ETH zürich

ETH Library

Entrepreneurial alertness toward responsible research and innovation: Digital technology makes the psychological heart of entrepreneurship pound

Journal Article

Author(s):
Fellnhofer, Katharina

Publication date:
2022-12

Permanent link:
https://doi.org/10.3929/ethz-b-000517908

Rights / license:
Creative Commons Attribution 4.0 International

Originally published in:
Technovation 118, https://doi.org/10.1016/j.technovation.2021.102384

This page was generated automatically upon download from the ETH Zurich Research Collection.
For more information, please consult the Terms of use.

Technovation 118 (2022) 102384

Contents lists available at ScienceDirect

Technovation

journal homepage: www.elsevier.com/locate/technovation

Entrepreneurial alertness toward responsible research and innovation: Digital technology makes the psychological heart of entrepreneurship pound

Katharina Fellnhofer [a,b,c,*]

[a] Swiss Federal Institute of Technology Zürich, ETH Zürich, Chair of Entrepreneurial Risks and Chair of Education Systems, Department of Management, Technology and Economics, Scheuchzerstrasse 7, SEC, CH-8092, Zuerich, Switzerland

[b] Associate and Marie Curie Fellow, HARVARD UNIVERSITY, Department of Sociology, William James Hall, 33 Kirkland St., Cambridge, MA, 02138, USA

[c] Research and Innovation Management GmbH, Marktplatz 7a, 3371, Neumarkt an der Ybbs, Austria

ARTICLE INFO

Keywords:
Innovation ecosystem
Digital applications
Digital platform ecosystem
Responsible research and innovation
Entrepreneurial alertness

ABSTRACT

Using entrepreneurial discovery theory, this study explains how digital applications can drive entrepreneurial alertness across heterogenous innovation ecosystems. A diverse set of stakeholders have been analyzed when performing entrepreneurial discovery tasks on a digital platform ecosystem. A quantitative survey-based experimentation phase with 686 individuals was conducted in two moderate-innovation ecosystems—Greece and Spain—and two defined as innovation leaders—Scotland and the Netherlands—on the European Innovation Scoreboard. Based on structural equation models, the findings show that digital applications, including discovery tasks, facilitate entrepreneurial alertness regardless of the innovation ecosystem in which the user operates. Additionally, Kruskal-Wallis tests reinforce that the relationship between perceived quality of digital applications for discovery tasks and perceived entrepreneurial alertness remains significantly positive despite heterogeneity across stakeholders and innovation ecosystem. Through its psychological foundations, this work reveals how digital technologies alert any kind of individual to potential entrepreneurial opportunities. It thus contributes to research on digital economies by evaluating digital technologies' potential to boost psychological starting drivers of any entrepreneurial endeavor across innovation ecosystem. Although this study is of interest to a wide range of stakeholders, it is particularly relevant for potential entrepreneurs and policymakers as an inspiration for new ideas to strengthen sustainable innovation ecosystems.

1. Introduction

The European Commission (EC) introduced the term "Responsible Research and Innovation" (RRI) to consolidate scientific excellence and technological implementation to impact Europe's innovation ecosystem[1] (EC, 2013; Von Schomberg, 2013). RRI aims to promote smart, sustainable, and inclusive growth that shapes European Union (EU) growth strategy (EC, 2010, p.11) at different levels of policymaking (Foray, 2015). Furthermore, RRI strategies follow smart specialization principles to be eligible to receive financing from different European structural funds (Foray, 2015; 2013). This smart specialization policy concept has enjoyed a simply phenomenal career in Europe. The beating heart of this political ambitiousness is the entrepreneurial discovery process that aims to engage a diverse set of actors to discover opportunities (Martínez-López and Palazuelos-Martínez, 2014). RRI and its impacts on the environment and society, particularly those in line with democratic principles, and their engagement of a wide range of stakeholders, from researchers, entrepreneurs, and policymakers to society at large, have received increasing attention in recent years (Foray, 2015, 2013; Gheorghiu et al., 2016; Mejlgaard et al., 2019).

Overall, innovation ecosystems define a joint effort of a diverse set of stakeholders in the direction of innovation (Moore, 1996). For instance,

* Swiss Federal Institute of Technology Zürich, ETH Zürich, Chair of Entrepreneurial Risks and Chair of Education Systems, Department of Management, Technology and Economics, Scheuchzerstrasse 7, SEC, CH-8092, Zuerich, Switzerland.

E-mail addresses: kfellnhofer@ethz.ch, katharina@rim.eu.com.

[1] The European Innovation Scoreboard compares innovation performance between the Member States of the European Union and selected third countries. The methodology relies on four main types of indicators and ten innovation dimensions, capturing 27 indicators in total. The four main types of indicators are framework conditions, investments, innovation activities, and impacts (EC, 2017).

https://doi.org/10.1016/j.technovation.2021.102384
Received 18 March 2021; Received in revised form 14 July 2021; Accepted 28 August 2021
Available online 30 September 2021
0166-4972/© 2021 The Author. Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

entrepreneurs supply resources, technologies, products, and services, policymakers provide enabling conditions and framework, and customers build demand and capabilities. Besides the driving force of engaging a diverse set of actors in an ecosystem, discovering entrepreneurial opportunities represents the heart of an entrepreneurial innovation ecosystem (Martínez-López and Palazuelos-Martínez, 2014) via "a process in which the entrepreneurial actors are discovering and producing information about new business and innovation activities and the government is collecting, assessing and transforming this knowledge into policy action" (Foray, 2015, p. 31). Consequently, within this ecosystem-based context, a diverse set of stakeholders is engaged in an ongoing process at the regional and national levels (Gheorghiu et al., 2016) to help engage thinkers and doers in entrepreneurial settings (Cavicchi et al., 2014; Santini et al., 2016).

For many decades, the prevailing belief was that entrepreneurial ideas and thus innovation were created by entrepreneurs. However, research has shown that innovation can be generated by a much wider set of stakeholders. Knowledge-based resources in an ecosystem that can be used for the discovery and exploitation of opportunities significantly facilitate venture performance (Wiklund and Shepherd, 2003). As attention to investigating the ways in which individuals dive into entrepreneurship has grown (Hienerth, 2006; Shah and Tripsas, 2007), the "one" who identifies this opportunity does not necessarily have to be the entrepreneur; indeed, it could be any individual engaged in the process (Tang et al., 2012). Given that users create innovative solutions for themselves (Franke et al., 2006; von Hippel, 2005), a diverse set of actors in an ecosystem, including citizens as users, can be a valuable source of entrepreneurship in the open innovation paradigm (Chesbrough, 2003), bearing in mind that knowledge is both tacit and local (Yin et al., 2004). In this way, users as actors become innovators and entrepreneurs, as Chandra and Coviello (2010) show through illustrations of eBay users who became arbitrage entrepreneurs. Furthermore, some of the greatest inventions, such as the light bulb, resulted from collective thought (Hargadon and Bechky, 2006; Leenders and Voermans, 2007). Previous studies have shown that social networks can accelerate a particular innovation (Perry-Smith, 2006). Thus, integrating a diverse set of stakeholders to identify entrepreneurial opportunities through entrepreneurial discovery tasks in a digital platform ecosystem—such as digital applications—has received attention not only from entrepreneurs but also from policymakers to boost the entrepreneurial mindset when (re)designing sustainable research and innovation strategies across Europe (Magro and Wilson, 2018).

With respect to the collective discovery of potential entrepreneurial opportunities, researchers have sought to advance the idea that the concept of entrepreneurial alertness, which resides in discovery theory (Alvarez and Barney, 2007; Alvarez et al., 2013) with substantial psychological and cognitive roots (Chavoushi et al., 2021), engages a proactive stance of a diverse set of actors with different prior knowledge, skills, and experiences (Baron, 2006; Shane, 2003). Digital platform ecosystems are particularly effective at enabling such multiple actors to jointly discover and create value for innovations online (Adner, 2006; Iansiti and Levien, 2004). The present study adopts not only the definition of Parker et al. (2017)—a digital platform's central purpose is to facilitate the integration of resources in economic-driven ecosystems including third parties to boost the platform's value—but also Sussan and Ács's (2017) conceptual framework regarding the digital entrepreneurial ecosystem merging the literature on digital ecosystems (Dini et al., 2011) and the literature on entrepreneurship ecosystems to steer our knowledge of entrepreneurship in the digital economy (Ács et al., 2014; Stam 2015a). Thus, the heart of being an entrepreneur applies to any individual in an ecosystem who seeks "to act on the possibility that one has identified an opportunity worth pursuing" (Shepherd and McMullen, 2006, p. 132).

Entrepreneurial alertness represents a key psychological factor in recognizing entrepreneurial opportunities (Baron, 2006; Gaglio et al., 2001a,b) and has been studied as a crucial step in any entrepreneurial endeavor (Valliere, 2013a) with powerful social and economic impact (Storr and John, 2015). Different stakeholders execute different activities, play various roles, and show a range of motivations and capabilities in such ecosystems (Adner and Kapoor, 2010; Baldwin, 2012; West and Wood, 2013). Digital technology and partnerships in digital entrepreneurial ecosystems support a diverse set of actors in their endeavor to create value and facilitate growth (Sebastian et al., 2020). Studies of its theoretical basis explore the importance of alertness in opportunity recognition. The latest literature review highlights that the concept of entrepreneurial alertness has roots in psychology, an area of research that remains underdeveloped and requires further attention (Chavoushi et al., 2021).

The notion of "alertness" is interwoven with innovation discovery perspectives and discovery ontology (Ramoglou and Tsang, 2016). It differs from related constructs like curiosity. Arikan et al. (2020) showed that entrepreneurial alertness is not able to fully justify entrepreneurial choices for opportunity creation. In this context, "curiosity"—as defined by Berlyne (1978) as a cognitive process of self-stimulation without any external stimuli—has been discussed as essential to encouraging entrepreneurial creation processes. Overall, alertness has been uniformly conceptualized as an antecedent to the discovery of opportunity (Valliere, 2013b). However, while alertness allows entrepreneurs to identify an opportunity, the quality of digital technology to engage a diverse set of stakeholders has not yet been investigated as ingredients for alertness or innovation discovery. We do not know if a diverse set of stakeholders can be alerted to entrepreneurial activities via digital applications on a digital platform in any kind of innovation ecosystem. Moreover, entrepreneurial alertness may not always exert a positive influence on entrepreneurs. For instance, the specific conditions under which alertness could negatively impact outcomes are not sufficiently clear. Additionally, Valliere (2013) raised questions that remain unanswered about why only some individuals are alert to and recognize new business opportunities. Through greater insights into this area, it will be possible to better understand how individuals can be alerted to innovation.

Following the notion that opportunities are identified or generated (Sarasvathy et al., 2003; Short et al., 2010; Sine and David 2003; Tang et al., 2012), digital applications for discovery tasks support potential entrepreneurs in their most important activities, helping them understand the complex environment and engage with stakeholders (Hill and Levenhagen, 1995). However, few empirical studies have looked directly at collective entrepreneurial perceptions across different stakeholders and entrepreneurial innovation activities across nations. Thus, the present study investigates two different innovation ecosystems as dedicated units of analysis while embracing their relation to entrepreneurial alertness as a phenomenon and its theoretical perspectives on the entrepreneurial discovery theory (cf. Bogers and West, 2012; Kapoor, 2018). It offers an analysis of how digital applications on a platform ecosystem shape individuals' perspectives on entrepreneurial alertness and examine how actors from different ecosystems, specifically nations defined as moderate and high innovators, assess the potential of the digital platform ecosystem to boost alertness for RRI. Consequently, this work provides empirical evidence to answer the following research question: *How does an innovation ecosystem moderate digital applications' power to facilitate actors' entrepreneurial alertness?*

Digital technology is used to provide discovery tasks to explore exogenous objective situations in ecosystems that can be observed and discovered *ex ante* in a first step by alerted individuals (Aldrich and Kenworthy, 1999; Alvarez and Barney, 2007). The study thus provides empirical evidence of how entrepreneurial collective discovery tasks for innovation on a digital platform ecosystem boost entrepreneurial alertness by engaging a diverse set of entrepreneurial actors.

The remainder of the paper is structured as follows. Section 2 describes the theory and background for developing the hypotheses presented in Section 3. Section 4 illustrates the methods—including measurements and a description of the sample under investigation—and provides validity analysis. Section 5 presents the findings of structural equation models and further tests, and Section 6 provides a discussion of the results' theoretical and practical implications, avenues for future research, and study limitations. Section 7 concludes this work.

2. Theory

2.1. The nature of entrepreneurial opportunities and a diverse set of stakeholders

New entrepreneurial opportunities constitute the backbone of entrepreneurship, so exploring and exploiting them plays a key role in innovation ecosystems (Baron, 2006; Short et al., 2010; Tang et al., 2012). Opportunities are seen as social constructions shaped through perceptions between a diverse set of individuals and their interactions in environments (Aldrich and Kenworthy, 1999; Alvarez and Barney, 2007). An opportunity is an image in the mind (Penrose, 1996) that affects behavior. For instance, being an unsatisfied user with different experiences, information, or changes in an ecosystem explains how new opportunities could be discovered (Shepherd et al., 2007; Tripsas, 2008).

To acquire a comprehensive understanding of the role of society in entrepreneurial discovery, intensive engagement is necessary (Parker et al., 2014). Previous reviews stress that the academic discourse of progress dedicated to entrepreneurial opportunities has been constrained by crucial elements related to interacting stakeholders (e.g., Davidsson, 2015). These achievements are followed by the view that the construct of entrepreneurial opportunities accepts systematic variation in the construct definition to elucidate conceptualizations (Wood, 2017). In this paper, the objective perspective of an intuitive and paradox-free interpretation of existing opportunities in an ecosystem is followed. The basis of a refined metatheory enables the engagement of different individuals who make cognitive contact with opportunities (Ramoglou and Tsang, 2016). In line with Davidsson (2017), this study focuses on multidimensional and continuous variations leading to the notion of "agency-intensity."

The environmental conditions of an ecosystem represent an ingredient of new entrepreneurial opportunities, and Jacobides et al. (2018) distinguish between "innovation" and "platform" ecosystems. While an innovation ecosystem focuses on a particular innovation and the group of supporting actors, a platform ecosystem considers how these actors use technologies such as platforms. Adner (2006, p. 98) describes an innovation ecosystem as "collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution." Platforms can operate within large networks that are not necessarily linked to innovation ecosystems (Adner and Kapoor, 2010; Nambisan and Sawhney, 2011). Interdependent actors cooperate to generate innovations (Adner, 2016; Adner and Kapoor, 2010; Kapoor and Lee, 2013), and the innovation ecosystem allows these actors to engage customers early for joint discovery (Adner, 2016).

2.2. The multidimensional model as a conceptual foundation for entrepreneurial discovery theory

This work is built on the entrepreneurial discovery theory developed by Murphy (2011), who describes a model with two orthogonal axes: the deliberation and serendipity axes. These two dimensions yield four quadrants: eureka, deliberate search, legacy, and serendipitous discovery. The deliberation axis indicates the degree to which focused activity, search, and investigation lead to the discovery of an opportunity. The serendipity axis indicates the degree to which an opportunity's discovery is unexpected and surprising (Murphy, 2011). Murphy (2011) makes clear that the multidimensional model goes beyond the oft-discussed matter of whether opportunities are formed through creation or discovery. Therefore, the study follows the notion of stakeholders' altering roles and associated patterns within platform-based ecosystems, which represent a characteristic of ecosystems (Iansiti and Levien, 2004). This is especially pertinent for digital platforms; Baldwin and von Hippel (2011) suggest that innovation on such platforms is open to any individual willing to engage in cooperative innovation (Gawer, 2014).

2.2.1. Eureka (high serendipity/high deliberation)

In the entrepreneurial discovery framework, high serendipity implies that opportunities are accidental, surprising, and unexpected. Even when large levels of deliberation shape an opportunity, uncertainty can still be high for its future evolution in complex environments. As a consequence, opportunity implies facets of luck and purpose (Murphy, 2011) that any individual can execute. Although the discovery theory focuses on the entrepreneur's thoughts and actions, the research stream that shows that innovation can be generated by a diverse set of stakeholders, including users, is followed. In recent years, greater attention has been paid to investigating the ways in which individuals dive into entrepreneurship (Hienerth, 2006; Shah and Tripsas, 2007). Given that users create innovative solutions for themselves (Franke et al., 2006; von Hippel, 2005), a diverse set of stakeholders, including citizens as users, can be a valuable source of entrepreneurship in the open innovation paradigm (Chesbrough, 2003), bearing in mind that knowledge is both tacit and local (Yin et al., 2004).

2.2.2. Deliberate search (low serendipity/high deliberation)

Centers on thoughtful searches, which are based on the abilities to search and manage information as drivers of entrepreneurial discovery (Fiet, 2002; Shaver and Scott, 1991). Eager individuals increase the likelihood of business ideas when systematically searching in familiar environments (Fiet, 2002; Fiet et al., 2004). The basis of the systematic search view is that identifying opportunities relies on matching the data an individual already has with a specific idea that may be found through systematic searching (Fiet, 2002; Tang et al., 2012). Fiet (2007) makes clear that not all actors search for opportunities, but those who do search systematically for opportunities discover more of them. Overall, this literature stream argues that the deliberations and actions of entrepreneurial activities shape the foundation for entrepreneurial opportunities. In this context, research largely focuses on searching, meaning that alert individuals systematically scan the environment for competitive imperfections caused by environmental changes. Thus, an alerted individual who discovers opportunities needs to collect and analyze data to evaluate the risk-return ratio associated with an entrepreneurial opportunity (Keh et al., 2002).

Overall, the quality of stakeholder participation is significant in exploring, exploiting, and accepting the knowledge of entrepreneurial opportunities in markets and networks (Cheng et al., 2013; Ommen et al., 2016). Ommen et al. (2016) examined 220 different enterprises using "fuzzy set qualitative comparative analysis" to explore the relations of six dimensions of participation quality: task-related resources, early involvement, degree of influence, transparency of processes, incentive mechanisms, and voluntariness of participation. The outcome shows that the positive engagement of stakeholders is characterized by complex relations between participation quality dimensions (Ommen et al., 2016). These dimensions form the basis of this work, which focuses on examining online mechanisms for entrepreneurial discovery in ecosystems.

2.2.3. Legacy (low serendipity/low deliberation)

An opportunity can also be shaped by the regulations or laws in an ecosystem. For example, policymakers discuss future changes that might affect industry sectors and jurisdictions, which allow entrepreneurs to anticipate them. As such, responding to policies and regulations requires an amendment that does not require a high level of deliberation (Murphy, 2011). Thus, this study is based on the discovery theory of opportunities, which refers to discovering knowledge production at the ecosystem level. In this context, alertness provides essential knowledge about conditions in the ecosystem. This knowledge may be about policy-driven, legal, technological, or market developments that interfere with new opportunities for greater value creation (Valliere, 2013b). Individuals (re)construct information and judge the opportunity quickly, before the window of opportunity closes (Taylor, 1981). Essentially, judgment and evaluation represent types of filters that help identify patterns that will be recognized and attended to (Reed, 2004). Such judgments help individuals generate insights into the value of discovered information that others are overlooking. Making judgments gives us a sense of the opportunities that exist (Kirzner, 1997; Yu, 2001) and helps us choose from many options. Often recognized as business acumen, judgments help us visualize the future, including practical business opportunities (Kirzner, 1985). These judgments are based on patterns to find niches (Dutta and Crossan, 2005; Tang et al., 2012).

Further, based on Kirzner's (1979) definition of the theory of alertness, differences in perceptions and interpretations that are central to opportunity assessments will vary among different stakeholders because of variations in the characteristics of the schema (e.g., content, activation, degree of complexity, and quality). Based on prior innovation literature, this "alertness schema" intensifies one's awareness of entrepreneurial opportunities that have commercialization potential, which is similar to the differentiation between invention and innovation. Invention encompasses opportunity identification, which converts to an innovation when the invention is enhanced with economic potential (Gaglio and Katz, 2001; Kirzner, 1979; Schumpeter, 2006).

2.2.4. Serendipitous discovery (high serendipity/low deliberation)

Which refers to the concept of entrepreneurial alertness, is based on the idea of individuals being attuned to pre-existing opportunities and market discontinuities (Alvarez and Barney, 2007). In discovery situations, individuals must be alert to (exogenous or endogenous) conditions that support the development of opportunities. The traditional alertness concept takes a more critical and realist epistemological stance and consequently places more importance on discovered opportunities (Alvarez and Barney, 2010).

Personal awareness and insights are connected to unveiling new opportunities (Kirzner, 1999; Kaish and Gilad, 1991). For some people, alertness—as a process and perspective—offers a way to become more aware of changes, shifts, opportunities, and valuable possibilities (Kirzner, 1973, 1979, 1985). The schema for "development" and "alertness" help people systemize and understand knowledge domains connected to new entrepreneurial opportunities (Gaglio and Katz, 2001). As a result, the scale of alertness allows one to include a substantial understanding of how ideas are started and concluded (Tang et al., 2012), such as how individuals discover opportunities for new profitable products or services (Baron, 2004; Mitchell et al., 2007; Tang et al., 2012). This study builds on this research stream by supporting the notion that entrepreneurial discovery tasks in an ecosystem facilitate entrepreneurial alertness.

Entrepreneurial thinking shapes the assessments of opportunities (Holcomb et al., 2009). Ketchen et al. (2007) argue that cooperative innovation, in which individuals from different-sized organizations share ideas, knowledge, and expertise, supports entrepreneurship. On the one hand, rather small entities use creativity to generate innovation while minimizing their responsibilities because of their size. On the other hand, large organizations explore opportunities outside their traditional business practices because they have slack resources on hand. These perceptions and interpretations can vary based on schema attributes that can be accurately identified in complex situations unrelated to the available information that shapes the habitual schema activators (Bargh, 1989; Fiske and Taylor, 2013; Gaglio and Katz, 2001). Moreover, evidence provided by Bargh and Pratto (1986) shows that the habitual use of a specific schema creates activation without an individual's intentional or attentional control: habitual use describes how alert entrepreneurs "notice without searching."

Fig. 1 depicts how entrepreneurial opportunities can be discovered by a diverse set of alerted stakeholders in an innovation ecosystem via a platform-based ecosystem.

3. Development of hypotheses

Policymakers have called for the greater engagement of different stakeholders in developing and implementing RRI strategies (McAdam et al., 2018). A stakeholder perspective implies a focus on those who assess and value opportunities and entrepreneurs who shape future products and services for society at large. Different stakeholder engagement strategies influence the overall performance of participatory innovation processes (Ommen et al., 2016). Amabile and Kramer (2011) stress that it is essential for engaged stakeholders to recognize progress in their meaningful work. The more an individual sees meaning and progress, the more productive he or she becomes because innovative behavior correlates positively with implementation possibilities (Birdi et al., 2016; Ommen et al., 2016). Gheorghiu et al. (2016) suggest that foresight-based tools could increase both the awareness of entrepreneurship and the engagement of different stakeholders. Foresight methods on digital platforms allow for the selection of (self-)reflective and collaborative entrepreneurial activities. Legitimacy should be built on creating a transparent research and innovation ecosystem, making it a process that allows for joint expectations of that ecosystem (Gheorghiu et al., 2016). One such digital application is *vision sharing (digital application under investigation #1)*, which allows a diverse set of stakeholders to create a common visual understanding for joint engagement.

Fostering relationships between different stakeholders through engagement activities can be used to overcome barriers present in an ecosystem. Engaged stakeholders can establish trust and increase the prospects of successful collaboration (Wall et al., 2017). Previous research on policy and innovation processes has stressed that successful stakeholder participation is characterized by an interaction of quality dimensions for participatory innovation processes (e.g., Abelson and Gauvin, 2006; Rowe and Frewer, 2004, 2005). This work follows Ommen et al.'s (2016) approach to measuring the quality of stakeholder participation, which covers "early involvement," "satisfaction," "task-related resources," "degree of influence," "transparency of processes," "incentive mechanisms," "voluntariness," and "implementation." Discovery tasks using web-based applications on a platform ecosystem can be a means to achieve such usability. During development, usability requires both a user interface focus and an organizational focus, while a continuous engagement of stakeholders represents a key driving force for successful discovery tasks (Uldall-Espersen and Frøkjær, 2007). Amabile and Kramer (2011) provide recommendations regarding appropriate settings consisting of transparent and meaningful aims, sufficient resources, and helpful colleagues to motivate a person to participate in innovative discovery tasks (Burroughs et al., 2011).

Different stakeholders in the process of entrepreneurial discovery can use methods such as alert search and scanning to be unconventional and persistent in examining new ideas (Busenitz, 1996; Tang et al., 2012). There are various ways to facilitate an entrepreneurial "strategic radar" (Gheorghiu et al., 2016). For example, Schoemaker et al. (2013, p. 816) suggest "a scenarios-based system for integrating the scanning as well as monitoring of external signals, the assessment of possible strategic responses, and any follow-up probes to amplify interesting signals." For instance, an application such as *regional assets mapping (digital application under investigation #2)* and *research infrastructure mapping (digital application under investigation #3)* enable a better understanding of the existing regional assets and key players for opportunity identification. Furthermore, exploring *clusters, incubators, and innovation ecosystems (digital application under investigation #4)* help better define niches for creating a competitive advantage and understand business needs. Finally, the *regional scientific production profile (digital application under investigation #5)* is based on bibliometric analysis and enables the exploitation of the latest research results for innovation. A sensory store boosts the enhancement of an individual's knowledge (Fuchs, 2001). While tacit knowledge can be developed through experience in a specific domain (Dimov and Shepherd, 2005), explicit knowledge is shareable information that is exterior to any one person. Based on psychological principles, the explicit and tacit knowledge of an individual shapes the integration and accumulation of novel information and supports adjustment to changing situations (Weick, 1996). Thus, any stakeholder should be able to scan and search for solutions to answer open entrepreneurial questions. Because no systematic strategy is in place (Kirzner, 1979), an individual will usually explore many options (Tang et al., 2012).

When scanning and searching, any individual can connect and associate knowledge that is crucial to the sphere of innovation discovery (Alvarez and Barney, 2002). Association and connection represent an individual's ability to link unconnected discovered information and knowledge for innovation. The creativity of individuals and their ability to discover during association (Shalley, 1995) allows people to understand complex systems while uncovering relationships (Lehrer, 2008; Tang et al., 2012). When detecting something unexpected, individuals alter existing schemata (Gaglio and Katz, 2001). Baas et al.'s (2008) meta-analysis shows that high activation levels and a focus on aspirations enhance entrepreneurial creativity (Higgins, 2006; Tang et al., 2012), which is key for entrepreneurial discovery when engaging a diverse set of stakeholders. Overall, entrepreneurial alertness allows individuals to connect the dots when searching and scanning the environment to analyze the usefulness of newly linked information (Tang et al., 2012).

Moreover, by using assessment and estimation when an opportunity emerges, individuals tend to judge (Shepherd and McMullen, 2006), and this judgment consists of two phases. The first occurs if one relies on a possible opportunity that exists for somebody, such as a third-person opportunity (Shepherd and McMullen, 2006). The second relates to benefits for the judging person (Tang et al., 2012). Different stakeholders are engaged in the discovery process. Therefore, when a potential entrepreneur believes that an entrepreneurial opportunity could be positive and beneficial, that entrepreneur will also evaluate his or her own willingness to face uncertainties. Shepherd and McMullen (2006) claim that the theory of alertness posited by Kirzner (1999) focuses on the business idea evaluation phase and concentrates on judging novel shifts, information, or changes and on deciding whether they would reflect a business opportunity with potential profits (Tang et al., 2012).

Tang et al. (2012) claim that a vital final element of entrepreneurial alertness is judgment, which extends the limitations of alertness to include evaluation. Recent studies stress that entrepreneurial alertness predicts entrepreneurial behavior. Li et al.'s (2020) study of a sample of 346 Chinese students reports that entrepreneurial alertness, among other factors, significantly influences entrepreneurial behavior. Another study in South Africa surveying 120 small businesses found that entrepreneurial alertness predicts economic growth (Urban, 2019). Based on the above line of argumentation, using digital applications is expected to make users alert to specific content; if a variety of stakeholders perceive digital applications for discovery tasks to be useful and meaningful in the entrepreneurial discovery process, they will have higher perceived levels of how those discovery tasks facilitate the entrepreneurial alertness of any individual. This hypothesis supports the notion that discovery tasks in a platform ecosystem can first draw attention to third-person opportunity and then evaluate first-person opportunity (Shepherd and McMullen, 2006). Applications designed for the entrepreneurial process are expected to positively foster entrepreneurial alertness. Thus, the following hypothesis is offered:

H1. Perceived quality of digital applications for entrepreneurial discovery tasks facilitate perceived entrepreneurial alertness.

Because opportunity is a fundamental concept in entrepreneurship (Shane and Venkataraman, 2000), the probability of identifying opportunities is contingent upon an individual noticing variation(s) of some kind in the environment (Valliere, 2013b). Recent research has highlighted the effect of available resources in the entrepreneurial process and the capacity to respond quickly and effectively to changes in the environment (Baron, 2008). In particular, Baron (2008) suggests that since affect has a significant impact on perception, affect is associated with alertness and opportunity recognition. Affects in the environment and thus in one's perceptual fields increase one's capability to detect a wide range of incidents (Matlin and Foley, 2001), which strengthens the impact of alertness on opportunity recognition.

Alertness is an ingredient in the entrepreneurial cognition process and represents sensitivity to new opportunities (Alvesson and Busenitz, 2001; Mitchell et al., 2007b). Being alert also means associating and connecting information about the environment, corresponding with Kirzner's (1999) later work on alertness. Alertness is a continuous process, and individuals scan and search the ecosystem several times to further illuminate the newly sought and connected information and determine its usefulness in an ecosystem. After scanning and searching the environment and connecting information, they will assess whether their newly conceived knowledge fits into current cognitive frameworks for business opportunities (Baron, 2006). Thus, as a logical argument it seems that the more entrepreneurial and innovation-friendly an ecosystem is, the faster this process can be executed by alert individuals. In other words, a nation with a high-scoring innovation ecosystem provides a more attractive environment for exploring and exploiting entrepreneurial opportunities. Thus, alertness may be expected to be linked to the environment.

In line with the above argumentation, perceived alertness levels are expected to relate to the strengths and weaknesses of national innovation ecosystems. An entrepreneurial individual responds to economic changes in a dynamic and uncertain environment. Decision criteria, available resources, and value creation goals support the individual in making decisions (Gaglio, 2004). The European Innovation Scoreboard provides a comparison of innovation performance between EU member states and selected third countries. The relative strengths and weaknesses of national innovation ecosystems are identified based on four main types of indicators: framework conditions, investments, innovation activities, and impacts (EC, 2017). Consequently, opportunities are viewed as social constructions shaped through perceptions individuals have of their environments (Aldrich and Kenworthy, 1999; Alvarez and Barney, 2007). Building on Kirzner's (1973, 1979) efforts and those of Kaish and Gilad (1991), the present study treats individuals who are more alert as having a "unique preparedness"; they are consistently scanning the environment to search for new information and changes, so the innovation ecosystem impacts the discovery of alerted individuals when using online applications. Overall, changes in the environment provide some explanations for how opportunities develop (Gaglio and Katz, 2001; Shane, 2000b; Shepherd et al., 2007; Tripsas, 2008). Thus, a nation's innovation ecosystem is expected to shape an individual's alertness level:

H2. The innovation ecosystem moderates the relationship between perceived quality of digital applications for discovery tasks and perceived entrepreneurial alertness.

Fig. 2 illustrates the research model under investigation. While hypothesis 1 focuses on the stakeholders' perceived quality of the digital applications for discovery tasks to facilitate entrepreneurial alertness, hypothesis 2 investigates the moderating effect of a nation's entrepreneurial innovation ecosystem on entrepreneurial alertness. In this context, stakeholders assess the efficacy of the platform ecosystem through the stakeholder engagement quality dimensions of digital applications for discovery tasks, which are linked to alertness for entrepreneurial discovery. Perceptions of innovation and platform ecosystems are linked with perceptions of entrepreneurial alertness based on a multidimensional model of discovery theory.

4. Methodology

4.1. Study design

This paper tackles different levels of analysis, such as digital applications on a platform ecosystem, individual cognitive variables, organizations, diverse stakeholders, and national ecosystems. Because data collection and operating were performed at different levels of analysis, this multilevel analysis requires a specific methodological tradition that links the theory to the specific measures and subsequent analysis. For this purpose, Scott et al.'s (2013) recommendations regarding multilevel models that account for different levels were considered. In this study context, the survey respondents are nested in different nations.

The digital applications and technology and the data were elaborated and collected during the European-funded project ONLINE S3 (www.onlines3.eu), which aimed to develop an e-policy platform augmented with a toolbox of applications to assist European stakeholders in elaborating or revising their smart specialization policies and RRI strategies. Thus, within this project all participants were recruited via a tailor-made stakeholder engagement strategy in each nation for RRI workshops to test 29 applications. However, the present study focuses on five applications that are especially relevant for entrepreneurial discovery. More precisely, individuals representing all four types of the quadruple helix of stakeholders (i.e., actors from government, academia, industry, and civil society) to promote a democratic decision-making approach for RRI (Carayannis and Campbell, 2009). Each workshop consisted of approximately 15 individuals roughly equally divided among researchers, entrepreneurs, policymakers, and civil society, who assessed the discovery tasks on the platform ecosystem. Although the digital applications are self-explanatory, the workshop participants were introduced to and shown how to use them. Workshop leaders provided general information about the ONLINE S3 project and the region-specific workshops for using the digital applications and invited stakeholders in their individual networks to participate. After each workshop, the stakeholders present completed the survey.

4.2. Data and sample

The total sample for this empirical work involves a single questionnaire-based survey carried out between November 2017 and February 2018 in Scotland (United Kingdom, UK),[2] Greece, the Netherlands, and Spain. A piloting data collection of 74 interviews informed the constructs used, but those results are not part of this report. The main study under investigation involved 686 individuals, with stakeholder participation roughly equally distributed by type (28.1% researchers, 26.4% policymakers, 22.7% entrepreneurs, and 22.7% citizens) and in terms of gender (43.3% males and 56.7% females). Participation by nation was as follows: 29.6% from Scotland/UK, 9.3% from Greece, 30.5% from the Netherlands, and 30.2% from Spain; 0.4% did not identify a region. Just over half (53.6%) of all participants had less than 10 years' work experience, and 46.4% had more. In terms of hours spent using the web-based applications contained the study, 58.5% used them for less than 2 h and 41.5% for more than 2 h. Finally, in terms of hours spent using web-based applications for RRI activities, 36.2% used them for less than 2 h and 63.8% used them for more than 2 h, thus indicating the experience level of the stakeholders. The digital applications under investigation are provided on a platform ecosystem (www.onlines3.eu), and the analytics of the platform indicated that the applications had 4873 viewers, of whom 4301 were unique. From November 2017 to December 2018, the average user spent approximately 125 s, or approximately 2 min, using each application. Table 1 depicts the sample characteristics.

In terms of multilevel analysis, this study investigates countries with moderate- and high-innovation ecosystems. While Greece and Spain represent moderate innovators, Scotland and the Netherlands are innovation leaders according to the European Innovation Scoreboard (EC, 2017). Overall, 39.5% of stakeholders were engaged from moderate-innovation ecosystems and 60.5% from high-innovation ecosystems.

4.3. Definition and measurement of the variables

4.3.1. Independent and dependent variables

Digital applications for discovery tasks. In this study, five digital applications for discovery tasks are investigated. Although 29 applications were used by a diverse set of stakeholders in the ONLINE3 project, the present study focuses on those applications that are most relevant for the entrepreneurial discovery process: (1) *vision sharing* allows actors to create visually attractive infographic material to strengthen stakeholder engagement; (2) *regional assets mapping* integrates a variety of relevant resources into a single tool that enables actors to better understand existing regional assets; (3) *research infrastructure mapping* maps research infrastructures and related key players at the regional level; (4) *clusters, incubators, and innovation ecosystems* help better define local business needs and niches in which regions have a competitive advantage; and (5) *regional scientific production profile* uses publication data to describe an area's scientific activity. These applications provide guidelines to boost entrepreneurial discovery based on knowledge production, stakeholder engagement, and entrepreneurial action through collaborative decision-making. Based on reliability tests and factor analyses (communalities were below 0.4), three of the initial eight candidate applications were excluded, leading to five applications that were chosen based on the entrepreneurial discovery process obtained from the smart specialization policy concept. The following applications were eliminated from this investigation: *(1) specialization indexes* produce technological and economic measures to understand the unique entrepreneurial position of the available regional technological and economic activities in global value chains; *(2) focus groups* provide help throughout the entrepreneurial discovery process through facilitators that organize and manage co-creation events and communicate relevant issues; and *(3) debate at a glance* assists actors with engaging a diverse set of stakeholders in decision making to exploit identified entrepreneurial opportunities and communicate the resulting vision to them.

Perceived application's quality dimension as independent variable. Regional and national European policymakers follow policy principles to design and implement RRI strategies for smart specialization to ensure they are eligible to receive money from a variety of European structural funds (Foray, 2015; 2013). The present study takes advantage of the results of previous policy and innovation processes research (e.g., Abelson and Gauvin, 2006; Rowe and Frewer, 2004; 2005) that emphasizes that successful stakeholder participation is influenced by quality dimensions that enable a better design of public participatory processes for innovation. Ecosystems tend to be influenced by platform-based architectures (Baldwin, 2018, 2019; Gawer, 2014; Jacobides et al., 2018; Kapoor and Agarwal, 2017). The 30-item scale for stakeholder participation quality measurement devised by Ommen et al. (2016) was modified to evaluate the digital applications on a platform-based architecture for discovery tasks. The original items were grouped into the following variables: "early involvement," "satisfaction, " "task-related resources," "degree of influence," "transparency of processes," "incentive mechanisms," "voluntariness," and "implementation." The perceived quality of applications relies on the concept of "usefulness," "level of satisfaction," and "ease of use" (Davis, 1989; Lund, 2001; Rojas and Macías, 2013). Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis et al., 1989, p. 320), while the word *useful* is defined as "capable of being used advantageously" (Davis et al., 1989, p. 320). Overall, perceived usefulness indicates a decent relationship between use and performance. Additionally, according to Davis, "perceived ease of use" explains "the

[2] Participants in this study were based in Scotland which is a country of the United Kingdom (UK). Thus, Scotland was chosen as a subset of the UK when it comes to the European Innovation Scoreboard. This study was carried out before Brexit occurred.

degree to which a person believes that using a particular system would be free of effort" (1989, p. 320); applications that are easy to learn and use tend to increase the level of user satisfaction. With this foundation, participants assessed the quality of the digital applications on a Likert scale from 1 (--) to 5 (++) by rating the following four questions or statements: "How user-friendly is this application?"; "How useful is this application?"; "How likely are you to use this application in future?"; and "The application can be used in various contexts (e.g., they are flexible, can be used for projects, funding applications, etc.)." Not all participants assessed all five applications. 0 indicated missing data. Cronbach's alpha was used to examine the internal consistency of this variable and achieved a reliability value of 96.8% (mean = 3.623, SD = 5.761, α = 0.826), which indicates a sufficient level of internal consistency.

European innovation ecosystem as moderating variable. Ecosystems differ in terms of the linkages between actors (Adner and Kapoor, 2010; Ganco et al., 2019) and the power and position of multilateral relationships (Adner, 2016; Kapoor and Lee, 2013). Thus, Davidsson's (2015) concept regarding "external enablers," which can create economic activities but cannot ensure venture success, was applied. By including external enablers, this work recognizes environmental conditions (Eckhardt and Shane, 2013; Shane, 2012). The European Innovation Scoreboard is used to compare innovation performance between Member States in the EU and selected third countries; it examines the relative strengths and weaknesses of national innovation ecosystems using an interactive tool that visualizes different profiles and indicators. The methodology relies on four main types of indicators—framework conditions, investments, innovation activities, and impacts—and 10 innovation dimensions that capture 27 indicators. The unweighted averages of these 27 indicators make up the Summary Innovation Index, which indicates the performance of European national innovation systems. The European nations are then categorized into four performance groups—innovation leaders, strong innovators, moderate innovators, and modest innovators—based on their average performance scores on the Summary Innovation Index. Innovation leaders are countries whose performance is more than 20% above the EU average; in the sample for this study, the innovation leaders are Scotland and the Netherlands, and the moderate innovators—nations with a performance between 50% and 90% of the European average—are Greece and Spain (EC, 2017). This comparison between innovation leaders and moderate innovators enables the assessment of the innovation's ecosystem impact on individuals' alertness in the entrepreneurial discovery process. The index from 2017 has been used as a baseline because samples were gathered in 2017 and 2018.

The United Kingdom for Scotland (1). The performance of the United Kingdom as an innovation leader grew over time by 11.7% relative to that of the EU in 2010. The relative strengths of the innovation ecosystem are attractive research systems, human resources, and employment impacts; its relative weaknesses are innovators, finance and support, and intellectual assets (EC, 2017).

Greece (2). Over time, Greece's performance as a moderate innovator improved by 0.7% in relation to that of the EU in 2010. The comparative strengths of its innovation ecosystem are innovators, attractive research systems, and human resources, while the comparative weaknesses are an innovation-friendly environment, intellectual assets, and finance and support (EC, 2017).

The Netherlands (3). Over time, the performance of the Netherlands as an innovation leader rose by 10.4% in relation to that of the EU in 2010. The comparative strengths of the Dutch innovation ecosystem are attractive research systems, human resources, and linkages. The relative weaknesses are firm investments, sales impacts, and intellectual assets (EC, 2017).

Spain (4). Spain's performance as a moderate innovator declined over time by 1.8% relative to the EU in 2010. The comparative strengths of Spain's innovation ecosystem are human resources, innovation-friendly environments, and attractive research systems; its comparative weaknesses are innovators, linkages, and finance and support (EC, 2017). Table 2 shows the sample correlation.

Entrepreneurial alertness as a dependent variable. A modified version of the entrepreneurial alertness scale from Tang et al. (2012) was applied. On a seven-point Likert-type rating ranging from 1 (strongly disagree) to 7 (strongly agree), participants were asked to assess the following statements: "The applications help the user acquire relevant information for new business ideas"; "The applications provide the user with helpful source material to scan for potential new business opportunities"; "The applications help the user identify new relationships which could lead to potential business opportunities"; "The applications help the user to see the bigger picture when identifying potential business opportunities"; "The applications help the user come up with new ideas and approaches to existing problems"; "The applications help the user see connections between previously unconnected pieces of information"; "The applications help the user to be more alert to and aware of potential opportunities"; "The applications help the user to distinguish between potential high-value opportunities and low-value opportunities"; "The applications help the user filter out insignificant information in order to make decisions." Thus, the applied scale comprises variables under "scanning and search," "association and connection," and "evaluation and judgment," discussed by Tang et al. (2012). Despite the reduction in items and modification for digital applications, the reliability of the scale remains high (see confirmatory factor analysis in Table 3). Cronbach's alpha achieved a reliability value of 96.3% (α = 0.962), with all variables meeting the suggested threshold of 0.70 (Hair et al., 1995; Nunnally, 1979; Sparkman et al., 1979). Thus, per Loewenthal (2004), the scale is a suitable tool.

4.3.2. Control variables

Stakeholder participation was controlled for if *stakeholders* from different communities (academia, entrepreneurs, politics, and society at large) differed in their perceptions; additionally, the analysis controlled for *gender* and *age*. Perceptions were expected to differ between males and females and between certain age groups. While younger people might be more familiar with a web-based approach, older people might be cautious or less comfortable in that regard. Length of *work experience* (in years) was also controlled for. *Prior knowledge* reflects an individual's distinctive information, and *experience in participation in smart specialization for RRI* offers one the capacity to contribute (Shane and Venkataraman, 2000; Venkataram, 1997). Next, *average hours of engagement* were controlled for to explore the impact experience had on perceptions. This type of knowledge is a vital part of intellectual performance and increases the possibility of identifying opportunities (Gimeno et al., 1997; Shane, 2003). The identification of opportunities supports the integration and accumulation of novel knowledge and the integration and adjustment to new circumstances (Weick, 1996). Prior knowledge is vital to identifying opportunities (Shane 2003; Tang et al., 2012). Knowledge and experience have been highlighted as significant factors empowering people in strengthening their cognitive abilities (Becker, 1964). Industry and start-up experience can be a key factor in increasing entrepreneurs' alertness to identifying new opportunities, and alertness level can be affected by active involvement, cognition, action, and experiential learning (e.g., Corbett, 2005; Dutta and Crossan, 2005; Lumpkin and Lichtenstein, 2005; Tang et al., 2012).

4.4. Confirmatory factor analysis

Confirmatory factor analysis (CFA) using maximum likelihood estimation was carried out with AMOS 27. The CFA tested how well the variables represent theoretical constructs. Items load on their respective construct, and a minimum of correlation between error variances within a construct was allowed for (Hair et al., 2010a,b). Overall, the research model fits the data very well ($\chi 2 = 760.497$; $\chi 2/df = 2.43$; CFI = 0.932; TLI = 0.917; IFI = 0.932; RMSEA = 0.046). All factor loadings are significant ($t > 3.1$; $p < 0.001$), square multiple correlation (SMC) values are greater than 0.30 (Bagozzi and Yi, 1988), and all Cronbach's alphas are greater than 0.6 (Hair et al., 2010; Nunnally, 1979). To achieve construct reliability, a value of CR ≥ 0.6 is met, and the average variance extracted (AVE) is greater than or equal to 0.5 to achieve this validity (Fornell and Larcker, 1981). All Kaiser-Meyer-Olkin measures of sampling adequacy are greater than 0.5 (Kahn et al., 2007), and all determinants of the constructs' correlation matrix are greater than the necessary value of 0.00001. Finally, all significant values reveal that suitable correlations exist in the dataset (Bartlett, 1937). Table 3 outlines the CFA.

5. Results

5.1. Descriptive results

Tables 3 and 4 display the descriptive statistics, showing the mean, standard deviation, and bivariate correlations acquired for each variable. As the table shows, there was greater participation by women than men: 297 males and 389 females. At the same time, gender is correlated with work experience, age, experience in smart specialization, and experience in using the applications. Overall, as expected, experience is positively associated with age.

5.2. Test assumptions, method and statistical interpretation

The established statistical technique of structural equation modeling (SEM) using AMOS 27 was applied by providing an adequate sample size, and the data met distributional assumptions. The maximum likelihood method is the most common way of estimating parameters and computing model fit; it requires multivariate, normally distributed, continuous variables. The model fit—$\chi2 = 760.497$; $\chi2/df = 2.43$; CFI = 0.932; TLI = 0.917; IFI = 0.932; RMSEA = 0.046—is adequate. According to Hu and Bentler (1999), the threshold values for model fit are above 0.90 for the CFI, IFI, and TLI, and below 0.07 for RMSEA.

Entrepreneurs are not only entrepreneurial in their core activities, but also in how they access resources; they thus often operate in networks that cross national boundaries. For instance, due to dual citizenship, they may be able to access funds in other countries as a result of a transnational regulatory structure (such as the EU). To test whether the nation state is the most appropriate category within which individual entrepreneurial behavior is connected to embeddedness in ecosystems, the differences between the investigated regions were analyzed across several variables. For example, the Shapiro-Wilk test was used to determine if the population was normally distributed; significant values were found in all four regions. Statistics for testing populations' normality indicate that all data deviate significantly from a normal distribution (Scotland: 0.978, df = 203, $p < 0.001$; Greece: 0.897, df = 64, $p < 0.001$; Netherlands: 0.960, df = 209, $p < 0.001$; Spain: 0.963, df = 207, $p < 0.001$). Fig. 3 illustrates the results.

Following the Shapiro-Wilk test, the non-parametric Kruskal-Wallis test was used to explore whether the variables under investigation differ significantly between nations and moderate and high innovator ecosystems. The results indicate that all four regions (df = 3) are significantly different according to Kruskal-Wallis H (KWH) in the following dimensions: engaged stakeholders (KWH = 40.008, $p < 0.001$), engaged organizations (KWH = 30.242, $p < 0.001$), participant age (KWH = 138.969, $p < 0.001$), participant gender (KWH = 26.502, $p < 0.001$), nationality (KWH = 476.732, $p < 0.001$), work experience (KWH = 100.81, $p < 0.001$), perception of digital application used (KWH = 239.386, $p < 0.001$), and entrepreneurial alertness (KWH = 118.739, $p < 0.001$). Despite these significant group differences, the overall relationship between digital applications and entrepreneurial alertness remains significant. Although entrepreneurs or any stakeholder in highly innovative countries appear to be better resourced, they value the quality of digital applications to strengthen their entrepreneurial alertness throughout the discovery process, which continues throughout the lifecycle of entrepreneurial endeavors, to a similar degree as those acting in a moderate-innovation ecosystem. This indicates that the digital applications studied here can be used regardless of national innovation ecosystem.

Furthermore, the Shapiro-Wilk and non-parametric Kruskal-Wallis tests were performed for different stakeholders to explore the effects of the digital applications on entrepreneurial alertness across individuals. According to the Shapiro-Wilk test, the populations for entrepreneurial alertness and digital applications are not normally distributed across the engaged stakeholders. There were significant values for differences in all four stakeholder types for entrepreneurial alertness: researchers: 0.977, df = 193, $p < 0.01$; policymakers: 0.977, df = 181, $p < 0.05$; entrepreneurs: 0.964, df = 156, $p < 0.001$; and citizens: 0.966, df = 156, $p < 0.01$. The same held for the perceived quality of digital applications for discovery tasks: researchers: 0.774, df = 193, $p < 0.001$; policymakers: 0.540, df = 181, $p < 0.001$; entrepreneurs: 0.690, df = 156, $p < 0.001$; and citizens: 0.635, df = 156, $p < 0.001$. Fig. 4 illustrates the results.

Following the Shapiro-Wilk test, the non-parametric Kruskal-Wallis test was used to explore whether the variables under investigation were significantly different between stakeholders. The results indicate that all four stakeholder types (df = 3) were significantly different: countries (KWH = 56.499, $p < 0.001$), engaged organizations (KWH = 358.166, $p < 0.001$), participant age (KWH = 52.086, $p < 0.001$), participant gender (KWH = 21.474, $p < 0.001$), work experience (KWH = 60.073, $p < 0.001$), and perception of digital applications used (KWH = 40.073, $p < 0.001$). Finally, entrepreneurial alertness (KWH = 4.919, n.s.) was not significantly different across stakeholders. Despite the significant stakeholder group differences regarding the perceived quality of the digital applications and the non-significant difference in perceived entrepreneurial alertness, the relationship between digital applications and entrepreneurial alertness remains significant. This indicates that the digital applications facilitate entrepreneurial alertness despite differences in their perceived quality across different stakeholders. Overall, the digital applications can be used by diverse types of stakeholders across national innovation ecosystems; they appear to be flexible as to user and environment heterogeneity.

5.3. Results of the structural equation model

Table 4 presents the statistics of goodness of fit for the model[3], which was evaluated by utilizing the chi-square statistic, the CFI (Bentler, 1995), and the RMSEA (Browne et al., 1993). The CFI rose above the threshold of 0.90 (Bentler, 1995; Hu and Bentler, 1999). The RMSEA reached a suitable fit under the suggested threshold of 0.07 (Browne et al., 1993; Jaccard and Wan, 1996; Rigdon, 1996). The chi-square/df value lies below 5.0, which indicates a sufficient fit level (Hair et al., 2010a,b). The GFI is above 0.8, also indicating a satisfactory fit. The CFI values fit since they are above the 0.90 threshold (Hu and Bentler, 1999; Byrne, 1994). Moreover, the values of TLI and IFI both show sufficient fit (Bentler and Bonett, 1980; Mulaik et al., 1989). The models are sensible from an empirical viewpoint and offer competing representations of the underlying structure of the tool. The outcome matches the conditions for CFA studies (Doll and Xia, 1997; Doll et al., 1994).

Table 4 summarizes the outcomes of hypothesis testing. Based on SEM, using discovery tasks via digital applications significantly influences stakeholders' perceptions of alertness ($\beta = 0.411$, $p < 0.001$). In other words, the more highly stakeholders perceive a digital application's quality regarding discovery tasks, the stronger their perception that entrepreneurial tasks will facilitate their entrepreneurial alertness.

[3] The normed chi-square ($\chi2$), goodness of fit index/The normed chi-square, goodness of fit index (GFI), TLI, and incremental fit index (IFT) were also included in the goodness-of-fit measures (GFI), Tucker Lewis Index (TLI), and incremental fit index (IFT), and Root Mean Square Residual (RMSEA) were also included in the goodness-of-fit measures.

Furthermore, the moderating effect of the innovation ecosystem of a nation (β = 0.362, $p < 0.001$) between the relationship of application quality and perceived entrepreneurial alertness is not significant, with a *p*-value of 0.201. Thus, national ecosystem does not affect the relationship. However, some control variables do impact the relationship in H1: nationality's impact on digital applications β = 0.013 (SE = 0.006, CR = 2.093, $p < 0.05$); age's impact on digital applications β = 0.206 (SE = 0.085, CR = 2.415, $p < 0.05$); work experience's impact on digital applications β = −0.271 (SE = 0.087, CR = −3.099, $p < 0.05$); region's impact on digital applications β = −1.717 (SE = 0.101, CR = −17.041, $p < 0.001$); hours engaged in project's impact on digital applications β = 0.220 (SE = 0.059, CR = 3.730, $p < 0.001$); and region's impact on entrepreneurial alertness β = 0.503 (SE = 0.125, CR = 4.021, $p < 0.001$). The following control variables impact the relationship in H2: region's influence on digital applications β = −0.232 (SE = 0.059, CR = −3.915, $p < 0.001$); region's influence on entrepreneurial alertness β = −0.150 (SE = 0.056, CR = −2.677, $p < 0.05$); and organization's influence on entrepreneurial alertness β = 0.073 (SE = 0.031, CR = 2.361, $p < 0.05$). The impact of the control variable indicates that although they affect the perceived quality of the applications and perceived entrepreneurial alertness separately, they do not significantly impact the relationship between the independent and dependent variables. Finally, Fig. 3 illustrates the SEM results with the unstandardized coefficients B for the hypotheses (N = 686). In line with Kirzner's (1979) definition of the theory of alertness, differences in perceptions and interpretations regarding entrepreneurial opportunity assessments will vary among different stakeholders. However, digital applications enable a different schema when making individuals alert. Even across different national innovation ecosystems, stakeholders perceive the applications as supportive in terms of the entrepreneurial process.

6. Discussion

This work empirically investigated how the psychological phenomenon of entrepreneurial alertness interacts in a digital ecosystem-based environment. To that end, a diverse set of stakeholders were analyzed when performing entrepreneurial discovery tasks using five digital applications on a digital platform ecosystem. A survey was completed by a total of 686 individuals in two moderate-innovation ecosystems—Greece and Spain—and two ecosystems defined as innovation leaders—the Netherlands and Scotland—according to the European Innovation Scoreboard. The findings show that high perceptions of application quality during discovery tasks in a digital platform ecosystem facilitates entrepreneurial alertness. This relationship remains significantly positive despite heterogeneity of innovation ecosystems and stakeholders. In other words, the results of this study indicate that, based on stakeholders' perceptions and regardless of the innovation ecosystem in which they operate, discovery tasks performed using digital applications have the potential to boost individuals' entrepreneurial alertness. Although our study focuses on comparing the results of two different ecosystems based on samples drawn from four countries using five digital applications and is thus limited in terms of generalizability, this study still provides fruitful theoretical and practical implications, as discussed in the following section.

6.1. Theoretical implications

The findings provide empirical evidence for the multidimensional model as a conceptual foundation for entrepreneurial discovery theory, which enriches the debate whenever an entrepreneurial opportunity is discovered or created (Murthy, 2011). While specific tasks on a digital platform ecosystem show the potential to support a diverse set of stakeholders discovering entrepreneurial ideas, the findings also highlight that this positive relationship created by digital applications is not influenced significantly by objective environmental conditions in an innovative ecosystem. Thus, these tools can boost entrepreneurial opportunities and thus facilitate entrepreneurial action across nations and at different levels of innovation ecosystems.

In this manuscript, the psychological implications of increasing alertness via digital applications is examined. However, there are other ways to hone alertness. For instance, entrepreneurs often refer to their intuition as a basis for opportunity identification. In this regard, emotional intelligence and metacognitive skills can contribute to both the development of entrepreneurial alertness and the effective use of entrepreneurial intuition (Blume and Covin, 2011). Based on Penrose (1996) view, entrepreneurial imagination shapes entrepreneurial behavior. Thus, starting a business is not only based on resource requirements but also an individual merging perceived means and goals (Baker and Nelson, 2005; Sarasvathy, 2001). Thus, on the one hand, the present study contributes to the discovery theory's line of research in that it focuses on a thoughtful search based on one's individual search tactics, information processing abilities, and effective choices using a platform ecosystem as drivers of entrepreneurial discovery (Fiet, 2002; Shaver and Scott, 1991). On the other hand, engaged stakeholders' alertness levels are facilitated by digital applications in different external environments (i.e., innovation ecosystems). In particular, this paper contributes to the creative-collective theory in which individuals become innovators and entrepreneurs through online applications by increasing their creativity and are able to detect opportunities by merging their existing information and resources with new information and resources. To conclude, this study provides evidence of the multidimensional nature of the entrepreneurial discovery theory.

6.2. Practical implications

Europe's economic growth depends significantly on the progress of small- and medium-sized enterprises (SMEs), which provide approximately 67% of all jobs Eurostat, 2020. Because entrepreneurs make vital contributions to Europe's economic growth (EC, 2008; 2017), increasing our understanding of how alertness affects and can boost innovation has caught the attention of European policymakers in their effort to support potential entrepreneurs in their individual career paths. Although there are models suggesting how to engage a wide range of stakeholders in policymaking (Davidson, 1998; Fung, 2006), the necessary concepts are not yet combined, entrepreneurship is not taken adequately into account, and the empirical impact of the participatory mechanism has not been fully assessed (Hurlbert and Gupta, 2015). The quality and design of participatory digital platforms and innovation ecosystems motivate stakeholders in different ways, and this study examines entrepreneurial discovery tasks that facilitate entrepreneurial alertness for a diverse set of stakeholders and boost the performance consequences for individuals via participatory approaches, thus contributing to their collective perception and finally helping improve a nation's innovation index (Ommen et al., 2016). Digital platforms, technology, and applications represent valuable tools in the search for solutions that will benefit society and have the high impact desired by policies and policymakers. However, those solutions have to be identified by alerted stakeholders, regardless of profession, position, or location. So far, only a few digital applications have been investigated regarding their applicability, validity, and reliability across stakeholders and had their stability across diverse nations confirmed. This work provides a first step in this direction to inspire their practical use by any kind of actor.

Furthermore, because female entrepreneurs make vital contributions to Europe's economic growth (EC, 2008, 2017), increasing the alertness of these individuals could also support continent-wide growth. Understanding the online and offline facilitators of entrepreneurial alertness helps entrepreneurship educators and policymakers design instruments for strengthening SMEs, particularly in opening up underutilized female potential.

Finally, because the majority of scientific contributions focus on qualitatively driven methodological approaches in RRI, this study provides further empirical evidence for the smart entrepreneurship policy concept (Fellnhofer, 2017, 2018).

6.3. Entrepreneurship and innovation policy implications

With regard to a holistic and democratic ecosystem-based approach, the transition from an entrepreneurship policy toward a policy for an entrepreneurial innovation economy is underway (Stam, 2015b), in which collectively discovered entrepreneurial opportunities (Overholm, 2015) shape innovation ecosystems (Nieth et al., 2018). As a comparative study, this paper contributes to the systemic concept of a path toward RRI (Alvedalen and Boschma, 2017). From a global perspective, while performance differences of the innovation ecosystem with Canada and the United States have become smaller than in 2010, the EU remains less innovative than countries such as Australia, Canada, Japan, South Korea, and the United States. While performance differences between the EU and Japan and South Korea have increased, the EU maintains a pioneering performance leader in the innovation ecosystem over China (EC, 2017). Although RRI has become renowned in policy realms for its forward-looking frameworks and approaches designed for maximum impact, the research field itself remains immature and lacks focus on how actors actually carry out RRI (Jakobsen et al., 2019). The applications developed during the ONLINE S3 project are investigated in terms of their wider applicability during further projects related to RRI, such as SeeRRI (www.seerri.eu) and RRI2SCALE (www.rri2scale.eu). Indicators and metrics based on various scales are created to capture and transform RRI into quantitative measures. Digital applications are useful tools to support this process. Based on this study's findings, digital platform ecosystems show strong potential to support RRI through a collaborative and democratic approach. Digital applications on platform ecosystems enable a diverse set of stakeholders to search, scan, connect, and assess potential opportunities jointly in harmony. Additionally, strategy workshops of this sort are well-established tools for engaging a diverse set of stakeholders for RRI activities; practical project examples include SeeRRI and RRI2SCALE.

6.4. Limitations and further research

The outcomes and associated limitations of this work suggest opportunities for further avenues of research. This paper concentrates on a diverse set of stakeholders in only four European nations who were all EU members at the time the study was conducted. Thus, one limitation is that only four countries have been examined. This study compares the results of two different ecosystems based on samples drawn from four countries using five digital applications. Thus, we are not able to conclude that our results apply to all individuals across all ecosystems. To increase the generalizability of the findings, the experimentation needs to be expanded across the EU, other European countries, and beyond. Furthermore, to increase entrepreneurial alertness activities across economic domains, researchers could use the scale of entrepreneurial alertness in other research disciplines (Oviatt and McDougall, 2005; Short et al., 2009; Tang et al., 2012).

Using qualitative data might lead to additional insights into how to improve the multidimensional model of entrepreneurial discovery. In an experimental setting with control groups, researchers could also compare other methodological approaches and platform ecosystems that offer stakeholder engagement in innovation ecosystems for entrepreneurial discovery.

Our study's core construct of entrepreneurial alertness is limited by the questionnaire items available from the survey related to individuals' situated cognitive attention to crucial entrepreneurial information about the world. Thus, future research is required to enrich the alertness scope by exploring *which* environmental stimuli can facilitate people's attention and adding an explanation of *how* that situated attention arises. Such future research could enhance the concept of entrepreneurial alertness through enriched strategies of schematic development that will tackle the fundamental question of *why* only some individuals recognize and/or exploit new entrepreneurial opportunities. This approach will nurture potential educational settings for facilitating entrepreneurial discovery.

The present study has focused on moderate- and high-innovation ecosystems. Thus, another limitation is that low-innovation ecosystems were not investigated, which could lead to different results. However, due to the significant differences across several control variables, it is expected that the results would also apply in those nations. Nevertheless, future work should include an examination of nations with low-innovation ecosystems.

Finally, although the study design did moderate for different innovation ecosystems, it did not link the actual use of the outcomes of the platform ecosystem to the final entrepreneurial exploitation of the opportunities that were created and discovered. This paper operates at multiple levels of analysis such as diverse stakeholders and national ecosystems. Thus, further empirical studies are necessary, and this paper should serve as a basis for longitudinal comparative studies.

7. Conclusion

This work analyzes stakeholder engagement on a digital platform ecosystem with a diverse set of actors through five digital applications for discovery tasks. The innovation ecosystem variable as an "external enabler" has been assigned, which includes general aspects of the environment (Davidsson, 2015) that fuel entrepreneurial alertness. To that end, via an empirical study, the effects of entrepreneurial perceptions and environment on entrepreneurial opportunities have been captured to investigate the multidimensional concept of entrepreneurial discovery. Specifically, a sample of 686 individuals was drawn from four EU countries: Greece, Scotland, Spain, and the Netherlands. Despite significant group differences, the relationship between the perceived quality of the five digital applications and perceived entrepreneurial alertness was similar across groups. This indicates that these digital applications can be used by diverse types of stakeholders in different innovation ecosystems. Group heterogeneity does not influence this positive relationship. However, further replication studies are required to strengthen this assumption.

With regard to its psychological foundation, this study helps clarify the different perceptions and interpretations based on schema attributes that shape habitual schema activators (Bargh, 1986; Fiske and Taylor, 2013; Gaglio and Katz, 2001). On a digital entrepreneurial platform facilitated through digital applications, this habitual use of a specific schema creates activation without intention: what Bargh and Pratto (1986) describe as alert individuals who "notice without searching." In this regard, the present study sheds light on the discovery approaches of a diverse set of actors in platform and innovation ecosystems. This work also has practical implications for researchers, entrepreneurs, and policymakers since it indicates that specific entrepreneurial tasks facilitate collective entrepreneurial alertness in discovering potential entrepreneurial opportunities, which is crucial not only for (re)designing and implementing European research and innovation strategies for policymakers and for improving entrepreneurially driven innovation ecosystems but also for finding niches for (entrepreneurial) growth.

Acknowledgement

We would like to thank the participants of the Special Conference at the Academy of Management in Israel in 2018 and the reviewers of this manuscript for their useful comments. In particular we would like to thank our ONLINE S3 consortium for their assistance in collecting data across Europe and SeeRRI project consortium for fruitful inspiration for this work. In particular, special thanks goes to Nicos Komninos, Anastasia Panori, Margarita Angelidou, Luke Pittaway, and Christina Kakderi for their thoughts on first drafts.

Finally, the authors would like to thank the European Commission for supporting this research project. This article reflects only the author's view. Neither Research Executive Agency nor the European Commission is responsible for any use that may be made of the information it contains.

The ONLINE S3 project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 710659. The SeeRRI projects which builds on the ONLINE S3 outcomes has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824588.

APPENDIX

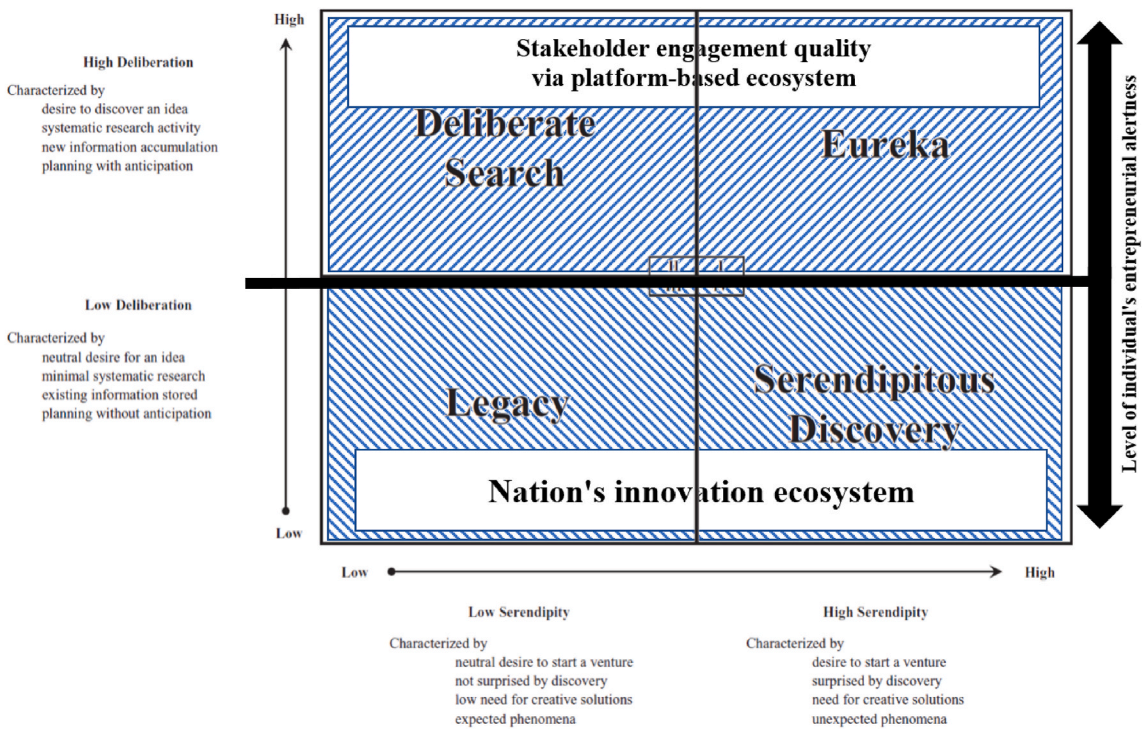

Fig. 1. Conceptual foundation for the research model

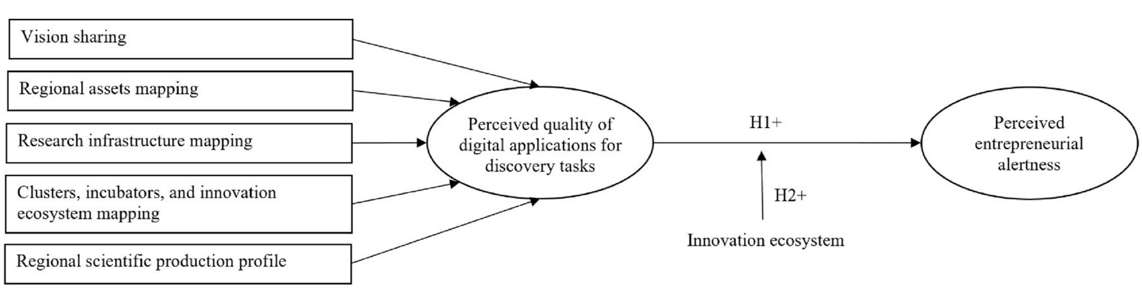

Fig. 2. Research model.

Table 1

Sample characteristics

N = 686	others	UK/Scotland	Greece	Netherlands	Spain	sum
Innovation ecosystem		*high innovator*	*moderate innovator*	*high innovator*	*moderate innovator*	
Stakeholder participation based on quadruple helix						
Research (1)	0	78	40	33	42	***193***
Government (2)	2	15	9	83	72	***181***
Business (3)	0	64	15	29	48	***156***
Civil Society (4)	1	46	0	64	45	***156***
sum	***3***	***203***	***64***	***209***	***207***	***686***
Gender						
Female (1)	2	120	33	143	91	***389***
Male (2)	1	83	31	66	116	***297***
sum	***3***	***203***	***64***	***209***	***207***	***686***
Age category						
below 25 years (1)	0	55	0	100	11	***166***
25–34 years (2)	1	50	7	62	48	***168***
35 to 44 (3)	0	56	29	24	78	***187***
45 to 54 (4)	2	31	23	6	61	***123***
above 55 years (5)	0	11	5	17	9	***42***
sum	***3***	***203***	***64***	***209***	***207***	***686***
Years of work experience						
below 5 years (1)	0	71	5	131	28	***235***
5–10 years (2)	0	46	6	21	60	***133***
11–20 years (3)	2	46	36	38	86	***208***
above 21 years (4)	1	40	17	19	33	***110***
sum	***3***	***203***	***64***	***209***	***207***	***686***
Hours spend in participation in smart specialization						
below 2 (1)	0	122	16	68	42	***248***
2-10 (2)	0	41	19	28	49	***137***
11-21 (3)	0	14	10	36	50	***110***
21-50 (4)	0	6	3	65	18	***92***
above 51 (5)	3	20	16	12	48	***99***
sum	***3***	***203***	***64***	***209***	***207***	***686***
Hours spend in using applications						
below 2 (1)	0	150	36	110	105	***401***
2-10 (2)	3	33	23	73	65	***197***
11-21 (3)	0	5	2	10	25	***42***
21-50 (4)	0	7	1	15	7	***30***
above 51 (5)	0	8	2	1	5	***16***
sum	3	**203**	**64**	**209**	**207**	***686***

Table 2
Descriptive Statistics and Correlations[b]

	N = 686	*Mean*	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1	Quadruple helix stakeholder	2.40	1.12	1.00											
2	Organization	2.77	1.81	.643**	1.00										
3	Age	2.57	1.21	-.145**	-.098*	1.00									
4	Gender	1.43	0.50	-.131**	−0.06	.253**	1.00								
5	Nationality	103.97	48.77	0.00	0.00	-.293**	-.144**	1.00							
6	Work experience	2.28	1.10	-.180**	-.165**	.848**	.223**	-.256**	1.00						
7	Regions	2.60	1.21	0.07	.082*	.078*	.082*	−0.05	0.01	1.00					
8	Hours engaged in RRI	2.50	1.45	.126**	0.06	0.05	-.125**	0.01	0.02	.267**	1.00				
9	Hours engaged in project	1.63	0.95	.141**	.157**	−0.06	-.150**	−0.05	-.086*	.114**	.469**	1.00			
10	Ecosystem (moderate innovator = 0, high innovator = 1)	0.60	0.49	.100**	−0.04	-.373**	-.179**	.542**	-.306**	-.618**	-.206**	−0.07	1.00		
11	Entrepreneurial alertness (1–5)	4.48	1.05	−0.06	0.05	.140**	0.05	-.259**	0.06	0.04	.098**	.108**	-.316**	1.00	
12	Digital applications (1–5, 0 for missing data)	0.72	1.15	-.211**	-.155**	.170**	0.06	-.125**	.153**	-.226**	0.03	0.03	-.299**	.322**	1.00

Note. Statistics are based on n = 686; **. Correlation is significant at the 0.01 level; *. Correlation is significant at the 0.05 level.

Table 3

Confirmatory factor analysis

	Item description	Mean	SD	Comm-unalities	Corrected item-scala-correlation	Standard-ized factor loadings[a]	Squared multiple correlation (SMC) ≥ 0.3[b]	Cronbach's $\alpha \geq 0.7$[c]	Composite reliability (CR) ≥ 0.6[d]	AVE ≥ 0.5[e]	Cronbach's if item is deleted	Kaiser-Meyer-Olkin Measure of Sampling Adequacy[f]	Determi-nant[g]	Bartlett's Test of Sphericity[h]
Entrepreneurial alertness (mean = 40.28, SD = 9.419, α = 0.919)														
Entrepreneurial alertness	The applications help the user acquire relevant information for new business ideas.	4.40	1.398	0.644	0.739	0.772	0.596	0.919	0.933	0.608	0.908	0.928	0.005	3637.97***
	The applications provide the user with helpful source material to scan for potential new business opportunities.	4.55	1.432	0.640	0.736	0.772	0.596				0.908			
	The applications help the user identify new relationships which could lead to potential business opportunities.	4.47	1.342	0.642	0.737	0.789	0.623				0.908			
	The applications help the user to see the bigger picture when identifying potential business opportunities.	4.72	1.260	0.620	0.720	0.761	0.58				0.909			
	The applications help the user come up with new ideas and approaches to existing problems.	4.37	1.303	0.588	0.698	0.738	0.544				0.911			
	The applications help the user see connections between previously unconnected pieces of information.	4.57	1.330	0.592	0.701	0.75	0.562				0.911			
	The applications help the user to be more alert to and aware of potential opportunities.	4.55	1.271	0.636	0.734	0.773	0.598				0.908			
	The applications help the user to distinguish between potential high-	4.26	1.360	0.598	0.709	0.708	0.502				0.910			

(*continued on next page*)

Table 3 (*continued*)

	Item description	Mean	SD	Comm-unalities	Corrected item-scala-correlation	Standard-ized factor loadings[a]	Squared multiple correlation (SMC) ≥ 0.3[b]	Cronbach's $\alpha \geq 0.7$[c]	Composite reliability (CR) ≥ 0.6[d]	AVE ≥ 0.5[e]	Cronbach's if item is deleted	Kaiser-Meyer-Olkin Measure of Sampling Adequacy[f]	Determi-nant[g]	Bartlett's Test of Sphericity[h]
	value opportunities and low-value opportunities.													
	The applications help the user filter out insignificant information in order to make decisions.	4.38	1.388	0.514	0.644	0.654	0.428				0.914			
Perceived quality of digital applications (mean = 3.623, SD = 5.761, α = 0.826)														
	Vision sharing	0.71	1.496	0.582	0.613	0.864	0.391				0.793			
	Regional assets mapping	0.97	1.719	0.544	0.581	0.814	0.363				0.808			
	Research infrastructure mapping	0.60	1.415	0.663	0.675	0.763	0.488	0.826	0.88432	0.606	0.777	0.847	0.158	1259.13***
	Clusters, incubators, and innovation ecosystem mapping	0.88	1.595	0.494	0.542	0.738	0.319				0.816			
	Regional scientific production profile	0.46	1.232	0.746	0.750	0.703	0.574				0.764			

All factor loadings are significant ($t > 3.1$; $p < 0.001$). b) SMC values should be greater than 0.30 (Baggozi and Yi, 1988). c) All Cronbach's alphas are greater than 0.6 (Nunnally, 1979; Hair et al., 2010). d) In order to achieve the construct reliability, a value of CR ≥ 0.6 is required. (Fornell and Larcker, 1981). e) The Average Variance Extracted (AVE) has to be greater or equal to 0.5 in order to achieve this validity (Fornell and Larcker, 1981). f) All Kaiser– Meyer–Olkin Measure of Sampling Adequacy are more than 0.5 (Kaiser, 1974). G) All determinants of the constructs' correlation matrix are greater than the necessary value of 0.00001. h) All significant values conclude that there are correlations in the data set that are suitable (Bartlett, 1937).

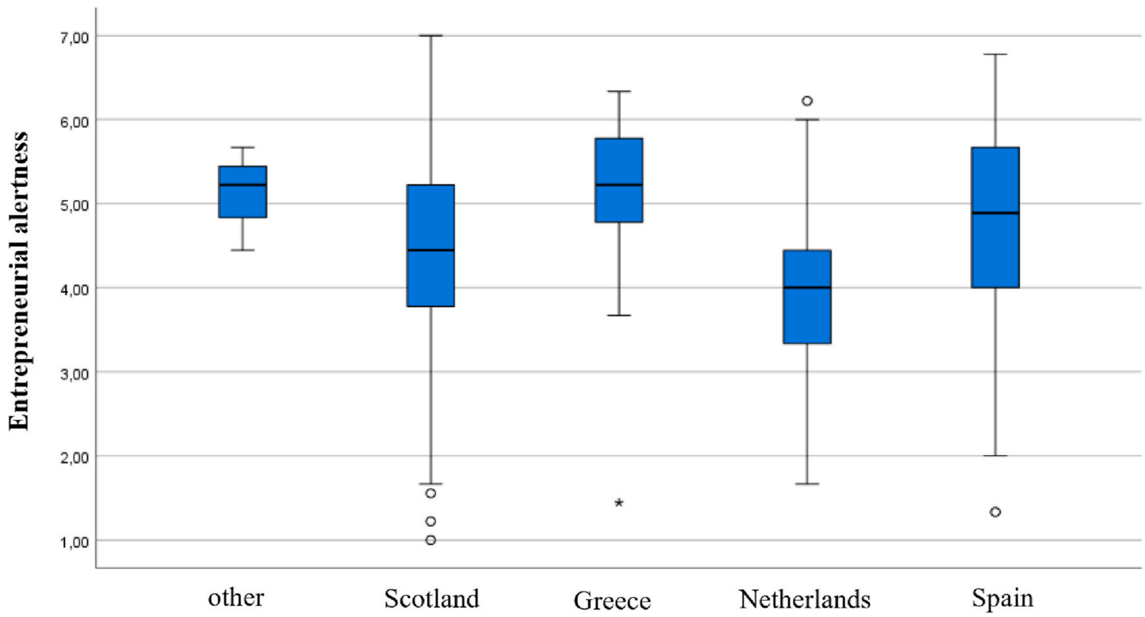

Fig. 3. Shapiro-Wilk test results for four regions
Note. Statistics for testing populations' normality which indicates that all data significantly deviates from a normal distribution. Scotland: 0.978, df = 203, $p < 0.001$; Greece: 0.897, df = 64, $p < 0.001$; Netherlands: 0.960, df = 209, $p < 0.001$; Spain: 0.963, df = 207, $p < 0.001$. A small number of extreme outliers are displayed as dots and a star.

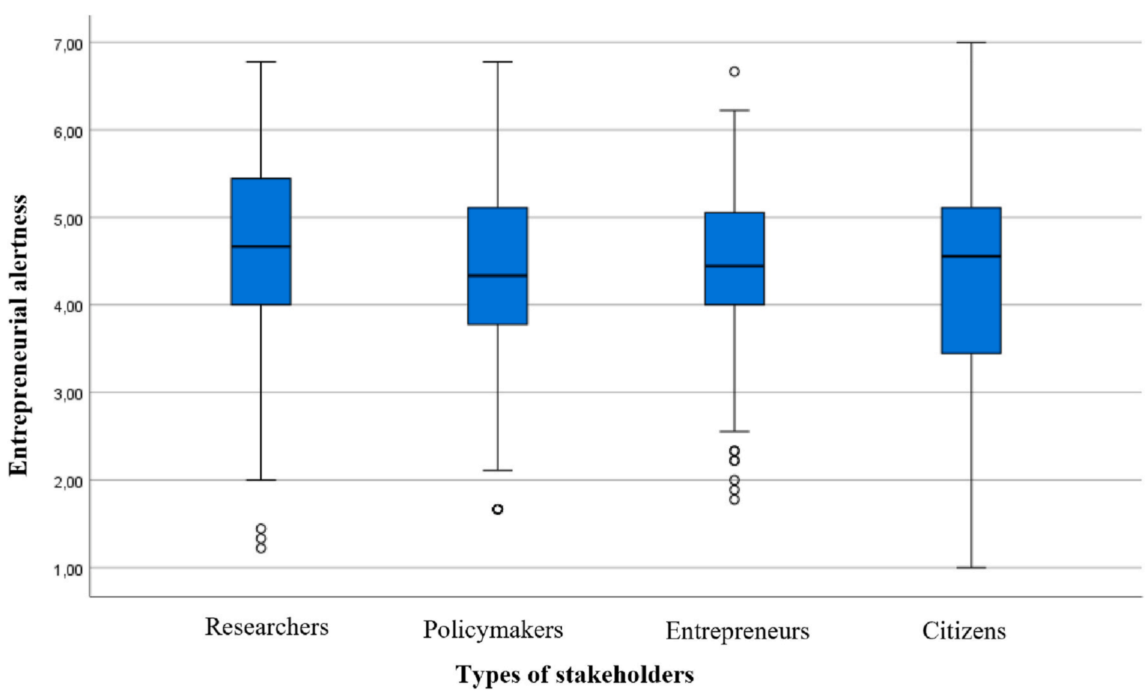

Fig. 4. Shapiro-Wilk test results for different types of stakeholders
Note. Statistics for testing populations' normality which indicates that all data significantly deviates from a normal distribution. entrepreneurial alertness: researcher: 0.977, df = 193, $p < 0.01$; policymaker: 0.977, df = 181, $p < 0.05$; entrepreneur: 0.964, df = 156, $p < 0.001$; citizen: 0.966, df = 156, $p < 0.01$. Extreme outliers are displayed as dots.

Table 4
Summary of goodness-of-fit indices and hypotheses testing

Fit indices	X^2	Degrees of freedom	Chi-square/df	CFI	TLI	IFI	RMSEA
760.497		313	2.43	0.932	0.917	0.932	0.046
Recommended values			<5	>0.90	>0.90	>0.90	<0.08
				Regression weights β		**S.E.**	**C.R.**
H1: Digital application → Entrepreneurial alertness				0.411***		0.046	8.987
Moderate and high innovator ecosystem as moderator				0.362***		0.053	6.787
H2: Digital application → Entrepreneurial alertness							
Model comparison for H2 (innovation ecosystem as moderator): p = 0.201, n.s.							

Notes: ***. significant at the 0.001 level. CFI = Comparative Fit Index, TLI = Tucker Lewis Index, IFI = Incremental Fit Index, RMSEA = Root Mean Square Residual. Not significant control variables have been eliminated.
Control variables for H2a: nationality → digital applications β = 0.013 (S.E. = 0.006, C.R. = 2.093, p < 0.05); age → digital applications β = 0.206 (S.E. = 0.085, C.R. = 2.415, p < 0.05); work experience → digital applications β = - 0.271 (S.E. = 0.087, C.R. = −3.099, p < 0.05); regiont → digital applications β = - 1.717 (S.E. = 0.101, C.R. = −17.041, p < 0.001); engaged hours in project → digital applications β = 0.220 (S.E. = 0.059, C.R. = 3.730, p < 0.001); region → entrepreneurial alertness β = 0.503 (S.E. = 0.125, C.R. = 4.021, p < 0.001).
Control variables for H2b: region → digital applications β = - 0.232 (S.E. = 0.059, C.R. = −3.915, p < 0.001); region → entrepreneurial alertness β = −0.150 (S.E. = 0.056, C.R. = −2.677, p < 0.05); organization → entrepreneurial alertness β = 0.073 (S.E. = 0.031, C.R. = 2.361, p < 0.05).

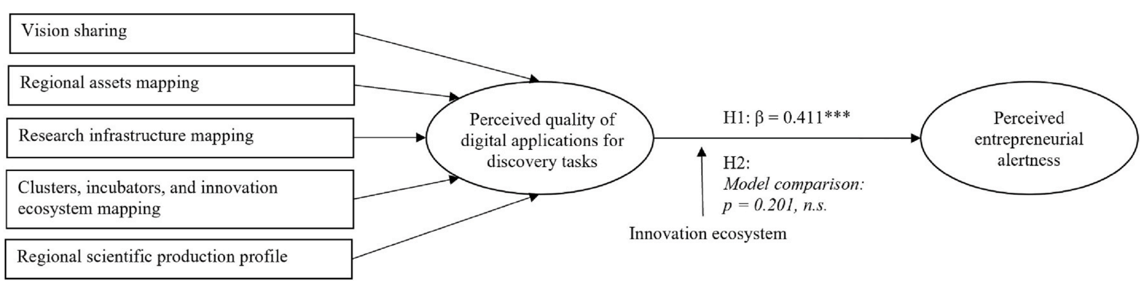

Fig. 5. Research model results
Notes: Structural equation model results stating Unstandardized Coefficients B, confidence interval of the Monte Carlo Method is a 90% confidence interval. Significance codes: *** = p < 0.001. The goodness of fit indices: χ2 = 760.497; χ2/df = 2.43; CFI = 0.932; TLI = 0.917; IFI = 0.932; RMSEA = 0.046.

References

Abelson, J., Gauvin, F.P., 2006. Assessing the impacts of public participation: Concepts, evidence and policy implications. Ottawa: Canadian Policy Research Networks.

Ács, Z.J., Autio, E., Szerb, L., 2014. National systems of entrepreneurship: measurement issues and policy implications. Res. Pol. 43, 476–494. https://doi.org/10.1016/j.respol.2013.08.016.

Adner, R., 2016. Ecosystem as structure: an actionable construct for strategy. J. Manag. 43, 39–58. https://doi.org/10.1177/0149206316678451.

Adner, R., 2006. Match your innovation strategy to your innovation ecosystem. Harv. Bus. Rev. 84.

Adner, R., Kapoor, R., 2010. Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. Strat. Manag. J. 31, 306–333. https://doi.org/10.1002/smj.821.

Aldrich, H.E., Kenworthy, A., 1999. The accidental entrepreneur: Campbellian antinomies and organizational foundings. Variations in organization science. In honor of Donald T, Campbell, pp. 19–33.

Alvarez, S., Barney, J., 2002. Resource-based theory and the entrepreneurial enterprise. In: Hitt, M.A., Ireland, R.D., Camp, S.M., Sexton, D.L. (Eds.), Strategic Entrepreneurship: Creating A New Mindset. Blackwell, Oxford, pp. 89–105.

Alvarez, S.A., Barney, J.B., 2010. Entrepreneurship and epistemology: the philosophical underpinnings of the study of entrepreneurial opportunities. Acad. Manag. Ann. 4, 557–583. https://doi.org/10.1080/19416520.2010.495521.

Alvarez, S.A., Barney, J.B., 2007. Discovery and creation: alternative theories of entrepreneurial action. Strateg. Entrep. J. 1, 11–26. https://doi.org/10.1002/sej.

Alvarez, S.A., Barney, J.B., Anderson, P., 2013. Forming and exploiting opportunities: the implications of discovery and creation processes for entrepreneurial and organizational research. Organ. Sci. 24, 301–317. https://doi.org/10.1287/orsc.1110.0727.

Alvedalen, J., Boschma, R., 2017. A critical review of entrepreneurial ecosystems research: towards a future research agenda. Eur. Plann. Stud. 25, 887–903. https://doi.org/10.1080/09654313.2017.1299694.

Alvesson, M., Busenitz, L., 2001. The entrepreneurship of resource-based theory. J. Manag. 27, 755–776.

Amabile, T.M., Kramer, S.J., 2011. The power of small wins. Harv. Bus. Rev. 89, 70–80.

Arikan, A.M., Arikan, I., Koparan, I., 2020. Creation opportunities: entrepreneurial curiosity, generative cognition, and knightian uncertainty. Acad. Manag. Rev. https://doi.org/10.5465/AMR.2018.0252.

Baas, M., De Dreu, C.K.W., Nijstad, B.A., 2008. A meta-analysis of 25 years of mood-creativity research: hedonic tone, activation, or regulatory focus? Psychol. Bull. 134, 779–806.

Bagozzi, R., Yi, Y., 1988. On the evaluation of structural equation models Citerat av mig. J. Acad. Market. Sci. 16, 74–94.

Baker, T., Nelson, R.E., 2005. Creating something from nothing: resource construction through entrepreneurial bricolage. Adm. Sci. Q. 50, 329–366. https://doi.org/10.2189/asqu.2005.50.3.329.

Baldwin, C., von Hippel, E., 2011. Modeling a paradigm shift: from producer innovation to user and open collaborative innovation. Organ. Sci. 22, 1399–1417. https://doi.org/10.1287/orsc.1100.0618.

Baldwin, C.Y., 2019. Platform systems vs. Step processes-the value of options and the power of modularity. In: Design Rules, vol. 2. Harvard Business School Research Paper Series, pp. 19–73. How Technology Shapes Organizations.

Baldwin, C.Y., 2018. Chapter 14 introducing open platforms and business ecosystems. In: Design Rules, vol. 2. Harvard Business School, Harvard Business School Research Paper Series, pp. 19–35. How Technology Shapes Organizations.

Baldwin, C.Y., 2012. Organization design for business ecosystems. J. Organ Dysfunct. 1, 20–23. https://doi.org/10.7146/jod.2012.1.7.

Bargh, J.A., 1989. Conditional automaticity: Varieties of automatic influence in social perception and cognition. Unintended thought,, 3–51.

Bargh, J.A., Pratto, F., 1986. Individual construct accessibility and perceptual selection. J. Exp. Soc. Psychol. 22, 293–311. https://doi.org/10.1016/0022-1031(86)90016-8.

Baron, R.A., 2006. Opportunity recognition as pattern recognition: How entrepreneurs "connect the dots" to identify new business opportunities. Acad. Manag. Perspect. 20, 104–119.

Baron, R.A., 2008. The role of affect in the entrepreneurial process. Acad. Manag. Rev. 33, 328–340.

Baron, R.A., 2004. The cognitive perspective: a valuable tool for answering entrepreneurship's basic "why" questions. J. Bus. Ventur. 19, 221–239.

Bartlett, M., 1937. Properties of sufficiency and statistical tests. Proc. R. Stat. Soc. Ser. A 160, 268–282.

Becker, G.S., 1964. Human Capital. University of Chicago Press, Chicago.

Bentler, P.M., 1995. EQS Structural Equations Program Manual. Multivariate Software.

Bentler, P.M., Bonett, D.G., 1980. Significance tests and goodness of fit in the analysis of covariance structures. Psychol. Bull. 88, 588–606.

Berlyne, D.E., 1978. Curiosity and learning. Motiv. Emot. https://doi.org/10.1007/BF00993037.

Birdi, K., Leach, D., Magadley, W., 2016. The relationship of individual capabilities and environmental support with different facets of designers' innovative behavior. J. Prod. Innovat. Manag. 33, 19–35. https://doi.org/10.1111/jpim.12250.

Blume, B.D., Covin, J.G., 2011. Attributions to intuition in the venture founding process: do entrepreneurs actually use intuition or just say that they do? J. Bus. Ventur. 26, 137–151. https://doi.org/10.1016/j.jbusvent.2009.04.002.

Bogers, M., West, J., 2012. Managing distributed innovation: strategic utilization of open and user innovation. Creativ. Innovat. Manag. 21, 61–75. https://doi.org/10.1111/j.1467-8691.2011.00622.x.
Browne, M.W., Cudeck, R., Bollen, K.A., Long, J.S., 1993. Alternative ways of assessing model fit. Sage Focus Ed 154, 136.
Burroughs, J.E., Dahl, D.W., Moreau, C.P., Chattopadhyay, A., Gorn, G.J., 2011. Facilitating and rewarding creativity during new product development. J. Market. 75, 53–67. https://doi.org/10.1509/jmkg.75.4.53.
Busenitz, L.W., 1996. Research on entrepreneurial alertness: sampling, measurement, and theoretical issues. J. Small Bus. Manag. 34, 35–45. https://doi.org/10.1016/j.jbusvent.2010.07.001.
Byrne, B.M., 1994. Structural Equation Modeling with EQS and EQS/Windows: Basic Concepts, Applications, and Programming. Sage, University of Ottawa, Canada.
Carayannis, E.G., Campbell, D.F.J., 2009. "Mode 3" and "Quadruple Helix": toward a 21st century fractal innovation ecosystem. Int. J. Technol. Manag. https://doi.org/10.1504/ijtm.2009.023374.
Cavicchi, A., Santini, C., Bailetti, L., 2014. Mind the "academician-practitioner" gap: an experience-based model in the food and beverage sector. Qual. Mark. Res. Int. J. 17, 319–335. https://doi.org/10.1108/QMR-07-2013-0047.
Chandra, Y., Coviello, N., 2010. Broadening the concept of international entrepreneurship: 'Consumers as international entrepreneurs'. J. World Bus. 45 (3), 228–236.
Chavoushi, Z.H., Zali, M.R., Valliere, D., Faghih, N., Hejazi, R., Dehkordi, A.M., 2021. Entrepreneurial alertness: a systematic literature review. J. Small Bus. Entrep. https://doi.org/10.1080/08276331.2020.1764736.
Cheng, C.F., Chang, M.L., Li, C.S., 2013. Configural paths to successful product innovation. J. Bus. Res. 66, 2561–2573. https://doi.org/10.1016/j.jbusres.2012.10.006.
Chesbrough, H., 2003. Open Innovation: the New Imperative for Creating and Profiting from Technology. Harvard Business School Press, Boston, MA.
Corbett, A.C., 2005. Experiential learning within the process of opportunity identification and exploitation. Enterpren. Theor. Pract. 29, 473–491. https://doi.org/10.1111/j.1540-6520.2005.00094.x.
Davidson, S., 1998. Spinning the wheel of empowerment. Planning 1262, 14–15.
Davidsson, P., 2017. Entrepreneurial opportunities as propensities: do Ramoglou & Tsang move the field forward? J. Bus. Ventur. Insights 7, 82–85. https://doi.org/10.1016/j.jbvi.2016.02.002.
Davidsson, P., 2015. Entrepreneurial opportunities and the entrepreneurship nexus: a re-conceptualization. J. Bus. Ventur. 30, 674–695. https://doi.org/10.1016/j.jbusvent.2015.01.002.
Davis, F.D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of informationtechnology. MIS Q. 13 (3), 319–340.
Davis, F.D., Bagozzi, R.P., Warshaw, P.R., 1989. User acceptance of computer technology: Acomparison of two theoretical models. Manag. Sci. 35 (8), 982–1003.
Dimov, D.P., Shepherd, D.A., 2005. Human capital theory and venture capital firms: exploring "home runs" and "strike outs. J. Bus. Ventur. 20, 1–21. https://doi.org/10.1016/j.jbusvent.2003.12.007.
Dini, P., Iqani, M., Mansell, R., 2011. The (im)possibility of interdisciplinarity: lessons from constructing a theoretical framework for digital ecosystems. Cult. Theor. Critiq. https://doi.org/10.1080/14735784.2011.621668.
Doll, W.J., Xia, W., 1997. Confirmatory factor analysis of the end-user computing satisfaction instrument: a replication. J. Organ. End User Comput. 9, 24–31.
Doll, W.J., Xia, W., Torkzadeh, G., 1994. A confirmatory factor analysis of the end-user computing satisfaction instrument. MIS Q. 453–461.
Dutta, D.K., Crossan, M.M., 2005. The nature of entrepreneurial Opportunities: understanding the process using the 4I organizational learning framework. Enterpren. Theor. Pract. 29, 425–449. https://doi.org/10.1111/j.1540-6520.2005.00092.x.
Eckhardt, J.T., Shane, S.A., 2013. Response to the commentaries: the individual-opportunity (IO) nexus integrates objective and subjective aspects of entrepreneurship. Acad. Manag. Rev. https://doi.org/10.5465/amr.2012.0192.
European Comission, 2008. Evaluation on Policy - Promotion of Women Innovators and Entrepreneurship.
European Commission, 2017. European innovation scoreboard 2017 - methodology report. Eur. Innov. Scorec. https://doi.org/10.2873/571375.
European Commission, 2010. Communication from the Commission EUROPE 2020 A strategy for smart, sustainable and inclusive growth. Com(2010) 2020. https://doi.org/10.1016/j.resconrec.2010.03.010.
Eurostat, 2020. Small and medium-sized enterprises: an overview, Eurostat News published on 14 May 2020, https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20200514-1.
Fellnhofer, K., 2018. Visualised bibliometric mapping on smart specialisation: a co-citation analysis. Int. J. Knowl. Base. Dev. 9, 76–99. https://doi.org/10.1504/IJKBD.2018.090502.
Fellnhofer, K., 2017. Evidence revisited: literature on smart specialisation calls for more mixed research designs. Int. J. Knowl. Base. Dev. 8, 229–248. https://doi.org/10.1504/IJKBD.2017.086407.
Fiet, J.O., 2007. A prescriptive analysis of search and discovery. J. Manag. Stud. 44, 592–611.
Fiet, J.O., 2002. The Systematic Search for Entrepreneurial Discoveries. Quorum, Westport, CT.
Fiet, J.O., Clouse, V.G.H., Norton Jr., W.I., 2004. Systematic search by repeat entrepreneurs. Oppor. Identif. Entrep. Behav. 1–27.
Fiske, S.T., Taylor, S.E., 2013. Social cognition: From brains to culture. Sage Publications Ltd.
Foray, D., 2013. Smart specialisation and the New Industrial Policy agenda. Policy Brief 8, 1–15.
Foray, D., 2015. Smart Specialisation: Opportunities and Challenges for Regional Innovation Policy, Smart Specialisation: Opportunities and Challenges for Regional Innovation Policy. Routledge, Abingdon.
Fornell, C., Larcker, D.F., 1981. Structural equation models with unobservable variables and measurement error: algebra and statistics. J. Mark. Res. 18, 382–388.
Franke, N., Von Hippel, E., Schreier, M., 2006. Finding commercially attractive user innovations: a test of lead-user theory. J. Prod. Innovat. Manag. 23, 301–315. https://doi.org/10.1111/j.1540-5885.2006.00203.x.
Fuchs, T., 2001. The tacit dimension. Philos. Psychiatr. Psychol. 8, 323–326. https://doi.org/10.1353/ppp.2002.0018.
Fung, A., 2006. Varieties of participation in complex governance. Publ. Adm. Rev. 66, 66–75.
Gaglio, C.M., 2004. The role of mental simulations and counterfactual thinking in the opportunity identification process. In: Entrepreneurship: Theory and Practice, pp. 533–552. https://doi.org/10.1111/j.1540-6520.2004.00063.x.
Gaglio, Marie, Connie, Katz, J.A., 2001a. The psychological basis of opportunity identification: entrepreneurial alertness. Small Bus. Econ. https://doi.org/10.1023/A:1011132102464.
Gaglio, Marie, Connie, Katz, J.A., 2001b. The psychological basis of opportunity identification: entrepreneurial alertness. Small Bus. Econ. 16, 95–111.
Gaglio, C.M., Katz, J.A., 2001. The psychological basis of opportunity identification: entrepreneurial alertness. J. Small Bus. Econ. 16, 95–111.
Ganco, M., Kapoor, R., Lee, G., 2019. From rugged landscapes to rugged ecosystems: structure of interdependencies and firms' innovative search. Acad. Manag. Rev. https://doi.org/10.5465/amr.2017.0549.
Gawer, A., 2014. Bridging differing perspectives on technological platforms: toward an integrative framework. Res. Pol. 43, 1239–1249. https://doi.org/10.1016/j.respol.2014.03.006.
Gheorghiu, R., Andreescu, L., Curaj, A., 2016. A foresight toolkit for smart specialization and entrepreneurial discovery. Futures 80, 33–44.
Gimeno, J., Folta, T.B., Cooper, A.C., Woo, C.Y., 1997. Survival of the fittest? Entrepreneurial human capital and the persistence of underperforming firms. Adm. Sci. Q. 42, 750–783.
Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., 1995. Multivariate data analysis, 4th ed. PrenticeHall, Englewood Cliffs, NJ.
Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., 2010a. Multivariate Data Analysis: A Global Perspective, seventh ed. Pearson Prentice Hall, New Jersey.
Hair, J.F., Black, B., Babin, B., Anderson, R.E., Tatham, R.L., 2010b. Multivariate Data Analysis, seventh ed. Prentice Hall, Upper Saddle River, NJ.
Hargadon, A.B., Bechky, B.A., 2006. When collections of creatives become creative collectives: a field study of problem solving at work. Organ. Sci. 17, 484–500. https://doi.org/10.1287/orsc.1060.0200.
Hienerth, C., 2006. The commercialization of user innovations: the development of the rodeo kayak industry. R D Manag. 36, 273–294. https://doi.org/10.1111/j.1467-9310.2006.00430.x.
Higgins, E.T., 2006. Value from hedonic experience and engagement. Psychol. Rev. 113, 439–460. https://doi.org/10.1037/0033-295X.113.3.439.
Hill, R.C., Levenhagen, M., 1995. Metaphors and mental models: sensemaking and sensegiving in innovative and entrepreneurial activities. J. Manag. 21, 1057–1074. https://doi.org/10.1177/014920639502100603.
Holcomb, T.R., Ireland, R.D., Holmes, R.M., Hitt, M.A., 2009. Architecture of entrepreneurial learning: exploring the link among heuristics, knowledge, and action. Enterpren. Theor. Pract. 33, 167–192. https://doi.org/10.1111/j.1540-6520.2008.00285.x.
Hu, L., Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct. Equ. Model. A Multidiscip. J. 6, 1–55.
Hurlbert, M., Gupta, J., 2015. The split ladder of participation: a diagnostic, strategic, and evaluation tool to assess when participation is necessary. Environ. Sci. Pol. 50, 100–113.
Iansiti, M., Levien, R., 2004. The keystone advantage: What the new dynamics of business ecosystems mean for strategy, innovation, and sustainability. Harvard Business Press Book, Cambridge.
Jaccard, J., Wan, C.K., 1996. LISREL Approaches to Interaction Effects in Multiple Regression. Sage Publications, Inc., Thousand Oaks, CA, US.
Jacobides, M.G., Cennamo, C., Gawer, A., 2018. Towards a theory of ecosystems. Strateg. Manage. J. 39, 2255–2276. https://doi.org/10.1002/smj.2904.
Jakobsen, S.E., Fløysand, A., Overton, J., 2019. Expanding the field of Responsible Research and Innovation (RRI)–from responsible research to responsible innovation. Eur. Plann. Stud. https://doi.org/10.1080/09654313.2019.1667617.
Kahn, B., O'Donnell, P., Wernsman, J., Bushell, L., Kavanaugh, A., 2007. Making the connection: legal advocacy and mental health services. Fam. Court Rev. 45, 486–500. https://doi.org/10.1111/j.1744-1617.2007.00164.x.
Kaiser, H.F., 1974. An index of factorial simplicity. Psychometrika 39 (1), 31–36.
Kaish, S., Gilad, B., 1991. Characteristics of opportunities search of entrepreneurs versus executives: sources, interests, general alertness. J. Bus. Ventur. 6, 45–61.
Kapoor, R., 2018. Ecosystems: broadening the locus of value creation. J. Organ Dysfunct. 7 https://doi.org/10.1186/s41469-018-0035-4.
Kapoor, R., Agarwal, S., 2017. Sustaining superior performance in business ecosystems: evidence from application software developers in the iOS and android smartphone ecosystems. Organ. Sci. 28, 531–551. https://doi.org/10.1287/orsc.2017.1122.
Kapoor, R., Lee, J.M., 2013. Coordinating and competing in ecosystems: how organizational forms shape new technology investments. Strat. Manag. J. 34, 274–296. https://doi.org/10.1002/smj.2010.

Keh, H.T., Foo, M. Der, Lim, B.C., 2002. Opportunity evaluation under risky conditions: the cognitive processes of entrepreneurs. Enterpren. Theor. Pract. 27, 125–148. https://doi.org/10.1111/1540-8520.00003.

Ketchen, D.J., Ireland, R.D., Snow, C.C., 2007. Strategic entrepreneurship, collaborative innovation, and wealth creation. Strateg. Entrep. J. 1, 371–385. https://doi.org/10.1002/sej.20.

Kirzner, I., 1973a. Competition and Entrepreneurship. University of Chicago Press, Chicago.

Kirzner, I., 1973b. Competition and entrepreneurship (chicago, 1973), perception, opportunity, and profit. In: Studies in the Theory of Entrepreneurship. University of Chicago Press, Chicago, Illinois.

Kirzner, I.M., 1999. Creativity and/or alertness: a reconsideration of the Schumpeterian entrepreneur. Rev. Austrian Econ. 11, 5–17.

Kirzner, I.M., 1997. Entrepreneurial discovery process and the competitive market process: an Austrian approach. J. Econ. Lit. 35, 60–85. https://doi.org/10.2307/2729693.

Kirzner, I.M., 1985. Discovery and the Capitalist Process. University of Chicago Press, Chicago.

Kirzner, I.M., 1979a. Perception, Opportunity, and Profit. University of Chicago Press, Chicago.

Kirzner, Israel M., 1979b. Perception, Opportunity, and Profit: Studies in the Theory of Entrepreneurship. University of Chicago Press, Chicago.

Leenders, M.A.A.M., Voermans, C.A.M., 2007. Beating the odds in the innovation arena: the role of market and technology signals classification and noise. Ind. Market. Manag. 36, 420–429. https://doi.org/10.1016/j.indmarman.2005.10.004.

Lehrer, J., 2008. The eureka hunt. New Yorker Ann. Sci. July 28 1–9.

Li, C., Murad, M., Shahzad, F., Khan, M.A.S., Ashraf, S.F., Dogbe, C.S.K., 2020. Entrepreneurial passion to entrepreneurial behavior: role of entrepreneurial alertness, entrepreneurial self-efficacy and proactive personality. Front. Psychol. https://doi.org/10.3389/fpsyg.2020.01611.

Loewenthal, K.M., 2004. An introduction to psychological tests and scales, 2nd ed. Psychology Press, Hove.

Lumpkin, G.T., Lichtenstein, B.B., 2005. The role of organizational learning in the opportunity-recognition process. Enterpren. Theor. Pract. 29, 451–472.

Lund, A.M., 2001. Measuring usability with the use questionnaire12. Usability Interface 8 (2), 3–6.

Magro, E., Wilson, J.R., 2018. Policy-mix evaluation: governance challenges from new place-based innovation policies. Res. Policy in press. https://doi.org/10.1016/j.respol.2018.06.010.

Martínez-López, D., Palazuelos-Martínez, M., 2014. Breaking with the Past in Smart Specialisation: A New Model of Selection of Business Stakeholders within the Entrepreneurial Process of Discovery (No. 1401). Universidade de Vigo, GEN-Governance and Economics research Network.

Matlin, M.W., Foley, H.J., 2001. Sensation and Perception. Allyn and Bacon, Boston.

McAdam, M., Miller, K., McAdam, R., 2018. Understanding Quadruple Helix relationships of university technology commercialisation: a micro-level approach. Stud. High Educ. 43, 1058–1073. https://doi.org/10.1080/03075079.2016.1212328.

Mejlgaard, N., Bloch, C., Madsen, E.B., 2019. Responsible research and innovation in Europe: a cross-country comparative analysis. Sci. Publ. Pol. https://doi.org/10.1093/scipol/scy048.

Mitchell, R.K., Busenitz, L.W., Bird, B., Marie Gaglio, C., McMullen, J.S., Morse, E.A., Smith, J.B., 2007a. The central question in entrepreneurial cognition research. Enterpren. Theor. Pract. 31, 1–27. https://doi.org/10.1111/j.1540-6520.2007.00161.x.

Mitchell, R.K., Busenitz, L.W., Bird, B., Marie Gaglio, C., McMullen, J.S., Morse, E.A., Smith, J.B., 2007b. The central question in entrepreneurial cognition research 2007. Enterpren. Theor. Pract. https://doi.org/10.1111/j.1540-6520.2007.00161.x.

Moore, J.F., 1996. The Death of Competition: Leadership and Strategy in the Age of Business Ecosystems, Leadership. Harper Paperbacks, New York.

Mulaik, S.A., James, L.R., Van Alstine, J., Bennett, N., Lind, S., Stilwell, C.D., 1989. Evaluation of goodness-of-fit indices for structural equation models. Psychol. Bull. 105, 430–445.

Murphy, P.J., 2011. A 2× 2 conceptual foundation for entrepreneurial discovery theory. Enterpren. Theor. Pract. 35, 359–374.

Nambisan, S., Sawhney, M., 2011. Orchestration processes in network-centric innovation: evidence from the field. Acad. Manag. Perspect. 25, 40–57. https://doi.org/10.5465/AMP.2011.63886529.

Nieth, L., Benneworth, P., Charles, D., Fonseca, L., Rodrigues, C., Salomaa, M., Stienstra, M., 2018. Embedding entrepreneurial regional innovation ecosystems: reflecting on the role of effectual entrepreneurial discovery processes. Eur. Plann. Stud. 26, 2147–2166. https://doi.org/10.1080/09654313.2018.1530144.

Nunnally, J. C. (1979). Nunally psychometric theory. McGrawhill, New York.Penrose, E. T. 1959/1995. The Theory of the Growth of the Firm. 3rd ed. Oxford UniversityPress, Oxford.

Ommen, N.O., Blut, M., Backhaus, C., Woisetschläger, D.M., 2016. Toward a better understanding of stakeholder participation in the service innovation process: more than one path to success. J. Bus. Res. 69, 2409–2416.

Overholm, H., 2015. Collectively created opportunities in emerging ecosystems: the case of solar service ventures. Technovation 39–40, 14–25. https://doi.org/10.1016/j.technovation.2014.01.008.

Oviatt, B.M., McDougall, P.P., 2005. Defining international entrepreneurship and modeling the speed of internationalization. Enterpren. Theor. Pract. 29, 537–553.

Parker, G., Van Alstyne, M., Jiang, X., 2017. Platform ecosystems: how developers invert the firm. MIS Q. Manag. Inf. Syst. https://doi.org/10.25300/MISQ/2017/41.1.13.

Parker, M., Acland, A., Armstrong, H.J., Bellingham, J.R., Bland, J., Bodmer, H.C., Burall, S., Castell, S., Chilvers, J., Cleevely, D.D., Cope, D., Costanzo, L., Dolan, J.A., Doubleday, R., Feng, W.Y., Godfray, H.C.J., Good, D.A., Grant, J., Green, N., Groen, A.J., Guilliams, T.T., Gupta, S., Hall, A.C., Heathfield, A., Hotopp, U., Kass, G., Leeder, T., Lickorish, F.A., Lueshi, L.M., Magee, C., Mata, T., McBride, T., McCarthy, N., Mercer, A., Neilson, R., Ouchikh, J., Oughton, E.J., Oxenham, D., Pallett, H., Palmer, J., Patmore, J., Petts, J., Pinkerton, J., Ploszek, R., Pratt, A., Rocks, S.A., Stansfield, N., Surkovic, E., Tyler, C.P., Watkinson, A.R., Wentworth, J., Willis, R., Wollner, P.K.A., Worts, K., Sutherland, W.J., 2014. Identifying the science and technology dimensions of emerging public policy issues through horizon scanning. PloS One 9. https://doi.org/10.1371/journal.pone.0096480.

Penrose, E., 1996. The theory of the growth of the firm. Long. Range Plan. 29, 596. https://doi.org/10.1016/S0024-6301(96)90295-2.

Perry-Smith, J.E., 2006. Social yet creative: The role of social relationships in facilitating individual creativity. Acad. Manag. J. 49 (1), 85–101.

Ramoglou, S., Tsang, E.W.K., 2016. A realist perspective of entrepreneurship: opportunities as propensities. Acad. Manag. Rev. https://doi.org/10.5465/amr.2014.0281.

Reed, S.K., 2004. Cognition: Theories and Applications, sixth ed. Wadsworth/Thomson Learning, Belmont, CA.

Rigdon, E.E., 1996. CFI versus RMSEA: a comparison of two fit indexes for structural equation modeling. Struct. Equ. Model. A Multidiscip. J. 3, 369–379.

Rojas, L.A., Macías, J.A., 2013. Bridging the gap between information architecture analysis and software engineering in interactive web application development. Sci. Comput. Program. 78 (11), 2282–2291.

Rowe, G., Frewer, L.J., 2004. Evaluating public-participation exercises: A research agenda. Sci. Technol. Hum. Val. 29 (4), 512–556.

Rowe, G., Frewer, L.J., 2005. A typology of public engagement mechanisms. Sci. Technol. Hum. Val. 30 (2), 251–290.

Santini, C., Marinelli, E., Boden, M., Cavicchi, A., Haegeman, K., 2016. Reducing the distance between thinkers and doers in the entrepreneurial discovery process: an exploratory study. J. Bus. Res. 69, 1840–1844. https://doi.org/10.1016/j.jbusres.2015.10.066.

Sarasvathy, S.D., 2001. Causation and effectuation: toward a theoretical shift from economic inevitability to entrepreneurial contingency. Acad. Manag. Rev. 26, 243–263.

Sarasvathy, S.D., Dew, N., Velamuri, S.R., Venkataraman, S., 2003. Three views of entrepreneurial opportunity. In: Acs, Z.J., Audretsch, D.B. (Eds.), Handbook of Entrepreneurship Research: an Interdisciplinary Survey and Introduction. Kluwer, Dordrecht, The Netherlands, pp. 141–160.

Schoemaker, P.J.H., Day, G.S., Snyder, S.A., 2013. Integrating organizational networks, weak signals, strategic radars and scenario planning. Technol. Forecast. Soc. Change 80, 815–824. https://doi.org/10.1016/j.techfore.2012.10.020.

Schumpeter, J., 2006. Historia del análisis económico, Revista Venezolana de Ciencias Sociales. Editorial Ariel, Barcelona.

Scott, M.A., Simonoff, J.S., Marx, B.D., 2013. The SAGE Handbook of Multilevel Modeling, the SAGE Handbook of Multilevel Modeling. Sage Publications. https://doi.org/10.4135/9781446247600.

Sebastian, I.M., Weill, P., Woerner, S.L., 2020. Driving Growth in Digital Ecosystems. MIT Sloan Manag. Rev.

Shah, S.K., Tripsas, M., 2007. The accidental entrepreneur: the emergent and collective process of user entrepreneurship. Ssrn 1, 123–140. https://doi.org/10.2139/ssrn.1022358.

Shalley, C.E., 1995. Effects of coaction, expected evaluation, and goal setting on creativity and productivity. Acad. Manag. J. 38, 483–503. https://doi.org/10.2307/256689.

Shane, S., 2012. Reflections on the 2010 AMR decade award: delivering on the promise of entrepreneurship as a field of research. Acad. Manag. Rev. 37, 10–20. https://doi.org/10.5465/amr.2011.0078.

Shane, S., 2003. A General Theory of Entrepreneurship. The Individual-Opportunity Nexus. Edward Elgar, Cheltenham.

Shane, S., 2000. Prior knowledge and the discovery of entrepreneurial opportunities. Organ. Sci. 11, 448–469. https://doi.org/10.1287/orsc.11.4.448.14602.

Shane, S., Venkataraman, S., 2000. The promise of entrepreneurship as a field of research. Acad. Manag. Rev. 25, 217–226.

Shaver, K.G., Scott, L.R., 1991. Person, process, choice: the psychology of new venture creation. Entrep. Theory Into Pract. 16, 23–45.

Shepherd, D.A., McMullen, J.S., 2006. Entrepreneuruial action and the role of uncertainty in the thoery of the entrepreneur. Acad. Manag. Rev. 31, 132–152. https://doi.org/10.5465/AMR.2006.19379628.

Shepherd, D.A., McMullen, J.S., Jennings, P.D., 2007. Formation of opportunity beliefs: a coherence theory perspective. Strateg. Entrep. J. 1, 75–95.

Short, J.C., Ketchen, D.J., Shook, C.L., Ireland, R.D., 2010. The concept of "opportunity" in entrepreneurship research: past accomplishments and future challenges. J. Manag. 36, 40–65. https://doi.org/10.1177/0149206309342746.

Short, J.C., Moss, T.W., Lumpkin, G.T., 2009. Research in Social Entrepreneurship: past contributions and future opportunities. Strateg. Entrep. J. 3, 161–194. https://doi.org/10.1002/sej.

Sine, W.D., David, R.J., 2003. Environmental jolts, institutional change, and the creation of entrepreneurial opportunity in the US electric power industry. Res. Pol. 32, 185–207. https://doi.org/10.1016/S0048-7333(02)00096-3.

Sparkman, R.M., Hair, J.F., Anderson, R.E., Tatham, R.L., Grablowsky, B.J., 1979. Multivariate data analysis with readings. J. Market. Res. https://doi.org/10.2307/3150726.

Stam, E., 2015a. Entrepreneurial ecosystems and regional policy: a sympathetic critique. Eur. Plann. Stud. https://doi.org/10.1080/09654313.2015.1061484.

Stam, E., 2015b. Entrepreneurial ecosystems and regional policy: a sympathetic critique. Eur. Plann. Stud. 23, 1759–1769. https://doi.org/10.1080/09654313.2015.1061484.
Storr, V.H., John, A., 2015. The determinants of entrepreneurial alertness and the characteristics of successful entrepreneurs. In: Culture and Economic Action. https://doi.org/10.4337/9780857931733.00009.
Sussan, F., Acs, Z.J., 2017. The digital entrepreneurial ecosystem. Small Bus. Econ. https://doi.org/10.1007/s11187-017-9867-5.
Tang, J., Kacmar, K.M.M., Busenitz, L., 2012. Entrepreneurial alertness in the pursuit of new opportunities. J. Bus. Ventur. 27, 77–94.
Taylor, S.E., 1981. The interface of cognitive and social psychology. In: Harvey, J. (Ed.), Cognition, Social Behavior, and the Environment. Erlbaum, Hillsdale, N.J., pp. 189–211
Tripsas, M., 2008. Customer preference discontinuities: a trigger for radical technological change. Manag. Decis. Econ. 29, 79–97. https://doi.org/10.1002/mde.1389.
Uldall-Espersen, T., Frøkjær, E., 2007. Usability and software development: roles of the stakeholders. In: Proceedings of the 12th International Conference. HCI International, pp. 642–651. https://doi.org/10.1007/978-3-540-73105-4_71, 2007.
Urban, B., 2019. Institutional influence on entrepreneurial alertness and business growth in an emerging market context. Inst. Econ.
Valliere, D., 2013a. Towards a schematic theory of entrepreneurial alertness. J. Bus. Ventur. https://doi.org/10.1016/j.jbusvent.2011.08.004.
Valliere, D., 2013b. Towards a schematic theory of entrepreneurial alertness. J. Bus. Ventur. 28, 430–442.
Venkataram, S., 1997. The distinctive domain of entrepreneurship research. In: Katz, J., Brockhaus, R. (Eds.), Advances in Entrepreneurship, Firm Emergence, and Growth. JAI Press, Greenwich, Conn., pp. 119–138
von Hippel, E., 2005. Democratizing Innovation. MIT Press, Cambridge, MA.
Von Schomberg, R., 2013. A vision of responsible research and innovation. In: Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society, pp. 51–74. https://doi.org/10.1002/9781118551424.ch3.
Wall, T.U., McNie, E., Garfin, G.M., 2017. Use-inspired science: making science useable by and useful to decision makers. Front. Ecol. Environ. 15, 551–559. https://doi.org/10.1002/fee.1735.
Weick, K.E., 1996. Drop your tools: an allegory for organizational studies. Adm. Sci. Q. 41, 301–313. https://doi.org/10.2307/2393722.
West, J., Wood, D., 2013. Evolving an open ecosystem: the rise and fall of the Symbian platform. Adv. Strat. Manag. 30, 27–67. https://doi.org/10.1108/S0742-3322(2013)0000030005.
Wiklund, J., Shepherd, D., 2003. Knowledge-based resources, entrepreneurial orientation, and the performance of small and medium-sized businesses. Strat. Manag. J. 24, 1307–1314.
Wood, M.S., 2017. Misgivings about dismantling the opportunity construct. J. Bus. Ventur. Insights 7, 21–25. https://doi.org/10.1016/j.jbvi.2017.01.001.
Yin, X., Zhang, J., Wang, X., 2004. Sequential Injection Analysis System for the Determination of Arsenic by Hydride Generation Atomic Absorption Spectrometry. Fenxi Huaxue. Chicago University Press, Chicago, IL. https://doi.org/10.1017/CBO9781107415324.004.
Yu, T.F., 2001. Entrepreneurial alertness and discovery. Rev. Austrian Econ. 14, 47–63. https://doi.org/10.1023/A:1007855505727.

Katharina Fellnhofer is a Marie-Curie-Fellow at the Swiss Federal Institute of Technology Zürich, ETH Zürich, Switzerland, also hosted by Harvard University, Department of Sociology. Katharina is the founder of the Research and Innovation Management GmbH, an enterprise focusing on research projects under the European framework programme. As an Erwin-Schrödinger-Fellow she was a docent at the Lappeenranta University of Technology, Finland. She holds a doctorate in social and economic sciences from the University of Innsbruck, Austria.