# The undigital behavior of innovative startups: empirical evidence and taxonomy of digital innovation strategies

Piera Centobelli
*Department of Industrial Engineering, University of Naples Federico II, Naples, Italy*
Roberto Cerchione
*Department of Engineering, University of Naples Parthenope, Naples, Italy*
Emilio Esposito
*Department of Industrial Engineering, University of Naples Federico II, Naples, Italy, and*
Renato Passaro and Ivana Quinto
*Department of Engineering, University of Naples Parthenope, Naples, Italy*

Received 4 August 2021
Revised 12 January 2022
28 April 2022
Accepted 10 June 2022

## Abstract

**Purpose** – This paper aims to conceptualize the digital behavior of startups and investigate the emerging behaviors about digital strategies of the Italian startup firms enrolled in the Startup Act policy initiative. Digital technologies were divided into intra- and inter-organizational digital infrastructures, and this categorization offers startups the opportunity to identify a set of enabling technologies that could be used to improve their digital strategies.

**Design/methodology/approach** – An empirical analysis has been conducted to investigate the degree of adoption of digital intra- and inter-organizational digital infrastructures in the entire population of 6,178 Italian firms listed in the Register of Innovative Startups.

**Findings** – The paper proposes a taxonomy bringing together four startup behaviors for adopting digital technologies: digital follower, technical influencer, social influencer and digital leader. From the perspective of policy makers, considering the financial efforts that public authorities are supporting in the last decade, implications are mainly concerned with policy measures aimed both to reinforce the overall adoption of digital technologies and to develop a balanced adoption of intra- and inter-organizational digital infrastructures.

**Originality/value** – Measures addressed to support female and foreign entrepreneurship could be useful to support a more dynamic and well-balanced cultural and racial contamination, thus improving the adoption of digital tools.

**Keywords** Digital behavior, Digitalization, Digital transformation, Digital infrastructures, Emergent entrepreneurship, Startups, Startup strategies

**Paper type** Research paper

## 1. Introduction

The rapid development of digital technology has deeply impacted on the business processes and entrepreneurial activities, questioning the extant innovation and entrepreneurship



International Journal of Entrepreneurial Behavior & Research
Vol. 28 No. 9, 2022
pp. 219-241
Emerald Publishing Limited
1355-2554
DOI 10.1108/IJEBR-08-2021-0626

theories (Berger and Kuckerts, 2016a, b; Castagna *et al.*, 2020; Cerchione *et al.*, 2022; Kraus *et al.*, 2019; Nambisan *et al.*, 2017; Zaheer *et al.*, 2019).

A vast literature highlights that digitalization is achieving a crucial role in the global economy and a pivotal importance for the competitiveness of firms operating in both manufacturing and service industries (Nambisan *et al.*, 2017). A growing number of papers are showing how firms can leverage digitalization to promote significant product and process innovations and cultural changes affecting simultaneously different types of performance, i.e. economic and financial, environmental, human, market, organizational, social, technical and technological (Guenther *et al.*, 2016; Kraus *et al.*, 2019; Prause and Günther, 2019; Raguseo and Vitari, 2018; Saldanha *et al.*, 2013, 2017). Therefore, digitalization is opening up fascinating innovation opportunities for innovators, entrepreneurs and society (Decker and Günther, 2016; Gottschalck and Günther, 2017; Cohen *et al.*, 2017; Nambisan, 2017; Ramaswamy and Ozcan, 2018).

The convergence between digital technologies and entrepreneurship has led to the rise of a new research stream known as *digital entrepreneurship*.

The concept of digital entrepreneurship refers to the use of digital technology to support the creation of new ventures and the transformation of existing ones (European Commission, 2015). In particular, these firms are characterized by a high intensive use of digital technologies to execute different business operations and activities (Ismail *et al.*, 2012), define new business models and strategies (Elia *et al.*, 2020) and engage with customers and stakeholders (Shabbir *et al.*, 2016). For example, technologies such as social media, analytics and big data are strongly supporting the new venture creation process, from idea generation and opportunity recognition to production, marketing and distribution, reducing the barriers between invention and business creation (Steininger, 2019).

Digital technologies have rendered entrepreneurial processes less constrained than in the traditional economy (Sahut *et al.*, 2021), created a new fluidity with the regard to the easier and quicker transition between different phases, improved innovation performance (Nambisan, 2017), supported the reduction of invention-to-innovation barriers (Nambisan, 2017) and enabled the development of key relationships with different partners (Elia *et al.*, 2020), thus accelerating the evolution of new ventures (Huang *et al.*, 2017).

Overall, digital technologies play a critical role in every organization, especially for startups (Setia *et al.*, 2013; Ghezzi and Cavallo, 2020). In fact, with digital technologies large companies, and small and medium firms can exploit additional innovation and entrepreneurial opportunities, make their activities more manageable, improve customer service performances, increase efficiencies and reduce costs (Huang *et al.*, 2017; Kraus *et al.*, 2019; Rippa and Secundo, 2019).

More specifically, the established organizational routines and innovation processes affecting firm's strategies are likely changing together with the direction being identified by the adoption of digital solutions. For instance, the processes of data acquisition, storage and transfer are changing in terms of the amount of data and information to be managed due to the emergence of appropriate digital infrastructures (Sundblad, 2018). Similarly, firms adopting digital solutions have to acquire and transform different types of external data compared to non-digital firms, thus requiring the opportunity to use new enabling technologies (Laursen and Salter, 2006; Mazzola *et al.*, 2016).

Nevertheless, despite there being a consolidated body of literature that analyses the processes of digitalization in both large companies and small and medium enterprises, as regards startups the literature is still unstructured. More in details, while the literature proposes different approaches for dealing with digitalization in established firms, focusing on the critical factors driving or hindering the adoption of digital technologies, the specific enabling solutions adopted and their impact on firms' performance, only in

recent times an increasing number of contributions have been focusing on digitalization in startups (Liu *et al.*, 2012; Presutti *et al.*, 2011; Rubin *et al.*, 2015) and the role of a digital technology perspective of emergent entrepreneurship (Aldrich, 2014; Audretsch and Belitski, 2020; Audretsch *et al.*, 2019a, b; Dy *et al.*, 2017; Kuester *et al.*, 2018; Nambisan, 2022; Kuester *et al.*, 2018) as already identified by the recent literature review on the topic published by Rippa and Secundo (2019).

According to Centobelli *et al.* (2017), in today's competitive environment, the significance of managing digitalization in startups is demonstrated by one of the most known definitions of startup provided by Blank and Dorf (2012) as an "organization formed to search for a repeatable and scalable business model". In fact, due to the scarcity of tangible assets that characterizes a startup, it is necessary to leverage on digital technologies to manage intangible resources, mainly data, information and knowledge and achieve scalability objectives (Liu *et al.*, 2012; Presutti *et al.*, 2011; Rubin *et al.*, 2015). Furthermore, thanks to digital technologies, product ideas and business models can be quickly defined, tested, validated, modified and re-developed through experimentation and implementation cycles (Ries, 2011). Hence, entrepreneurs can promptly scale their ideas into viable businesses while exploiting digital technologies (Sahut *et al.*, 2021). In fact, the digitalization of the entrepreneurial processes has significantly favored the reduction of invention-to-innovation barriers (Anderson, 2014; Steininger, 2019).

In this framework, considering that startups are seen as one the most important channels for the social and economic development, industrial changing and renewal and employment net rate (Audretsch, 2007; OECD, 2017), it is key to shed light on the digital behaviors of the startups (Zaheer *et al.*, 2019) and on the related affecting factors. Digital behavior indicates the strategy startups pursuit in terms of what digital technologies they use and for what aims.

Moreover, leaving Italian firms almost exclusively to take advantage of administrative and economic advantages on which to leverage to establish themselves on the markets has led to the development of a startups characterized by a weak digital behavior, which can constitute a weakness for the survival and development of startups (Brynjolfsson and Saunders, 2009; Kraus *et al.*, 2019; Sahut *et al.*, 2021). This result also reflects the findings of other studies revealing the low attitude in attracting equity funding by the digital-related sectors in Italy (Breschi *et al.*, 2018) and the gap between Italy and the major developed countries in establishing an entrepreneurial environment for innovative startups which is caused by various factors including the use of digital technologies (OECD, 2018).

Based on the above-described scenario, this paper provides the main findings of an empirical analysis conducted in the entire population of 6,178 Italian firms listed in the Register of Innovative Startups in 2018, which allowed us to provide a first overview on this topic.

In particular, the main aim of the present paper is threefold: (1) to identify the digital behaviors of startups, (2) to provide a taxonomy of the digital behaviors of the Italian startup firms enrolled in the Startup Act policy initiative and (3) to proposes a useful framework to identify possible strategies to improve current startups' digital behaviors.

This topic seems to be very interesting for both researchers and practitioners due to the role played by digital technologies in supporting the development, survival and success of enterprises (Kraus *et al.*, 2019; Sahut *et al.*, 2021), especially for startups (Secundo *et al.*, 2021).

The paper is structured in seven sections. After this introduction, the conceptual background is illustrated. The third section presents the materials and methods adopted, whereas the context of investigation is described in the fourth section. The results regarding startup digital behaviors are analyzed in the fifth section; the sixth section proposes a taxonomy of startup digital behaviors, and the discussion is presented in the seventh section.

The final section includes conclusions and implications and identifies future research directions to be explored.

## 2. Conceptual background

Digital technologies are providing a growing number of opportunities for companies in terms of innovation processes (Secundo *et al.*, 2020, 2021; Urbinati *et al.*, 2020). Some of these digital solutions are easy to implement, cheap, malleable, editable and interactive (Nambisan *et al.*, 2017). Additionally, several studies show that digitization is deeply affecting entrepreneurial outputs (products/services) and processes (Aldrich, 2014; Huang *et al.*, 2017; Nambisan, 2017). As for products and services digitalization, it implicates a greater flexibility by offering outputs, which continue to evolve even after they have been introduced to the market. Due to the digital technologies, entrepreneurs can continuously and easily redefine their value proposition according to the re-scoping of the business opportunity (Nambisan, 2017). This means that entrepreneurs are called upon to define more dynamic innovation and entrepreneurial paths or trajectories and also because they are facilitated by the use of digital technologies (Nambisan *et al.*, 2017).

Digitalization of entrepreneurial processes let quicker product ideas and business models evolution, as well as an extreme business scalability (i.e. the ability to rapidly enhance the capabilities and performance with ease and at minimum costs) (Brynjolfsson and Saunders, 2009; Ries, 2011; Steininger, 2019). Digital technologies facilitate the development of relationships among different actors, which interact dynamically to carry out business and innovation processes. This means that the diffusion of digital technologies has provided new possibilities for the development of entrepreneurial projects by leveraging collaboration (Elia *et al.*, 2020).

Hence, in new and dynamic markets, startups should be the first to identify and explore opportunities provided by digital technologies (Hitt *et al.*, 2001), in particular with regard to the launch of a new venture (Giones and Brem, 2017).

Therefore, digital technologies represent an important business channel for large firms, small and medium enterprises (SMEs) and startups (Schiuma, 2017) for different scopes, such as new product development (Bashir *et al.*, 2017), innovation of existing products or processes, analysis of market and customer needs and satisfaction (Dotsika and Watkins, 2017; Ogink and Dong, 2019).

The comprehension of such a digital technology driven evolution calls for appropriate analytic and interpretative framework, particularly about the digitalization of entrepreneurial processes. In this view, the contribute of Nambisan (2017) highlights the importance of considering various concepts, constructs and processes related to digital technologies elements (artifacts, platforms and infrastructures) in order to get a more effective comprehension of the digital entrepreneurship phenomenon. This helps to appropriately set up research perspectives on less-bounded entrepreneurship in the digital technology-based society (Aldrich, 2014). Moreover, traditional models and frameworks in entrepreneurship literature have often assumed fairly stable and fixed boundaries of new entrepreneurial processes, where startups' success depended mainly on how well an entrepreneur recognizes a business opportunity, executes specific activities and defines his/her business plan (e.g. Brinckmann *et al.*, 2010; Honig and Karlsson, 2004). Regrettably, these studies provide limited insights and explanations about entrepreneurial behaviors and actions in the digitalized world (Nambisan, 2017). As a consequence, further studies are thus needed in order to shed light on the digital behaviors of startups and offer a promising framework developing more accurate theoretical explanations of this phenomenon. As already mentioned, digital behaviors refer to the strategy startups follow in terms of whether, how many and how digital technologies are exploited for fulfill different kind of tasks.

Moreover, the Nambisan's approach (2017) supports the need to comprehend the potential of the digital behavior of current startuppers, since startups' digital behavior and the related level affect both the entrepreneurship nature (in terms of uncertainty, risk and opportunities) and the management of the business.

Following Nambisan's classification (2017), while digital artifacts (digital applications and/or content part of a new product/service) and digital platforms (set of services and architecture to host complementary offerings) impact on the development of the new venture idea (outcome), digital infrastructure can be considered an external enabler that is able to support business scalability (Nambisan, 2017). In fact, according to Nambisan (2017), digital infrastructure can be considered the most critical digital tools for improving business performance and flexibility to deal with unpredictable, turbulent and ever-changing environments. Furthermore, new digital infrastructures have shown the capability to support end-to-end entrepreneurial activities (Nepelski *et al.*, 2017). Based on this definition, we believe that digital infrastructure can be very relevant to the survival and success of startups. For this reason, we have decided to focus on them considering their criticality for the analyzed companies.

In this study, we break down the digital infrastructure category according to the conceptualization of digital tools proposed by Nambisan (2017). Of course, this category of digital tools plays a crucial role in shaping entrepreneurial behaviors, actions and processes. Specifically, as discussed previously, based on the specific characteristics (e.g. malleability and interactivity) and abovementioned effects (e.g. business scalability and fluidity of entrepreneurial processes) of digital technologies, it appears to be relevant to investigate whether, how and how many digital tools startups have adopted digital technologies which allow us to propose a taxonomy of the digital behaviors of startups. Two main categories of digital infrastructures are identified:

(1) *Intra-organizational digital infrastructures* are the technical infrastructures enabling the design, the functioning and the integration of the startup's digital behaviors. These tools are, usually, highly specific and, thus, rigid in terms of ability to be re-programed to different functions (von Briel *et al.*, 2018);

(2) *Inter-organizational digital infrastructures* are defined as a set of internet-based solutions allowing the individual startups to promote their business activities and collaborate with external partners. They are easily adaptable to new functions and can entertain different connections with large numbers of content-creating users at once (von Briel *et al.*, 2018).

The set of the two categories have been identified by aligning the main digital infrastructures analyzed in the body of literature on digitalization in both large firms and SMEs and those proposed in the recent emerging literature on digitalization in startups (Nambisan, 2017; Nambisan *et al.*, 2017).

However, to corroborate the sample of the main digital technologies derived from the systematic research that is part of this work, we involved four digital technology experts (two digital entrepreneurship professors, one senior consultant and one startup founder).

## 3. Materials and methods

A web-based document analysis methodology has been used to investigate the degree of adoption of intra- and inter-organizational digital infrastructures in a sample of Italian startups.

As the web is becoming a critical tool for the dissemination of startup strategies, there is a growing amount of research on the World Wide Web. The research conducted among the

startups is based on a systematic approach. A comprehensive review and content analysis was carried out using the information available on the websites of the startups analyzed. To have a more comprehensive picture of each individual startup investigated, information from additional sources (e.g. company reporting, industry reports, industry magazines and startup ecosystem actors' websites) were collected and analyzed. The websites and the complementary sources were analyzed for the presence of information related to the adoption of specific digital infrastructures supporting the startup in the process of digital transformation.

The empirical analysis has been conducted through the following six steps:

(1) *Document search* (Labuschagne, 2003; Zhang and Wildemuth, 2005), in which startup websites and other relevant sources (e.g. company reporting, industry reports and industry magazines) are identified using keywords in various search engines, websites and databases

(2) *Document selection* (Labuschagne, 2003; Zhang and Wildemuth, 2005), in which the materials of interest are selected in parallel by two researchers and collected in a document management system including a folder for each startup

(3) *Manual analysis* (Hsieh and Shannon, 2005; Bowen, 2009), in which the two researchers have conducted the conventional analysis described by Hsieh and Shannon (2005) to analyze in depth the materials of interest selected. In this phase, a database has been created to identify for each startup preliminary list of individual digital infrastructures adopted

(4) *Computer-assisted analysis* (Laender *et al.*, 2002; Zhang and Wildemuth, 2005), in which each material of interest is further analyzed to code frequency of keywords represented by the individual digital infrastructures identified by cross-examining information using query functions for web mining and knowledge discovery

(5) *Confirmation analysis* (Angers and Machtmes, 2005; Bowen, 2009), in which the findings are confirmed and/or supplemented by an interview carried out by telephone or videoconference to ensure the reliability of results

(6) *Triangulation of findings* (Patton, 1990; Eisner, 1991; Angers and Machtmes, 2005; Bowen, 2009), in which the results provided by manual analysis (Step 3), computer-assisted analysis (Step 4), and confirmation analysis (Step 5) are validated through cross verification.

Chi-square tests have been performed in order to verify whether the digital behavior of the Italian startups can be affected by environment-specific factors (e.g. industry and geographical locations) and/or firm/founder-specific factors (e.g. age, team composition and size). In particular, through the Chi-square tests, we analyze which factors mostly affected the adoption of digital technologies, namely the intra-organizational and inter-organizational tools.

Moreover, a standardized residual approach has been adopted since the omnibus Chi-square value does not specify which combination of categories contributes to the statistical significance (Beasley and Schumacker, 1995). Such methodology is characterized by a more conservative approach in order to reduce the Type I error rate.

In the next sections, some descriptive statistics about the Italian startups are presented and the results of the Chi-square tests are thoroughly discussed. Finally, based on such results, a profile of the Italian startup has been defined.

## 4. Context of investigation

### *4.1 The Italian startup regulation*

Pushed by the European Commission (EC) interest toward the Young Initiative Companies (YIC) initiative (Czarnitzki, Delanote, 2013), since 2012, the Italian Government has been engaged in the creation of a coherent, all-encompassing legislation intended to promote the establishment and the growth of new innovative firms with a high technological value. Such effort has culminated in the Decree-Law 179/2012 "Growth Decree 2.0" also known as "Italy's Startup Act" which has introduced into the Italian legal system a definition of the "innovative startup" and is also addressed to support social mobility, new employment, enhance the universities–businesses links (Passaro *et al.*, 2017; Hahn *et al.*, 2019; Colombelli *et al.*, 2020; Minola *et al.*, 2021) and increase the foreign capitals and talents attraction capability of Italy.

Unlike other countries, the regulatory framework emerged in Italy does not impose any sectorial or age-related restriction, and the supporting measures cover the whole lifecycle of the startups from the birth to the maturity stages. Moreover, the policy for innovative startups has been improved and broadened in the period 2013–2017 by further legislative interventions adopted and does not introduce any industry-specific restriction.

Can be enclosed in the startup policy framework those firms with shared capital whose capital shares are neither listed on a regulated market nor on a multilateral negotiation system, which fulfill seven specific requirements (Table 1).

Startup firms that are able to satisfy these requirements can apply to be inserted in the "Register of Innovative Startups" proposed by the Italian Minister of Economic Development (MISE); then, they can take advantage of a set of supporting measures immediately after registration for a maximum of five years since the date of establishment (Table 2).

The effectiveness of this policy measure has been assessed by various scholars who have reached conflicting conclusions when the features of the startup firms have been taken into consideration (Instilla, 2017, 2018; OECD, 2018; Mosca, 2017; Biancalani, 2020).

In particular, although the adoption of these supporting measures has resulted in a relevant increasing since 2012 of the number of startup firms listed in the register, such explosion has not led to an increase of the quality features and the digital behavior of these firms.

Leaving firms almost exclusively to take advantage of administrative and economic advantages on which to leverage to establish themselves on the markets has led to the development of a startupper profile that is characterized by a weak digital behavior, which can constitute a weakness for the survival and development of startups (Brynjolfsson and Saunders, 2009; Kraus *et al.*, 2019; Sahut *et al.*, 2021).

| | Requirements |
|---|---|
| 1 | Newly established or established firm from less than 5 years |
| 2 | Headquarter based in Italy or in another EU country with at least a production branch in Italy |
| 3 | Yearly turnover lower than €5 million |
| 4 | Not the result of a merger, split-up or selling-off of a firm or branch |
| 5 | No profits distribution |
| 6 | Exclusive or prevalent firm mission addressed to the production, development and commercialization of innovative goods or services of high-tech value |
| 7 | innovation character of the firm identified by at least one of the three following criteria:<br>(a) at least 15% of the firm's expenses attributable to R&D activities<br>(b) at least 1/3 of the total workforce are PhD students/PhD holders or 2/3 of the total workforce must hold a master's degree<br>(c) the firm is the holder, depositary or licensee of a registered industrial property patent or the owner/author of a registered software |

**Table 1.**
Eligibility criteria to identify Innovative startup according to the Italy's Startup Act (Decree 179/2012)

| Category | Policy measures |
|---|---|
| Administrative | - Adoption of a standard simplified model with digital signature and free incorporation procedure<br>- Flexible corporate management (shares with specific rights, financial operations on shares) fast fail bankruptcy procedure; simplified procedure or conversion to innovative SME in case of bankruptcy |
| Cost reduction | - Cuts to red tape, exemption from payment of annual fees to Chamber of Commerce and other fees<br>- Extension of terms for covering losses<br>- Exemption from regulations on dummy companies<br>- Remuneration through stock options and work for equity schemes |
| Labor | - Tailor-made labor law<br>- Flexible remuneration system; tax credit for hiring highly qualified personnel |
| Financial | - Exemption from the duty to affix the compliance visa for compensation of VAT credit<br>- Possibility to collect capital through equity crowdfunding authorized online portals<br>- Fast-track, simplified and free-of-charge access for innovative startups to the SME Guarantee Fund) |
| Fiscal | - Tax incentives for corporate and private investments in startups |
| Services access | - Admission at Italian International Trade Agency support services program: ad hoc services to access foreign markets |
| A set of measures and services that are part of the "Industry 4.0" action | |

**Table 2.**
Main policy measures to support Innovative Startups according to the Italy's Startup Act (Decree 179/2012)

This result also reflects the findings of other studies revealing the low attitude in attracting equity funding by the digital-related sectors in Italy (Breschi *et al.*, 2018) and the gap between Italy and the major developed countries in establishing an entrepreneurial environment for innovative startups which is caused by various factors including the use of digital technologies (OECD, 2018).

### *4.2 Italian startup overview*

The population investigated comprises a majority of firms born from 2013 (79.42%) (Table 3) that are mainly focused in the North of Italy (53.83%) (Figure 1).

The breakdown of the startups investigated reported in Table 4 highlights that the 76.64% of startups have a core business in service industry. As for the employee band, they mainly involve 0–4 employees (Figure 2).

The population of Italian startups is largely composed by male, middle age (over 35 years) and Italian individuals (Table 5). These groups are considered to have a wider societal impact

| Founding year* | *N* | % |
|---|---|---|
| 2010 | 5 | 0.08% |
| 2011 | 71 | 1.15% |
| 2012 | 125 | 2.02% |
| 2013 | 1,070 | 17.32% |
| 2014 | 1,608 | 26.03% |
| 2015 | 1830 | 29.62% |
| 2016 | 1,469 | 23.78% |
| *Total* | *6,178* | *100%* |

**Note(s):** *The Italy's Startup Act/2012 allowed startup firms born in 2010–2011 to be registered

**Table 3.**
Startups by registration year

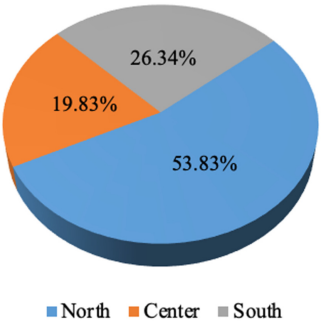


**Figure 1.**
Startups by geographic area

| Industry | *N* | % |
|---|---|---|
| Service | 4,735 | 76.64% |
| Manufacturing | 968 | 15.67% |
| Commerce | 282 | 4.56% |
| Handcraft | 102 | 1.65% |
| Tourism | 59 | 0.96% |
| Agriculture | 29 | 0.47% |
| NA | 3 | 0.05% |
| *Total* | *6,178* | *100%* |

**Table 4.**
Startups by industry

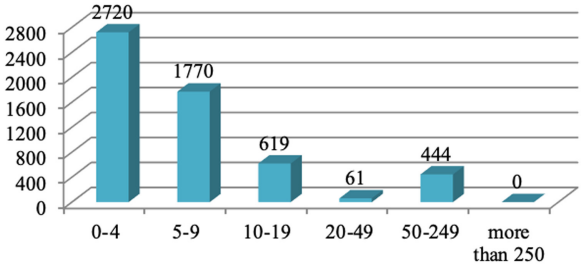


**Figure 2.**
Startup size according to the number of employees

| Category | Youth prevalence *N* | Youth prevalence % | Female prevalence *N* | Female prevalence % | Foreign prevalence *N* | Foreign prevalence % |
|---|---|---|---|---|---|---|
| NO | 4,862 | 78.70% | 5,382 | 87.12% | 6,024 | 97.51% |
| STRONG (more than 50%) | 198 | 3.20% | 175 | 2.83% | 39 | 0.63% |
| MAJORITY (between 50 and 66%) | 565 | 9.15% | 366 | 5.92% | 62 | 1.00% |
| EXCLUSIVE (more than 66%) | 529 | 8.56% | 242 | 3.92% | 45 | 0.73% |
| NA | 24 | 0.39% | 13 | 0.21% | 8 | 0.13% |
| *Total* | *6,178* | *100%* | *6,178* | *100%* | *6,178* | *100%* |

**Table 5.**
Characteristics of the founding team

beyond their contribution to employment and economic growth (OECD, 2018). It is worth to note that both the results about the share of female founders and the age of founders are coherent with those of OECD (2018).

## 5. Startup digital behavior

Based on the sample of 6,178 Italian startups illustrated in the previous context of investigation, this section aims to identify their digital behavior. To this end, in line with the conceptual framework, digital infrastructures have been divided into two main categories, i.e. intra-organizational digital infrastructures and inter-organizational digital infrastructures.

The data analysis stresses that on average Italian startups adopt 1.23 inter-organizational digital infrastructures and 1.75 intra-organizational digital infrastructures (Table 6). This highlights that these firms use a limited set of the two digital infrastructures considered and are mostly inward oriented since they invest mainly in the creation and development of a proper and technical infrastructure, which enables the functioning and the integration of the startups' intra-organizational digital infrastructures. Indeed, this aspect can probably be encouraged by the public financial incentives available for investments in digital infrastructure.

Specifically, focusing on the inter-organizational infrastructures, the most adopted tools are the website (70.67%), the mashup (14.28%) and the search engine optimization (SEO) (13.09%) (Table 7). Although the website is the most adopted inter-organizational infrastructures by Italian startups, other studies show that only the 50% of them has a running website (Instilla, 2017). Moreover, it is important to highlight that the most adopted inter-organizational infrastructures are addressed to support the startups' visibility (website, mashup and SEO). With regard to the intra-organizational infrastructures, the web server (57.85%), the framework (44.79%) and the use of a specific programing language (23.81%) are the most adopted.

As shown in Table 8, the Chi-square tests highlight that significant relationships between some factors and the adoption level of the two classes of digital technologies exist.

In particular, it is possible to note that size (number of employees), industry and geographical area meaningfully affect the adoption level of both the intra- and inter-organizational digital infrastructures. The prevalence of young founders has exclusively an

**Table 6.**
Average number of intra- and inter-organizational digital infrastructures adopted per startup

| Weighted average (inter-infrastructures) | Dev st (inter-infrastructures) | Weighted average (intra-infrastructures) | Dev st (intra-infrastructures) |
|---|---|---|---|
| 1.226 | 0.822 | 1.753 | 1.124 |

**Table 7.**
Most adopted intra- and inter-organizational tools

| Inter-organizational digital infrastructures | No of startups | % | Intra-organizational digital infrastructures | No of startups | % |
|---|---|---|---|---|---|
| Website | 4,366 | 70.67% | Web server | 3,574 | 57.85% |
| Mashup | 882 | 14.28% | Framework | 2,767 | 44.79% |
| SEO | 809 | 13.09% | Programming language | 1,471 | 23.81% |
| Facebook | 755 | 12.22% | Operating system | 1,136 | 18.39% |
| Google+ | 454 | 7.35% | CMS | 859 | 13.90% |
| Twitter | 169 | 2.74% | Multimedia content system | 595 | 9.63% |
| YouTube | 143 | 2.31% | Analytics | 432 | 6.99% |

| Variables | Chi-square value Inter-infrastructures | Intra-infrastructures |
|---|---|---|
| Female prevalence | 13.519 | 19.367 |
| Youth prevalence | 23.811** | 23.320 |
| Foreign prevalence | 11.623 | 27.266** |
| Share capital | 41.621 | 62.260** |
| Year of registration | 38.934 | 73.401* |
| Size (no of employees) | 28.919* | 60.127* |
| Industry | 71.164* | 143.885* |
| Geographical area | 48.764* | 79.407* |

**Note(s):** *$p$-value<0.05; **$p$-value<0.1

**Table 8.**
Chi-square value

impact on the adoption level of inter-organizational tools, while the prevalence of foreign, the class of the share capital and the year of registration affect only the adoption of the intra-organizational digital infrastructures.

A standardized residual approach has been adopted (Beasley and Schumacker, 1995) to specify which combination of categories contributes to the statistical significance. Focusing on the youth prevalence, it is possible to highlight that a significance difference exists between the group with a majority of young founders (less than 35 years) and the group with no young founders ($\alpha = 0.0035$), where the first group performs better than the second one in terms of the adoption level of inter-organizational tools.

With regard to the foreign prevalence, the results show that a well-balanced cultural and racial contamination improves the adoption level of intra-organizational digital infrastructures ($\alpha = 0.0033$); in other words, teams with a strong presence of foreign founders (less than 50%) adopt, on average, more intra-organizational digital infrastructures than team with the exclusive presence of foreign people. As the number of Italian startups with the presence of foreign people is very low (0.02%), such result appears to be less critical.

The age of the startups (which coincides with the year of the registration) affects the adoption level of the intra-organizational digital infrastructures. Findings show that significant differences exist between startups born more recently (2014, 2015 and 2016) and older ones (2012) (Table 9). In other words, younger startups show a higher adoption level of digital infrastructures than the older ones, and this represents a result coherent with the unified theory of acceptance and use of technology (UTAUT) (Venkatesh *et al.*, 2003). Indeed, this could be meant as a counterintuitive result since it is supposed that startups need more time and money to equip themselves with intra-organizational digital infrastructures, although such result could depend on the presence of public funding (e.g. digitalization vouchers) that supports Italian startups in buying digital infrastructures.

The size of the startups (number of employees) affects the adoption level of both intra- and inter-organizational digital infrastructures. In particular, post-hoc tests show that significance differences exist between small micro-firms (0–4 employees) and large micro-firms (5–9) ($\alpha = 0.025$) in terms of average number of inter-organizational tools adopted. With

| Year[a] | Year[b] | Differences ($Y^a$ - $Y^b$) |
|---|---|---|
| 2012 | 2014 | −0.429* |
| | 2015 | −0.464* |
| | 2016 | −0.426* |

**Note(s):** *$p$-value adjusted<0.0011

**Table 9.**
Post-hoc test - years of registration

regard to the intra-organizational digital infrastructures, significance differences exist between medium (10–49 employees) and large firms (more than 250 employees) ($\alpha = 0.019$). These latter results can be understood as expected since differences in the size and structure of companies are presumed to affect the availability of managerial, organizational and financial resources to invest in digital tools (Aguila-Obra and Padilla-Meléndez, 2006). Indeed, Järvinen *et al.* (2012) found that micro-firms perceive a lower management resistance in the adoption of digital marketing tools when compared with larger firms.

The industry also plays a key role in affecting the adoption level of the intra- and inter-organizational digital infrastructures. Although the tourism industry shows some significance difference in terms of the adoption level of both the categories of digital infrastructures, the number of the startups in this sector is very low (0.96%). For this reason, such result appears to be less critical.

The share of capital affects only the level of adoption of intra-organizational digital infrastructures. In particular, the results of the post-hoc tests show that statistically significant differences exist between the companies belonging to the share capital class of 2,000,001–5,000,000 euros and 0–100,000 euros and between startups belonging to the share capital class 5,000,001–10,000,000 euros and 0–100,000 euros.

Focusing on the results of the post-hoc tests about the impact of the geographical area on the digital adoption level of inter-organizational tools, it is possible to claim that significance differences exist between the North and South of Italy ($\alpha = 0.00002$). It is possible to suppose that these results depend on the socio-economic structure, which boosts the development of the startups and their innovation strategies and investments. No significance differences exist between Central Italy and the other two geographical areas. With regard to intra-organizational digital infrastructures, while significance differences exist between Center and South of Italy ($\alpha = 0.001$), no significance differences exist between the North and the rest of Italy.

This section has outlined the digital features of the startup under analysis considering two groups of digital infrastructures. Then, these features have been analyzed to find the presence of relationships with respect to environment-specific factors and company/founder specific factors.

## 6. Taxonomy of startup digital behaviors

This section aims to identify the digital behaviors of startups. To address this issue, the first step was to build a taxonomy based on the level of adoption of the intra-organizational and inter-organizational digital infrastructures. The results shown in Table 10 highlight how the level of adoption of both categories of digital infrastructures is very low. Indeed, the most part

**Table 10.**
Cross-adoption of intra- and inter-organizational digital infrastructures

| Inter-infrastructures | Intra- infrastructures 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1.63% | 5.13% | 6.13% | 2.22% | 1.21% | 0.19% | 0.02% | 0% | 16.53% |
| 1 | 7.22% | 16.11% | 17.59% | 6.70% | 3.27% | 0.50% | 0.13% | 0% | 51.52% |
| 2 | 3.77% | 7.51% | 9.63% | 3.50% | 1.21% | 0.29% | 0% | 0% | 25.91% |
| 3 | 0.34% | 0.44% | 1.94% | 1.86% | 0.15% | 0.11% | 0% | 0% | 4.84% |
| 4 | 0% | 0% | 0.87% | 0.13% | 0.13% | 0.02% | 0.03% | 0% | 1.18% |
| 5 | 0% | 0% | 0% | 0% | 0% | 0% | 0.02% | 0% | 0.02% |
| 6 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0.00% |
| 7 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0.00% |
| Total | 12.96 | 29.19 | 36.16 | 14.41 | 5.97 | 1.11 | 0.20 | 0.00 | 100.00% |

of Italian startups shows a very limited adoption of the two digital infrastructures considered. In fact, 43% adopt no more than one intra-organizational digital infrastructure and almost 80% no more than two intra-organizational digital infrastructures. As for the inter-organizational tool, 68% adopt no more than one infrastructure and 94% no more than two infrastructures. As for the joint adoption of the two technologies considered the higher share is that of startups that use two different intra-organizational digital infrastructures and one inter-organizational digital infrastructure (17.59%). On the contrary, only the 0.02% (one Italian startup) has adopted six intra-organizational digital infrastructures and five inter-organizational infrastructures. No Italian startup adopts all the digital infrastructures considered in this study. It is also worth noting that 12.96% of startups do not adopt any intra-organizational digital infrastructures and 16.53% do not adopt any inter-organizational infrastructures.

Based on this evidence, taxonomy of startups strategies is proposed and thoroughly discussed by highlighting differences and homogeneity among Italian startups grouped on the base of their digital behavior, as well as by defining possible strategies able to support new ventures along a coherent, effective and efficacy digital growth.

Specifically, starting from the results reported in Table 10, it is possible to identify four areas defined by considering the median values of both digital inter- and intra-organization digital infrastructures adopted by the investigated startups (respectively, equal to 1 and 2 tools). High-left located startups use few intra- and inter-organizational digital infrastructures (A1). High-right located startups use few inter-organizational tools and many intra-organizational digital infrastructures (A2). On the contrary, low-left located startups use few intra-organizational and many inter-organizational digital infrastructures (A3). Finally, low-right located startups use many intra- and inter-organizational digital infrastructures (A4). The four areas identify different strategies for startups using digital infrastructures (Table 11).

Area A1 is particularly important considering that about the 53.81% of startups investigated are located in this area. This area includes startups that have still to acquire awareness of the strategic value of a digital behavior. They have still not invested in intra- and inter-organizational digital infrastructures to support their innovation process. This is the area of the *Digital Followers*.

The startups located in the A2 area (14.24%) use mainly intra-organizational digital infrastructures. The fact that these startups do not adopt inter-organizational digital infrastructures highlights that they are investing in digital infrastructures or exploiting the technical potential they already have, but they do not actually leverage on social reputation. To shift toward Area 4, these startups need to acquire awareness of the importance of investing resources in the field of social media. This is the area of the *Technical Influencers*.

Area A3 contains the startups that despite exploring the opportunity of a variety of inter-organizational tools are not still able to adopt many intra-organizational digital

| | Intra-organizational digital infrastructures Low | Intra-organizational digital infrastructures High |
|---|---|---|
| **Inter-organizational digital infrastructures** Low | *Digital Follower* (53.81%) **(A1)** | *Technical Influencer* (14.24%) **(A2)** |
| **Intra-organizational digital infrastructures** High | *Social Influencer* (24.50%) **(A3)** | *Digital Leaders* (7.45%) **(A4)** |

**Table 11.** Taxonomy of digital innovation strategies adopted by startups

infrastructures. The results highlight that only the 24.50% of startups are located in this area and are pursuing a social strategy to achieve a digital behavior. This means that there are few startups investing in the field of social media or exploiting the social potential that their founders could already have. Nevertheless, the startups located in this area have great potential for growth. Area A3 is the area of the *Social Influencers*.

Finally, Area A4 regards startups that have a perception of the strategic value of a digital behavior and, therefore, explore the potentiality of a variety of intra- and inter-organizational digital infrastructures. This low number of startups (7.45%) has invested to improve their innovation processes through the adoption of innovative digital infrastructures. This is the area of the *Digital Leaders*.

According the proposed interpretation, the large part of the Italian startups is having a *digital follower* approach to the adoption of digital technologies. An evolution toward the A4 area is necessary so that these firms can overcome the critical aspects of the first phases of their lifecycle and improve their competitive performance. To go through this evolution, startups can follow different digital behaviors. A first digital behavior is a *balanced improving* behavior whereas they introduce gradually and mutually the inter- and intra-organizational digital infrastructures to follow an innovation strategy that leads them to assume a role of digital leader. The second digital behavior is an unbalanced behavior, which leads startups to favor first the adoption of inter-organizational tools (A3) and then the intra-organizational digital infrastructures (A4). For instance, through learning and training technical skills and a consequent adoption of intra-organizational digital infrastructures they could easily shift toward A4. This digital behavior can be defined as a *social improving* behavior and is followed by 24.5% of startups.

A third digital behavior is an unbalanced one and is based on favoring the adoption of intra-organizational digital infrastructures in a first step (A2) and then that of inter-organizational digital infrastructures in a second step (A4). This can be defined as a *technical improving* behavior. Currently, a limited group (14.24%) of Italian startups seems to follow this last improving behavior becoming first *technical influencer* and then *digital leaders*. On the basis of data, it emerges that startup firms preferably seem to follow an unbalanced social improving behavior compared to an unbalanced technical influencer behavior.

## 7. Discussion

This section is addressed to analyze and discuss the results of this study. Based on the antecedents of startups' digital behaviors, we provide a profile of Italian startup firms and then on the related framework of the Startup Act policy initiative to verify the way the latter has impacted on the creation of these firms, the enhancement of their number and features.

Drawing on descriptive analysis of the firms enrolled in the Register of Innovative Startups (section 4) and on their adoption of digital infrastructures (section 5), a profile of Italian innovative startups has been defined (Table 12).

In a nutshell, as far as the founders, the Italian startups are mainly founded by male, middle age Italian individuals. Instead, for what concerns the firms features, they are quite young micro-firms of the service industry having the legal form of limited liability companies, a discrete level of capitalization and a limited digital behavior.

At the best of our knowledge, the only study comparable with the profile of Italian startup enrolled in the policy is focused on a comparison among founders at cross-country level (OECD, 2018). According to this study, Italian startuppers not only have similarities with those of other countries (shares of founders holding a PhD, serial and academic entrepreneurs and female founders), but also dissimilarities (shares of undergraduate student entrepreneurs, MBA holders and patents holders).

| Variable | Results |
|---|---|
| Female prevalence | Italian SUs are founded mainly by men (87%) |
| Youth prevalence | Italian SUs' founders are not so young (<35 years) (80%) |
| Foreign prevalence | SUs' founders are Italian |
| Legal form | Italian SUs are mainly limited liability companies (97%) |
| Share capital | Italian SUs are well capitalized. Specifically, 65% shows a share capital between 10.000 and 100.000 Euros |
| Size (no of employees) | Italian SUs are very small firms (micro-firms) with a number of employees between 0–9 units (73%) |
| Year of registration | Italian SUs are quite young as the most part was born in 2014 (26%), 2015 (30%) and 2016 (24%) |
| Industry | Italian SUs operate mainly in the service industry (77%), followed by the industrial sector (16%) |
| Geographical area | SUs are mainly located in the North of Italy (54%); in the South there are about the 26% of Italian SUs and in the center there are only the 20% |
| Digital behavior | Weak digital behavior (about 13–15% do not adopt digital infrastructures) |
| Digital strategies | Followers: 53.81%; technical influencers: 14.24% |

**Table 12.**
Italian startup profile

The only studies addressed to the digital behavior of startups are gray literature provided by Instilla (2017, 2018) reports. The 2017 report, with the aim to analyze the quality of the 7.568 startups enrolled in the Register of Innovative Startups, considers the level of digital behavior analyzed by testing the basic digital technologies (website and SEO) features and highlights that only 49.7% of startups have a functioning website. Moreover, the 2017 Report observes that the startup not enrolled in the policy have a better digital behavior since in terms of active/functioning/responsive website and mobile optimization. The 2018 report, based on a population of 9,705 startups (+28%), confirms the results in terms of websites adoption, but it stresses the deterioration of a sufficient mobile optimization. The results provided by the both the reports confirm the limited digital behavior of Italian startup firms enrolled in the policy. Some of the criticalities emerged in the review of the studies are in line with those evidenced in our study, underlying the positive but limited and incomplete effect of the Startup Act initiative.

The huge presence of digital follower among Italian startups is largely derived by the peculiarities of the Italian startup policy which "appears to focus more on saving distressed firms, rather than favouring the birth of new ones" (OECD, 2018, p. 20). This policy, while is coherent with the emerged profile of the Italian startup profile, does not provide a specific support to the development of a digital behavior of startups, thus showing a sort of asynchrony between innovation strategies and digitalization. Being digital followers, Italian startups are less competitive and successful than other startups. Indeed, several studies have proven that digital technologies play a significant role for startups (Setia *et al.*, 2013; Ghezzi and Cavallo, 2020). With digital technologies, startups could exploit additional innovation and entrepreneurial opportunities, revise dynamically their value proposition, be extremely scalable, improve performances, increase efficiencies and reduce costs (Brynjolfsson and Saunders, 2009; Huang *et al.*, 2017; Kraus *et al.*, 2019; Ries, 2011; Rippa and Secundo, 2019; Steininger, 2019). Remaining digital followers, it constrains startups to adapt to an economic context with few opportunities and far from the stimuli provided by the innovative heart of the country.

Becoming a digital leader is a key for startups to feed their innovation process, be competitive on international markets, overcome the critical issues of the early years and consolidate their successful results (Presutti *et al.*, 2011; Rubin *et al.*, 2015; Kuester *et al.*, 2018). Using digital technologies, entrepreneurs can promptly transform their ideas into viable businesses (Anderson, 2014; Steininger, 2019; Sahut *et al.*, 2021).

Regrettably, Italian firms are not capable on their own to move from the position of follower to that of digital leaders who require the integrated adoption of a wide range of intra- and inter-organizational digital infrastructures as well as a demanding financial, organizational and knowledge effort.

## 8. Conclusions, implications, limitations and future research directions

Based on the database of the population of Italian startups, the present paper had a threefold aim: (1) to identify the digital behaviors of startups, (2) to provide a taxonomy of the digital behaviors of the Italian startup firms enrolled in the Startup Act policy initiative and (3) to proposes a useful framework to identify possible strategies to improve current startups' digital behaviors.

The results highlight that Italian startups adopt on average 1.23 inter-organizational infrastructures and 1.75 intra-organizational digital infrastructures. Italian startups invest mainly in the creation and development of a proper digital technical infrastructure which enables the functioning and the integration of the intra-organizational digital infrastructures.

Those that are addressed to support the startups' visibility, namely the website, the mashup and the SEO, regarding the intra-organizational digital infrastructures, the web servers, the framework and the use of a specific programming language are the most adopted.

As for the influence of environment-specific factors and firm/founder-specific factors, the results of Chi-square tests highlight that (1) the number of employees, the industry and the geographical area strongly affect the adoption level of both intra- and inter-organizational digital infrastructures, according to the Technology-Organization-Environment (TOE) framework (1990); (2) the prevalence of young founders (less than 35 years) has exclusively an impact on the adoption level of inter-organizational infrastructures and this represents a result in line with the UTAUT model of Venkatesh *et al.* (2003) and (3) the prevalence of foreign, the class of the share capital and the year of registration affect only the adoption of the intra-organizational digital infrastructures.

Concerning the foreign prevalence, despite the number of Italian startups with the presence of foreign people is very low (0.02%), the results show that a well-balanced cultural and racial contamination improve the adoption level of the digital tools. As for the age of the startups, younger startups show a higher adoption of digital and technical infrastructures level than the older ones. This could be meant as a counterintuitive result since it is supposed that startups need of more time and money to equip themselves with intra-organizational digital infrastructures, although such result could depend on the presence of public funding (e.g. digitalization vouchers), which support Italian startups in buying digital infrastructures. On the other hand, this positive relationship between age and adoption level is coherent with the results of the Venkatesh *et al.* (2003) model.

The size of the startups (number of employees) and the industry also affect the adoption level of both intra- and inter-organizational digital infrastructures. Finally, the analysis of the impact of geographical area on the intra-organizational digital infrastructures shows significance differences between the North and South of Italy. These results depend on the socio-economic structure which boosts the development of the startups and their innovation strategies and investments. No significance differences exist between Central Italy and the other two geographical areas. Focusing on the inter-organizational tools, no significance differences exist between the North and the rest of Italy.

Furthermore, the paper proposes a taxonomy that synthesizes the strategies of using intra- and inter-organizational digital infrastructures on the part of startups. Specifically, four strategies were identified: *Digital Follower*, *Technical Influencer*, *Social Influencer* and *Digital Leader*.

The *Digital Follower* is a startup that has still to acquire awareness of the strategic value of a digital behavior. This startup has still not invested in intra- and inter-organizational digital infrastructures to support the innovation process.

The *Technical Influencer* is a startup that adopts mainly intra-organizational digital infrastructures. This startup has invested in building a digital infrastructure or exploiting its technical potential, but it does not actually leverage on social reputation.

The *Social Influencer* is a startup that uses mainly inter-organizational infrastructures. This startup has invested in the field of social media or exploiting the social potential that their founders could already have.

The *Digital Leader* is a startup with a full perception of the strategic value of a digital behavior. This startup has invested in a variety of intra- and inter-organizational digital infrastructures supporting their innovation strategies.

To move from the *Digital Follower* position to that of *Digital Leader*, startup firms can follow more digital behaviors. The behavior that seems to prevail is the unbalanced social one, which involves that startup invest firstly in the adoption of inter-organizational infrastructures and then in the adoption of intra-organizational digital infrastructures.

The overall picture that emerges from the analysis of the adoption of intra- and inter-organizational digital infrastructures of the Italian startup population highlights a situation of a generally weakness of the digital behavior of these firms. This situation is in line with the lights and shadows picture on the reality of the Italian startups which is emerged in various studies following the adoption of the Startup Act policy.

Very few startups seem to leverage on digital technologies to support significant innovations strategies and improve their own competitive performances. This result is strictly coherent with a recent analysis that is addressed to analyze the level of diffusion of various basic digital tools among the population of Italian startups (Instilla, 2018). Moreover, this could contribute to some of the weaknesses of the innovation behavior of these firms which has been recently emphasized in the first large sample analysis of Italian startups (MISE-Istat, 2017).

### *8.1 Implications*

Several implications can be derived from this paper according to the different factors-specific perspectives considered.

From the startups' point of view, this paper shows that they could further increase the impact of innovation strategies by better exploiting the opportunity offered by the digitalization. Then, they have to decide which kind of improving behavior to follow, a *balanced*, a *technical or a social improving* behavior. Some useful elements to sustain this choice should be the coherence with the expected competitive performance, the set of competence available in the entrepreneurial team and the availability of financial resources to funding the innovation strategy.

Anyway, to support the passage of startups from the position of *Digital Follower* to that of *Digital Leaders,* an integrated policy is required able to support the development of innovation ecosystems.

From the digital providers' perspective, this paper stresses that startups typically do not have dedicated resources to monitor the process of innovation in the field of digital transition. Nevertheless, they may well represent a significant market. To seize this opportunity, it is necessary create not only a new market segment dedicated to startups, but also direct communication channels between startups and digital providers. In this view, large digital provider should assume a leading role in sustaining the specific digital behavior of small business which represent a vital fabric of the Italian economic system and which, in turn, can lead to strong growth in the digital market.

From the perspective of policy makers, considering the financial efforts that public authorities are supporting in the last decade, implications are mainly concerned with policy measures aimed both to reinforce the overall adoption of digital technologies by the part of startups and to develop a balanced adoption of intra- and inter-organizational digital infrastructure, in order evolve toward the area of *Digital Leaders*. Similarly, measures addressed to support female and foreign entrepreneurship could be useful to support a more dynamic and well-balanced cultural and racial contamination, thus improving the adoption of digital tools.

From a general point of view, an integrated policy is needed able to provide a supportive startup ecosystem (particularly in lagging regions) in which the attempt to support both the digital behavior of startupper in adopting a large set of tools and the digitalization of the economic system should play a key role. Moreover, policy measures should be taken to encourage large digital technology providers and system integrators to make integrated tools and services packages available for digitizing startups and small businesses and allow them to evaluate also the opportunity represented by the impact of Industry 4.0, enabling technologies on the development of sustainable capabilities of individual startups and innovation ecosystems.

Additional implications can be also derived from the point of view of incubators and consultants which have to contribute to build an appropriate cultural, managerial and competence context to support an appropriate and balanced adoption of digital tools.

Finally, our study shows further interesting research implications. In fact, we propose a useful framework to evaluate the current startup's digital behavior and identify possible improving strategies for startups that can be used to additional studies. Moreover, this study could be meant as a first step toward an in-depth analysis of (1) the digitalization level of firms, (2) the impact of digital technologies on business performances and (3) identification of best practices for supporting digital transition of firms.

### *8.2 Limitations and future research directions*

As other studies attempting to frame and represent reality, our paper is not free from limitations. First, a critical limitation depends on the peculiarity of the context under investigation, i.e. Italian startups in the early stages of their development, which could limit the generalization and relevance of our findings. In order to address such limitation, future research should try to replicate our study in different geographical contexts. This could let to make critical comparisons among diverse samples, which could further contribute to enrich digital entrepreneurship literature.

Second, this paper does not focus on the analysis of the impact of digital behaviors on different kind of performances, such as innovation, economic, financial and market ones, as well as on the evolution and transformation of business models, innovation strategies and human resources management processes. Concerning these limitations, some future research directions can be identified. A first research direction regards the alignment between intra- and inter-organizational digital infrastructures and the nature of business models. In this perspective, an analysis of sector-specific factors could be further analyzed. Moreover, an in-depth analysis to verify whether and how the digital behavior affects different kind of performance of a startup appears to be critical and necessary. Also, an investigation about how startups involved in managing their digital transition processes develop the necessary digital skills. Finally, future studies can investigate and test such improving strategies in the long run.

Third, the paper does not analyze the impact of each considered antecedents on the adoption level of digital infrastructures. To address this limitation, future research should focus on the investigation of the effects of each considered antecedents on the digital behaviors of startups. To do this, a Structural Equation Modeling (SEM) analysis and/or a Qualitative Comparative Analysis (QCA) could be performed.

Fourth, in the paper, we do not consider platforms and artifacts (Nambisan, 2017), as well as Industry 4.0 technologies among the digital infrastructures considered. Further studies should focus on their role and the related impact on the digital behavior.

We think that the results we have obtained in this study are encouraging enough to justify for us, and we hope for other scholars further research directions on the digital behaviors of startups. For example, a further interesting research direction could be conducted to evaluate the impact of the digital behavior of startups and the behavior followed toward achieving a *Digital Leader* position on their income and market performance. Finally, an additional research direction regards the necessity of future studies investigating the different functionalities of websites adopted by startups (e.g. static, dynamic and eCommerce), as well as the use of additional social media (e.g. Instagram and TikTok), considering that website design relies upon the specific business model.

## References

Aguila-Obra, A. and Padilla-Meléndez, A. (2006), "Organizational factors affecting Internet technology adoption", *Internet Research*, Vol. 16 No. 1, pp. 94-110.

Aldrich, H. (2014), "The democratization of entrepreneurship? Hackers, makerspaces, and crowdfunding", *Annual Meeting of the Academy of Management*, Philadelphia.

Anderson, C. (2014), *Makers: The New Industrial Revolution*, Random House USA.

Angers, J. and Machtmes, K. (2005), "An ethnographic-case study of beliefs, context factors, and practices of teachers integrating technology", *The Qualitative Report*, Vol. 10 No. 4, pp. 771-794.

Audretsch, D.B. (2007), "Entrepreneurship capital and economic growth", *Oxford Review of Economic Policy*, Vol. 23 No. 1, pp. 63-78.

Audretsch, D.B. and Belitski, M. (2020), "The role of R&D and knowledge spillovers in innovation and productivity", *European Economic Review*, Vol. 123, 103391.

Audretsch, D.B., Belitski, M. and Desai, S. (2019a), "National business regulations and city entrepreneurship in Europe: a multilevel nested analysis", *Entrepreneurship: Theory and Practice*, Vol. 43 No. 6, pp. 1148-1165.

Audretsch, D.B., Cunningham, J.A., Kuratko, D.F., Lehmann, E.E. and Menter, M. (2019b), "Entrepreneurial ecosystems: economic, technological, and societal impacts", *Journal of Technology Transfer*, Vol. 44 No. 2, pp. 313-325.

Bashir, N., Papamichail, K.N. and Malik, K. (2017), "Use of social media applications for supporting new product development processes in multinational corporations", *Technological Forecasting and Social Change*, Vol. 120, pp. 176-183.

Beasley, T.M. and Schumacker, R.E. (1995), "Multiple regression approach to analyzing contingency tables: post hoc and planned comparison procedures", *The Journal of Experimental Education*, Vol. 64 No. 1, pp. 79-93.

Berger, E.S.C. and Kuckertz, A. (2016a), "Female entrepreneurship in startup ecosystems worldwide", *Journal of Business Research*, Vol. 69 No. 11, pp. 5163-5168.

Berger, E.S.C. and Kuckertz, A. (2016b), "The challenge of dealing with complexity in entrepreneurship, innovation and technology research – an introduction", in Berger, E.S.C. and Kuckertz, A. (Eds), *Complexity in Entrepreneurship, Innovation and Technology Research – Applications of Emergent and Neglected Methods*, Springer International Publishing, Cham, pp. 1-9.

Biancalani, F., Czarnitzki, D. and Riccaboni, M. (2020). "The Italian Startup Act: empirical evidence of policy effects", Working Papers of Department of Management, Strategy and Innovation, Leuven 648452, KU Leuven, Faculty of Economics and Business (FEB), Department of Management, Strategy and Innovation, Leuven.

Blank, S. and Dorf, B. (2012), *The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company*, BookBaby, Pennsauken, NJ.

Bowen, G.A. (2009), "Document analysis as a qualitative research method", *Qualitative Research Journal*, Vol. 9 No. 2, pp. 27-40.

Breschi, B., Lassébie, M.J. and Menon, C. (2018), "A portrait of innovative startups across countries", *OECD Science*, Technology and Industry Working Papers. 2018/02.

Brinckmann, J., Grichnik, D. and Kapsa, D. (2010), "Should entrepreneurs plan or just storm the castle? A meta-analysis on contextual factors impacting the business planning–performance relationship in small firms", *Journal of Business Venturing*, Vol. 25 No. 1, pp. 24-40.

Brynjolfsson, E. and Saunders, A. (2009), *Wired for Innovation: How Information Technology is Reshaping the Economy*, MIT, Cambridge.

Castagna, F., Centobelli, P., Cerchione, R., Esposito, E., Oropallo, E. and Passaro, R. (2020), "Customer knowledge management in SMEs facing digital transformation", *Sustainability (Switzerland)*, Vol. 12 No. 9, 3899.

Centobelli, P., Cerchione, R. and Esposito, E. (2017), "Knowledge management in startups: systematic literature review and future research agenda", *Sustainability*, Vol. 9 No. 3, 361, doi: 10.3390/su9030361.

Cerchione, R., Centobelli, P., Riccio, E., Abbate, S. and Oropallo, E. (2022), "Blockchain's coming to hospital to digitalize healthcare services: designing a distributed electronic health record ecosystem", *Technovation*, 102480.

Cohen, B., Amorós, J.E. and Lundy, L. (2017), "The generative potential of emerging technology to support startups and new ecosystems", *Business Horizons*, Vol. 60 No. 6, pp. 741-745.

Colombelli, A., Grilli, L., Minola, T. and Mrkajic, B. (2020), "To what extent do young innovative companies take advantage of policy support to enact innovation appropriation mechanisms?", *Research Policy*, Vol. 49 No. 10, 103797.

Czarnitzki, D. and Delanote, J. (2013), "Young Innovative Companies: the new high-growth firms?", *Industrial and Corporate Change*, Vol. 2 No. 5, pp. 1315-1340.

Decker, C. and Günther, C. (2016), "Coordinating family entrepreneurship: when money seeks opportunity", *International Journal of Entrepreneurial Venturing*, Vol. 8 No. 1, pp. 46-61.

Dotsika, F. and Watkins, A. (2017), "Identifying potentially disruptive trends by means of keyword network analysis", *Technological Forecasting and Social Change*, Vol. 119, pp. 114-127.

Dy, A.M., Marlow, S. and Martin, L. (2017), "A Web of opportunity or the same old story? Women digital entrepreneurs and intersectionality theory", *Human Relations*, Vol. 70 No. 3, pp. 286-311.

Eisner, E.W. (1991), *The Enlightened Eye: Qualitative Inquiry and the Enhancement of Educational Practice*, Collier Macmillan Canada, Toronto.

Elia, G., Margherita, A. and Passiante, G. (2020), "Digital entrepreneurship ecosystem: how digital technologies and collective intelligence are reshaping the entrepreneurial process", *Technological Forecasting and Social Change*, Vol. 150, 119791.

European Commission (2015), *Digital Transformation of European Industry and Enterprises*, available at: http://ec.europa.eu/DocsRoom/documents/9462/attachments/1/translations/en/renditions/native.

Ghezzi, A. and Cavallo, A. (2020), "Agile business model innovation in digital entrepreneurship: lean startup approaches", *Journal of Business Research*, Vol. 110, pp. 519-537.

Giones, F. and Brem, A. (2017), "Digital technology entrepreneurship: a definition and research agenda", *Technology Innovation Management Review*, Vol. 7 No. 5, pp. 44-51.

Gottschalck, N. and Günther, C. (2017), "Lost in transformation: strategy formulation in a digitized world", in Ellermann, H., Kreutter, P. and Messner, W. (Eds), *The Palgrave Handbook of Managing Continuous Business Transformation*, Palgrave Macmillan, London, doi: 10.1057/978-1-137-60228-2_3.

Guenther, C., Oertel, S. and Walgenbach, P. (2016), "It's all about timing: age-dependent consequences of founder exits and new member additions", *Entrepreneurship: Theory and Practice*, Vol. 40 No. 4, pp. 843-865.

Hahn, D., Minola, T. and Eddleston, K.A. (2019), "How do scientists contribute to the performance of innovative start-ups? An imprinting perspective on open innovation", *Journal of Management Studies*, Vol. 56 No. 5, pp. 895-928.

Hitt, M.A., Ireland, R.D., Camp, S.M. and Sexton, D.L. (2001), "Strategic entrepreneurship: entrepreneurial strategies for wealth creation", *Strategic Management Journal*, Vol. 22 Nos 6-7, pp. 479-491.

Honig, B. and Karlsson, T. (2004), "Institutional forces and the written business plan", *Journal of Management*, Vol. 30 No. 1, pp. 29-48.

Hsieh, H.-F. and Shannon, S.E. (2005), "Three approaches to qualitative content analysis", *Qualitative Health Research*, Vol. 15 No. 9, pp. 1277-1288.

Huang, J., Henfridsson, O., Liu, M. and Newell, S. (2017), "Growing on steroids: rapidly scaling the user base through digital innovation", *MIS Quarterly*, Vol. 41 No. 1, pp. 301-314.

Instilla (2017), Report Startup SEO 2017.

Instilla (2018), Report Startup SEO 2018.

Ismail, N., Jaffar, N., Khan, S. and Leng, T.S. (2012), "Tracking the cyber entrepreneurial intention of private universities students in Malaysia", *International Journal of Entrepreneurship and Small Business*, Vol. 17 No. 4, pp. 538-546.

Järvinen, J., Tollinen, A., Karjaluoto, H. and Jayawardhena, C. (2012), "Digital and social media marketing usage in b2b industrial section", *The Marketing Management Journal*, Vol. 22 No. 2, pp. 102-117.

Kraus, S., Palmer, C., Kailer, N., Kallinger, F.L. and Spitzer, J. (2019), "Digital entrepreneurship: a research agenda on new business models for the twenty-first century", *International Journal of Entrepreneurial Behavior and Research*, Vol. 25 No. 2, pp. 353-375, doi: 10.1108/IJEBR-06-2018-0425.

Kuester, S., Konya-Baumbach, E. and Schuhmacher, M.C. (2018), "Get the show on the road: go-to-market strategies for e-innovations of start-ups", *Journal of Business Research*, Vol. 83, pp. 65-81.

Labuschagne, A. (2003), "Qualitative research: airy fairy or fundamental?", *The Qualitative Report*, Vol. 8 No. 1, pp. 100-103.

Laender, A.H., Ribeiro-Neto, B.A., da Silva, A.S. and Teixeira, J.S. (2002), "A brief survey of web data extraction tools", *ACM Sigmod Record*, Vol. 31 No. 2, pp. 84-93.

Laursen, K. and Salter, A. (2006), "Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms", *Strategic Management Journal*, Vol. 27 No. 2, pp. 131-150.

Liu, H., Wang, Q. and Mei, Y. (2012), "Effects of start-up firm's social network on knowledge transfer: an empirical study", *In Proceedings of the International Conference on Information Management, Innovation Management and Industrial Engineering, Sanya, China, 20-21 October 2012*, pp. 228-233.

Mazzola, E., Bruccoleri, M. and Perrone, G. (2016), "The effect of inbound, outbound, and coupled open innovation practices on firm performance: empirical evidences from biopharmaceutical industry", *International Journal of Technology Management*, Vol. 70, pp. 2-3.

Minola, T., Hahn, D. and Cassia, L. (2021), "The relationship between origin and performance of innovative start-ups: the role of technological knowledge at founding", *Small Business Economics*, Vol. 56 No. 2, pp. 553-569.

MISE-Istat (Italian Minister of Economic Development - The Italian National Institute of Statistics) (2017), Startup surveys 2016, Rome.

Mosca, G. (2017), "Il flop delle start up italiane: non creano impiego, stentano ad andare all'estero e non sono aiutate dal Paese", *Business Insider Italia*, 28/4/2017, available at: it.businessinsider.com (accessed April 2019).

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

Nambisan, S. (2022), "Digital innovation and international business", *Innovation*, Vol. 24 No. 1, pp. 86-95.

Nambisan, S., Lyytinen, K., Majchrzak, A. and Song, M. (2017), "Digital Innovation Management: reinventing innovation management research in a digital world", *MIS Quarterly*, Vol. 41 No. 1, pp. 223-228.

Nepelski, D., Bogdanowicz, M., Biagi, F., Desruelle, P., De Prato, G., Gabison, G., Piroli, G., Pesole, A., Thumm, N. and Van Roy, V. (2017), "7 ways to boost to support digital innovation and entrepreneurship in Europe. Key messages from the European innovation policies for the digital shift project", JRC Science for Policy Reports, JRC 28305 EN. doi: 10.2791/019397.

OECD (2017), *OECD Science, Technology and Industry Scoreboard 2017: The Digital Transformation*, OECD Publishing, Paris, doi: 10.1787/9789264268821-en.

OECD (2018), "The evaluation of the Italian 'start-up act'", OECD Science, Technology and Industry policy papers, September, No. 54.

Ogink, T. and Dong, J.Q. (2019), "Stimulating innovation by user feedback on social media: the case of an online user innovation community", *Technological Forecasting and Social Change*, Vol. 144, pp. 295-302.

Passaro, R., Quinto, I. and Thomas, A. (2017), "Start-up competitions as learning environment to foster the entrepreneurial process", *International Journal of Entrepreneurial Behavior and Research*, Vol. 23 No. 3, pp. 426-445.

Patton, M.Q. (1990), *Qualitative Evaluation and Research Methods*, SAGE Publications.

Prause, M. and Günther, C. (2019), "Technology diffusion of industry 4.0", *An Agent-Based Approach*, Vol. 9 Nos 1-2, pp. 29-48.

Presutti, M., Boari, C. and Majocchi, A. (2011), "The importance of proximity for the start-ups' knowledge acquisition and exploitation", *Journal of Small Business Management*, Vol. 49, pp. 361-389.

Raguseo, E. and Vitari, C. (2018), "Investments in big data analytics and firm performance: an empirical investigation of direct and mediating effects", *International Journal of Production Research*, Vol. 56 No. 15, pp. 5206-5221.

Ramaswamy, V. and Ozcan, K. (2018), "What is co-creation? An interactional creation framework and its implications for value creation", *Journal of Business Research*, Vol. 84, pp. 196-205.

Ries, E. (2011), *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*, Currency.

Rippa, P. and Secundo, G. (2019), "Digital academic entrepreneurship: the potential of digital technologies on academic entrepreneurship", *Technological Forecasting and Social Change*, Vol. 146, pp. 900-911.

Rubin, T.H., Aas, T.H. and Stead, A. (2015), "Knowledge flow in technological business incubators: evidence from Australia and Israel", *Technovation*, Vol. 41, pp. 11-24.

Sahut, J.M., Iandoli, L. and Teulon, F. (2021), "The age of digital entrepreneurship", *Small Business Economics*, Vol. 56 No. 3, pp. 1159-1169.

Saldanha, T.J.V., Melville, N.P. and Ramirez, R. (2013), "Information systems for collaborating versus transacting: impact on manufacturing plant performance in the presence of demand volatility", *Journal of Operations Management*, 2013 Vol. 31 No. 6, pp. 313-329.

Saldanha, T.J.V., Mithas, S. and Krishnan, M.S. (2017), "Leveraging customer involvement for Fueling innovation: the role of relational and analytical information processing capabilities", *MIS Quarterly*, 2017 Vol. 41 No. 1, pp. 267-286.

Schiuma, G. (2017), "Arts catalyst of creative organisations for the fourth industrial revolution", *Journal of Open Innovation: Technology, Market, and Complexity*, Vol. 3 No. 1, p. 20.

Secundo, G., Rippa, P. and Cerchione, R. (2020), "Digital Academic Entrepreneurship: a structured literature review and avenue for a research agenda", *Technological Forecasting and Social Change*, Vol. 157, p. 120118.

Secundo, G., Del Vecchio, P. and Mele, G. (2021), "Social media for entrepreneurship: myth or reality? A structured literature review and a future research agenda", *International Journal of Entrepreneurial Behavior and Research*, Vol. 27 No. 1, pp. 149-177, doi: 10.1108/IJEBR-07-2020-0453.

Setia, P., Setia, P., Venkatesh, V. and Joglekar, S. (2013), "Leveraging digital technologies: how information quality leads to localized capabilities and customer service performance", *MIS Quarterly*, Vol. 37 No. 2, pp. 565-590.

Shabbir, M.S., Mohd Shariff, M.N., Kiran, R., Ahmad Zaidi, M.F. and Shahzad, A. (2016), "Cyber entrepreneurship: a note on indigenous perspective from a developing country", *The Social Sciences*, Vol. 11 No. 5, pp. 704-709.

Steininger, D.M. (2019), "Linking information systems and entrepreneurship: a review and agenda for IT associated and digital entrepreneurship research", *Information Systems Journal*, Vol. 29 No. 2, pp. 363-407.

Sundblad, W. (2018), "Data is the foundation for artificial intelligence and machine learning", *Forbes* (online review), available at https://www.forbes.com/sites/willemsundbladeurope/2018/10/18/ (accessed April 2020).

Urbinati, A., Chiaroni, D., Chiesa, V. and Frattini, F. (2020), "The role of digital technologies in open innovation processes: an exploratory multiple case study analysis", *R&D Management*, Vol. 50 No. 1, pp. 136-160.

Venkatesh, V., Morris, M.G., Davis, G.B. and Davis, F.D. (2003), "User acceptance of information technology: toward a unified view", *MIS Quarterly*, Vol. 27 No. 3, pp. 425-478.

von Briel, F., Davidsson, P. and Recker, J. (2018), "Digital technologies as external enablers of new venture creation in the IT hardware sector", *Entrepreneurship Theory and Practice*, Vol. 42 No. 1, pp. 47-69.

Zaheer, H., Breyer, Y., Dumay, J. and Enjeti, M. (2019), "Straight from the horse's mouth: founders' perspectives on achieving 'traction' in digital start-ups", *Computers in Human Behavior*, Vol. 95, pp. 262-274.

Zhang, Y. and Wildemuth, Barbara, M. (2005), *Qualitative Analysis of Content*, Vol. 1 No. 2, pp. 1-12.

**Corresponding author**
Roberto Cerchione can be contacted at: roberto.cerchione@uniparthenope.it