in the pillars of human capital and research (Rank 1) and creative outputs (Rank 4), while its lowest performance is in the institutions pillar (Rank 31). South Korea ranks first in research and development (R&D), intangible assets and information and communication technologies (ICTs). The subpillars with the lowest performance were ecological sustainability (Rank 60) and regulatory environment (Rank 59).

Stronger innovation bases in human capital and research, R&D and intangible assets have improved innovative products and companies in the Republic of Korea under the impact of knowledge. Based on a study by Prokop *et al.* (2021), South Korea has a good environment for efficient collaborative activities and knowledge models, with positive impacts on technological conversion and consistent results compared to other countries.

Cho and Lee (2018) and Lee *et al.* (2019) state that entrepreneurial orientation affects business performance. South Korea is transitioning from an industrial to an entrepreneurial society by investing in entrepreneurship education to improve early-stage entrepreneurs' success. Although both authors agree that entrepreneurship education is advancing in South Korea, they do not confirm its impact on business performance.

Taken together, Switzerland, the USA and South Korea illustrate how strong GII inputs, particularly in knowledge creation, R&D and university–industry collaboration – tend to correspond to higher GEM outputs in entrepreneurial activity. However, differences in institutional design and education policies explain variations in entrepreneurial intentions and societal engagement across these ecosystems.

4.4 Israel

Israel ranks 16th in the GII with top performance in business sophistication and market sophistication. It has low performance in infrastructure and institutions. The subpillars with the best position are "Innovation linkage" and "Knowledge diffusion," while the worst subpillars are "Tertiary education" and "Intangible assets." In the GEM, Israel has the best performance in industry and "Entrepreneurial Employee Activity." It has a low performance in "It is easy to start a business." The main motivation for entrepreneurs is "Build great wealth."

Israel's strengths lie in its "Business and market sophistication," with a high level of university-industry R&D collaboration and a strong impact on venture capitalists. However, the country's low levels in "It is easy to start a business" and "Fear of failure (opportunity)"

reflect poor government support and bureaucracy and low performance in the Institutions and "Human capital and research" pillars of the GII.

Israel contrasts with other high-income ecosystems by combining strong market and business sophistication with persistent institutional and bureaucratic constraints. This highlights that high innovation capacity does not automatically translate into favorable entrepreneurial conditions, reinforcing the need to interpret GII and GEM jointly rather than independently.

4.5 India

India ranks 40th in GII and excels in "Market sophistication" (Rank 19) but lags in infrastructure (Rank 78). In terms of subpillars, it performs best in "Trade, diversification, and market scale" (Rank 9) and "Investment" (Rank 17), while "Ecological sustainability" (Rank 115) is its lowest-performing subpillar. In the GEM, India has the top performance in attitudes and perceptions related to "Good opportunities to start a business in my area," with 83.3% (Rank 2). On the other hand, it ranks second in "fear of failure (opportunities)" with 54.1%. The primary motivations for entrepreneurs in India are "Continuing a family tradition" (74.3%, Rank 1), "Earning a living" (91.5%, Rank 2) and "Making a difference" (75.9%, Rank 3).

India's innovation ecosystem is strong in "Market sophistication" with impact through credit for startups and scaleups and venture capital investments and in pillar "Institutions," subpillar "Business environment" has ranked 12 for "Entrepreneurship policies and culture." In the GEM, it is interesting that there are many parameters with good performance, such as "good opportunities to start a business in my area" and three better ranked performances in motivational topics: "to make a difference," "continue family tradition" and "to earn a living."

During the roundtable discussion on the entrepreneurial ecosystem in India (Jha, 2018), panelists highlighted the sociocultural factors that influence entrepreneurs' behaviors. For example, traditional family pressures and societal norms often dictate personal behavior and discourage individuals from pursuing conventional career paths. Additionally, the concept of "error culture" is a relevant factor for entrepreneurs' learning experiences with failures. However, in Indian culture, it is challenging to embrace this mindset as fear of failure is prevalent and can hinder opportunities.

4.6 Chile

Chile ranks 50th in the GII and performs well in the "Institutions" pillar (39th place), but lags in "Business Sophistication" (57th place) and "Human Capital and Research" (57th place). Chile ranks second in "Job Expectations" and third in "Total Early-Stage Entrepreneurial Activity" in the GEM. The main motivation for entrepreneurs in Chile is to earn a living, according to 73.9% of the respondents (Rank 14). Chile's best subpillar is "Knowledge Impact" (17th place), while its worst is "Creative Goods and Services" (123rd place).

The Chilean ecosystem shows great performance in the "Institutions" pillar of the GII, reflecting the government's policies to support entrepreneurship. According to Villegas-Mateos (2021) and Espinoza *et al.* (2019), the government has implemented initiatives to enhance the entrepreneurial ecosystem, focusing on understanding growth opportunities. Chile's priorities include modernizing finance, building regional ecosystems, fostering technologies and promoting inclusion.

4.7 Brazil

Brazil, ranked 54th in the GII, has the best performance in "Business sophistication" (ranked 35th) and the lowest performance in "Institutions" (ranked 102nd). In terms of subpillars, it ranks 18th in "Trade, diversification, and market scale," while it ranks 121st in "Business environment." In the GEM, Brazil ranks third in "Always consider social impact," and it has a 70.6% score for "Know someone who has started a new business" (ranked fourth). Additionally, it ranks fifth in "Entrepreneurial intention," with a score of 53.0%. It ranks 40th in "International (25%+ revenue)" and has a 75.7% score for "To make a difference" as its main entrepreneur motivation.

Brazil's business sophistication is positively reflected in its high performance in intellectual property payments and high-tech imports. However, it ranks low in the Institutions pillar, specifically in the "Business environment" subpillar. This suggests that there is room for improvement in government policies regarding business creation and development. Although Brazil's GEM performance is not impressive, its post-school education system excels in entrepreneurial education according to Campos *et al.* (2021). Their evidence-based model shows that universities play a significant role in fostering students' entrepreneurial aspirations.

4.8 South Africa

South Africa, ranked 61st in GII, performs best in the "Market sophistication" pillar (rank 39), but is low in the "Institutions" and "Human capital and research" pillars (both rank 81). The country's best sub-pillar performance is in "Investment" (rank 25), while the worst is in "Business environment" (rank 119).

South Africa ranks low in "fear of failure" and "total early-stage entrepreneurial activity" despite having a good position in new businesses per population. The primary motivation for entrepreneurs is to make a difference, with South Africa ranking first in market capitalization and 17th in educational expenditure. However, the country ranked 119th in the business environment and 111th in policies for doing business.

Bate (2021) notes that TEA's performance is good but does not scale with GDP per capita or employment tax. Institutional structures influence the entrepreneurial ecosystem, while bureaucratic policies do not limit entrepreneurial intention. Culture contributes to entrepreneurial mindsets. The impact of bureaucratic procedures and policies on entrepreneurship, economy and society is being assessed, along with culture's effect on entrepreneurial growth.

Business ecosystems have invested in knowledge assets to advance research on innovative products. Switzerland, the USA and Korea have achieved high knowledge output through university–industry collaboration. Government policies supporting entrepreneurial education, as seen in Switzerland and Korea, help develop entrepreneurial skills for transitioning to an entrepreneurial society. This shows how educational support reinforces innovation outcomes, linking GII inputs to GEM outputs.

Across India, Brazil, Chile and South Africa, common patterns emerge: relatively strong entrepreneurial motivation and social orientation coexist with weaker institutional environments and limited conversion of knowledge into scalable innovation outputs. Cultural norms, education systems and policy stability play a decisive role in shaping entrepreneurial behavior, explaining why similar GII scores may lead to divergent GEM outcomes across these ecosystems.

These comparative findings directly address the research questions by demonstrating the complementarities and tensions between GII and GEM when assessing ecosystem performance and the added interpretive value of incorporating societal and institutional

context into policy analysis. The results reinforce the usefulness of the proposed framework as an analytical tool for ecosystem assessment rather than a ranking or causal model.

This article demonstrates that countries across global rankings offer practices and policy insights adaptable to other national contexts when aligned with local cultural characteristics. The study provides a structured comparative analysis using secondary data to identify patterns, contrasts and strategic opportunities in public policy and innovation research.

5. Conclusions

This article emphasizes tailoring development strategies to each innovation ecosystem's specific context rather than replicating models like Silicon Valley. Through analysis of GII and GEM metrics, the study shows that ecosystems cannot be assessed through isolated indicators. By integrating innovation, entrepreneurship and societal metrics, findings reveal that countries have distinct ecosystem patterns, where innovation inputs do not necessarily lead to entrepreneurial or societal outcomes.

The results highlight three consistent patterns: ecosystems with strong knowledge and R&D capacities require complementary institutional quality and entrepreneurial education to convert innovation into impact; cultural attitudes toward risk, failure and social purpose significantly shape entrepreneurial behavior; and similar indicator scores may reflect fundamentally different policy challenges depending on local context.

For public policy, the framework provides a practical tool to move beyond rankings by identifying misalignments between innovation capacity, entrepreneurial dynamics and societal outcomes. Policymakers can use the combined reading of GII and GEM to diagnose whether policy gaps lie in education, institutions, market conditions or cultural barriers, enabling more targeted and context-sensitive interventions.

For practice and ecosystem management, the results support the design of differentiated strategies focused on entrepreneurial education, institutional simplification and university–industry collaboration, rather than the replication of external models. For teaching and capacity building, the framework offers a structured way to illustrate how global indicators can be critically interpreted in innovation and entrepreneurship programs.

For research, this exploratory and non-causal framework contributes to the literature by demonstrating how global indicators can be analytically integrated to support comparative ecosystem analysis. It provides a foundation for future studies combining primary data, longitudinal designs or in-depth case analyses.

Overall, the study bridges theory and practice by reframing global innovation and entrepreneurship metrics as strategic instruments for policy learning, institutional design and societal well-being, reinforcing their role in fostering inclusive and sustainable development.

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