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Digital entrepreneurship landscapes in developing Asia: insights from the Global Index of Digital Entrepreneurship Systems

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Abstract

Purpose – Digitalization is changing the way entrepreneurs pursue opportunities. We have elaborated a conceptual framework to gain a better understanding of digital entrepreneurship. Using this framework, we have developed the Global Index of Digital Entrepreneurship Systems (GIDES), an analytical tool designed to measure and comprehend the impact of digitalization on entrepreneurship. This study aims to answer the research question of what specific bottlenecks are hindering the performance of digital entrepreneurial systems in the countries under investigation, with a particular focus on developing Asian economies.

The Global Index of Digital Entrepreneurship Systems (GIDES) was developed on behalf of the Asian Development Bank (ADB) in 2021. The background study behind present paper was prepared for the report Asian Development Outlook 2022 Update: Entrepreneurship in the Digital Age. Asian Development Outlook 2022 Update Background Papers, https://www.adb.org/documents/asian-development-outlook-2022-update-background-papers (September 10, 2023), E. Autio, É. Komlósi, L. Szerb, and M. Tiszberger (2021): Asian Index of Digital Entrepreneurship Systems (2021), https://www.adb.org/sites/default/files/institutional-document/826606/adou2022bp-asian-index-digital-entrepreneurship-systems-2021.pdf (December 15, 2023).

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Design/methodology/approach – GIDES is a composite indicator that evaluates the performance of digital entrepreneurial systems on a national scale. Unlike traditional entrepreneurship or most entrepreneurial ecosystem measures, GIDES adopts a systemic approach using the Penalty for Bottleneck (PFB) algorithm to spot bottlenecks that potentially degrade overall system performance.

Findings – GIDES assesses the digital entrepreneurship systems of 113 countries, with a specific focus on 21 developing Asian economies. Singapore is ranked first among developing Asian countries globally. However, most developing Asian economies have significant room for improvement. While developing Asia excels in terms of physical infrastructure, it needs to work on its culture and informal institutions.

Originality/value – Digital transformation is not happening in isolation. Instead, it is closely linked to and happens within the context of entrepreneurship. The level of digitalization of the economy, described by digital framework conditions, impacts entrepreneurial activity through their influence on national-level general and systemic framework conditions. Thus, GIDES monitors all the general, structural and digital frameworks that support digital entrepreneurship. Consequently, it offers a deeper understanding of how digitalization impacts entrepreneurship.

Keywords Entrepreneurship, Digitalization, Digital entrepreneurship systems, Composite indicator, GIDES, Asian developing countries

Paper type Research paper

1. Introduction

The digital revolution is profoundly reshaping economies and societies. However, digital transformation is not an isolated phenomenon; rather, it is intricately linked with entrepreneurship. As digital technologies and infrastructures evolve, they create new opportunities for entrepreneurs and transform how these opportunities are pursued. Understanding this symbiotic relationship is crucial for grasping the true impact of digitalization.

While various studies have developed composite indicators like DEDI, DESI, or NRI [1] to measure countries' progress in digitalization, they largely overlook the critical role of entrepreneurship in converting digital advances into economic growth and societal well-being. Current metrics *fail to capture how digitalization affects entrepreneurship*; a process vital for realizing the potential of digital technologies.

Entrepreneurs are integrating digital technologies into their business operations, which is changing how they create, deliver, and capture customer value (Fitzgerald *et al.*, 2014; Liu *et al.*, 2011; Nambisan *et al.*, 2019; Vial, 2019). This transformation is known as *digital entrepreneurship* (DE) referring to entrepreneurial businesses that leverage digital technologies (Davidson and Vaast, 2010; Hull *et al.*, 2007; Nambisan, 2017). These entrepreneurs are often pioneers in exploring and using emerging digital affordances to drive their ventures forward, such as innovating in business models, creating value, and enhancing productivity. This not only transforms their own businesses but also influences the broader landscape of entrepreneurship and contributes to enhanced regional and national economic productivity (Autio *et al.*, 2018).

However, understanding DE requires examining both the entrepreneur and their operational *context* (Zaheer *et al.*, 2019). Examining this context at various levels, such as the regional and national levels, allows researchers to gain insights into the regulatory frameworks and support structures that shape entrepreneurial activity. At the regional level, contexts regulating entrepreneurial activity have been studied mostly under the rubric of *"entrepreneurial ecosystems"* (EE) (Thomas and Autio, 2020). At the national level, entrepreneurial activity has been studied mostly under the moniker of *"national systems of entrepreneurship"* (NSE) or simply *"national entrepreneurship systems"* (Ács *et al.*, 2014). The two concepts overlap: entrepreneurship ecosystems are the building blocks of national entrepreneurial systems. The systemic approach to entrepreneurship highlights the need for a more explicit development of the country-level concept of digital entrepreneurship systems. Incorporating a *digitalization perspective* into these entrepreneurship systems is crucial for understanding how digital technologies influence entrepreneurship.

To address this gap, we propose a conceptual framework that integrates digitalization's impact on entrepreneurship. Building on this framework, we have developed the *Global Index of Digital Entrepreneurship Systems* (GIDES), an analytical tool designed to measure and comprehend the impact of digitalization on entrepreneurship. As the foundation of our conceptual framework, we chose the NSE concept (Ács *et al.*, 2014), which posits that an individuals' entrepreneurial attitudes and aspirations are primarily shaped by their country's institutional context.

Our conceptual framework model and GIDES address three key limitations in current research. While several frameworks – including the NSE – consider contextual factors influencing entrepreneurship, they (1) *do not differentiate between general and structural framework conditions*, and (2) *do not account for digital transformation's impact*. Moreover, current measurement attempts generally (3) *fail to reflect the systemic nature of entrepreneurship*. We aim to address these limitations in current research on national entrepreneurship systems outlined in Chapter 2. Our "digital entrepreneurship system" framework and its corresponding composite indicator, the GIDES, address these shortcomings. Unlike previous models, ours considers all three layers: general, structural, and digital. Additionally, the index calculation employs the Penalty of Bottleneck (PfB) method (Ács *et al.*, 2014), offering a comprehensive systemic perspective. While ecosystem indices are commonly developed, (4) *they are not consistently tested for reliability*, despite the numerous subjective decisions involved in creating composite indices. Therefore, the robustness analysis aims to show that GIDES (and its selected indicators) is highly reliable and covers the aspects of digital entrepreneurship systems. GIDES can be a valuable tool for identifying priority areas for policy intervention. With our study, we aim to answer the following research question:

RQ1. What specific bottlenecks are hindering the performance of digital entrepreneurial ecosystems in the countries under investigation, particularly in developing Asian economies?

The structure of this paper is as follows. Section 2 lays a conceptual groundwork for the impact of digitalization on entrepreneurship. Section 3 introduces the structure of GIDES, explains its calculation, and the robustness analysis. Section 4 delves into the findings. The concluding section summarizes the study's key takeaways.

2. Theoretical background

2.1 National systems of entrepreneurship (NSE)

To understand the drivers of a country's digital entrepreneurship level, we must first grasp how the workings of the national system of entrepreneurship (NSE) (Ács *et al.*, 2014). The NSE framework posits that individuals' pursuit of entrepreneurial opportunities catalyzes a *resource allocation dynamic* at the national level, channeling resources towards productive economic uses. Engaging in a new business opportunity inherently involves certain risks, as it demands significant human and financial resources. Investing in one opportunity necessarily means forgoing potential benefits elsewhere, which can therefore be seen as an opportunity cost (McMullen and Shepherd, 2006). In any given country, the national entrepreneurial resource allocation dynamic is shaped by a myriad of individual-level decisions that allocate resources to either low- or high-productivity uses. Low-productivity entrepreneurship involves necessity-driven ventures often offering low-technology products or services, while high-productivity entrepreneurship encompasses innovative, high-growth ventures that leverages advanced technologies (including digital technologies) for enhanced scalability.

This resource allocation dynamic is shaped by two key mechanisms. First, if the opportunity perceived by the entrepreneur turns out to be of high quality, it yields substantial profit potential. In such cases, the entrepreneur is motivated to persist, thereby

allocating their human, financial, and knowledge resources towards highly productive endeavors. Conversely, if the opportunity is of low quality, the entrepreneur will soon perceive higher earnings potential in alternative occupations, and therefore, abandon the entrepreneurial opportunity. The interplay of these two mechanisms results in a high-quality entrepreneurial dynamic that directs resources towards productive uses, thereby enhancing county-level Total Factor Productivity (TFP) and fostering economic development (Ács *et al.*, 2014). Empirical evidence supports this theory. Drawing on data from 46 countries over the period 2002–2011, Acs *et al.* (2018) found that the NSE plays a crucial role in explaining cross-country variations in economic growth.

The NSE theory aims to reconcile two dominant perspectives: the institution-centric approach of the "national systems of innovation" (NIS) literature (Lundvall, 2007; Lundvall *et al.*, 2002; Rosenberg and Nelson, 1994) and the entrepreneur-centric focus of the entrepreneurship research (Kirzner, 1997; Shane and Venkataraman, 2000). The NIS literature posits that once the institutional setup of the country is established, innovative activity will emerge automatically. The NIS literature emphasizes the role of institutions in fostering innovation but overlooks individual-level entrepreneurial agency, while traditional entrepreneurship research focuses on individual judgment and choice, often neglecting the broader country-level institutional context (Acs *et al.*, 2017). To address this conceptual gap, Ács *et al.* (2014) proposed the NSE conceptual model, which identifies the entrepreneurial individual as the primary influencer of resource allocation dynamic in an economy. However, it also recognizes that individual choices are regulated by national-level institutional framework conditions. Individual are guided by the trade-offs when deciding whether to invest their human, financial, and knowledge capital in pursuing entrepreneurial opportunities or alternative career paths. According to the NSE theory, these trade-offs are mediated by country-level institutional framework conditions. These conditions determine whether individuals perceive entrepreneurial opportunities as personally beneficial (a "first-person opportunity") or as beneficial to others (a "third-person opportunity"). This perception significantly influences their decisions to pursue these opportunities (Ács *et al.*, 2014; McMullen and Shepherd, 2006). Thus, the NSE theory provides a holistic framework that integrates individual agency with institutional factors, offering a more comprehensive understanding of how entrepreneurship drives national economic development.

While the National System of Entrepreneurship (NSE) framework underscores the pivotal role of institutional framework conditions in shaping a country's entrepreneurial resource allocation dynamic, it does not fully elucidate the factors that determine the quality of these conditions. Upon closer examination, it becomes evidence that high-quality framework conditions are those that either encourage individuals with substantial high human, financial, and knowledge capital to invest in entrepreneurial opportunities, or enable new start-ups to mobilize resources more effectively for pursuing opportunities. In the first case, research suggests that individuals with high human capital face greater opportunity costs when allocating their resources, and therefore require higher potential returns from the opportunities they consider (Autio and Acs, 2010; Davidsson and Honig, 2003). This increases the likelihood that highly qualified individuals will pursue opportunities with significant productivity potential, as the expected returns must compensate for their higher opportunity costs. This selective allocation of high-caliber human capital to promising ventures enhances overall economic productivity. In the second case, improved resource mobilization capabilities among entrepreneurs increase the probability of successful opportunity pursuit, thereby allocating resources to uses that represent a higher earnings potential (and therefore, a higher productivity potential) than alternative career choices for the same individual. Consequently, this increases the likelihood that an individual's human, financial, and knowledge resources are allocated to the highest-productivity use among their available occupational alternatives. In essence, high-quality institutional framework conditions optimize the entrepreneurial resource

allocation dynamic by either attracting top talent to high-potential ventures or by facilitating more effective resource mobilization. Both mechanisms enhance the likelihood of resources being channeled into highly productive uses, thereby fostering innovation, economic growth, and national competitiveness.

At the country level, it is evident that two types of framework conditions play a crucial role in determining the quality of a country's entrepreneurial resource allocation dynamic. Firstly, there are conditions that influence individual-level entrepreneurial choices, such as who decides to become an entrepreneur. Secondly, there are conditions that affect the process of pursuing entrepreneurial opportunities effectively, after the entrepreneurial venture has been established. The first category includes general framework conditions for conducting business in each country including factors have been widely studied such as formal institutions (rule of law, regulation of entry, bankruptcy legislation, enforceability of contracts), labor market flexibility, and overall institutional quality (e.g. absence of corruption) (Armour and Cumming, 2008; Autio and Fu, 2015; Botero *et al.*, 2004; de Soto, 2000; Djankov *et al.*, 2002, 2003, 2006; Lee *et al.*, 2007). Social trade-offs affecting entrepreneurial choice are shaped by informal institutions such as cultural and social norms (Autio *et al.*, 2013; Hayton *et al.*, 2002; Wennberg *et al.*, 2013). Additionally, other general framework conditions at the country level comprise market openness, ease of entrepreneurial entry, and physical infrastructure for doing business (Acs *et al.*, 2015; Buttner, 2006; Mesquita and Lazzarini, 2008).

The second set of country-level framework conditions regulate the resource mobilization process of new venture once the entrepreneurial choice has been made and the venture has been established ("stand-up" stage), and subsequently, in the later stages of the business venture as well ("start-up" and "scale-up" stages). These framework conditions have a direct impact on the resources available to the new venture, influencing how well the start-up venture is able to realize its full potential (Aldrich, 1999; Baum and Oliver, 1996; Hannan and Freeman, 1977). Relevant framework conditions in this category include human capital (Marvel *et al.*, 2016; Shane, 2003; Unger *et al.*, 2011), knowledge spillovers (Audretsch and Lehmann, 2005; Iftikhar *et al.*, 2022; Qian *et al.*, 2013); financial capital (Charfeddine and Zaouali, 2022); and inter-firm networks and policy support (Koo and Cho, 2011; Zhao *et al.*, 2022).

In our conceptual framework model, we label the country-level framework conditions regulating entrepreneurial choice as *General Framework Conditions* (GFC) and the resource-related framework conditions as *Systemic Framework Condition* (SFC).

2.2 Entrepreneurial ecosystems

The NSE concept shed light on how country-level regulators influencing the quality of the entrepreneurial resource allocation dynamic, but it has not addressed the impact of digitalization on this dynamic. This oversight is likely due to how digitalization has fundamentally altered the micro-level heuristic to entrepreneurial opportunity pursuit. Lean Entrepreneurship has emerged in recent years, emphasizing action over extensive business planning and advocating for rapid, incremental experimentation (Blank, 2013; Blank and Eckhardt, 2023; Ries, 2011). This shift has been facilitated by the reduced cost of entrepreneurial experimentation enabled by digital technologies and infrastructures, allowing new ventures to compete through innovative business models and approaches to value creation, delivery, and capture (Zott and Amit, 2007). This digital transformation of the entrepreneurial heuristic, along with organizational innovations such as new venture accelerators, co-working spaces, and makerspaces, has led to a robust field of research on entrepreneurial ecosystems, building on Feld's (2012) influential work on entrepreneurial communities in urban settings. As a result, the entrepreneurial ecosystem (EE) tradition explores regional-level regulators of entrepreneurship (García-Lillo *et al.*, 2023).

There is no universal definition for EEs, but most definitions describe them as regional communities of stakeholders embedded in a particular economic, social, and institutional context. These communities generate outcomes at a system level similar to the 'ecosystem service' provided by natural ecosystems (Audretsch and Belitski, 2017; Neck *et al.*, 2004; Roundy *et al.*, 2018; Spigel, 2017; Stam and van de Ven, 2021). At the national level, NSEs consist of regional EEs and the country-level framework conditions for entrepreneurship.

Autio *et al.* (2018) placed the widespread adoption of digital technologies and infrastructures as the key driver and enabler of the entrepreneurial ecosystem phenomenon. They argued that entrepreneurial ecosystems represent a new type of a regional cluster driven by digitalization. Unlike conventional regional clusters (industrial districts, innovative milieus, and knowledge clusters) that focus on proximity-induced spillovers of mostly technical and industry-specific knowledge, entrepreneurial ecosystems specialize in accumulating and disseminating non-industry-specific knowledge. These ecosystems facilitate the regional accumulation and dissemination of experiential knowledge on using emerging digital tools to organize business operations for creating, delivering, and capturing customer value.

Digital entrepreneurs play a key role in bringing entrepreneurial ecosystems to life. They use novel cloud-based digital resources such as payment systems, location-aware digital tools, digital maps, and digital platforms to support innovative business models. Because entrepreneurial ecosystems foster a shared knowledge base that consists of non-technical and non-industry-specific knowledge, digital entrepreneurs within these ecosystems are more likely to compete against incumbents in various industry sectors rather than against each other. As a result, digital entrepreneurs in entrepreneurial ecosystems are more inclined to exchange their experiences from digital business model experiments with one another. This willingness to share experiential insights can enhance their ability to effectively compete against established incumbents within their respective sectors. This sharing of experiential insights has shaped the organization of regional entrepreneurial ecosystems, leading to the development of organizational innovations like venture accelerators, co-working spaces, and makerspaces designed to facilitate voluntary sharing of experiential insights from digital business model experimentation. This is reflected in a recent definition of digital entrepreneurial ecosystems by Bejjani *et al.* (2023, p. 8) who define DEE as "*complex and dynamic systems composed of heterogeneous actors that exploit digital technologies for value co-creation while relying on digital infrastructure that supports governance mechanisms, facilitates access to resources, enables the development of complementarities, and overcomes spatial boundaries.*"

Table 1 synthesizes the key concepts, theories, and findings covering the NSE theory, the role of institutions, the impact of digitalization, and the EE concept.

In our review of the NSE and EE literature, we found an important gaps. While the NSE literature provides insights into national-level components and outcomes of entrepreneurial resource allocation dynamic, the regional-level EE literature offers a detailed understanding of how digitalization impacts these micro-level dynamics, *there is a lack of comprehensive integration of digitalization-related insights into national-level measurements of entrepreneurial resource allocation dynamic*. Therefore, we constructed a framework model that incorporates the effects of digitalization on a country's entrepreneurial resource allocation dynamic.

To thoroughly understand the impact of different factors on entrepreneurial activities, a comprehensive approach is needed. Current measures of entrepreneurship at the country level, however, often focus on simple "count" and "prevalence" indices, and do not consider the system dynamics and diverse productivity potential of entrepreneurial activities [2]. There are some conceptual frameworks for characterizing national systems of entrepreneurship, but they lack a systemic approach and clear methodological

Concept/Theory	Authors/Citation	Key ideas	Relevance to the study
National Systems of Entrepreneurship (NSE)	Ács *et al.* (2014) Acs *et al.* (2017, 2018)	• NSE concept explains how individual entrepreneurial actions drive national resource allocation. NSE bridges *institution-centric* and *entrepreneur-centric* views • NSE plays a crucial role in explaining differences in economic growth between countries	• Foundation for understanding digital entrepreneurship (DE) in national contexts • Provides empirical evidence supporting the impact of NSE on economic development
	Forerunners • Entrepreneurship process is a dynamic and complex system, ranging from individual decisions to institutional framework conditions (Shane and Venkataraman, 2000; Shane, 2003) • Business survival depends on the ability to get the necessary resources (Mintzberg *et al.*, 1998) • New approach to entrepreneurship research (behavior, context, entrepreneurial outcome (Low and MacMillan, 1988) • Entrepreneurship is a socially embedded phenomenon (Aldrich and Zimmer, 1986) • The diversity of the environmental context determines the existence of various types of entrepreneurs (*Vesper,* 1980)		
National Innovation System (NIS)	Lundvall (2007, 2010, 2016), Lundvall *et al.* (2002), Peters (2006), Rosenberg and Nelson (1994)	• NIS literature emphasizes the role of institutions in fostering innovation	• Comparison points for understanding the gap between institution-centric and entrepreneur-centric perspectives • Provides the institutional-centric view contrasted with individual perspectives in NSE.
The theory of entrepreneurial personality traits	Salmony and Kanbach (2022) Daspit *et al.* (2023)	• Focuses on individual judgment and choice in entrepreneurship • Focus on entrepreneurial profile, characteristics, personality traits	• Provides the individual-centric view contrasted with institutional perspectives in NSE
	Forerunners • Ability to recognize opportunities (*Kirzner, 1997*) • A desire for fulfilment, a high risk-taking capacity; a capacity for internal control, tolerance of ambiguity (*Brockhaus and Horwitz,* 1985) • Tendency to be creative (*Martin,* 1982) • Psychological characteristics: pursuit of excellence, the need for independence, and the desire for fulfilment (McClelland, 1961) • Entrepreneur is distinguished more by his ability to innovate (Schumpeter, 1934)		

(*continued*)

Table 1.
Key contributions on the research topic

Concept/Theory	Authors/Citation	Key ideas	Relevance to the study
Entrepreneurial Ecosystem	Audretsch and Belitski (2017), Neck *et al.* (2004), Roundy *et al.* (2018), Spigel (2017), Stam and Van de Ven (2021), Autio *et al.* (2018), Feld (2012), García-Lillo *et al.* (2023), Autio *et al.* (2018)	• Regional communities of stakeholders • System-level outcomes • Regional regulators of entrepreneurship • Specialization in non-technical, non-industry-specific knowledge	• Defines and explains the components and dynamics of entrepreneurial ecosystems • Identifying EE as a digital economy phenomenon that leverages technology to enable new ventures to pursue entrepreneurial opportunities through radical business model innovation
Impact of Digitalization on Entrepreneurship	Blank (2013), Blank and Eckhardt (2023), Ries (2011), Zott and Amit (2007) Bejjani *et al.* (2023)	• Lean entrepreneurship emphasizes rapid, incremental experimentation • Digitalization fundamentally alters the entrepreneurial heuristic and opportunity pursuit • Digital entrepreneurial ecosystems (DEE) rely on digital infrastructure and heterogeneous actors for value co-creation • Facilitation of digital business model experimentation	• Connects digitalization with new approaches in entrepreneurial experimentation and business model innovation • Provides insights into how digitalization shapes regional entrepreneurial dynamics

Source(s): Own edition

Table 1.

explanations [3]. In addition, these measures fail to capture the structural elements of NSEs [4] (Autio *et al.*, 2018). Despite entrepreneurship being recognized as a complex system, current measurement attempts often fail to fully reflect this systemic perspective, treating the whole as merely the sum of its parts. The GEDI/GEI index, based on the NSE concept, is an exception, and reflects a systemic approach [5]. It incorporates a systemic view through the Penalty of Bottleneck (PfB) algorithm, which acknowledges that poorly performing factors can hinder overall system performance. However, being based on the NSE, it shares the same conceptual limitations.

Our "digital entrepreneurship system" framework and its corresponding composite indicator, the GIDES, address these shortcomings. Unlike previous models, ours considers all three layers: general, structural, and digital. Additionally, our index calculation employs the PfB method, offering a comprehensive systemic perspective.

3. The global index of digital entrepreneurship systems (GIDES)

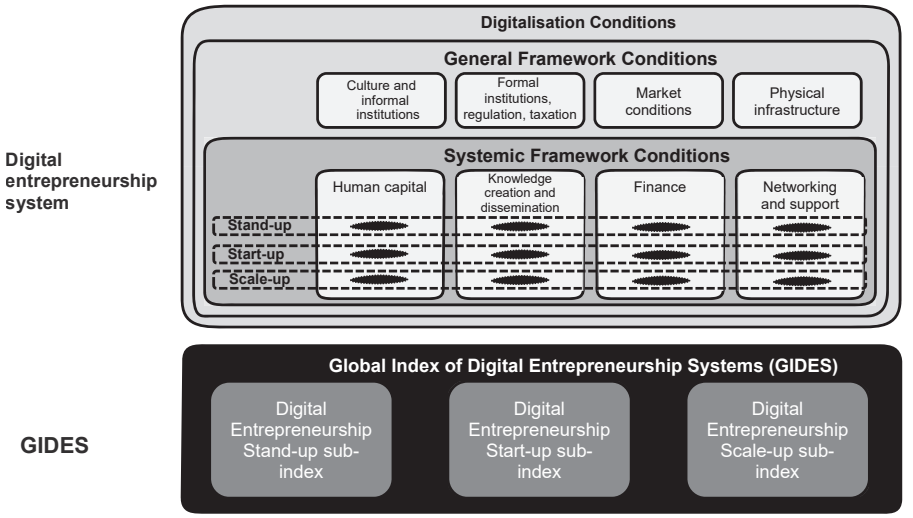
High-quality data on a country's framework conditions for entrepreneurship is crucial to better understand how a given country could enhance the quality of its entrepreneurial resource allocation dynamic, and consequently, the ability of this dynamic to contribute towards the country's TFP. Furthermore, the efficient operation of organizations in the

digital age necessitates all participants to possess a thorough understanding of the current state of digitalization. Consequently, they (primarily policymakers) need accurate metrics to monitor and utilize the productivity potential of digital advancements for economic and societal well-being to move towards a digital entrepreneurial economy (Autio *et al.*, 2019; Brown and Mason, 2014). In this section, we introduce the GIDES, which has been developed to facilitate this understanding.

3.1 GIDES index structure

The GIDES is a composite indicator created to monitor the digitalization of society and the economy, *with an emphasis on entrepreneurial processes in these*. The index is designed to use measures of digital conditions *as weights* to adjust the impact of country-level framework conditions that influence the quality of entrepreneurial resource allocation dynamic.

The country-level framework conditions for entrepreneurship, encapsulated in the eight pillars of the GIDES (Figure 1). As pointed out in the theoretical background chapter, different framework conditions regulate the quality of the country's entrepreneurial dynamic in two ways. On the one hand, as first layer, *general framework conditions* (GFCs) represent conditions that regulate entrepreneurial activity in the country through their effect on social and economic trade-offs, as experienced by individuals and entrepreneurial teams. GFCs include aspects such as (1) *Culture and informal institutions* (regulate attitudes towards entrepreneurship as a career choice); (2) *Formal institutions, regulation, and taxation* (the overall context within which firms do business and affect entrepreneurial choices including entry into entrepreneurship as well as post-entry growth aspirations); (3) *Market conditions* (regulate the size and accessibility of market opportunities); and (4) *Physical infrastructure* (regulates the cost and ease of doing business). All four main factors have been proven by the literature to influence entrepreneurial activity (Autio *et al.*, 2013; de Soto, 2000; Djankov *et al.*, 2002, 2003, 2006; Seung-Hyun *et al.*, 2007; Wennberg *et al.*, 2013). On the other hand, as second layer, *structural framework conditions* (SFCs) regulate the availability of external resources available to entrepreneurial firms at three stages of their lifecycle (standup, startup, and scaleup). In practice, businesses need many different resources to grow successfully. SFCs



Source(s): Own edition based on Autio *et al.* (2020)

Figure 1.
Structure of the GIDES index

have a different impact at the three stages of entrepreneurial development: stand-up, start-up, and scale-up. These resources are not substitutable against one another. Therefore, the SFCs must come together to help "co-produce" the system outcomes. SFCs are resource-related conditions directly affecting a country's entrepreneurial dynamics encompassing (1) *Human capital* (Marvel *et al.*, 2016; Shane, 2003; Unger *et al.*, 2011); (2) *Knowledge creation and dissemination* (Audretsch and Lehmann, 2005; Iftikhar *et al.*, 2022; Qian *et al.*, 2013); (3) *Finance* (Charfeddine and Zaouali, 2022); and (4) *Networking and support* (Koo and Cho, 2011; Zhao *et al.*, 2022).

As a third layer in our model, the *digital framework conditions* (DFCs) describe the general level of digitalization of the economy, as it affects entrepreneurial activity through its impact on general (GFCs) and systemic framework conditions (SFCs). For each framework condition in our model, we have selected a relevant digital indicator (as a weight) that reflects the specific digital conditions of the country pertaining to that general or structural condition.

The conceptual model and methodology of the GIDES are built upon our prior work, the European Index of Digital Entrepreneurship Systems (EIDES) [6]. The EIDES was initially developed during a 3-year research project (2018–2020) focused on EU-27 countries and the United Kingdom. This foundational work provided us with valuable insights into the interplay between digitalization and entrepreneurship within the European context. Recognizing the potential global applicability of our framework, we have now extended our research to create the GIDES.

3.2 Index operationalization

In GIDES, both general and structural framework conditions are operationalized as index pillars that are composed of sets of individual variables. Therefore, as a first step, the variable composition of the index pillars was determined by selecting appropriate indicators. Next, we calculated the values for each pillar. Each pillar value is obtained by calculating the arithmetic mean of the normalized variables. Each framework condition is thus represented by a single pillar value. Each index pillar is matched with a digital framework condition that resonates with it. The specific digital framework conditions are then used as weights to calculate the digitalized version of each of the index pillars.

Before aggregating (digitally weighted) individual pillar values into sub-indices, two methodological steps are followed to capture system dynamics: *Equalization of Pillar Averages* and the *Penalty for Bottleneck (PfB) Algorithm* (Ács *et al.*, 2014). The equalization step adjusts the scales of each pillar to have the same average value, while the bottleneck algorithm introduces non-substitutability across pillars (say, increases in Finance can only partly substitute for gaps in Human Capital and Talent). When individual pillars can only partly substitute each other, each of the conditions may act as a bottleneck that holds back the performance of the entire system. The PfB algorithm "penalizes" for gaps in the pillar composition of a given sub-index by inflicting a greater bottleneck penalization for greater variances among pillar values (i.e. greater differences among individual pillar values) in any given sub-index. This captures the notion that a poorly performing framework condition can hold back the performance of the entire system. The full details of these steps are explained in Supplementary_material_1. This approach provides an accurate representation of national digital entrepreneurial ecosystems. It allows for differentiation between digital and non-digital dynamics and provides insights into general framework conditions, digitalization, and the three sub-dynamics of the overall entrepreneurial dynamic.

GIDES consists of 103 individual indicators. The description of all the indicators used in the GIDES calculation can be found in Supplementary_material_2. The data used for GIDES calculation were mostly the latest available between June and August 2021, covering years 2019, 2020, or 2021 for most indicators. GIDES scores range theoretically from 0 (low) to 100 (high).

3.3 Robustness analysis

In composite indicator analysis, the compilation of the final index involves a series of choices. The aim of the robustness (or uncertainty) analysis is to examine the extent to which the final index value is sensitive to choices made during the index compilation when it comes to choices such as the selection of individual indicators and the weighting of different components of the index (Saisana *et al.*, 2005; Van Roy and Nepelski, 2016). As such, the choice of the indicators used to populate the index pillars in the overall index is generally formed by expert judgment, data availability, and checks on statistical consistency. In the case of the GIDES index, robustness analysis entailed compensability effect analysis; an examination of the role of individual index pillars and the different sub-indices in different country groups; and a drop-out effect examination of individual index pillars.

3.3.1 Compensability effect. Compensability is the *"existence of trade-off, i.e. the possibility of offsetting a disadvantage on some criteria by a sufficiently large advantage on another criterion"* (Munda, 2008, p. 71) Ordered Weighted Averaging (OWA) approach was used for the pillars to present one aspect of compensability in the case of the GIDES index (Yager, 1996). This technique looks for different weighting scenarios and strategies to combine individual indicators into an overall index. Five scenarios were defined for the OWA operators (set of weights, where the sum of the weights is 1):

(1) Purely optimistic operator (o): The variable (in our case, index pillar) with the largest value is assigned weight value 1, and all the other pillars are assigned weight value 0, the sum of all individual weights being 1. This means that the sub-index value equals the largest individual pillar value. Conceptually, in terms of system behavior, this approach expresses an "or" condition for individual system components: as long as at least 1 system component is healthy, the entire system is considered to be in a healthy state. In other words, the performance of the best performing system component is able to fully substitute for performance gaps among the less well performing system components.

(2) Purely pessimistic operator (p): The index pillar with the lowest value is assigned the weight of 1, and all other pillars are assigned weight value 0. Now the value of the overall index equals the value of its most poorly performing pillar. Conceptually, this can be understood as an "and" condition: individual system components cannot be used to compensate for possible gaps in other system components (i.e. zero substitutability), and the overall system performance is therefore defined by its most poorly performing component.

(3) Arithmetic means operator: The sub-index value is calculated as the arithmetic mean of its pillars, and the overall index value is calculated as the arithmetic mean of its sub-indices. Comparison against this strategy allowed us to check the difference between penalty-weighted results and simple arithmetic mean of all components.

(4) Arithmetic plus geometric means operator: Sub-indices are calculated as arithmetic means of its pillars, and the overall index value is calculated as the geometric mean of its sub-indices.

(5) Geometric means operator: Sub-indices are calculated as geometric means of individual pillars, and the overall index value is calculated as the geometric mean of its sub-indices.

In the first three strategies, the final index value is calculated as the simple arithmetic mean of its sub-indices. The OWA operators are applied for the pillars. Geometric mean, similarly to our penalized weighting scheme, supports the "and" condition, as it gives lower index

values if the distribution of individual pillar values is uneven. Altogether, thus, we have five weighting scenarios, which will be compared to our overall GIDES index values calculated using the Penalty for Bottleneck Algorithm. The results are presented in Figure 2.

In Figure 2, pessimistic and optimistic strategies provide maxima and minima, and the remaining scenarios yield index values in between. It is also clear that the aim of the penalty weighting was reached, as the overall GIDES index values are always below the average line. This means that substitutability among individual index pillars is restricted within the GIDES index, and balanced performance is rewarded where there are no large performance differences across individual pillars. Introducing the geometric mean in most cases yields values that are similar to the PFB algorithm and the simple arithmetic mean scenarios. The GIDES index value (based on PFB) is a little bit more below the different averages at the best positions of the ranking. This is also logical, as the best performing countries can afford to be penalized the most in absolute terms for the imbalance among individual pillar values.

Figure 2 focuses on the overall GIDES index scores. We can see that the penalized weighting scheme (Penalty for Bottleneck PFB) performs similarly to the non-extreme weighting strategies (extremes being the optimistic and pessimistic OWA solutions). The different non-extreme weighting scenarios yield very similar final scores. Additionally, the PFB strategy also reaches its objective of rewarding balanced distributions among individual pillar scores and unrewarding unbalanced distributions. We therefore conclude that the weighting scheme of the GIDES index can be regarded as free from distortions, while its penalizing aim is sufficiently met.

3.3.2 Analysis by country development stages. The countries included in the GIDES index were assigned into five development stages based on their GIDES index value: Leaders, Followers, Catchers-Up, Laggards, and Tailenders. As a further robustness check for the index, we first checked the contribution of the individual pillar values and sub-indices to this grouping. We applied the analysis of variance (ANOVA) method to see if the individual pillar values and the sub-indices exhibited a significant stochastic relationship with the development stages. Additionally, the deviation ratio [7] was calculated. In all cases, the

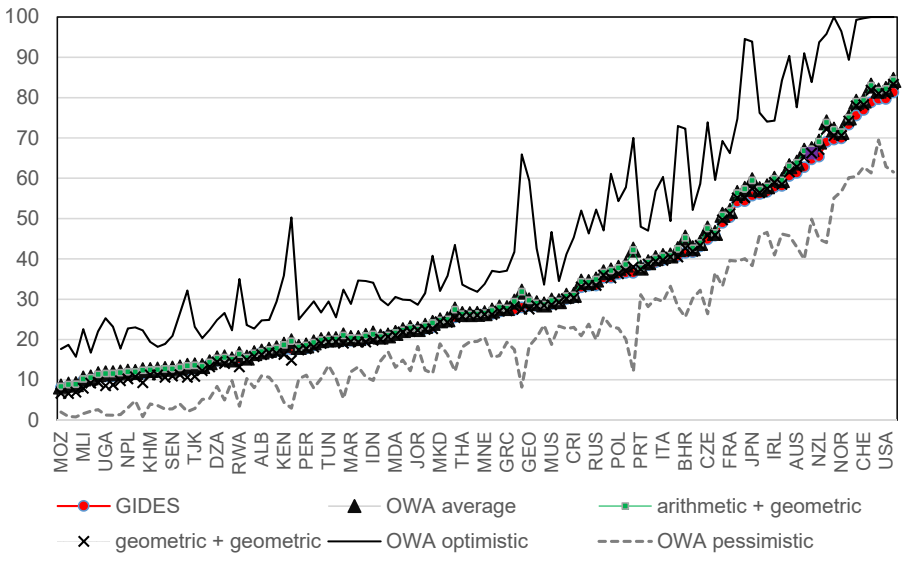


Figure 2.
GIDES values calculated with different weighting scenarios

Source(s): Own calculation

p-values were below 0.001, which means that the sub-indices and individual pillars exhibited a significant relationship with the development stages. All sub-indices and pillars exhibited deviation ratios above 0.70, indicating a strong stochastic relationship between the development stage and the sub-index or pillar values. This strongly supports the classification power of the development stages. Going into more detail, the pairwise comparison of the development stages was performed. As the group sizes were relatively small, the pairwise comparisons of the Kruskal-Wallis procedure were applied instead of the post hoc tests of ANOVA. Bonferroni adjusted p-values are indicated.

Tables 2 and 3 present the p-values of the Kruskal-Wallis pairwise comparisons by development stages. There are several pairs with non-significant differences, which might support the idea of including less development stages in the country grouping. The top three clusters might have been handled together. However, interpretability and policy guidelines (i.e. practical reasons) justified the distinction of these groups as well. Additionally, if we pay attention to the actual mean values of the pillars by development stages, a clear increasing pattern of these means can be recognized from left to right. This suggests that the creation of the five development stages is meaningful. This process was repeated with the "raw" pillars, and it can be concluded that the comparison by development stages represents similar results after and before the transformation of the pillars.

3.3.3 Drop-out effect of the pillars. A typical test of the robustness of an index is to drop out one pillar at a time and check the resulting changes (if any) in the rank of the regions (OECD, 2008). This is an appropriate method to evaluate the balance among the pillars in the GIDES index. During this analysis GIDES values are calculated with the original methodology and the penalized weighting method, but we discarded one pillar at a time. The contextual influence pillars were dropped out individually before the average adjustment procedure. The entrepreneurship sub-dynamics pillars were removed from each phase (stand-up, start-up, scale-up) at the same time. Eight simulations were run to see the effect of excluding a pillar.

The box-plot figure (Figure 3) refers to the different simulations. It displays the minimum and maximum values together with the lower and upper quartile (Q1, Q3) values (range and inter-quartile range) of the distribution of the difference between the modified ranks, obtained by discarding one pillar at a time, and the reference rank, which is computed based on the original GIDES index scores. The horizontal axis labels tell us which pillar was excluded.

The maximum of the interquartile range (difference of the upper and lower quartile: Q3-Q1) is 3, but it appears only in the case of "Formal institutions, regulation and taxation". For all other cases, the interquartile range is only 2 positions (Q1 is -1 and Q2 is $+1$). This means that in each case, the middle 50% of the rank changes is at most one position only. This analysis shows that the main characteristics and the rankings of countries are captured correctly by the GIDES methodology. There are no pillars that unduly dominate the index over other pillars, and the overall index result is a balanced outcome of the pillars. Looking at the full range (max-min) the lowest is -13, while the highest is $+10$. These are only modest differences compared to the number of the observations (113 countries), and there are only six countries concerned: Bangladesh, Georgia, India, Oman, Sri Lanka, Tajikistan.

Our three robustness analyses provide solid support for the robustness of the overall GIDES index. The analyses suggest that the index provides a synthetic picture of the Global Index of Digital Entrepreneurship Systems for the included countries, while representing a balanced diversity of the different index pillars.

4. Results

4.1 Country ranking

Figure 4 shows the GIDES performances for each of the 113 countries (for country scores see Supplementary_material_3). Singapore featured the world's best performing Digital

Table 2. Kruskal-Wallis pairwise comparisons of development stages by pillars

Structure		Pillar	1–2	1–3	1–4	1–5	2–3	2–4	2–5	3–4	3–5	4–5
Contextual influences		Culture and informal institutions	0.999	0.285	***	***	0.999	*	***	0.319	***	***
		Formal institutions, regulation and taxation	0.999	0.112	***	***	0.999	*	***	0.607	***	0.001
		Market conditions	0.999	0.492	***	***	0.999	*	***	0.178	***	***
		Physical infrastructure	0.999	0.387	***	***	0.999	*	***	0.359	***	0.001
Entrepreneurship sub-dynamics	Stand-up	Human capital	0.999	0.289	***	***	0.999	*	***	0.214	***	***
		Knowledge creation and dissemination	0.999	0.324	***	***	0.999	*	***	0.314	***	***
		Finance	0.999	0.204	***	***	0.999	**	***	0.184	***	0.009
		Networking and support	0.999	0.223	***	***	0.999	*	***	0.261	***	0.001
	Start-up	Human capital	0.999	0.196	***	***	0.999	*	***	0.331	***	0.001
		Knowledge creation and dissemination	0.999	0.289	***	***	0.999	*	***	0.340	***	***
		Finance	0.999	0.273	***	***	0.999	**	***	0.178	***	0.006
		Networking and support	0.999	0.333	***	***	0.999	**	***	0.108	***	0.003
	Scale-up	Human capital	0.999	0.398	***	***	0.999	*	***	0.218	***	0.001
		Knowledge creation and dissemination	0.999	0.237	***	***	0.999	*	***	0.571	***	***
		Finance	0.999	0.161	***	***	0.999	**	***	0.181	***	0.022
		Networking and support	0.999	0.377	***	***	0.999	**	***	0.158	***	***

Note(s): *$p < 0.1$; **$p < 0.05$***$p < 0.001$
Source(s): Own calculation

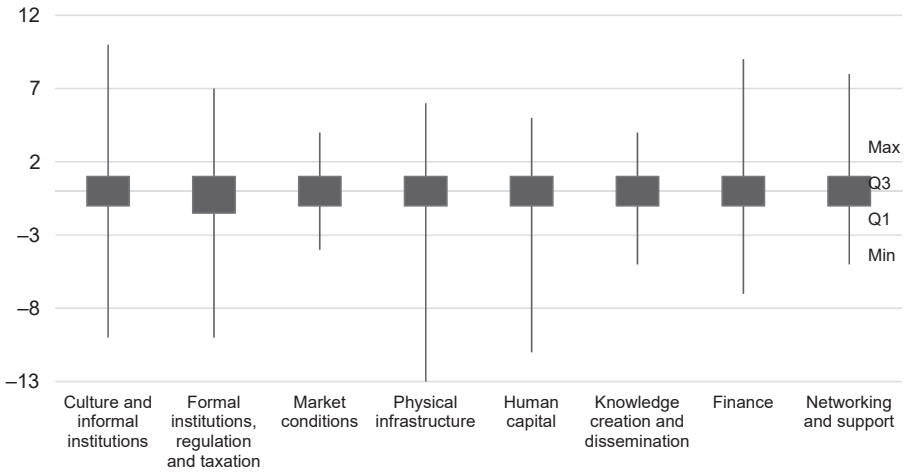
Entrepreneurship System, followed by the United States, Sweden, Denmark, and Switzerland. The majority of the countries in the GIDES top 30 are European.

Examining the GIDES scores at the regional level highlights significant differences in median performance across world regions (Figure 5). The differences between regions are more pronounced across the different pillars. The average GIDES score (last column) for

Sub-index	1–2	1–3	1–4	1–5	2–3	2–4	2–5	3–4	3–5	4–5
Stand-up	0.999	0.367	***	***	0.999	*	***	0.219	***	***
Start-up	0.999	0.337	***	***	0.999	*	***	0.220	***	***
Scale-up	0.999	0.377	***	***	0.999	*	***	0.202	***	***

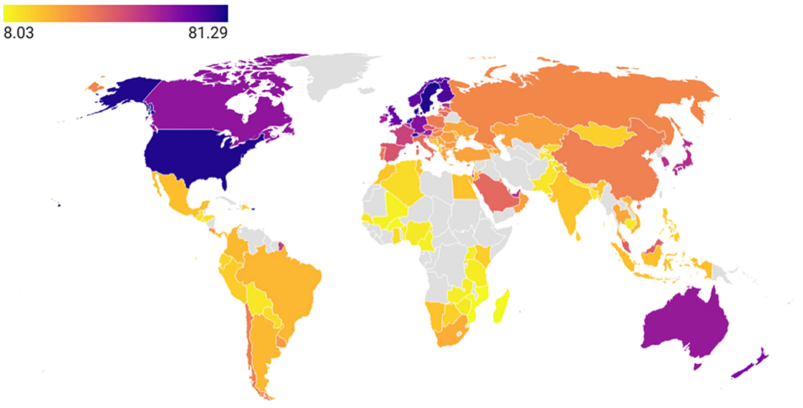
Source(s): Own calculation

Table 3. Kruskal-Wallis pairwise comparisons of development stages by sub-indices



Source(s): Own calculation

Figure 3. Distribution of the rank differences, discarding one pillar at a time



Note(s): Countries in grey are not included in the analysis
Source(s): Own edition

Figure 4. GIDES scores

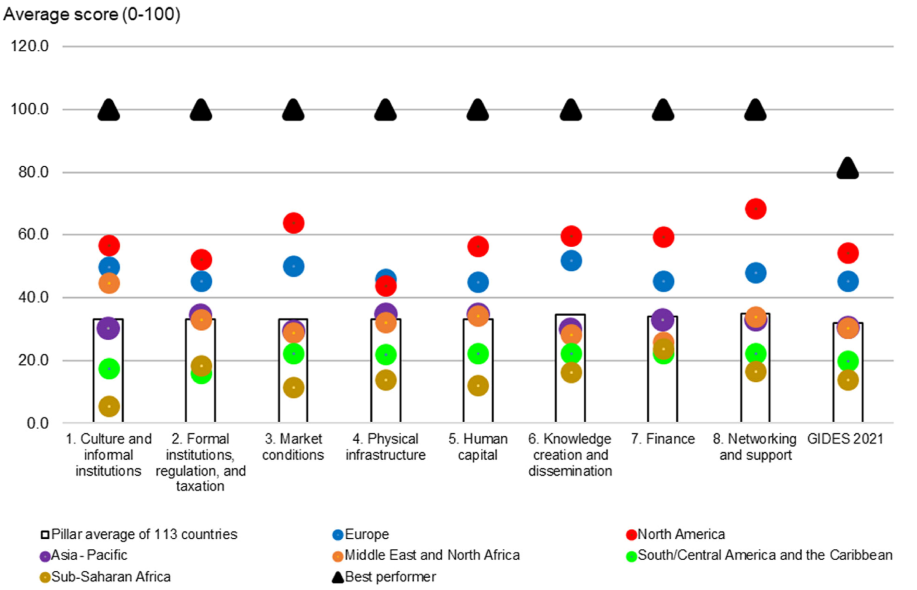


Figure 5.
Digital EE gaps across world regions: comparing average scores by pillars

Source(s): Own edition

the 113 economies is 31.9, measured on a scale of 0–100, with 100 indicating the "frontier", an ideal and hypothetical scenario where a country performs perfectly on every aspect of the index. The North American and European regions outperform the rest of the world for all pillars, but they still fall short of the ideal performance frontier by 45 and 55 index points, respectively. The Asia-Pacific region region's average lag is more than 70 points. Even Singapore still has room for improvement, as it falls short of the frontier by 19 points.

Based on cut-off points derived from the data, the countries were divided into five groups: *leaders* (GIDES score above 60), *followers* (GIDES score above 45 and up to 60), *catchers-up* (GIDES score above 35 and up to 45), *laggards* (GIDES scores above 20 and up to 35) and *tailenders* (GIDES score below 20) (Table 4). Several patterns are notable in this grouping. First, when considering the gross national income (GNI) per capita data, only high-income countries fall into the category of leaders and followers. The catchers-up mostly comprise high-income economies, while the laggards mainly consist of upper-middle-income countries. Most of the tailenders are low-income or lower-middle-income countries. Second, some countries perform above expectations given their level of development. For instance, despite being upper-middle-income countries that would typically be categorized as laggards, China and Malaysia are among the catchers-up. Ukraine, Vietnam, and Indonesia are classified as lower-middle-income countries and would fall into the tailenders group. However, they are assigned into the laggards group in GIDES. Third, there are countries that underperform relative to their level of development. Despite being high-income countries, Hungary, Kuwait, Croatia, Uruguay, Oman, and Greece fall into the laggards category, whereas they should be considered catchers-up or followers. Furthermore, Lebanon, Bosnia and Herzegovina, Peru, Dominican Republic, Botswana, Albania, Ecuador, Paraguay, and Guatemala are upper-middle-income countries that would be classified as laggards, but they are grouped among the tailenders.

High-income group			Upper-middle-income group			Lower-middel-income group			Low-income group	
Country	Rank		Country	Rank		Country	Rank		Country	Rank
Singapore	10		**Malaysia**	61	(+)	Ukraine	120	(+)	Rwanda	174
United States	6		**China**	60	(+)	**Vietnam**	132	(+)	Uganda	172
Sweden	11		Russian Federation	59		**Indonesia**	113	(+)	Mali	171
Denmark	8		Costa Rica	58		Egypt, Arab Rep.	118		Madagascar	187
Switzerland	2		Bulgaria	63		Morocco	124		Burkina Faso	173
Netherlands	13		Mauritius	62		**India**	143		Mozambique	188
Finland	15		Romania	56		Tunisia	128			
Norway	3		**Georgia**	108		**Philippines**	121			
Luxembourg	5		**Kazakhstan**	68		**Sri Lanka**	114			
United Kingdom	23		Turkey	64		Kenya	147			
New Zealand	21		Montenegro	70		**Mongolia**	116			
Germany	17		Serbia	73		**Kyrgyz Republic**	160			
Canada	19		**Armenia**	109		Ghana	137			
Australia	12		**Thailand**	77		Algeria	119			
Austria	14		**Azerbaijan**	105		Honduras	139			
Israel	20		South Africa	93		**Tajikistan**	164			
Ireland	7		North Macedonia	89		**Bangladesh**	141			
Belgium	16		Brazil	71		**Pakistan**	154			
Estonia	34		Jordan	107		Senegal	153			
Japan	24		Argentina	65		Bolivia	123			
United Arab Emirates	18		Colombia	88		El Salvador	117			
Korea, Rep.	27		Moldova	102		**Cambodia**	151			
France	22		Mexico	69		Nigeria	142			
Malta	33		Panama	57		Zimbabwe	162			
Spain	29		Namibia	103		**Nepal**	158			
Czech Republic	38		Lebanon	91	(–)	Benin	154			
Slovenia	32		Bosnia and Herzegovina	84	(–)	Tanzania	163			
Bahrain	35		Peru	85	(–)	Zambia	158			
Saudi Arabia	37		Dominican Republic	75	(–)	Cameroon	150			
Lithuania	40		Botswana	81	(–)					
Italy	26		Albania	94	(–)					
Cyprus	31		Ecuador	90	(–)					
Latvia	42		Paraguay	95	(–)					
Portugal	36		Guatemala	104	(–)					
Qatar	9									
Slovak Republic	41									
Poland	49									
Chile	54									
Hungary	45	(–)								
Kuwait	25	(–)								
Croatia	52	(–)								
Uruguay	47	(–)								
Oman	53	(–)								
Greece	39	(–)								

Leaders
Followers
Catchers-up
Laggards
Tailenders

Note(s): The countries in bold are the twenty-one developing Asian countries. (+) Country performance above expectations for level of development; (–) Country performance below expectations for level of development. No operator means that country performance is in line with the level of development. Rankings shown are those given by the World Bank (based on the GNI per capita (US$) in 2020 at nominal values, according to the Atlas method)
Source(s): Own calculation

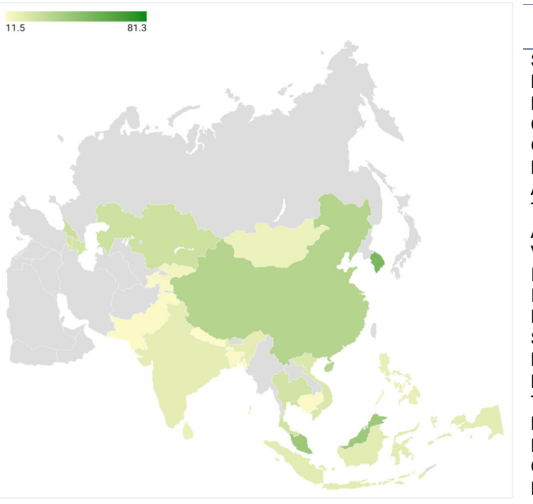
Table 4.
GIDES country groupings based on performance at different income levels

4.2 Key takeaways for developing Asian countries

Our analysis examines a group of 21 developing Asian countries (Figure 6). The rankings of developing Asian countries vary significantly: the gap between the best (Singapore) and worst-performing (Nepal) countries in the region is considerable 69.8 index points. The GIDES rankings of developing Asian countries are broadly aligned with their economic development levels. GIDES is especially relevant for developing Asia because it has reached an income level where productivity growth is vital for sustaining the remarkable economic growth it enjoyed in the past few decades. Entrepreneurship, in particular innovative entrepreneurship, contribute greatly to productivity growth.

Based on the GIDES ranking, Singapore outperforms all other Asian countries. Among developing Asian countries, South Korea is the only follower, while Malaysia and China are the only catchers-up countries. However, despite being in the same group, they differ greatly in their rankings. Malaysia ranks 10 places ahead of China in all three sub-indices. The next seven countries on the list (from Georgia to Indonesia) are among the laggards, while the last 10 (from India to Nepal) belong to the group of tailenders Tajikistan, Bangladesh, Pakistan, Cambodia, and Nepal all perform below the tailenders group's average.

Table 5 displays the pillar scores for each country as well as two benchmarks: the average scores for the countries with the most advanced digital entrepreneurial ecosystems (leaders) and the average scores for the 21 developing Asian countries. The last two columns in Table 5 show the highest and lowest scores for each pillar in each country. We found that the pillar with the smallest variance across developing Asian countries is Physical infrastructure, while the Culture and informal institution pillar, which measures the recognition of entrepreneurs by the population, shows the largest variance (ranging from 3.1 in Nepal to 97.2 in Singapore). Examining the least favorable pillars, we observe that the majority of developing Asian countries struggle with recognizing the importance of entrepreneurs, as reflected by the Culture and informal institutions pillar. This is the weakest pillar in 14 out of 21 countries, including all tailenders, three laggards (Indonesia, Vietnam, and Thailand), and one catchers-up (China). On the other hand, the most favorable pillar is



Country	GIDES 2021	
	Score	Rank
Singapore	81.3	1
Korea, Rep.	54.1	22
Malaysia	43.1	27
China	35.3	39
Georgia	28.3	50
Kazakhstan	27.4	52
Armenia	26.0	58
Thailand	25.9	59
Azerbaijan	25.5	60
Vietnam	23.1	63
Indonesia	20.4	71
India	19.6	75
Philippines	18.5	79
Sri Lanka	17.5	82
Mongolia	17.2	84
Kyrgyz Republic	15.2	88
Tajikistan	12.8	95
Bangladesh	12.5	96
Pakistan	12.3	97
Cambodia	12.0	101
Nepal	11.5	104

Figure 6.
GIDES scores of the twenty-one developing Asian countries

Source(s): Own edition

Country	1	2	3	4	5	6	7	8	Less favorable	Most favorable
Singapore	97.2	85.7	61.6	74.8	100.0	82.0	100.0	83.8	Market conditions	Human capital, Finance
Korea, Rep.	55.6	40.7	70.3	61.3	66.4	50.4	50.7	61.6	Formal institutions, regulation, taxation	Market conditions
Malaysia	46.7	45.6	43.4	32.2	58.5	40.5	40.9	48.9	Physical infrastructure	Human capital
China	25.6	33.4	61.1	51.4	32.0	27.6	39.2	30.3	Cultural and informal institutions	Market conditions
Georgia	28.5	59.3	18.8	32.0	20.1	22.0	37.3	22.6	Market conditions	Formal institutions, regulation, taxation
Kazakhstan	37.9	27.8	25.8	36.0	41.1	25.0	25.4	18.9	Networking and support	Human capital
Armenia	27.6	28.5	19.4	25.0	32.1	28.9	27.6	24.1	Market conditions	Human capital
Thailand	18.3	22.4	27.5	33.4	25.0	23.8	32.2	31.5	Cultural and informal institutions	Physical infrastructure
Azerbaijan	39.9	31.2	17.1	28.2	40.7	26.1	15.4	23.5	Finance	Human capital
Vietnam	11.6	19.5	31.2	40.8	24.4	22.7	20.7	24.9	Physical infrastructure	Culture and informal institutions
Indonesia	10.4	22.1	14.7	24.0	29.0	22.3	22.0	30.4	Cultural and informal institutions	Networking and support
India	5.3	26.4	19.8	32.4	23.1	20.8	20.1	23.0	Cultural and informal institutions	Physical infrastructure
Philippines	8.0	16.2	19.3	19.2	21.5	24.4	18.0	30.9	Cultural and informal institutions	Networking and support
Sri Lanka	3.0	14.4	8.7	50.3	13.4	23.8	21.7	24.1	Cultural and informal institutions	Physical infrastructure
Mongolia	8.4	12.4	16.1	22.4	16.1	18.2	30.2	21.4	Cultural and informal institutions	Finance
Kyrgyz Republic	11.8	12.1	10.9	18.8	21.4	16.9	17.0	17.0	Market conditions	Human capital
Tajikistan	3.7	15.6	8.5	2.9	22.7	19.7	18.6	19.4	Physical infrastructure	Human capital
Bangladesh	2.1	10.0	7.8	32.1	8.5	14.5	20.1	14.6	Cultural and informal institutions	Physical infrastructure
Pakistan	4.9	13.9	9.1	26.5	6.0	15.9	14.2	16.0	Cultural and informal institutions	Physical infrastructure
Cambodia	4.0	14.4	8.8	18.5	9.4	13.1	13.1	20.0	Cultural and informal institutions	Networking and support
Nepal	3.1	11.6	7.6	22.7	7.4	17.5	14.5	13.6	Cultural and informal institutions	Physical infrastructure
Average of the Asian region	***21.6***	***26.8***	***24.2***	***32.6***	***29.5***	***26.5***	***28.5***	***28.6***	***Cultural and informal institutions***	***Physical infrastructure***
Average of the leaders	***85.2***	***85.6***	***71.9***	***61.9***	***73.8***	***76.9***	***70.7***	***75.6***	***Physical infrastructure***	***Culture and informal institutions, Formal institutions, taxation, regulation***

Note(s): The colors reflect to the value of the score from the best (green) toward the medium (amber) to the worst (red). First row: 1 = Culture, informal institutions; 2 = Formal institutions, regulation, taxation; 3 = Market conditions; 4 = Physical infrastructure; 5 = Human capital; 6 = Knowledge creation and dissemination; 7 = Finance; 8 = Networking and support

Source(s): own calculation

Table 5.
The pillar level values of the twenty-one developing Asian countries

Physical infrastructure in seven of the 21 countries, Human capital in six countries, and Networking and support in three.

Overall, we can conclude that the weakest pillar for developing Asian countries is Culture and informal institutions, while the most favorable pillar is Physical infrastructure. Asian governments can help improve the attitude of their citizens toward entrepreneurship through public education campaigns that highlight the contributions of entrepreneurship to economic growth and development. Such campaigns are not costly and hence represent a cost-effective form of promoting entrepreneurship. In contrast to Asia, for countries with the most advanced digital ecosystems (leaders), the most favorable pillars are typically Culture and informal institutions and Formal institutions, regulation, and taxation, while Physical infrastructure is the least favorable.

The analysis at the pillar level confirms that the digital entrepreneurial ecosystem profiles of the 21 Asian developing countries are highly diverse. As a result, each country must develop a customized policy for promoting digitalization and entrepreneurship by addressing the identified bottlenecks. For instance, focusing on improving the Market conditions pillar in Singapore and the Culture and informal institution pillar in Nepal could lead to a significant enhancement in the digital entrepreneurial ecosystem performance of these two countries.

5. Discussion

5.1 Conclusions

Recent research underscores the pivotal role of a supportive environment in fostering innovative entrepreneurs who generate substantial employment (Autio and Rannikko, 2016). Moreover, country-level conditions exert important influence on the quality of the country's

entrepreneurial dynamic (Autio and Fu, 2015). Given this, it is important to develop metrics to measure relevant country-level framework conditions for entrepreneurship, enabling policy makers to design better-informed strategies to improve the country's entrepreneurial resource allocation dynamic. In today's digital age, a particularly pertinent set of country-level framework conditions is found in digitalization. Digital technologies and infrastructures are the key drivers of business model innovation and digital transformation. Digital framework conditions are particularly pertinent for entrepreneurship because entrepreneurs are at the frontier of discovering how new digital affordances can be harnessed to discover novel ways to organize for the creation, delivery, and capture of value. Digital entrepreneurs, often operating in transnational entrepreneurial ecosystems, occupy the frontier in experimenting with novel digital affordances and harnessing them to challenge industry incumbents with radically new business models. This way, digital entrepreneurs act as the primary agents of progress towards a frontier of the digital economy and improvement of total factor productivity therein.

However, country-level digitalization is a complex multifaceted phenomenon. To date, there have been few systemic measures to capture this phenomenon and how it combines with the country's entrepreneurial resource allocation dynamic. To address this gap and to help policymakers better and assess the state of the country's digital entrepreneurship system, we developed a new composite indicator, the GIDES. The index captures the interplay between country-level digitalization and its entrepreneurial resource allocation dynamic. To provide a clear reflection of the complex country-level dynamic, we developed an index methodology that its set apart from traditional, "count" indices by its systemic approach that portrays the country-level entrepreneurial dynamic within the country's digitalization context. Traditional provide primary snapshot data that describes the prevalence of entrepreneurs and self-employed persons, but they say little about the context within which those entrepreneurs find themselves. This is an important shortcoming, since the entrepreneur's context exercises an important influence upon how significant productivity potential a given entrepreneur will possess to begin with, and how likely the entrepreneur is to realize that potential and drive economic development. The integrated approach presented in this paper can help policymakers contextualize the strategic options and feasibility of policy support.

As another constraint of "count" indices of entrepreneurial activity is that such indices are normally computed as arithmetic averages between individual index components, which constrains their ability to truthfully portray systemic phenomena and highlight areas that should be prioritized for policy intervention. Such indices implicitly assume full substitutability among index components, as shortcomings in any one index component can be fully substituted for by increases in any other index component. This approach conflicts with the reality of systemic phenomena such as regional entrepreneurial ecosystems or national systems of entrepreneurship. To provide another simplistic example, increasing public funding for start-ups is not likely to significantly enhance the productivity potential of the country's entrepreneurial resource allocation dynamic if individuals with high human and social capital prioritize alternative career options over entrepreneurship. Even well-funded start-ups are not likely to innovate and succeed if their entrepreneurial management teams are weak. In reality, gaps in different constituent components of national systems of entrepreneurship are only limitedly substitutable against one another, and the Penalty for Bottleneck algorithm of the GIDES index has been designed to provide a clearer reflection of this reality. Relevant for policy debates, this feature of the GIDES index has permitted us to perform the policy optimization simulation, which highlights potential priority areas for policy action: the type of guidance "count" indices are unable to provide when there are several confounding factors, as is the case for entrepreneurship and digitalization in many economies.

Summarizing, what sets GIDES apart is its ability to merge both digitalization and entrepreneurship systems into one unified, multifaceted measure at the country level. This allows for a consistent and quantifiable assessment of the strengths and weaknesses of a country's digital entrepreneurship system. Our methodology identifies priority areas for policy intervention to enhance the country's digitally enhanced entrepreneurial resource allocation dynamic.

The GIDES index enables meaningful comparisons across 113 countries worldwide. It ranks Singapore first globally, with several Asian economies like South Korea, Malaysia, and China also performing well. However, most Asian developing economies lag behind, indicating substantial room for improvement. On average, these countries score highest in *physical infrastructure* but lowest in *culture and informal institutions*, suggesting low cultural support for digital entrepreneurship. This implies that cultural support for digital entrepreneurship is generally low in most Asian developing countries. Factors such as how people view entrepreneurs in terms of status and career choice, the level of corruption affecting this view, and how widely accepted digitization is, contribute to this trend.

In conclusion, GIDES offers a nuanced, systemic view of digital entrepreneurship ecosystems, enabling policymakers to identify and address bottlenecks more effectively. While this analysis provides valuable insights, it is just the beginning of a thorough investigation into the specific challenges faced by the 21 developing Asian countries. Further country case studies and industry analyses will be crucial in tailoring strategies to each unique context.

5.2 Limitations

The GIDES brings several methodological advances over traditional indices, allowing for more relevant insights for policy. However, it nevertheless has several limitations:

(1) *Geographical heterogeneity within countries*: While GIDES offers a national-level perspective, it may not account for significant regional variations within countries. This is especially important for large, diverse countries, where digital entrepreneurship ecosystems may differ greatly between urban and rural areas or among different regions. Future research could focus on developing regional-level indices to capture these nuances.

(2) *Cross-sectional nature of the data*: GIDES offers a snapshot of digital entrepreneurship systems at a specific moment in time. However, this approach limits our understanding of how these systems evolve over time. Future research would benefit from using longitudinal data to track how changes.

(3) *Causality and directionality*: Our study does not prove causal relationships between digital framework conditions and entrepreneurial outcomes. In the future, research could use longitudinal data and advanced statistical techniques, to explore causal pathways and potential feedback loops within digital entrepreneurship systems.

(4) *Non-linearity and interaction effects*: GIDES assumes that there are linear relationships between indicators and outcomes. However, it is possible that the relationship is non-linear. Future studies could explore these non-linearities and interactions using other techniques, such as network analysis or Qualitative Comparative Analysis (QCA).

(5) *Weight of the pillars*: Another limitation has to do with how values have been assigned to pillar weights. Although our Penalty for Bottleneck and Average Pillar Adjustment methods represent an improvement over simple unweighted arithmetic means calculations, they remain computational methods, and there is no theory to inform weight valuation. The prioritization of individual index pillars is likely to vary from country to country, depending on each country's idiosyncratic conditions and societal and economic arrangements.

These limitations acknowledged, GIDES index methodology nevertheless represents an important advance over conventional index methodologies, particularly in terms of its ability to highlight potential priority areas for policy action. While our study provides valuable insights into the state of digital entrepreneurship systems globally, it also opens numerous avenues for future research. By addressing these research areas, scholars can deepen our understanding of digital entrepreneurship, inform more effective policies, and ultimately contribute to the development of more vibrant, inclusive, and resilient digital entrepreneurship ecosystems worldwide:

(1) *Ecosystem orchestration*: Future research could delve into the role of *ecosystem orchestrators* – actors who coordinate and facilitate interactions among diverse stakeholders in digital entrepreneurship ecosystems. Studies could examine how these orchestrators emerge, their strategies for ecosystem governance, and their impact on ecosystem performance.

(2) *Digital resilience:* The COVID-19 pandemic underscored the importance of digital resilience. Future research could examine how digital entrepreneurship systems contribute to economic resilience during crises.

(3) *Digital entrepreneurship and sustainability*: digital entrepreneurship systems can significantly contribute to sustainable development by leveraging technologies. These systems enable innovations in various sectors, including circular economies, smart cities, agriculture, renewable energy, and social inclusion. Future research should focus on how different components of these systems influence sustainability-oriented startups and guide policymakers in harnessing digital entrepreneurship for a more sustainable future, particularly in developing countries.

5.3 Implications for policy practice

Given that the primary motivation behind the GIDES index was to help inform policy, we offer some thoughts how policy makers could best harness the index to facilitate policy insight. First, as highlighted above, we do not believe that we will ever be able to find a single, "ideal" configuration of a country's digital entrepreneurship system that would fit all countries. This means that insights regarding "what works well" in one country may or may not travel well to another country context. In fact, we believe that the further away two countries are in terms of economic development, the less transferable such insights are likely to become. However, this does not mean that no country comparisons would ever be valuable. We believe that the most valuable comparisons would be ones comparing countries at similar levels of economic development. We believe that policy insights could be maximized by the following heuristic:

(1) Form a peer group of 2–3 countries committed to improving their digital entrepreneurship systems. The countries should be quite similar to one another in terms of economic development – e.g. a group of ASEAN member countries.

(2) Consider each country's GIDES index profiles to identify each country's relative strengths and weaknesses.

(3) Go beyond the GIDES index and conduct close-up studies of each country's strengths and weaknesses using rich country-specific data. This includes identification and close-up analysis of relevant policy programs in each country's areas of relative strength.

(4) Organize regular workshops to debate emerging lessons and identify transferable good practice.

In addition, each participating country should engage entrepreneurial ecosystem stakeholders, policymakers, and other important stakeholders in their own priority areas for a bottom-up process of ecosystem analysis, bottleneck identification, and ideation and implementation of bottom-up, grounded policy initiatives. Given that the GIDES index is an "outside-in" index, in the sense that it looks at each country's national system of digital entrepreneurship from the "outside" using descriptive metrics, it is important to complement GIDES insights with insights derived from the "inside" of the country's digital entrepreneurship system. We believe that a combination of "outside in" and "inside out" insights not only help form a balanced and unbiased view of the system dynamics while also helping build stakeholder-level commitment to the implementation of prioritized policy interventions.

Notes

1. Digital Ecosystem Development Index (DEDI) by Katz and Callorda (2018), Digital Economy and Society Index (DESI) by the EC (2022); Network Readiness Index (NRI) by Dutta and Lanvin (2022).
2. (1) Preference for self-employment, EC 2012; Flash Eurobarometer 354 (Entrepreneurship in the EU and beyond) http://ec.europa.eu/public_opinion/flash/fl_354_en.pdf; (2) Total early-stage Entrepreneurial Activity (TEA), Global Entrepreneurship Monitor, https://www.gemconsortium.org/; (3) Start-up ranking, source: StartupRanking.com, https://www.startupranking.com/ (available: 9th November, 2023)
3. Kauffman Foundation's EE initiative (Bell-Masterson and Stangler, 2015); 2) EE measurement framework by Stam (2015) and Stam and van de Ven (2018).
4. Startup Genome's Global Startup Ecosystem Index ranks city-level ecosystems based on their performance but does not examine ecosystems at either the stand-up or scale-up stage. (https://startupgenome.com/)
5. Detailed description of the index methodology offered by Ács *et al.* (2014).
6. EIDES (Autio *et al.*, 2018, 2019, 2020) was the first attempt to measure both the framework (physical) and digital conditions for entrepreneurial stand-up, start-up, and scale-up in the 27 EU countries and the United Kingdom.
7. The deviation ratio suggests how strong is the relationship between the grouping criterion (development stage) and the quantitative variables (sub-indices and pillars). Relationships above 0.70 are considered as strong, between 0.30 and 0.70 as moderate and below 0.30 as weak.

References

Ács, Z.J., Autio, E. and Szerb, L. (2014), "National systems of entrepreneurship: measurement issues and policy implications", *Research Policy*, Vol. 43 No. 3, pp. 476-494, doi: 10.1016/j.respol.2013.08.016.

Acs, Z.J., Estrin, S., Mickiewicz, T. and Szerb, L. (2018), "Entrepreneurship, institutional economics, and economic growth: an ecosystem perspective", *Small Business Economics*, Vol. 51, pp. 501-514, doi: 10.1007/s11187-018-0013-9.

Acs, Z.J., Stam, E., Audretsch, D.B. and O'Connor, A. (2017), "The lineages of the entrepreneurial ecosystem approach", *Small Business Economics*, Vol. 49, pp. 1-10, doi: 10.1007/s11187-017-9864-8.

Acs, Z., Szerb, L. and Autio, E. (2015), *Global Entrepreneurship Index 2015*, Springerbriefs in Economics, Springer, London.

Aguinis, H., Suárez-González, I., Lannelongue, G. and Joo, H. (2012), "Scholarly impact revisited", *Academy of Management Perspectives*, Vol. 26 No. 2, pp. 105-132.

Aldrich, H.E. (1999), *Organizations Evolving*, SAGE, Newbury Park, CA.

Aldrich, H. and Zimmer, C. (1986), "Entrepreneurship through social networks", in Sexton, D.L. and Smilor, R.W. (Eds), *The Art and Science of Entrepreneurship*, Ballinger, Cambridge, MA, pp. 3-23.

Armour, J. and Cumming, D. (2008), "Bankruptcy law and entrepreneurship", *American Law and Economics Review*, Vol. 10 No. 2, pp. 303-350, doi: 10.1093/aler/ahn008.

Audretsch, D.B. and Belitski, M. (2017), "Entrepreneurial ecosystems in cities: establishing the framework conditions", *Journal of Technology Transfer*, Vol. 42 No. 5, pp. 1030-1051, doi: 10.1007/s10961-016-9473-8.

Audretsch, D.B. and Lehmann, E.E. (2005), "Does the knowledge spillover theory of entrepreneurship hold for regions?", *Research Policy*, Vol. 34 No. 8, pp. 1191-1202, doi: 10.1016/j.respol.2005.03.012.

Autio, E. and Acs, Z.J. (2010), "Intellectual property protection and the formation of entrepreneurial growth aspirations", *Strategic Entrepreneurship Journal*, Vol. 4 No. 3, pp. 234-251, doi: 10.1002/sej.93.

Autio, E. and Fu, K. (2015), "Economic and political institutions and entry into formal and informal entrepreneurship", *Asia Pacific Journal of Management*, Vol. 32 No. 1, pp. 67-94, doi: 10.1007/s10490-014-9381-0.

Autio, E. and Rannikko, H. (2016), "Retaining winners: can policy boost high-growth entrepreneurship?", *Research Policy*, Vol. 45 No. 1, pp. 42-55, doi: 10.1016/j.respol.2015.06.002.

Autio, E., Pathak, S. and Wennberg, K. (2013), "Consequences of cultural practices for entrepreneurial behaviors", *Journal of International Business Studies*, Vol. 44 No. 4, pp. 334-362, doi: 10.1057/jibs.2013.15.

Autio, E., Szerb, L., Komlósi, É. and Tiszberger, M. (2018), *The European Index of Digital Entrepreneurship Systems*, Publications Office of the European, Luxembourg, doi: 10.2760/39256, available at: https://ec.europa.eu/jrc/sites/default/files/eides_2018.pdf

Autio, E., Szerb, L., Komlósi, É. and Tiszberger, M. (2019), *EIDES 2019 - the European Index of Digital Entrepreneurship Systems*, Publications Office of the European, Luxembourg, doi: 10.2760/107900, available at: https://ec.europa.eu/jrc/sites/default/files/eides_2019.pdf

Autio, E., Szerb, L., Komlósi, É. and Tiszberger, M. (2020), EIDES 2020 - the European Index of Digital Entrepreneurship Systems, Publications Office of the European, Luxembourg, doi: 10.2760/150797, available at: https://ec.europa.eu/jrc/sites/default/files/eides_2020.pdf

Baum, J.A.C. and Oliver, C. (1996), "Toward an institutional ecology of organizational founding", *Academy of Management Journal*, Vol. 39 No. 5, pp. 1378-1427, doi: 10.5465/257003.

Bejjani, M., Göcke, L. and Menter, M. (2023), "Digital entrepreneurial ecosystems: a systematic literature review", *Technological Forecasting and Social Change*, Vol. 189, 122372, doi: 10.1016/j.techfore.2023.122372.

Bell-Masterson, J. and Stangler, D. (2015), "Measuring an entrepreneurial ecosystem", *SSRN Electronic Journal*. doi: 10.2139/ssrn.2580336.

Blank, S. (2013), "Why the lean start-up changes everything", *Harvard Business Review*, Vol. 91, pp. 63-72.

Blank, S. and Eckhardt, J.T. (2023), "The lean startup as an actionable theory of entrepreneurship", *Journal of Management*, 014920632311680, doi: 10.1177/01492063231168095.

Botero, J., Djankov, S., La Porta, R., Lopez-de-Silanes, F. and Shleifer, A. (2004), "The regulation of labor", *Quarterly Journal of Economics*, Vol. 119 No. 4, pp. 1339-1382, doi: 10.1162/0033553042476215.

Brown, R. and Mason, C. (2014), "Inside the high-tech black box: a critique of technology entrepreneurship policy", *Technovation*, Vol. 34 No. 12, pp. 773-784, doi: 10.1016/j.technovation.2014.07.013.

Buttner, B. (2006), "Entry barriers and growth", *Economics Letters*, Vol. 93 No. 1, pp. 150-155, doi: 10.1016/j.econlet.2006.04.009.

Charfeddine, L. and Zaouali, S. (2022), "The effects of financial inclusion and the business environment in spurring the creation of early-stage firms and supporting established firms", *Journal of Business Research*, Vol. 143, pp. 1-15, doi: 10.1016/j.jbusres.2022.01.014.

Daspit, J.J., Fox, C.J. and Findley, S.K. (2023), "Entrepreneurial mindset: an integrated definition, a review of current insights, and directions for future research", *Journal of Small Business Management*, Vol. 61 No. 1, pp. 12-44, doi: 10.1080/00472778.2021.1907583.

Davidson, E. and Vaast, E. (2010), "Digital entrepreneurship and its sociomaterial enactment", *43rd Hawaii International Conference on System Sciences*, IEEE, pp. 1-10.

Davidsson, P. and Honig, B. (2003), "The role of social and human capital among Nascent entrepreneurs", *Journal of Business Venturing*, Vol. 18 No. 3, pp. 301-331, doi: 10.1016/S0883-9026(02)00097-6.

de Soto, H. (2000), *The Mystery of Capital*, Basic Books, New York.

Djankov, S., La Porta, R., Lopez-de-Silanes, F. and Shleifer, A. (2002), "The regulation of entry", *Quarterly Journal of Economics*, Vol. 117 No. 1, pp. 453-517, doi: 10.1162/003355302753399436.

Djankov, S., La Porta, R., Lopez-de-Silanes, F. and Shleifer, A. (2003), "Courts. The quarterly", *Journal of Economics*, Vol. 118 No. 2, pp. 453-517, doi: 10.1162/003355303321675437.

Djankov, S., McLiesh, C. and Ramalho, R.M. (2006), "Regulation and growth", *Economics Letters*, Vol. 92 No. 3, pp. 395-401, doi: 10.1016/j.econlet.2006.03.021.

Dutta, S. and Lanvin, B. (2022), *The Network Readiness Index 2022 by Portulans Institute*, available at: https://networkreadinessindex.org/wp-content/uploads/reports/nri_2022.pdf

EC (2012), *Flash Eurobarometer 354 (Entrepreneurship in the EU and beyond)*, EC, Brussels, available at: http://ec.europa.eu/public_opinion/flash/fl_354_en.pdf

EC (2022), "Digital economy and society index (DESI) 2022", available at: https://digital-strategy.ec.europa.eu

Feld, B. (2012), *Startup Communities: Building an Entrepreneurial Ecosystem in Your City*, Wiley, Hoboken, NJ.

Fitzgerald, M., Kruschwitz, N., Bonnet, D. and Welch, M. (2014), "Embracing digital technology: a new strategic imperative", *MIT Sloan Management Review*, Vol. 55 No. 2, pp. 1-12.

García-Lillo, F., Seva-Larrosa, P. and Sánchez-García, E. (2023), "What is going on in entrepreneurship research? A bibliometric and SNA analysis", *Journal of Business Research*, Vol. 158, 113624, doi: 10.1016/j.jbusres.2022.113624.

Hannan, M.T. and Freeman, J.H. (1977), "The population ecology of organizations", *American Journal of Sociology*, Vol. 82 No. 5, pp. 929-964, doi: 10.1086/226424.

Hayton, J.C.J., George, G.G. and Zahra, S.A.S. (2002), "National culture and entrepreneurship: a review of behavioral research", *Entrepreneurship Theory and Practice*, Vol. 26 No. 4, pp. 33-52, doi: 10.1177/104225870202600403.

Hull, C.E.K., Hung, Y.T.C., Hair, N., Perotti, V. and DeMartino, R. (2007), "Taking advantage of digital opportunities: a typology of digital entrepreneurship", *International Journal of Networking and Virtual Organisations*, Vol. 4 No. 3, pp. 290-303, doi: 10.1504/IJNVO.2007.015166.

Iftikhar, M.N., Justice, J.B. and Audretsch, D.B. (2022), "The knowledge spillover theory of entrepreneurship: an Asian perspective", *Small Business Economics Journal*, Vol. 59 No. 4, pp. 1401-1426, doi: 10.1007/s11187-021-00577-3.

Katz, R. and Callorda, F. (2018), *Accelerating the Development of Latin American Digital Ecosystem and Implications for Broadband*, Telecommunications Policy, Elsevier, Amsterdam, pp. 661-681, doi: 10.1016/j.telpol.2017.11.002.

Kirzner, I. (1997), "Entrepreneurial discovery and the competitive market process: an Austrian approach", *Journal of Economic Literature*, Vol. 35, pp. 60-85.

Koo, J. and Cho, K.R. (2011), "New firm formation and industry clusters: a case of the drugs industry in the U.S", *Growth and Change*, Vol. 42 No. 2, pp. 179-199, doi: 10.1111/j.1468-2257.2011.00549.x.

Lee, S.H., Peng, M.W. and Barney, J.B. (2007), "Bankruptcy law and entrepreneurship development: a real options perspective", *Academy of Management Review*, Vol. 32 No. 1, pp. 257-272, doi: 10.5465/amr.2007.23464070.

Liu, D., Chen, S. and Chou, T. (2011), "Resource fit in digital transformation - lessons learned from the CBC bank global E-banking project", *Management Decision*, Vol. 49 No. 10, pp. 1728-1742, doi: 10.1108/00251741111183852.

Low, M.B. and MacMillan, I.C. (1988), "Entrepreneurship: past research and future challenges", *Journal of Management*, Vol. 14 No. 2, pp. 139-161, doi: 10.1177/014920638801400202.

Lundvall, B.-Å. (2007), "National innovation systems – analytical concept and development tool", *Industry and Innovation*, Vol. 14 No. 1, pp. 95-119, doi: 10.1080/13662710601130863.

Lundvall, B.Å. (2016), *The Learning Economy and the Economics of Hope*, Anthem Press, London.

Lundvall, B.Å. (Ed.). (2010), *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*, Anthem Press, London.

Lundvall, B.-Å., Johnson, B., Andersen, E.S. and Dalum, B. (2002), "National systems of production, innovation and competence building", *Research Policy*, Vol. 31 No. 2, pp. 213-231, doi: 10.1016/s0048-7333(01)00137-8.

Marvel, M.R., Davis, J.L. and Sproul, C.R. (2016), "Human capital and entrepreneurship research: a critical review and future directions", *Entrepreneurship Theory and Practice*, Vol. 40 No. 3, pp. 599-626, doi: 10.1111/etap.12136.

McClelland, D.C. (1961), *The Achieving Society*, Princeton, Van Nostrand, NJ .

McMullen, J.S. and Shepherd, D.A. (2006), "Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur", *Academy of Management Review*, Vol. 31 No. 1, pp. 132-152, doi: 10.5465/amr.2006.19379628.

Mesquita, L.F. and Lazzarini, S.G. (2008), "Horizontal and vertical relationships in developing economies: implications for SMEs' access to global markets", *Academy of Management Journal*, Vol. 51 No. 2, pp. 359-380, doi: 10.5465/AMJ.2008.31767280.

Mintzberg, H., Ahlstrand, B. and Lampel, J. (1998), *Strategy Safari: A Guided Tour through the Wilds of Strategic Management*, Prentice-Hall, New York.

Munda, G. (2008), *Social Multi-Criteria Evaluation for a Sustainable Economy*, Springer-Verlag, Berlin Heidelberg.

Nambisan, S. (2017), "Digital entrepreneurship: toward a digital technology perspective of entrepreneurship", *Entrepreneurship Theory and Practice*, Vol. 41 No. 6, pp. 1029-1055, doi: 10.1111/etap.12254.

Nambisan, S., Wright, M. and Feldman, M. (2019), "The digital transformation of innovation and entrepreneurship: progress, challenges and key themes", *Research Policy*, Vol. 48 No. 8, 103773, doi: 10.1016/j.respol.2019.03.018.

Neck, H.M., Meyer, G.D., Cohen, B. and Corbett, A.C. (2004), "An entrepreneurial system view of new venture creation", *Journal of Small Business Management*, Vol. 42 No. 2, pp. 190-208, doi: 10.1111/j.1540-627X.2004.00105.x.

OECD (2008), *Handbook on Constructing Composite Indicators: Methodology and User Guide*, OECD, Paris.

Peters, S. (2006), *National Systems of Innovation*, Palgrave Macmillan, London, available at: https://doi.org/10.1057/9780230512603

Qian, H., Acs, Z.J. and Stough, R.R. (2013), "Regional systems of entrepreneurship: the nexus of human capital, knowledge and new firm formation", *Journal of Economic Geography*, Vol. 13 No. 4, pp. 559-587, doi: 10.1093/jeg/lbs009.

Ries, E. (2011), *The Lean Startup*, Crown Business, New York.

Rosenberg, N. and Nelson, R.R. (1994), "American universities and technical advance in industry", *Research Policy*, Vol. 23 No. 3, pp. 323-348, doi: 10.1016/0048-7333(94)90042-6.

Roundy, R.T., Bradshaw, M. and Brockman, B.K. (2018), "The emergence of entrepreneurial ecosystems: a complex adaptive systems approach", *Journal of Business Research*, Vol. 86 No. 1, pp. 1-10, doi: 10.1016/j.jbusres.2018.01.032.

Saisana, M., Saltelli, A. and Tarantola, S. (2005), "Uncertainty and sensitivity analysis techniques as tools for the quality assessment of composite indicators", *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, Vol. 168 No. 2, pp. 307-323, doi: 10.1111/j.1467-985X.2005.00350.x.

Salmony, F.U. and Kanbach, D.K. (2022), "Personality trait differences across types of entrepreneurs: a systematic literature review", *Review of Managerial Science*, Vol. 16, pp. 713-749, doi: 10.1007/s11846-021-00466-9.

Schumpeter, J.A. (1934), "*The Theory of Economic Development: An Inquiry into Profits*", *Capital, Credits, Interest, and the Business Cycle*, Transaction Publishers, Piscataway.

Seung-Hyun, L., Peng, M. and Barney, J. (2007), "Bankruptcy law and entrepreneurship development: a real options perspective", *Academy of Management Review*, Vol. 32 No. 1, pp. 257-272, doi: 10.5465/amr.2007.23464070.

Shane, S. (2003), *A General Theory of Entrepreneurship: The Individual–Opportunity Nexus*, Edward Elgar, (New Horizons in Entrepreneurship), Cheltenham, p. 352.

Shane, S. and Venkataraman, S. (2000), "The promise of entrepreneurship as a field of research", *Academy of Management Review*, Vol. 25 No. 1, pp. 217-226, doi: 10.2307/259271.

Spigel, B. (2017), "The relational organization of entrepreneurial ecosystems", *Entrepreneurship Theory and Practice*, Vol. 41 No. 1, pp. 49-72, doi: 10.1111/etap.12167.

Stam, E. (2015), "Entrepreneurial ecosystems and regional policy: a sympathetic critique", *European Planning Studies*, Vol. 23 No. 9, pp. 1759-1769, doi: 10.1080/09654313.2015.1061484.

Stam, E. and van de Ven, A. (2021), "Entrepreneurial ecosystem elements", *Small Business Economics*, Vol. 56 No. 2, pp. 809-832, doi: 10.1007/s11187-019-00270-6.

Stam, E. and van de Ven, A. (2018), "*Entrepreneurial ecosystems: a systems perspective*", Utrecht University School of Economics, U.S.E. Working Paper Series 18-06, available at: https://www.uu.nl/sites/default/files/rebo_use_wp_2018_1806_2.pdf

Thomas, L. and Autio, E. (2020), "Innovation ecosystems in management: an organizing typology", in Aldag, R. (Ed.), *Oxford Research Encyclopaedia of Business and Management*, Oxford University Press, Oxford, doi: 10.1093/acrefore/9780190224851.013.203.

Unger, J.M., Rauch, A., Frese, M. and Rosenbusch, N. (2011), "Human capital and entrepreneurial success: a meta-analytical review", *Journal of Business Venturing*, Vol. 26 No. 3, pp. 341-358, doi: 10.1016/j.jbusvent.2009.09.004.

Van Roy, V. and Nepelski, D. (2016), *Assessment of Framework Conditions for the Creation and Growth of Firms in Europe*, Joint Research Centre, JRC Scientific and Policy Reports – EUR 28167 EN, doi: 10.2791/2811.

Vial, G. (2019), "Understanding digital transformation: a review and a research agenda", *The Journal of Strategic Information Systems*, Vol. 28 No. 2, pp. 118-144, doi: 10.1016/j.jsis.2019.01.003.

Wennberg, K., Pathak, S. and Autio, E. (2013), "How culture moulds the effects of self-efficacy and fear of failure on entrepreneurship", *Entrepreneurship and Regional Development*, Vol. 25 Nos 9-10, pp. 756-780, doi: 10.1080/08985626.2013.862975.

Yager, R.R. (1996), "Quantifier guided aggregating using OWA operators", *International Journal of Intelligent Systems*, Vol. 11 No. 1, pp. 49-73, doi: 10.1002/(SICI)1098-111X(199601)11:1<49::AID-INT3>3.0.CO;2-Z.

Zaheer, H., Breyer, Y. and Dumay, J. (2019), "Digital entrepreneurship: an interdisciplinary structured literature review and research agenda", *Technological Forecasting and Social Change*, Vol. 148, 119735, doi: 10.1016/j.techfore.2019.119735.

Zhao, F., Barratt-Pugh, L., Standen, P., Redmond, J. and Suseno, Y. (2022), "An exploratory study of entrepreneurial social networks in the digital age", *Journal of Small Business and Enterprise Development*, Vol. 29 No. 1, pp. 147-173, doi: 10.1108/JSBED-10-2020-0359.

Zott, C. and Amit, R. (2007), "Business model design and the performance of entrepreneurial firms", *Organization Science*, Vol. 18 No. 2, pp. 181-199, doi: 10.1287/orsc.1060.0232.

Supplementary material
The supplementary material for this article can be found online

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