Digital Platform Innovation in European SMEs

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Digital platform innovation in European SMEs

An analysis of SME Instrument Business Proposals and Case Studies

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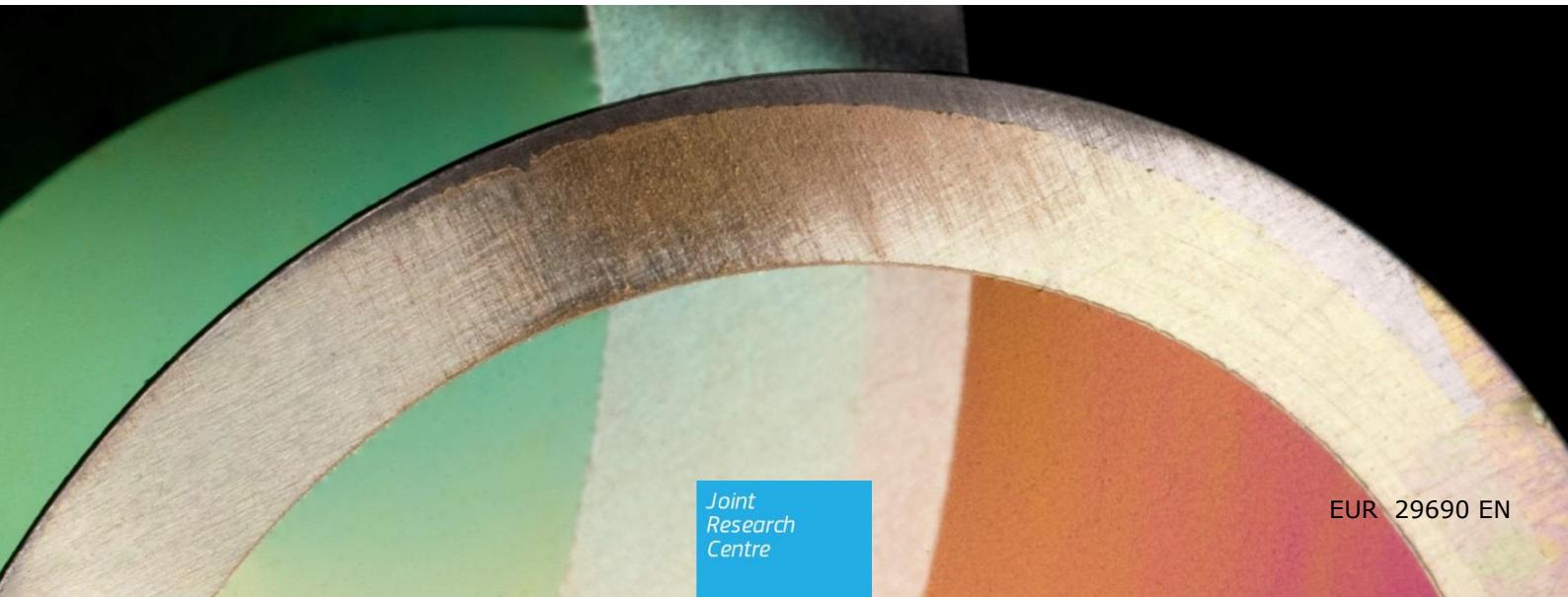

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Abstract

The study explores how European SMEs applying to the SME Instrument (SMEi) funding scheme under Horizon 2020 innovate use the digital platform business model. The study demonstrates a widespread awareness of the digital platform concept as a tool to be applied to gain momentum and growth, taking advantage of the digital affordances. The main challenges to scale-up include how to manage external communities and orchestrate them in order to build innovation ecosystems; how to find a profitable business model; and secure funding for growth. Firms located in peripheral regions face additional difficulties in finding complementary resources.

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Foreground

Digitisation has transformed the character of business activities as for both the business opportunities and the practices to pursue them. The current report provides an analysis on how European SMEs are seizing the opportunities unfolded by the digital economy. In particular, it formulates an idea of how new and original business and innovation strategies are emerging from European SMEs operating through digital platforms. It investigates the characteristics of SMEs developing platform innovations and the potential mediation role of these innovations across different market segments and sectors. The research explores the business strategy adopted by the digital company, focusing on: business model design and development; networking and collaboration activity; internationalization; appropriation strategy; characteristics of innovation processes; R&D organization and management. In exploring the platform innovation, and based on the definitions and taxonomies proposed, the study particularly focuses on the following aspects:

- The function and structure of the diverse "digital platforms" in which the SMEs operate; and the definition of "platform" that they adopt;
- The degree of "disruption" of the platform innovation;
- The potential network effects connected to the platform scale-up;
- The role of data analytics, reductions in transaction and information costs in multi-sided markets resulting from the platform innovation.

Executive Summary

This study analyses the patterns of digital platform innovation among SMEs applying to the SME Instrument (SMEi) funding scheme under the Horizon 2020 Framework Programme. It aims at understanding how the smallest players of the European economy translate digital affordances into business models and capture value in the digital economy.

Two elements were considered in defining "digital platforms/digital markets": a) the nature of digital platform innovations, i.e. the company's product/technology, the characteristics of the innovation processes, nature of networking, and collaboration activities; and b) the accompanying business model design and development, i.e. the choice of how to generate revenues . On these bases, and employing both quantitative and qualitative research methodologies, the following research questions are addressed:

What is the landscape of European SMEs developing Digital Platform innovations?

How is value created? Who captures this value? Who owns or controls the platform? What are the potential network effects connected to platform success? How does the platform innovation disrupt extant business models?

In the first instance, a quantitative, descriptive analysis was conducted on the activities and financial profiles of European SMEs developing digital platform innovations. The sample consisted of 2,320 active SMEs that, participated in the SMEi between January 2014 and March 2017, the innovative funding scheme introduced by the eighth European Framework Programme Horizon 2020.

This analysis offered insights on the scenario of the European digital platform SMEs and their main characteristics. The main points are included below:

- The highest concentration of SMEs showing evidence of digital platform innovation in SMEi proposals can be found in Italy, Spain, and the United Kingdom. This distribution reflects the structure of the entire population of applicants and beneficiaries of the SMEi. Consistently with the high level of development of digital entrepreneurship ecosystems in the Nordic countries (Autio et al., 2018) the most interesting exception is Finland where large percentage submitted a proposal concerned digital platforms innovation.
- SMEs operating through digital platforms are mainly new-born ventures classifying as start-ups: 41% ages 5 years old or less, and 21% ages less than 3 years old. A very small percentage (2.7%) of participants is over 30 years old, and almost one third of the sample (32%) is over 10 years old.
- SMEs operating in the service sectors are the most active in digital platform innovations and represent more than 90% of the sample. Digital platform SMEs operating in the manufacturing sector are mostly concentrated in Eastern Europe and in Italy.
- The majority of the SMEs in the services sectors operate in High-Tech Knowledge-Intensive service categories, including scientific R&D, computer programming, media and telecommunication, and information services.
- SMEs operate in eight sectoral clusters: i) Data services and market analysis for digital business; ii) Health and Biomedical; iii) Energy and Manufacturing; iv) Mobile, Apps, and IoT; v) Data security, Cloud, and Cybersecurity; vi) Marketing, Advertising/Other services for digital platforms; vii) Online content platforms; viii) Transport, Smart Cities, Urban. The categorisation in each cluster was not exclusive, meaning that each SME could fall in more than one cluster. The Data service and market analysis for digital business cluster was the most inclusive one. Health and Biomedical, Energy and Manufacturing, and Mobile apps and IoT clusters showed also a high level of SME activity.

The descriptive quantitative analysis was complemented by a qualitative analysis of the business models and strategies deployed by European SMEs to catch the opportunities offered by the digital platform economy. The insights can be summarised as follows:

- **Disintermediation/transformation of traditional industries**. Different aspects of the digital platform innovations may enable mechanisms of disintermediation, transformation, or even disruption of existing industries.
- **External community engagement** is a key managerial task to shape networks of users, contributors, and complementary businesses, whose presence on the platform motivates other members to join.
- **Orchestrating communities to build innovation ecosystems**. Digital platform SMEs often orchestrate networks of external communities across different industries and implement business models presenting elements of both platform and sharing economies.
- **Managing frictions**. The core business of digital platform SMEs is to align the interests of different communities converging onto the platform.
- **Easy to start-up difficult to scale-up**. Barriers to start-up the businesses are very low, while barriers to scale them up are high.
- **Digital platforms are laboratories** where multiple business models are tested at the same time.
- **Multiple funding sources to support growth**. The scale-up phase represents an important aspect of the validation phase of platform business models and different types of funding with different objectives are relevant both in the start-up and in the scale-up phase.
- **Previous experience matters**. The previous background of entrepreneurs is a powerful source of inspiration, since it allows for identifying or discovering opportunities in the pre-start-up phase.
- **Geographical scale-up.** Market fragmentation still hampers the development of new businesses through digital platforms in the EU.
- **Digital platforms in peripheral areas**. The scale-up phase of digital platforms may be adversely affected by an SME's location. The public funding is especially relevant for SMEs established in peripheral areas with weak innovation and entrepreneurial ecosystems.
- **The SMEi opens new business opportunities.** The SMEi helps SMEs to experiment and seek new growth opportunities. It is stimulating the diversification and the expansion activities.

1 Introduction

This study explores the current landscape of European SMEs having applied to the SME Instrument (SMEi) funding scheme under the Horizon 2020 (H2020) program. It looks at SMEs whose proposals involve the development of digital platforms. The scope of the study was to shed light on how these companies are facing the evolution of the digital platform economy.

1.1 The role of digital platforms as an innovation model

The advent and spreading of ICTs and their progressive socialisation and application to productive environments are the leverage of the modern industrial revolution. Even though the digital era emerged decades ago with the Internet and the IT-based transformation of services, vast improvements in data processing, transfer and access are pushing for a new techno-economic paradigm: the "Platform Economy" or "Digital Platform Economy".

Digitalisation and the cloud are the infrastructures on which new types of economic activities and organisational models operate, i.e. platform-based markets and business/commercial/institutional ecosystems. Digital platforms are the essence of this innovative reorganisation of the economy: they represent the hinges and the facilitators of the action and development of software, hardware, operations, and networks. Platforms provide a set of shared techniques, technologies, and interfaces to a broad set of users, contributors (e.g. third-party app developers) and complementary businesses that, when sufficiently rich, result in the formation of an ecosystem (Kenney and Zysman, 2016). Scholars represented this ecosystem as organised on four layers that globally interact with and build on each other: i) equipment manufacturing; ii) network operators; iii) platform, contents, and applications; iv) users and consumers (Fransman, 2014; Nepelski, 2019). In the virtue of the global projection of the digital ecosystem and the interconnectedness of said levels, the platforms require a transformation of corporate strategies and at the same time pose a wide range of policy challenges (Zysman and Kenney, 2018), redefining the traditional boundaries and practices of business, changing the way value is generated and captured in the digital economy (European Commission, 2014).

Platform economies are characterised by modularity: many platforms operating in niche markets remain such in most of the cases, while others grow, specialise further and develop, even taking over other niche businesses, until they manage to become platform themselves. Expanding and facilitating entrepreneurship, digital platforms play a major role in fostering and creating new opportunities for bottom-up innovation (Kenney and Zysman, 2015). As far as supply is concerned, digital platforms promote new forms of entrepreneurship and innovation, enabling individuals to fully take advantage of technological opportunities and fulfil their own ambitions or reach alternative goals. This leads to the rise of the so-called new generation of "micro-entrepreneurship" conducted by individuals previously limited to and left on the margins of traditional business activities (Sundarajan, 2014), as well as to the establishment of a new category of professionals known as "digital entrepreneurs": "those persons who seek to generate value, through the creation or expansion of economic activity, by identifying and exploiting new ICT or ICT-enabled products, processes, and corresponding markets (Bogdanowicz, 2015, p. 15). In terms of demand, users and customers can gain a range of advantages by using the platforms and, depending on the functions of the specific platform, they usually show very different motivations for using them, from economic or environmental factors to transparency and social objectives (Schor, 2016).

1.2 Defining digital platform innovations and digital business models

For the purpose of this study, two types of elements were considered to be relevant to the definition of "digital platforms/digital markets": a) **the nature of digital platform**

innovations, i.e. the company's product/technology, characteristics of the innovation processes, nature of networking, and collaboration activities; and b) **the accompanying business model design and development**, i.e. the choice of how to generate revenues from that platform - "who sells to whom" - the development of the appropriation strategy.

Specifically, and in order to sense the **nature of digital platform innovations** and the scope of their market impact, we considered different categories of platforms (Kenney and Zysman, 2016:65):

I. **Platforms for platforms** – this category includes foundational platforms facilitating the construction of the tools on which other platforms are built. Some examples are the Internet itself, Operating System platforms (e.g. iOS or Android), and Cloud services platforms (e.g. Amazon web);

II. **Platforms that make available digital tools** and help with the creation of other platforms/marketplaces – this category includes platforms acting as repositories of digital tools (e.g. sales support, human resources, accounting, insurance, and open source software platforms). These platform innovations create value by cutting transaction costs (such as search efforts or customer lock-in) and reduce disintermediation by traditional actors, drastically lowering prices for software, tools, and other foundation blocks for small companies. Examples are Wonolo for staffing services and Git Hub for open source software;

III. **Platforms mediating work** – this category includes platforms mediating work in different ways: from platforms transforming the work of previously independent professionals (e.g. LinkedIn) to platforms enabling companies to crowdsource work that requires human judgment (e.g. Amazon Mechanical Turk) and websites creating virtual markets for labour exchange (e.g. Upwork);

IV. **Retail platforms** – this category includes the most widespread online platforms: digital marketplaces that initiated the concept of platform economy (e.g. Amazon, eBay, Etsy);

V. **Service-providing platforms** –this category includes platforms recognised as having the most disruptive power. Service-providing platform are displacing traditional service companies (e.g. Airbnb or Lyft), or financial institutions (e.g. crowdsourcing platforms such as Kickstarter or VC platforms such as Angel List).

With regard to the investigation of the **business model design and development**, we took into account the three categories of platform business models proposed by Boudreau and Lakhani (2009). These categories are identified on the bases of the degree of control of the platform (who typically oversees technology development, income streams, and the end-customer relationship) or, conversely, the autonomy enjoyed by the economic agents involved (external communities of innovators and users):

I. **Integrator platform business models** – in this type of business model the company incorporates innovations brought in from the outside and sells the final product to customers. This model involves a high degree of control since the platform is wedged between the external innovators and the customers. For example, Apple's App Store is placed between iPhone software developers (external innovators) and customers, the platform directly monitors the app development (technical specifications) and directly sells them to customers.

II. **Product platform business models** – in this type of business model companies have less control over the technology since external innovators build on top of the existing technology and then directly sell to customers (being able to set prices and to retain IPR over their technical developments). An example is Intel Inside's strategy for microprocessors: the company provides the technology and the rules for its use, while the licensees innovate on that platform and sell the applications to customers.

III. **Two-sided (or multi-sided) platform business models** - in this type of business model external innovators and customers can transact directly with one another as long as they affiliate with the platform's owner. In such cases, the platforms act as a "catalyst" (Evans, 2016), facilitating the transactions and interactions between the different categories of economic agents (external innovators and customers). Although the external innovators might not interact with the platform owner during the design and development of new products, the owner can still demand some degree of control over the ecosystem, for example by setting rules and regulations as a condition for their affiliation (Bodreau and Hagiu, 2009).

1.3 Scope of the study

The background described in the previous section highlights the necessity to understand how and to what extent digital platforms are diverse in function and structure, in order to shape a suitable regulatory and policy framework. Moreover, although rich and relevant literature on platform economics is gradually flourishing (Martens, 2016), no real theory on the impact of the diverse types of platforms on the overall economy has been yet developed (Kenney and Zysman, 2015; 2016).

The scope of this study was to shed light on the process of adaptation of a relevant sample of European SMEs and their innovative responses to the evolution of the digital platform economy. The study investigated **how new and original business strategies are emerging among European SMEs having applied to the SMEi funding program and operating through digital platforms and markets**. The study analyses the characteristics of European SMEs developing platform innovations and the potential mediation role of this innovation across different markets and segments.

As a result, the following research questions are addressed, employing both quantitative and qualitative research methodologies:

(1) What is the landscape of European SMEs developing Digital Platform innovations?

(2) How is value created? Who captures this value? Who owns or controls the platform? What are the potential network effects connected to platform success? How does the platform innovation disrupt extant business models?

1.4 Methodology[1]

For the purpose of this study, we used a sample of SMEs that applied to the SMEi. From the 33,056 proposals submitted to the SMEi from January 2014 to March 2017, we selected SMEs whose projects reported clear evidence of digital platform innovation. The final sample consisted of 2,320 firms. These companies were analysed with respect to their size, financial performance and patenting activity. For the purpose of the cases analysis, 9 firms were analysed in-depth.

[1] For full the methodology description, see Annex II.

2 Digital platform SMEs in Europe: economic profiles of SMEi applicants and beneficiaries

2.1 Geography, demographics and industries of operation

Starting with the geographical distribution of the SMEs in the sample, Figure 1 shows that SMEi applicants reporting evidence of digital platforms (hereafter: digital platform SMEs) tend to be concentrated in a rather small number of countries.

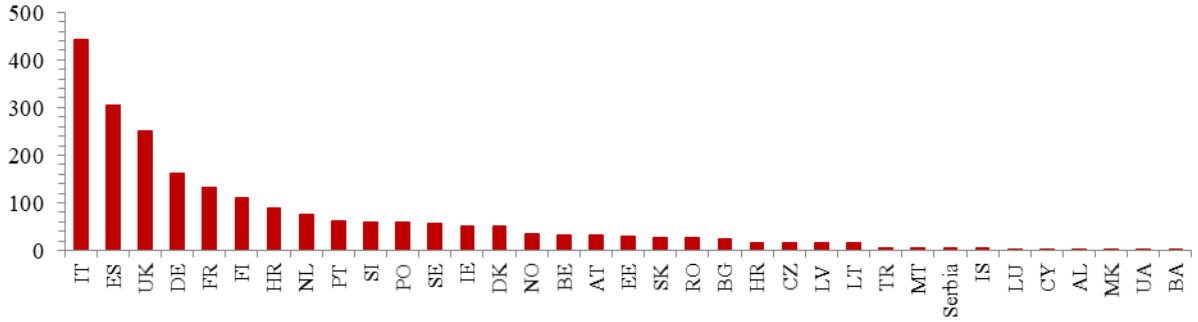
Applicants coming from the three most represented countries (Italy, Spain, and the United Kingdom) amount to almost half of the total. Italy ranks first among the Member States with 442 applicants, counting for a fifth of all the digital platform SMEs taken into consideration. Besides Italy, other countries with a large number of applicants are Spain (306) and the United Kingdom (250), followed at some distance by Germany and France with 162 and 133 firms, respectively. Countries from Eastern and Northern Europe amount to a smaller part of the total number of applicants, with only Finland having more than one hundred digital platform SMEs applying to the SMEi.

The geographical concentration is not surprising. This finding matches the distribution of the total number of applicants, as documented by Di Minin et al (2016). For instance, Di Minin et al. (2016) report that, from its launch to mid-2016, the SME Instrument received 5,336 proposals from Italian SMEs and 4,124 bids from Spanish firms, which again shared the podium with SMEs from UK.

The overall ranking of countries with more applicants on digital platforms closely resembles the one of the total of applicants. The most interesting exception is Finland which, despite not having a large number of SMEs applying to the SMEi (ranking 9th among Member States), has a quite large number of firms submitting proposals related to platforms (5% of the total, thus ranking 6th). This aligns with the country's precedent of industrial specialisation, encompassing traditional strength in ICT (exemplified by Nokia's early leadership in telecommunications).

Finally, we observe that the small and medium enterprises applying to the SMEi are rather well established, with an average age of 9.66 years (Table 1).

Figure 1. Geographical distribution of digital platform SMEs applying to SMEi.



Note: 2302 firms that submitted a proposal to the SMEi between January 2014 to March 2017.

Table 1. Distribution of digital platform SMEs by country and age.

Country	Number of SMEs	Age (mean)	Age (St. Dev.)
Albania	.	.	.
Austria	32	7.25	5
Belgium	33	9.7	8.46
Bosnia and Herzegovina	.	.	.
Bulgaria	23	10.78	8.01
Croatia	16	10.25	7.77
Cyprus	.	.	.
Czech Republic	16	8.06	8.1
Denmark	50	8.1	7.07
Estonia	29	8.31	6.39
Finland	111	8.05	7.57
France	133	11.44	10.66
Germany	162	6.85	6.06
Hungary	88	11.03	6,79
Iceland	.	.	.
Ireland	52	6.92	7.03
Italy	442	11.83	10,04
Latvia	15	7.67	6.73
Lithuania	15	7.33	4.55
Luxembourg	.	.	.
Macedonia (FYROM)	.	.	.
Malta	5	12	6.28
Netherlands	76	8.75	7.86
Norway	34	8.15	4.72
Poland	58	8.72	5.62
Portugal	62	8.24	6
Romania	26	6.96	5.64
Serbia	5	16.4	8.99
Slovakia	28	10.82	6.43
Slovenia	60	14.23	9.45
Spain	306	10.53	7.68
Sweden	56	8.39	7.24
Turkey	6	11	6.69
Ukraine	.	.	.
United Kingdom	250	7.63	7.46
Total	2,201	9.66	8.25

([1]) Statistics for countries reporting fewer than 5 observations are not displayed. The total is based on the number of SMEs for which demographic data is available.

On one side, SMEs from Romania, Ireland and Germany have a particularly low mean age, probably reflecting a better recovery of entrepreneurial activity in the aftermath of the economic crisis spread in 2008. On the opposite side, SMEs from Serbia, Slovenia and Malta, age distribution is much higher than the average.

In addition, we observe particularly high values of the standard deviation calculated on the SMEs' age in the overall sample (8.25), and even higher values among SMEs from Italy, Belgium, France, Serbia, and Slovenia. As a dispersion measure, the magnitude of standard deviation reflects a large heterogeneity among SMEi applicants in terms of age.

To this point, a closer look at the distribution of the full sample according to age classes (Figure 2) reveals further facts. In spite of the fact that 41% of SMEs in the sample are start-ups (5 years old or less), and that 21% of the new ventures are still in the early stages of development (from 1 to 3 years old), a considerable amount of SMEs score in the upper age classes (32% is over 10 years old and 2.7% is over 30 years, including some companies which are more than 60 years old).

Figure 2. Distribution of digital platform SMEs by age groups.

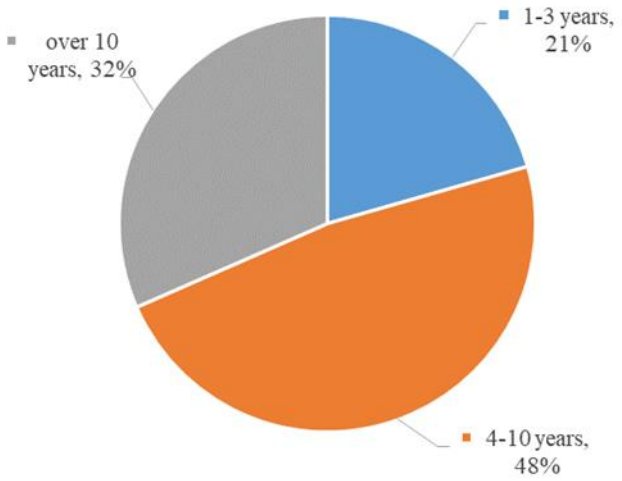


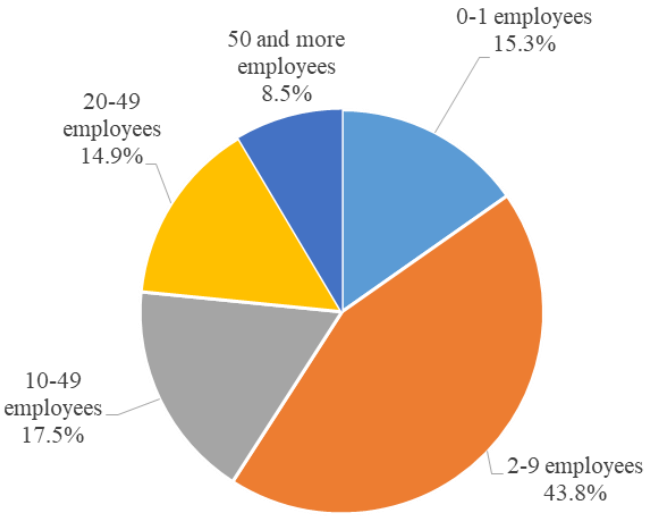
Figure 3 and Table 2 respectively report the distribution of digital platform SMEs in the sample by size classes and show some statistics on company size at country level.

Almost 60% of the SMEs in the sample consist of micro-enterprises (0-9 employees) among which more than 15% has 0 or 1 employees[2]. The remaining 40% is equally distributed across size classes.

The aggregate statistics reported in Table 3 shows a large discrepancy between the overall mean value, amounting to 19 employees, and the median value, which is a much smaller size of only 7 workers, a second important piece of evidence of the high degree of heterogeneity within the pool of SMEi applicants. Although the difference may appear quite small in absolute terms, in relative terms it means that some applicants are several times larger than the median competitor.

([2]) Data available from the Amadeus – Bureau van Dijk Database specifically refer to companies' employees. As such, the measure of company size used in this report excludes self-employed persons (i.e. the sole or joint owner of the enterprises) unless they are also in paid employment (in that case, they are considered as employees).

Figure 3. Distribution of digital platform SMEs by size groups.



At the country level, the United Kingdom stands out both for the mean and median values of firms' size (34 employees and 7 employees respectively), more than double of the values observed in the overall sample. Other countries with a high mean size include Lithuania, Serbia, France, and Bulgaria. However, their median firm size is very close to the global median, which hints to the presence of few larger SMEs that consistently raise the mean value for the entire country.

In Figure 4, the relative position of countries with respect to the mean size and age of digital platform SMEs is reported. Most of the countries in the sample are in the fourth quadrant, which means they have average lower age and size with respect to the overall sample.

What should be noted here is the peculiar case of Romania. Firms established in this country show the lowest average age and size values in the European Union, due to a very high incidence of young sole-employee companies.

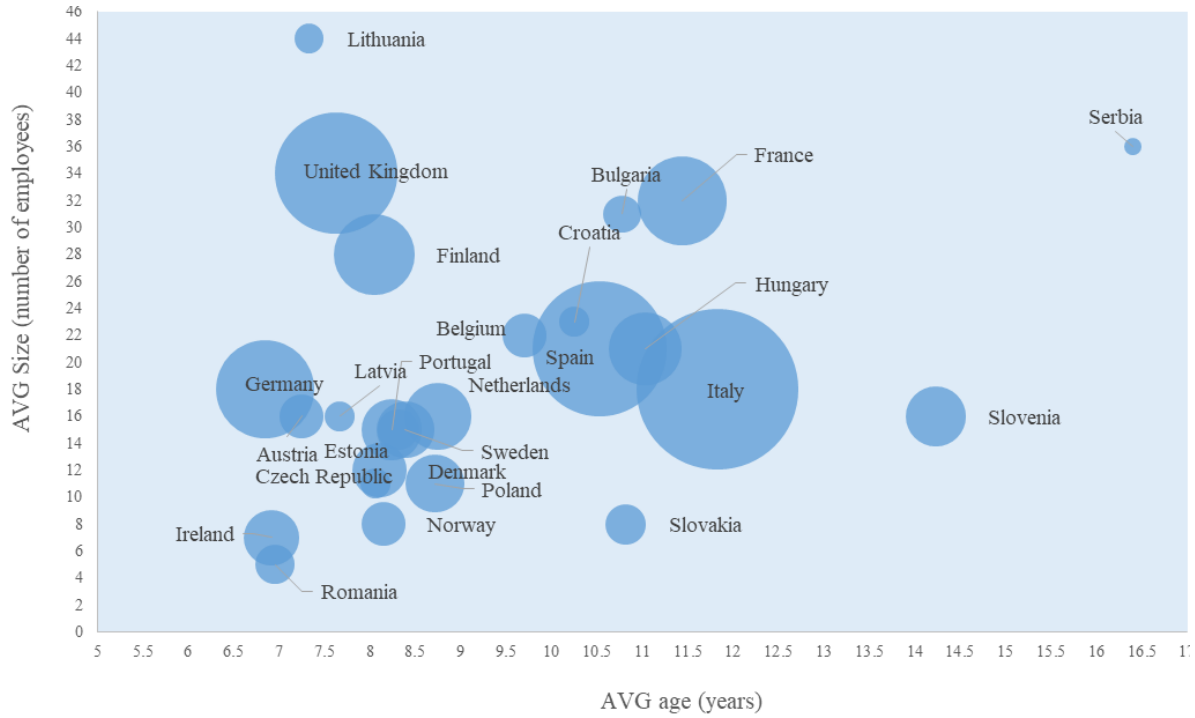
Relevant exceptions are Italy, Slovakia, and Slovenia: these countries position within the third quadrant, meaning that SMEs established in these member states present higher age but lower mean size.

Table 2. Distribution of digital platform SMEs by country and number of employees.

Country	Number of SMEs	Number of employees (mean)	Number of employees (Standard Deviation)	Number of employees (median)
Albania	.	.	.	.
Austria	20	16	31	5
Belgium	18	22	61	6
Bosnia Herzegovina	.	.	.	.
Bulgaria	23	31	67	7
Croatia	16	23	33	7
Cyprus	.	.	.	.
Czech Republic	10	11	14	5
Denmark	30	12	13	5
Estonia	23	15	25	8
Finland	70	28	52	9
France	55	32	42	12
Germany	146	18	40	4
Hungary	71	21	27	11
Iceland	.	.	.	.
Ireland	34	7	6	5
Italy	362	18	33	7
Latvia	15	16	26	5
Lithuania	15	44	67	6
Luxembourg	.	.	.	.
Macedonia (FYROM)	.	.	.	.
Malta	.	.	.	.
Netherlands	49	16	34	6
Norway	33	8	8	6
Poland	15	11	13	5
Portugal	57	15	19	5
Romania	26	5	10	1
Serbia	5	36	72	4
Slovakia	23	8	11	3
Slovenia	57	16	20	7
Spain	283	21	35	8
Sweden	54	15	31	5
Turkey	.	.	.	.
Ukraine	.	.	.	.
United Kingdom	22	34	42	18
Total	1,538	19	35	7

([1]) Statistics for countries reporting fewer than 5 observations are not displayed. The total is based on the number of SMEs for which financial and employment data is available.

Figure 4. Plot of European countries according to average age and size of digital platform **SMEs.**



The size of the bubble represents the number (%) of digital platform SMEs in each country.
([1]) Statistics for countries reporting fewer than 5 observations are not displayed.

Shifting the attention to the distribution of firms across industries, Table 3 shows that, unsurprisingly, the large majority of SMEi applicants in the digital platform domain operate in the service sectors (89.8%). Very few SMEs are classified under the residual category of "other industries", with the partial exception of Poland.

Although this distribution appears to be particularly stable across countries, it is worth noticing that the weight of manufacturing sector among SMEi applicants is higher in Serbia, Croatia, Czech Republic, and Italy (more than 15%) and that in those countries we had already observed a higher average age/dispersion. On the contrary, other countries with solid manufacturing traditions like Germany and Sweden have very few applicants coming from the manufacturing sector.

From this preliminary data, we can conclude that the SMEs operating in the service sectors are more active in digital platform innovation and that this pattern holds across Europe. Evidence from the following section(s) will provide new arguments supporting these considerations.

Table 3. Distribution of digital platform SMEs by country and industry.

Country	Number of SMEs	manufacturing %	services %	other industries %
Albania	.	.	.	.
Austria	32	6.3%	93.8%	0.0%
Belgium	33	6.1%	93.9%	0.0%
Bosnia and Herzegovina	.	.	.	.
Bulgaria	24	8.3%	91.7%	0.0%
Croatia	16	18.8%	81.3%	0.0%
Cyprus	.	.	.	.
Czech Republic	16	18.8%	81.3%	0.0%
Denmark	49	8.2%	91.8%	0.0%
Estonia	29	6.9%	93.1%	0.0%
Finland	111	8.1%	91.0%	0.9%
France	133	11.3%	86.5%	2.3%
Germany	162	4.9%	94.4%	0.6%
Hungary	88	2.3%	97.7%	0.0%
Iceland	.	.	.	.
Ireland	50	4.0%	96.0%	0.0%
Italy	442	15.6%	82.6%	1.8%
Latvia	15	13.3%	86.7%	0.0%
Lithuania	15	13.3%	86.7%	0.0%
Luxembourg	.	.	.	.
Macedonia (FYROM)	.	.	.	.
Malta	.	.	.	.
Netherlands	76	0.0%	98.7%	1.3%
Norway	34	5.9%	94.1%	0.0%
Poland	58	10.3%	82.8%	6.9%
Portugal	62	4.8%	93.5%	1.6%
Romania	26	7.7%	92.3%	0.0%
Serbia	5	20.0%	80.0%	0.0%
Slovakia	28	3.6%	92.9%	3.6%
Slovenia	60	11.7%	88.3%	0.0%
Spain	306	7.2%	90.8%	2.0%
Sweden	56	5.4%	94.6%	0.0%
Turkey	6	0.0%	100.0%	0.0%
Ukraine	.	.	.	.
United Kingdom	242	8.3%	90.9%	0.8%
Total	2189	8.9%	89.8%	1.3%

([1]) Statistics for countries reporting fewer than 5 observations are not displayed. The total is based on the number of SMEs for which financial and employment data is available.

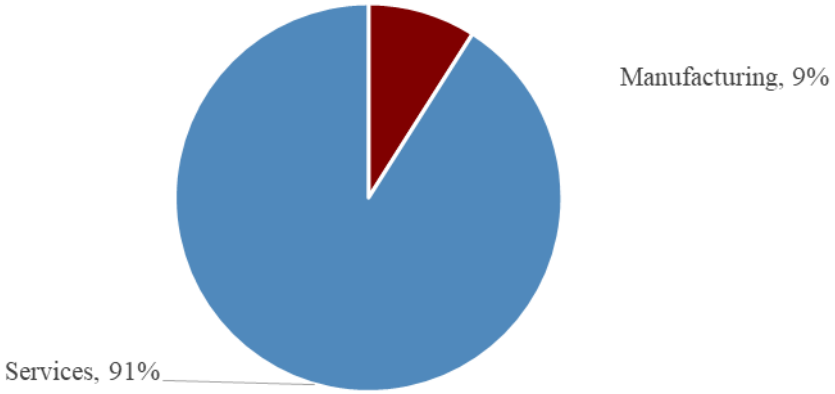
2.2 R&D and innovation activities

In this section, we investigate the R&D and innovation activities of our sample SMEs applying to the SMEi within the domain of digital platforms. We provide evidence of companies' technological intensity from two complementary perspectives:

- at the industry-level, we provide evidence of the technological content of companies' activities according to the High-tech Classification of Manufacturing Industries and to the definition of Knowledge Intensive Services (KIS), both based on NACE Rev.2 2-digit level, (EUROSTAT 2017a; 2017b).
- at the company-level, we compile statistics on the R&D intensity and patenting activities of firms in the sample, based on data retrieved from the Amadeus – Bureau Van Dijk database.

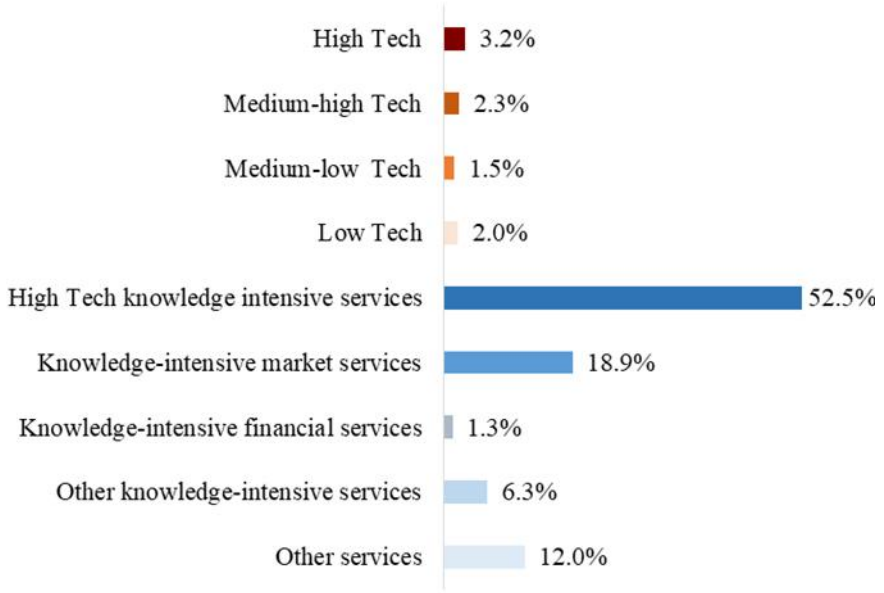
First, 91% of SMEs in the total sample operate in the services sector, and 1,134 firms out of 2,161 (half of the companies in our sample) are classified as High-Tech Knowledge Intensive Services (Figure 5). This category includes scientific research and development, computer programming, media and telecommunications services, and information service activities.

Figure 5. Distribution of digital platform SMEs by industry.



Besides High-Tech Knowledge Intensive Services, representing over 52% of firms (Figure 6), the second, most common category of SMEs in the sample is that of knowledge-intensive market services (408 companies out of 2,161). Ranging from architectural and engineering businesses (technical testing and analysis) to advertising and market research, management and consulting, legal and accounting, professional and S&T activities, to air and water transport, market KIS represents 19% of the digital platform companies in the sample.

Figure 6. Distribution of digital platform SMEs based on technological content



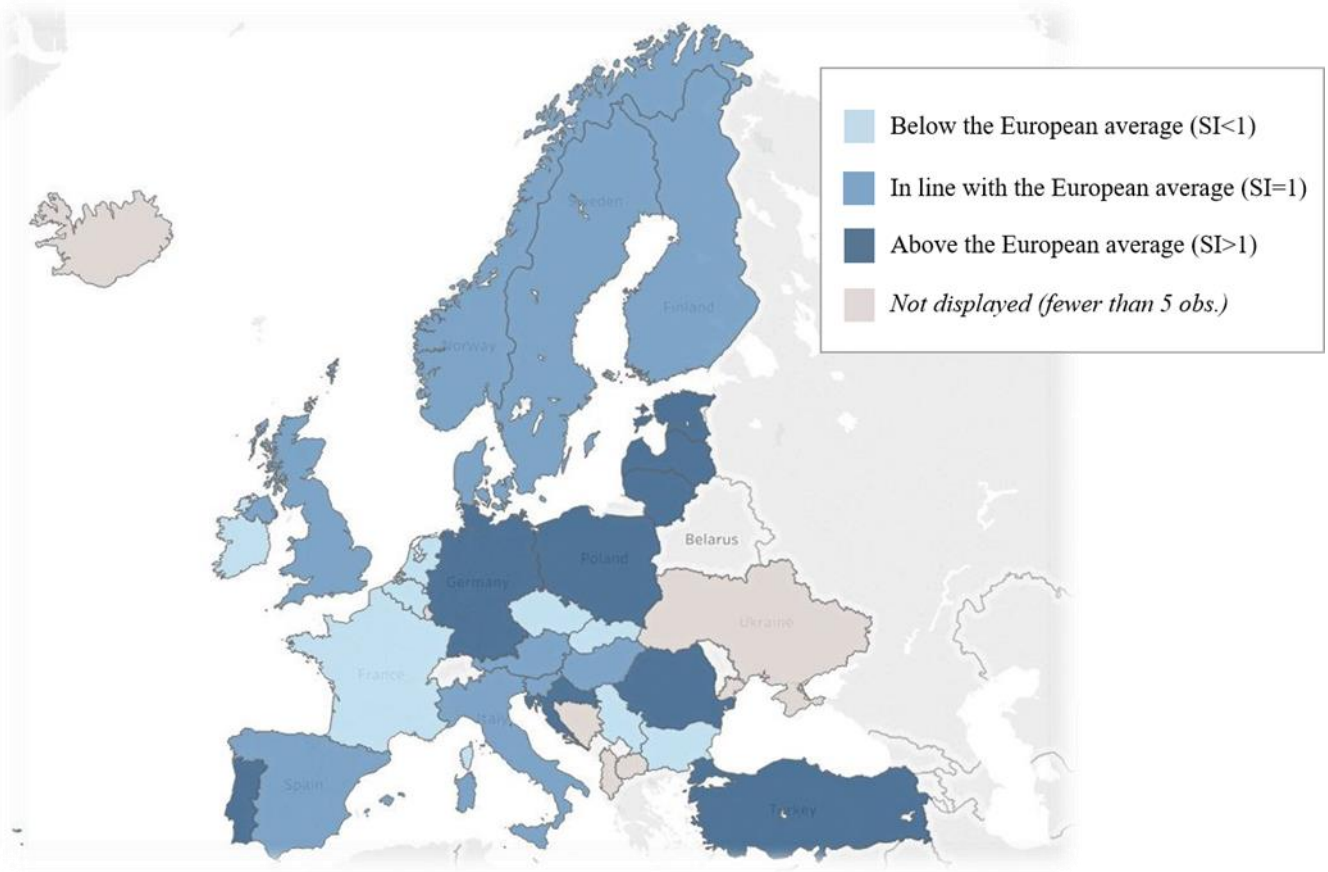
High-tech Classification of Manufacturing Industries - Definition of Knowledge-Intensive Services.

The distribution of firms in the manufacturing sector appears more balanced. Most of the SMEs operate in high-tech (3.2%) and medium/high-tech industries (2.3%), but the weight of these companies on the total sample is just over 5% (118 firms over 2,161).

To provide a comprehensive view of the distribution of technology-intensive firms across European countries, we computed a Specialisation Index (SI) for each country, by normalising the share of SMEs operating in high-tech manufacturing and knowledge intensive services with the correspondent share in the total sample. Being 1 the European average specialisation in high-tech and knowledge intensive industries, the value of the Specialisation Index for each country indicates a higher (>1), equal (=1) or lower specialisation (<1) with respect to the European average value.

Figure 7 displays the map of countries' specialisation indexes based on the technological content of digital platform companies' activities. From this perspective, three groups of countries emerge. A first group shows very little variation of the SI around one (which indicates a relative specialisation equal to the European average); the group includes, among the others, Norway, Sweden, Denmark, Finland Italy, Spain and the UK. A higher concentration of SMEs operating in high-technology manufacturing and service industries (SI>1) is observed in Germany and in some of the leading new member countries, where, coherently with a favourable scale-up context (Autio et al., 2018) we observe a small but relevant nucleus of young high-tech manufacturing companies.

Figure 7. Countries' specialisation index (SI) based on technological content.



(High-tech Manufacturing Industries – High Tech Knowledge-Intensive Services)

A third group of countries, composed, among the others, by Ireland, France, Belgium and the Netherlands show lower concentrations of high technology manufacturing/knowledge intensive services firms operating through digital platforms with respect to the European average (SI=0.5).

In all these countries, SMEi proposals concerning digital platform innovations mainly originate from SMEs operating in the cultural industries[3].

([3]) More in detail, such companies operate in the category of "Other knowledge intensive services" which includes Publishing activities, Education, Creative, arts and entertainment activities, Sports activities and amusement and recreation activities.

Table 4. Average R&D intensity of digital platform SMEs by country.

Country	Number of SMEs	R&D intensity % (mean)	R&D intensity % (St. Dev.)
Albania	.	.	.
Austria	29	3.1	6.8
Belgium	33	25.4	29.8
Bosnia and Herzegovina	.	.	.
Bulgaria	24	5.0	14.9
Croatia	16	29.4	40.0
Cyprus	.	.	.
Czech Republic	10	28.4	37.3
Denmark	43	34.8	34.0
Estonia	26	30.5	37.6
Finland	98	45.6	32.6
France	133	21.6	25.0
Germany	70	12.9	23.9
Hungary	84	21.2	28.3
Iceland	.	.	.
Ireland	36	18.9	31.0
Italy	442	17.8	23.0
Latvia	14	19.4	27.9
Lithuania	.	.	.
Luxembourg	.	.	.
Macedonia (FYROM)	.	.	.
Malta	5	29.5	41.5
Netherlands	60	10.5	26.1
Norway	34	24.7	29.2
Poland	49	23.0	34.5
Portugal	57	21.2	29.7
Romania	26	7.2	16.7
Serbia	5	0.0	0.0
Slovakia	28	11.8	24.7
Slovenia	60	8.5	15.6
Spain	306	23.5	24.8
Sweden	49	37.6	33.3
Turkey	.	.	.
Ukraine	.	.	.
United Kingdom	198	16.1	29.8
Total	1,949	20.7	27.9

([1]) Statistics for countries reporting fewer than 5 observations are not displayed. The total is based on the number of SMEs for which financial and employment data is available.

Shifting to company-level analysis, we first computed a measure of R&D Intensity based on financial data retrieved from the Amadeus Bureau van Dijk Database, as the percentage share of intangible fixed assets over total assets. It needs to be noted that this measure of R&D intensity is based on capital structure rather than on R&D expenditures. This limits direct comparison between the two measures.

Table 4 reports the average values of R&D intensity of SMEs in the sample for each country. It reveals that our dataset covers enterprises with a relatively high ratio of intangible assets over fixed assets, averaging at 20.7% overall.

Such finding is in line with the sectorial overview provided above, which finds a predominance of knowledge-intensive firms. Scandinavian countries are by far the most knowledge-intensive, with Finnish firms having an average 45.6% of intangible assets. However, these countries also show a high standard deviation for this measure, hinting to uneven distributions with both "R&D champions" and firms with low levels of intangible assets.

On the other hand of the spectrum, we find Austria, Bulgaria, Romania, and Slovenia, whose SMEs have on average very low intangible assets. In addition, they also appear to be quite homogeneous as shown by their low standard deviations. Among the largest EU economies, only German firms have on average a proportion of intangible fixed assets that is lower than the global mean.

Finally, we explore more in detail the stock of knowledge-related assets by focussing on patents (Table 5). Patent data constitute one of the most used and available empirical proxies for studying innovation activities (Jaffe et al. 1993; Jaffe and de Rassenfosse, 2017).

Nevertheless, patents suffer from many well-known drawbacks that make them an imprecise proxy for innovation. Not only are patents inherently less suited to protect a certain type of inventions relative to other mechanisms (Teece, 1986), but they are also often used for strategic goals that differ from protecting true novelties (Cohen et al., 2000). Furthermore, the distribution of patent applications is highly skewed in terms of company size, a finding that is particularly evident for international patent filings (Blind et al, 2006). Keeping this caveat in mind, we consider the stock of patent granted to each SME as reported in Amadeus.

Starting with a bird's eye view, the Amadeus database reports a stock of 1,926 patents granted to the 2,203 SMEs in the period of analysis (i.e. slightly less than 1 patent each). Considering the distribution of the stock of patents, we see that Italy accounts for the lion's share (32.2%) followed by the United Kingdom (21.3%) while, despite the high number of applicants, Spain and Germany account for very small shares.

Turning to patenting intensity, measured through the normalised values of per-capita indicators, the UK (1.8), Italy (1.6), France (1.5) and Finland (1.4) Sweden (1.3) belong to a restricted group of countries with very high levels of patenting activities.

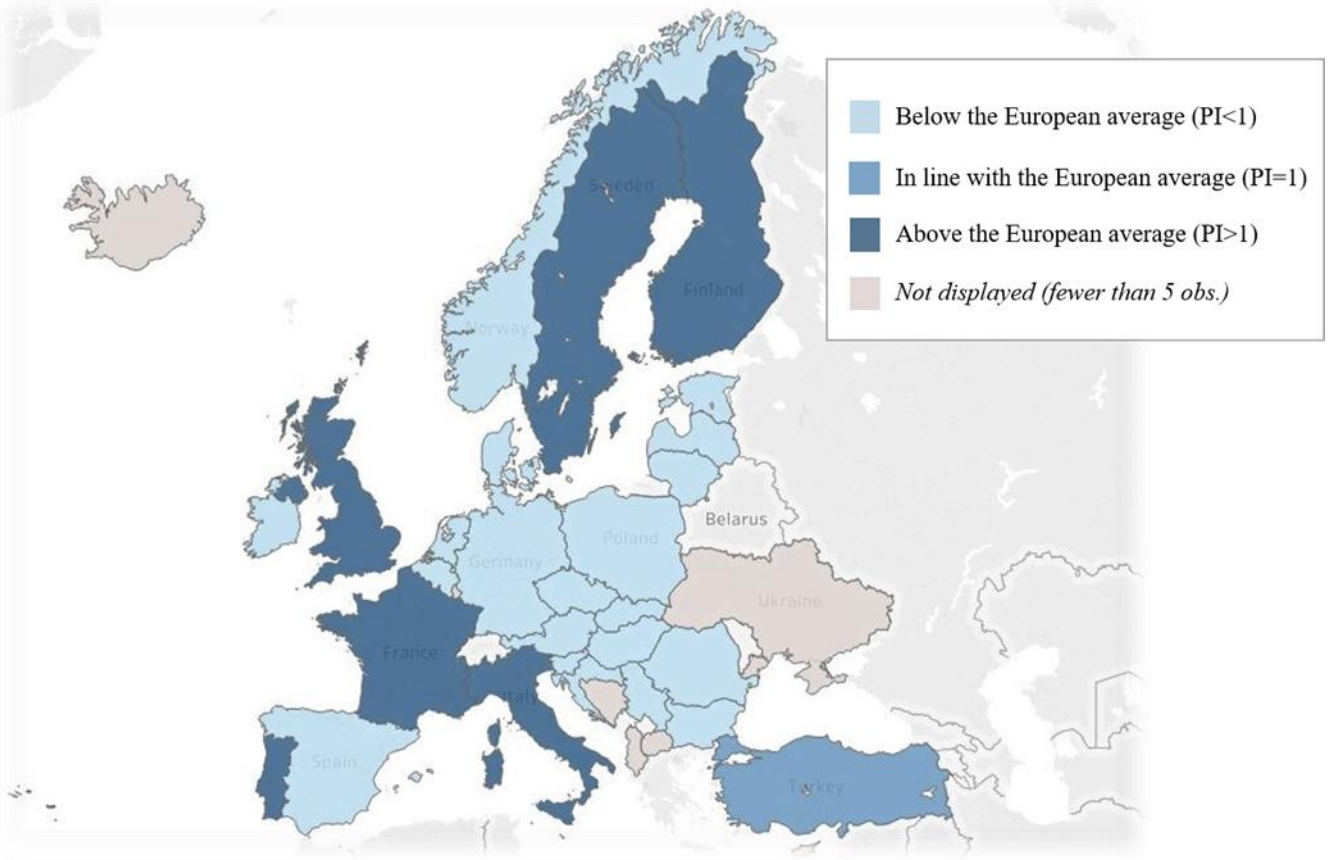
Table 5. Distribution of patents granted to digital platform SMEs by country

Country	Number of SMEs	Number of patents	Patenting Intensity (normalised values)
Albania	.	.	.
Austria	32	19	0.7
Belgium	33	8	0.3
Bosnia and Herzegovina	.	.	.
Bulgaria	24	1	0.1
Croatia	16	1	0.1
Cyprus	.	.	.
Czech Republic	16	0	0.0
Denmark	50	26	0.6
Estonia	29	9	0.3
Finland	111	132	1.4
France	133	172	1.5
Germany	162	113	0.8
Hungary	88	38	0.5
Iceland	.	.	.
Ireland	52	13	0.3
Italy	442	621	1.6
Latvia	15	0	0.0
Lithuania	15	3	0.2
Luxembourg	.	.	.
Macedonia (FYROM)	.	.	.
Malta	5	0	0.0
Netherlands	76	30	0.5
Norway	34	17	0.6
Poland	58	8	0.2
Portugal	62	60	1.1
Romania	26	7	0.3
Serbia	5	0	0.0
Slovakia	28	9	0.4
Slovenia	60	45	0.9
Spain	306	116	0.4
Sweden	56	62	1.3
Turkey	6	5	0.9
Ukraine	.	.	.
United Kingdom	250	411	1.8
Total	2,203	1,926	1.0

([1]) Statistics for countries reporting fewer than 5 observations are not displayed. The total is based on the number of SMEs for which patent data is available.

Figure 8 shows that this group of countries have markedly higher levels of patenting intensity than the European average (PI>1) while, consistently with the large inter-country heterogeneity observed above, the PI values of the observed SMEs in all the remaining EU countries are markedly lower than the European average (PI<1).

Figure 8. Patenting Intensity (PI) of digital platform SMEs by country.



3 Profiling digital platform SMEs in Europe

The process applied to identify digital platform SMEs' profiles among SMEi digital platform applications started from the collection of proposal abstracts. The aim was to identify natural groups among the total number of applications in order to then conduct an analysis on individual groups. Given that we are dealing with textual data, we apply a topic modelling analysis, which is the counterpart of the cluster analysis for numeric data. Latent Dirichlet Allocation (LDA) is a popular algorithm for implementing topic-modelling procedures (for a more detailed description, see Blei, Ng & Jordan, 2003). In our context, each proposal abstract is treated as a mixture of topics, and a combination of words characterizes each topic. LDA allows to simultaneously estimate both the mixtures: defining the mixture of words associated with each topic, while also finding the mixture of topics that describe each proposal abstract. The final output of the algorithm is the classification of each proposal into one or more than one topic according to the words used in the abstract. According to LDA specifications, the number of topics (k) is a fixed parameter that needs to be defined before running the algorithm. To ensure interpretability and robustness of the results, we implemented the LDA procedures for several values of k, from k=15 to k=5. For each value of k, we examined the resulting topics through the list of relevant words characterising each one. The final value of k is 8, determined as the maximum number of topics that allows a distinct interpretation of each group, hence minimising topic overlapping. The list of the 8 clusters resulting from the analysis and the relevant keywords per each cluster is reported in Table 6.

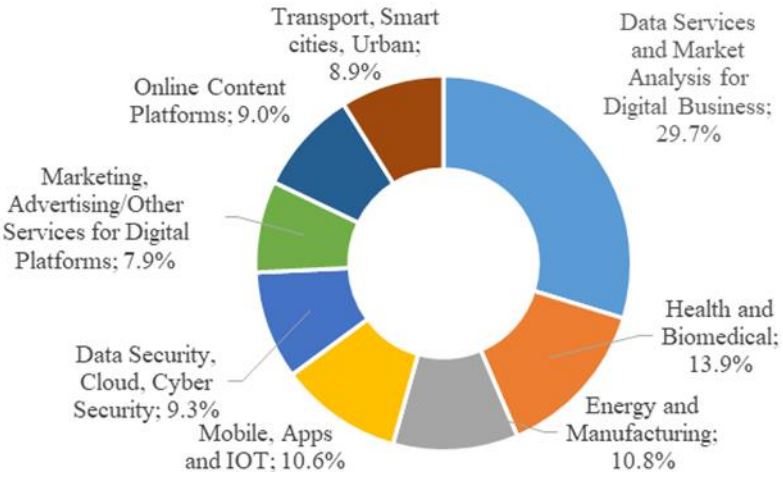
Table 6. Clusters definition.

CLUSTER NUMBER	CLUSTER NAME	RELEVANT TERMS (TOPICS) CHARACTERIZING THE CLUSTERS
1	Data Services and Market Analysis for Digital Business	Market; Business; Data; Platform; Software; Service; Management; Model
2	Health and Biomedical	Health; Medical; Patients; Care; Healthcare; Clinical; Data; System; Device; Treatment; Monitoring
3	Energy and Manufacturing	Energy; System; Production; Water; Control; Monitoring; Data; Cost; Quality
4	Mobile, Apps and IoT	Mobile; Devices; User; Smart; App; IOT; Internet; System; Video; Software; Cloud
5	Data Security, Cloud, and Cyber Security	Data; Security; System; Mobile; Service; Users; Privacy; Information; Protection; Cloud; Storage; Cyber; Payment; Identity
6	Marketing, Advertising/Other Services for Digital Platforms	Online; Marketing; Customers; Advertising; Retailers; Products; Mobile; Data
7	Online Content Platforms	Content; Learning; Social; Media; Platform; Education; Users; Music; Video; Online; Students; Games
8	Transport, Smart cities, Urban	Transport; Public; Cities; Services; Local; Mobile; Car; Citizens; Travel; Platform; Tourism; City

Figure 9 shows the occurrence of the topics singled out with the clustering method in the full sample and within each sector. Most of the SMEs made a proposal concerning "Data

services and market analysis for digital business". The second-most addressed topic was Health and Biomedical, followed by Energy and Manufacturing and Mobile, Apps, and IoT. Less frequent are Data Security, Cloud Cyber Security and Online Content Platform, Transport Smart city, Urban, and Market services for digital platforms (i.e. marketing, advertising, other services).

Figure 9. Distribution of digital platform SMEs according to topic clusters.



The distribution of topics across the sectors in which the SMEs operate does not show any distinctive pattern with respect to the full sample (see Table 7). In every sector, almost 30% of SMEs made a proposal concerning "Data services and market analysis for digital business", 14% involving Health and Biomedical, and 10% concerning Energy and Manufacturing or Mobile, Apps and IoT, and so on.

Proposals relative to Online Content Platforms and Data Security, Cloud, and Cyber Security are much more frequent among firms operating in the services sectors- especially those operating as high-tech knowledge-intensive services - while proposals coming from manufacturing firms tend to cluster around Energy and Manufacturing, Health and Biomedical, and Mobile, Apps and IoT.

Among these, high tech and medium-high-tech manufacturing businesses have a higher incidence of digital platform proposals related to Health and Biomedical and Energy and Manufacturing, while low and medium-low technology firms developed proposals related to Mobile, Apps and IoT topics.

Such evidence suggests that SMEi proposals concerning the development of digital platform innovations build, at least to a certain extent, on the firms' in-house R&D capacity. Also, it is worth noticing that, from a geographical perspective, bigger economies are more representative of the different topics while this is not the case of smaller countries, whose applicants tend to cluster around fewer topics. This may suggest that the SMEi project can have a multi-market impact. If true, the SMEi could offer SMEs the opportunity to diversify their portfolio of competencies by starting new ventures and explore new areas of activity.

Table **8** displays the distribution of project proposals across the clusters, showing the degree of overlap among different topics. As previously discussed, (see section 4.1) including a proposal in one cluster does not exclude the possibility of being included in another cluster. Such overlaps between generic technological capabilities, e.g. data services, and particular sector of activities, e.g. health, hints on versatility of digital technologies.

Table 7. Distribution of digital platform SMEs based on technological activity and topic clusters.

	Data Services and Market Analysis for Digital Business	Health and Biomedical	Energy and Manufacturing	Mobile, Apps and IoT	Data Security, Cloud, Cyber Security	Marketing, Advertising/Other Services for Digital Platforms	Online Content Platforms	Transport, Smart cities, Urban	Total
MANUFACTURING	**28.4%**	**14.9%**	**16.7%**	**15.0%**	**7.7%**	**5.4%**	**6.4%**	**5.5%**	**100%**
High and Medium-high tech	28.2%	15.9%	15.9%	17.1%	6.3%	4.1%	5.8%	6.7%	100%
Low and Medium-low tech	28.8%	13.2%	17.9%	11.7%	10.1%	7.4%	7.4%	3.5%	100%
SERVICES	**29.8%**	**13.8%**	**10.2%**	**10.1%**	**9.5%**	**8.2%**	**9.2%**	**9.3%**	**100%**
High tech knowledge intensive services	30.0%	13.2%	9.6%	10.2%	10.1%	9.0%	8.9%	8.9%	100%
Other services	29.6%	14.4%	10.9%	10.0%	8.7%	7.1%	9.6%	9.7%	100%
Total	**29.7%**	**13.9%**	**10.8%**	**10.6%**	**9.3%**	**7.9%**	**9.0%**	**8.9%**	**100%**

Table 8. Overlaps between clusters

	Data Services and Market Analysis for Digital Business	Health and Biomedical	Energy and Manufacturing	Mobile, Apps and IoT	Data Security, Cloud, Cyber Security	Marketing, Advertising/Other Services for Digital Platforms	Online Content Platforms	Transport, Smart cities, Urban
Data Services and Market Analysis for Digital Business	2133	1051	825	802	717	603	686	676
Health and Biomedical	1051	995	324	390	355	282	289	320
Energy and Manufacturing	825	324	773	290	214	181	155	218
Mobile, Apps and IoT	802	390	290	758	245	199	240	240
Data Security, Cloud, Cyber Security	717	355	214	245	669	192	239	218
Marketing, Advertising/Other Services for Digital Platforms	603	282	181	199	192	567	151	178
Online Content Platforms	686	289	155	240	239	151	643	181
Transport, Smart cities, Urban	676	320	218	240	218	178	181	640

3.1 Cluster 1: Data Services and Market Analysis for Digital Business

Keywords: Market; Business; Data; Platform; Software; Service; Management; Model

The Data Services and Market Analysis for Digital Business cluster is the most inclusive one. It groups the largest part of the proposals submitted, which focus on **data services**, **market analysis**, and **digital platforms.** These projects generally aim to improve technologies in daily life activities, urban solutions, medical applications, the Internet of Things (IoT), and Cyber Security. As the following sections show, these topics are also developed in a wide plethora of technical applications in different fields.

Essentially, Cluster 1 proposals promote the creation of **digital platforms** to collect and process data, making them available to **end users**. On the one hand, these implementations aim to increase **public services efficiency** and encourage **responsible behaviour**. Conversely, they aim to facilitate people's life, connect people and things (IoT) or help users in sharing content.

Main characteristics of SMEs falling within Cluster 1 are the application of digital technologies that **monetise and build on data**, **software** and **cloud-based platforms** in order to speed up the delivery of product and services to the market. These companies transform raw information to **trigger knowledge diffusion** and **improve contents and activities' management**. The main goals of firms included in Cluster 1 are generally to create sources for planning, management, protection, promotion, valuation and monetisation of innovative solutions.

Cluster 1 SMEs leverage their activities on **wide ecosystems of partners**, with which they establish technological and service collaborations to secure the highest level of **integration** and **interoperability** of their products and services on digital marketplaces.

In conclusion, the cluster analysis shows that organising and using data on a large scale play a vital part of innovation implementation. Data often collected and shared on platforms, is considered crucial for a huge variety of applications from the most traditional sectors (e.g. agriculture, food, etc.) to most innovative ones, such as the use of Artificial Intelligence (AI) for data processing and marketing analysis, or cyber and data security.

SMEs' profiles

Cluster 1 on "Data Services and Market Analysis for Digital Business" includes almost the totality of digital SMEs (2,290 out of 2,320), out of which only 115 resulted to be non-active. As previously discussed, including a proposal in one cluster, does not exclude the possibility of being included in another cluster. Therefore, it is interesting to notice the distribution of proposal across the clusters. Being the **widest** and **more general** one, just 39 active and 2 non-active companies fell solely in the "Data Services and Market Analysis for Digital Business" cluster, while all the other firms presented a proposal included in more than one cluster. The most noticeable overlap is between Cluster 1 and Cluster 2 on "Health and Biomedical", with 1,051 proposals included in Cluster 1 also falling into Cluster 2, followed by Cluster 3 on "Energy and Manufacturing" and Cluster 4 on "Mobile, Apps and IoT", respectively 825 and 802 shared proposals (Table **8**). 811 SMEs out of 2,175 submitted more than one proposal (between 2 and 6) that always fell into Cluster 1.

Cluster 1 company age averages **10 years** (only slightly higher than the 9.7 years average of the total sample of digital SMEs); their size coincides with the mean of the total sample (19 employees) and, typically, they own **one patent** (total sample average 0.87), see Figure 11.

Reflecting the distribution of the total sample of digital SMEs, 91% of Cluster-1 SMEs operates in the Service sector while only 9% deal in Manufacturing, with Knowledge-

Intensive High-tech being the majority of services SMEs (57%) and High-Tech only about one third (36%) of total manufacturing firms in Cluster 1 (Figure 10).

Figure 10. Characteristics of firms in Cluster 1.
(avg. age, size, and no of patents)

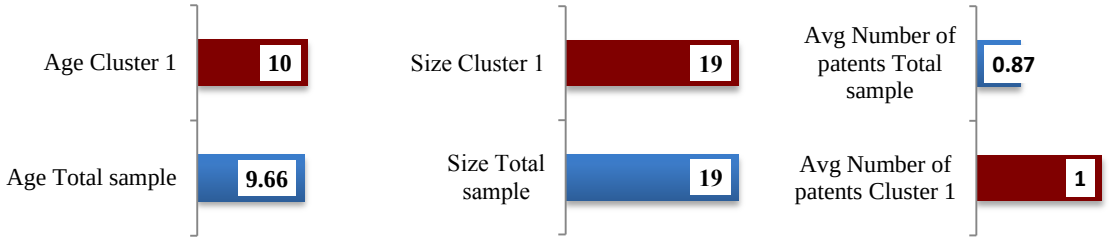
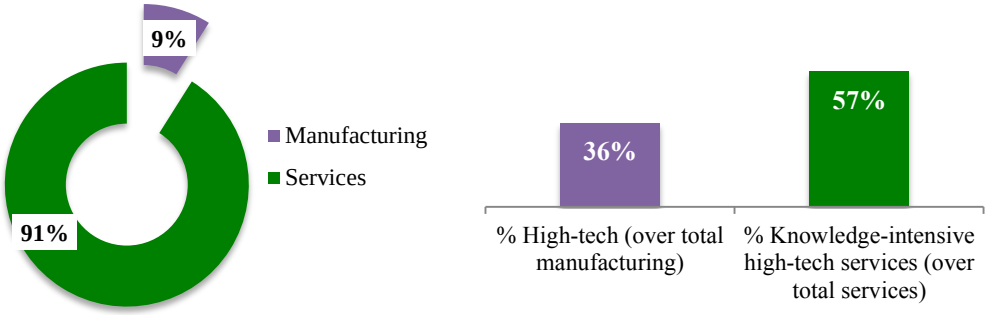


Figure 11. Distribution of firms in Cluster 1 by industry and technological content.



3.2 Cluster 2: Health and Biomedical

Keywords: Health; Medical; Patients; Care; Healthcare; Clinical; Data; System; Device; Treatment; Monitoring

Three interesting insights emerge from the analysis of the proposals grouped in cluster 2. First, the cluster analysis shows that some proposals aim to develop **digital solutions** to assist people in making **responsible and informed use of medications**. These projects allow, for instance, helping the general public to increase their knowledge of healthcare, supporting them in an "intelligent" use and purchase of medicines, or developing wireless stethoscopes that integrate devices and online platforms (**intelligent brain**) through the collection of data and the comparison with standard values that help detecting potential pathologies.

Second, the cluster analysis shows that some other projects focus on the development and implementation of **hardware and software for people's needs**. Some examples are the Braille digital printers that reduce the costs of copies and improve the quality of life of communities, educational institutes, and individual users.

Finally, the cluster also includes proposals focussing on **public health**. One of the examples of the topics is, for example, the wastewater networks management. Since governments only have partial information of their underground (waste) water infrastructure, some proposals suggest 3D technology to be used to connect dedicated platforms allowing operators to monitor the status of the water infrastructures in real time.

SMEs' profiles

Cluster 2 on "Health and Biomedical" includes 1,065 digital SMEs whose great majority is active, while only 49 resulted to be non-active. Just one (non-active) company fell merely in Cluster 2 within "Health and Biomedical", while all the other firms put forward a proposal included in more than one cluster (Table **8**). In addition, 89 active companies submitted a proposal that was only part of Cluster 2 with the general Cluster 1 was excluded. As was said for the "Data Services and Market Analysis for Digital Business" cluster, the most interesting overlapping proposals resulting for Cluster 2 is with proposals in Cluster 1 (1,051 proposals). The other noticeable overlapping instances are with Cluster 4 on "Mobile, Apps and IoT" (390 proposals) and Cluster 5 on "Data Security, Cloud, Cyber Security" (see Table **8**). 297 companies out of 1,065 submitted more than one proposal (between 2 and 6) that always fell into Cluster 2.

Cluster 2 company age is on average **9.9 years** (only slightly higher than the average of 9.7 years of the total sample of digital SMEs). Generally, Cluster 2 SMEs size (**17.6 employees**) is slightly smaller than the average of the total sample (19) and they own less than one patent (0.7 against total sample average of 0.87), see Figure 12. Again, reflecting the distribution of the total sample of digital companies, 90% of Cluster 2 SMEs operate in the Service sectors while only 10% being active in manufacturing sectors, with Knowledge-Intensive High-tech being the majority of service companies (55%) and High-Tech more than one third (37%) of the total manufacturing firms in Cluster 2 (See Figure 13).

SMEs applying to the SMEi with a proposal falling within Cluster 2 "Health and Biomedical" are generally firms working in research and experimental development on natural science and bioengineering. They develop innovative apps and cloud **platforms for secure, cost-effective, and efficient health-related data storage and sharing**. Cluster 2 businesses also provide advanced technology solutions and apply the principles of **Industry 4.0** to offer cutting-edge medical devices and products. These SMEs offer affordable and integrated business to their users and clients in the pharmaceutical, food and beverage, and chemistry fields. In general, they also provide maintenance, assistance, and training services to professionals and patients using their solutions and products.

Cluster 2 SMEs generally conduct R&D activities in collaboration with industrial, professional, and academic partners and are significantly involved in scientific publications. They show strong engagement in **searching activities** and commitment in **advancing the scientific knowledge** that will be at the basis of their entrepreneurial activity.

Figure 12. Characteristics of firms in Cluster 2.
(avg. age, size and no of patents)

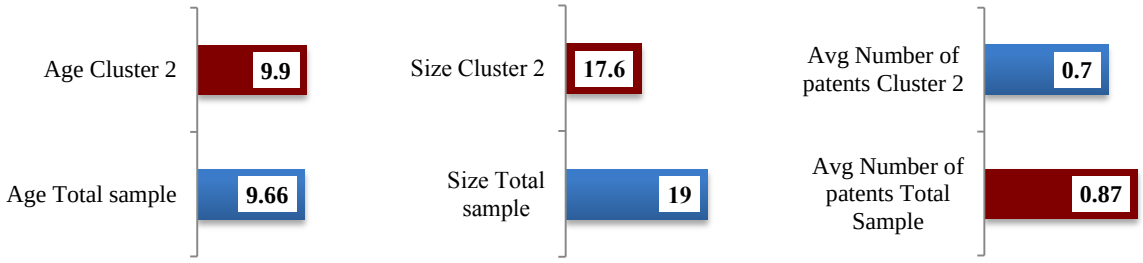
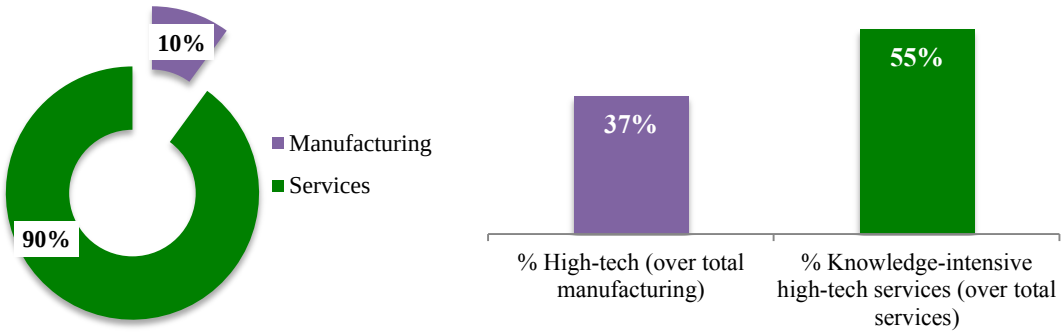


Figure 13. Distribution of firms in Cluster 2 by industry and technological content.



3.3 Cluster 3: Energy and Manufacturing

Keywords: Energy; System; Production; Water; Control; Monitoring; Data; Cost; Quality

Two insights emerge from the analysis of the proposal grouped in Cluster 3. First, the cluster analysis shows that some proposals seek to **reduce energy costs** and **control water waste**. On the one hand, these projects allow for, for instance, improved building energy performance, helping users to save on energy bills and reduce CO_2 emissions. They also promote the use of mobile charging stations that employ clean energy, including rooftop photovoltaic installations, as well as wind power, or combined heat and power plants. On the other hand, some other projects focus on the water management sector. These projects develop, for example, online platforms that aim to support farmers' by providing tools for monitoring water consumption and giving management advice that contributes to costs saving and water reduction.

Second, the cluster analysis shows that some projects centre on proposals related to **manufacturing** and **retail sale of consumers' goods**. For example, some projects provide platforms dedicated to the "influencers" that widely populate social networks. These platforms aim to facilitate the distribution of products and to monitor their marketing performances on social networks.

SMEs' profiles

Cluster 3 on "Energy and Manufacturing" includes 838 digital SMEs of which only 39 resulted to be non-active. Just one active company fell only in Cluster 3, while all the others presented a proposal that applied to more than one cluster (Table **8**). Furthermore, 122 active companies submitted a proposal falling only in Cluster 3, excluding the general Cluster 1. As above, the most noticeable overlapping proposal resulting for Cluster 3 is with proposals for Cluster 1 (825 applications). The other noticeable overlapping is between Cluster 3 proposals and Cluster 2 (324) and Cluster 4 on "Mobile, Apps and IoT" (290 proposals) (see Figure 14). Finally, 40 companies out of 838 submitted more than one proposal (between 2 and 4) falling into Cluster 3.

Clusters 3 SMEs age for this cluster is **10.7 years**, higher than the 9.7 years average of the total sample of digital SMEs, and these companies are the **largest in terms of size**, with an approximate number of **20.8** employees (total sample average is 19 employees). Firms included in Cluster 3 also **own more patents**, with an average of **1.6** compared with the total sample average of 0.87.

Again, reflecting on the distribution of the total sample of digital SMEs, 86% of Cluster 3 SMEs operate in the Service sectors while only 14% are active in the manufacturing sector, with the majority of service companies being Knowledge-Intensive High-Tech (54%) and only about one third High-Tech (29%) out of the total manufacturing firms in Cluster 3 (See Figure 15).

SMEs in the "Energy and Manufacturing" cluster apply a '*green philosophy*' to offer functional and technically-advanced machines and products to the national and international markets. The objective of these companies is generally to use accurately-selected **raw materials** and apply innovative technology to deliver the best quality in an efficient, reliable and **sustainable** manner. Cluster 3 SMEs usually operate in traditional sectors of manufacturing but deploy business strategies that diversify their portfolio in order to get to different market segments and add value to their business. Indeed, these SMEs are getting value from data organised and made available for their users and customers on **digital cloud platforms**. Cluster 3 SMEs offer integrated hardware and software solutions that combine **cost-effective monitoring and control, analysis, alert, and reporting activities**.

These SMEs engage in a variety of **collaborations** with a diversified type of partners with complementary assets throughout the value chain in which they are active.

By working on promising technologies that exploit the power of data and their application across several sectors, these SMEs gain **external recognition** in terms of not only awards and prizes for their products and solutions, but also in terms of funding (both public and private) thus supporting further development of their business.

Figure 14. Characteristics of firms in Cluster 3.
(avg. age, size and no of patents)

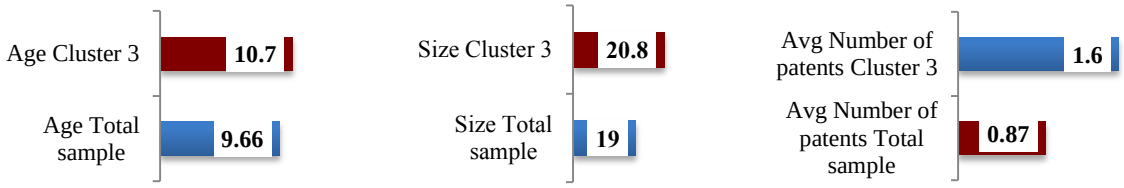
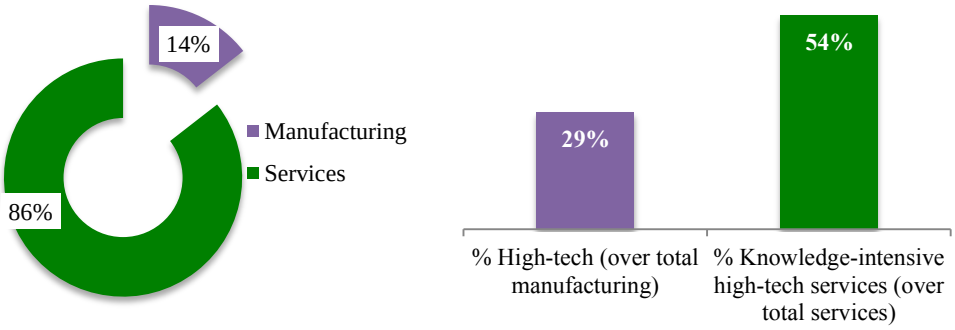


Figure 15. Distribution of firms in Cluster 3 by industry and technological content.



3.4 Cluster 4: Mobile, Apps and IoT

Keywords: Mobile; Devices; User; Smart; App; IoT; Internet; System; Video; Software; Cloud

Proposals in Cluster 4 deal with the idea of incrementing services for daily life purposes, on apps and mobile devices. The fields concerned are the navigations systems in urban areas, digital transmissions through the cloud of TV and radio services, or 3D model digitalisation.

Two different insights emerge from the analysis of the proposal grouped in the cluster. First, the cluster analysis shows that some proposals aim to improve the **massive use** of

the Internet of Things technology. For instance, these projects point to the creation of platforms that **connect mobiles with tools** used in the daily life. Others, instead, aim to create networks for data collection, monitoring, decision-making, and process optimisation.

Second, some proposals deal with **innovation for smarter access to public goods and services**. These projects, for instance, aim to preserve cultural heritage by using digitisation techniques that offer digital 3D modelling experiences for a most realistic and reliable way of preserving precious artefacts. Other SMEs want to launch inventions that apply 3D modelling to history, art, and biology for the practical use in science, education and industry. Finally, the proposals also create platforms for inner-city drivers (**shared-mobility**) to access underused private garages from one-click apps unlocking private parking spaces to public users with no need to change infrastructures.

SMEs' profiles

Cluster 4 on "Mobile, Apps and IoT" includes 815 digital SMEs only 40 of which appeared to be non-active. No active company fell only within Cluster 4, while all the other firms presented a proposal were included in more than one cluster (Table **8**). 42 active companies submitted a proposal that applied only to Cluster 4, excluding the general Cluster 1. Again, the higher overlapping is with Cluster 1 (802 proposals). The other noticeable overlapping is with Cluster 2 (390) and Cluster 3 on "Energy and Manufacturing" (290 proposals). Just 11 companies out of 815 submitted more than one proposal (between 2 and 3) that always fell into Cluster 4.

On average, Clusters 4 SMEs size (19.4) is almost equal to the average of the total sample (19 employees) and they own **1.2 patents** (against a total sample average of 0.87), see Figure 16. These SMEs are also **slightly older**, with their age averaging at 10.4 years.

87% of Cluster 4 SMEs operates in service sectors while only 13% is active in manufacturing sectors. Cluster 4 is consistent with the general sample in terms of Knowledge Intensive High-tech in the services sector (58%), but the percentage of **High-Tech SMEs in the manufacturing sector** accounts almost for half of the sample (**46%**) (See Figure 17).

As suggested by the label itself, firms in Cluster 4 are digital SMEs which operate in the **IoT domain**. Such companies mostly operate in the IT sector to develop software and open source platforms that aim at new product development, reduced technical complexities and time to market, enhanced user experience, and improved project management through cloud-based platforms, mobile application, and smart devices.

Cluster 4 SMEs develop their activities collaborating with partners on the integration of their product and services in clients' businesses and **heavily involve their users** in the innovation processes in order to guarantee high-quality user experience. They employ revenues share and license models in their strategies.

Cluster 4 seems to have the highest concentration of **spin-offs from universities and research centres**, with strong scientific bases and high-knowledge intensity. They receive public funding support, generally from their national and/or local government that allows them to continuously develop their business in order to be sustainable and competitive on the market with constantly updated products and services.

Figure 16. Characteristics of firms in Cluster 4.
(average age, size and nr of patents)

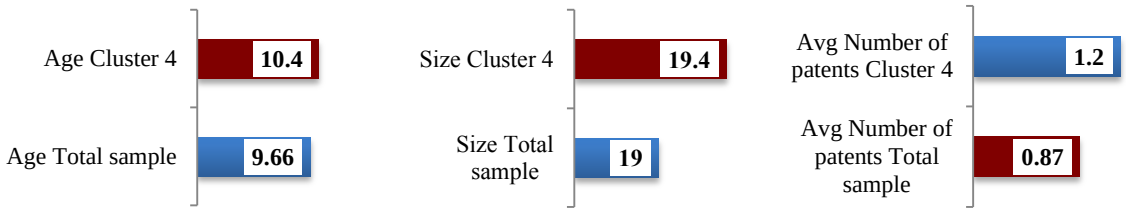
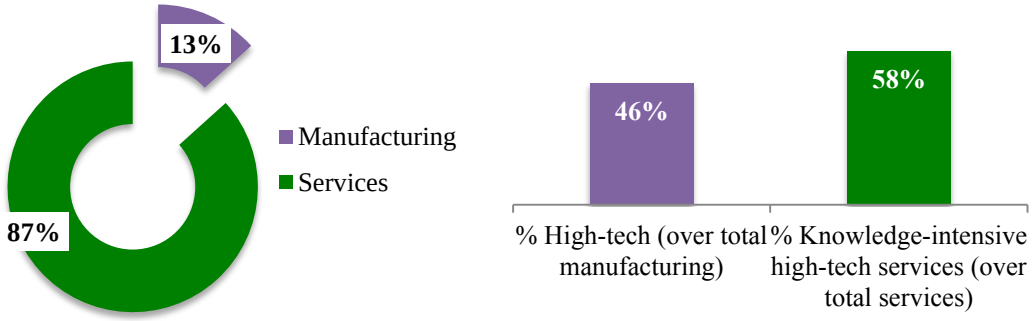


Figure 17. Distribution of firms in Cluster 4 by industry and technological content



3.5 Cluster 5: Data Security, Cloud, Cyber Security

Keywords: Data; Security; System; Mobile; Service; Users; Privacy; Information; Protection; Cloud; Storage; Cyber; Payment; Identity

The core of the proposals grouped in Cluster 5 points to the importance of **data security** and **cybersecurity**. More specifically, some proposals aim to increase the security by complex preparedness, rapid detection and fast response. The most relevant tools used are **advanced machine learning** and **unique algorithms** that allow for the detection of advanced threats and behavioural abnormalities.

Cybersecurity is tightly linked to data security. Over the last years, the percentage of cyber-attacks has grown exponentially. Consequently, some projects aim to secure people's and companies' assets by providing an increased level of protection for digital transaction systems against cyber-attacks. On the one hand, these projects focus on improving the **detection and protection** capabilities of cyber-operators against threats, frauds, and incidents. On the other hand, many projects rather **adopt specialised devices** to record the pulse and digital sensor data from industrial machines, sub-sectors, and facilities enabling continuous and complete monitoring of the off-site electrical grid. Protecting the power grid is a sensitive matter, especially for industries involved in strategic sectors such as electric or nuclear power plants, water supply and wastewater systems, communications, and so on. Industrial automation and control systems are considered vital for such industries.

SMEs' profiles

Cluster 5 on "Data Security, Cloud, and Cyber Security" includes 731 digital SMEs of which 48 resulted to be non-active. No active company fell only in Cluster 5, while all the other firms presented a proposal included in more than one cluster (Table **8**). 50 active companies submitted a proposal included only in Cluster 5, excluding the general Cluster 1. Besides the overlapping of proposals from Cluster 5 and Cluster 1 (717 proposals), the only noticeable overlapping is between Cluster 5 and Cluster 2 proposals on "Health and Biomedical (355) (see Figure 18). Just 15 companies out of 815 submitted more than one proposal (between 2 and 4) that fell into Cluster 5.

Cluster 5 company age is on average **8.8 years** (lower than the 9.7 years average of the total sample of digital SMEs). Clusters 5 SMEs size (**18.1**) is slightly smaller than the average of the total sample (19 employees), and the average patent owned by Cluster 5 SMEs is **lower** than in the total sample (0.6 against 0.87), see Figure 18.

Reflecting on the distribution of the total sample of digital SMEs, 92% of Cluster 5 SMEs operate in the Service sectors while only 8% is active in the manufacturing sector, with the Knowledge-Intensive High-tech being the majority of service companies (61%) and High-Tech only about one third (31%) of total manufacturing firms in Cluster 5 (see Figure 19).

SMEs in Cluster 5 generally develop online platforms for marketing and e-commerce. They develop software applications suited to the **needs of end customers** and provide installation, integration, and maintenance services. Cluster 5 firms operate on several activities, building their competitive advantage on the principles of **Industry 4.0** and **big data**.

To combine their products and solutions with other products, Cluster 5 SMEs work in partnership with system integrators, solutions providers, and digital and marketing companies. Partnerships generally aim to improve **customer experience** and develop **affordable solutions**. For these reasons, users and customers are involved in design and development activities.

Cluster 5 SMEs receive many awards for e-commerce activities and services provided. They also benefit from their founding investors (both public and private) to support their business with seed funding and grants.

Figure 18. Characteristics of firms in Cluster 5
(average age, size, and nr of patents)

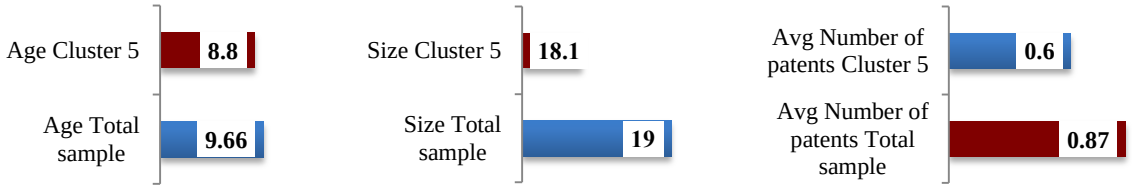
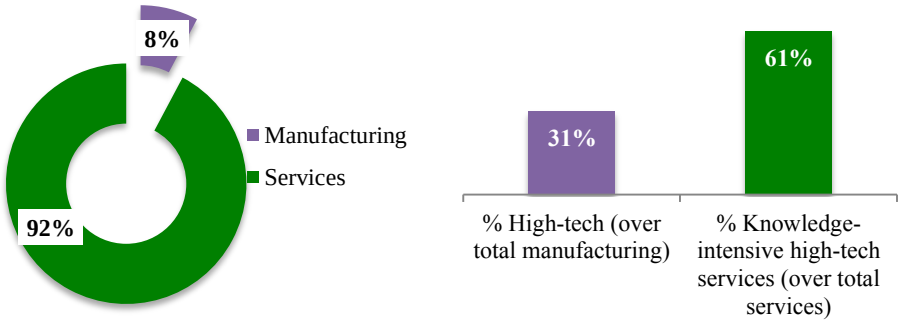


Figure 19. Distribution of firms in Cluster 5 by industry and technological content



3.6 Cluster 6: Marketing, Advertising/Other Services for Digital Platforms

Keywords: Online; Marketing; Customers; Advertising; Retailers; Products; Mobile; Data

A major insight emerging from the analysis of the proposals grouped in Cluster 6 is that these mainly point to the **development of platforms** for different fields.

First, a substantial part of the proposals develops platforms in connection with marketing activities. For instance, SMEs offer solutions dedicated to **online retail** and **advertising** of product and services by applying free licenses and empowering multiple services for professionals, SMEs, and corporations.

Second, another part of proposals is dedicated to the **innovative mobility** field. For example, these proposals point to the creation and the implementation of open sources platforms, such as car and bike sharing, to make the sector even more heterogeneous and to provide renting users with more affordable vehicles while only paying a fee for the effective time used.

Finally, other proposals aim to improve the use of platforms in the area of **public good** in which users can participate to **socially and environmentally virtuous actions** creating a high-growth business around the commercial opportunities. For example, every time they recycle packaging, batteries or electronic devices, donate shoes and clothes, use public transport, keep utility bills low or learn through quizzes, they gain access to measurable, rewarding, and sharable accomplishment.

SMEs' profiles

Cluster 6 on "Marketing, Advertising/Other Services for Digital Platform" includes 611 digital SMEs out of which 53 resulted to be non-active. Just one active company fell only in Cluster 6, while all the other firms presented proposals included in more than one cluster (Table **8**). 53 active companies submitted a proposal that was included only in Cluster 6, excluding the general Cluster 1. Almost all the proposals in Cluster 6 are also included in Cluster 1 (603 out of 611) and the most relevant overlapping for Cluster 1 is with proposals from Cluster 2 on "Health and Biomedical (282) (see Figure 20). A mere 21 companies out of 815 submitted more than one proposal (between 2 and 5) that fell into Cluster 6.

Cluster 6 company age is about **10 years** (almost equal to the 9.7 years average of the total sample of digital SMEs). SMEs in this cluster are **slightly larger** (averaging 20 employees against the total sample mean of 19 employees), each one typically owning **one patent** (Figure 20).

Confirming the distribution of the total sample of digital SMEs, 94% of Cluster 6 SMEs operate in the service sectors while only 6% is active in the manufacturing sectors, with the Knowledge-Intensive High-tech being the majority of service companies (63%) and High-Tech exactly one third (33%) of total manufacturing firms in Cluster 6 (See Figure 21).

Cluster 6 SMEs generally develop their own software and systems that combine **information technologies** and **cloud computing** to conduct activities in marketing and advertising, communication channels-enabling and device manufacturing.

Cluster 6 firms work on transparent, secure, and efficient **multi-sided platform** to perform business transactions and provide services that ensure customers **data security** and high-level of solution usability. They usually **protect their technologies through formal and informal tools of appropriation (IPR)** and receive efficiency and high-performance certifications.

These SMEs gain funding from the public sector and from private investors to develop their business. Cluster 6 firms collaborate with industrial partners for system development and integration, and with **universities** on **joint research projects**.

Figure 20. Characteristics of firms in Cluster 6
(avg. age, size and no of patents)

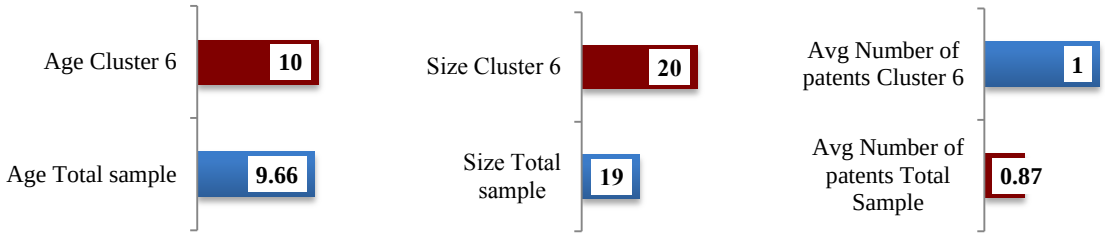
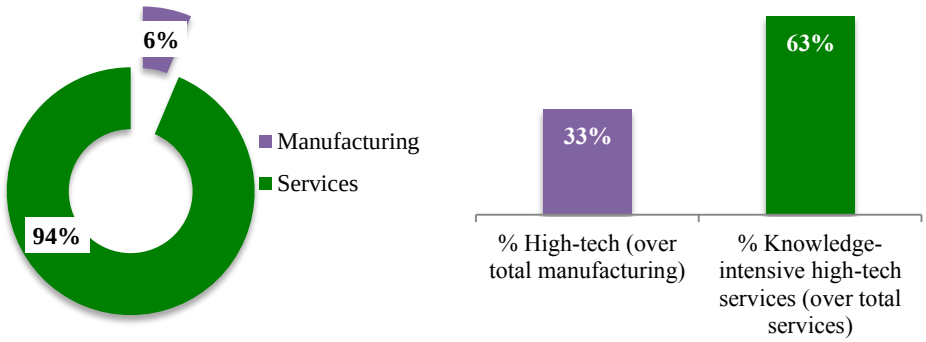


Figure 21. Distribution of firms in Cluster 6 by industry and technological content



3.7 Cluster 7: Online Content Platforms

Keywords: Content; Learning; Social; Media; Platform; Education; Users; Music; Video; Online; Students; Games

Two different insights emerge from the analysis of the proposal grouped in Cluster 7. First, the cluster analysis shows that a substantial part of proposals aims to improve platforms in which **users can share contents**, physical objects, or even ideas. These platforms may also allow users to easily publish and sell **digital content** on physical media.

Second, the cluster analysis also shows that some other projects focus their attention on proposals linked to **Augmented Reality** (**AR**). AR is applied to a vast array of fields. Some proposals aim to create platforms that allow for augmented reality contents and games for educational purposes on mobile devices.

The sectors of activity include smartphone gaming and online sharing contents such as music and media.

SMEs' profiles

Cluster 7 on "Online Content Platform" includes 692 digital SMEs, with only 36 resulted to be non-active. No active company fell only in Cluster 7, while all the other firms presented a proposal that was included in more than one cluster (Table **8**). 86 active companies submitted a proposal included only in Cluster 7, excluding the general Cluster 1. Understandably, the most noticeable overlapping proposals resulting for Cluster 7 is with proposals in Cluster 1: almost all the proposals falling within the "Online Content Platforms" (686 out of 692) were also included in the general Cluster 1 on "Data Services and Market Analysis for Digital Business". The only other noticeable overlapping is between Cluster 7 and Cluster 2 on "Health and Biomedical (289) (see Figure 22). Just

21 companies out of 692 submitted more than one proposal (between 2 and 4) that fell into Cluster 7.

Cluster 7 company age is on average **9.3 years** (almost equal to the 9.7 years mean of the total sample of digital SMEs). Clusters 7 SMEs are the **smallest in size** (17.4) if compared with the total sample average (19 employees), and these companies generally own **fewer patents** than the total sample (**0.5** against the 8.7), (see Figure 22).

Again, reflecting on the distribution of the total sample of digital SMEs, 93% of Cluster 7 SMEs operates in the Service sectors while only 7% is active in Manufacturing sectors, with the Knowledge-Intensive High-Tech being the majority of services companies (55%) and **High-Tech more than one third** (**37%**) of total manufacturing firms in Cluster 7 (See).

SMEs in Cluster 7 usually develop proprietary platforms taking advantage from the potential impact of the **digital revolution for business**. They exploit the rationales of **gamification** by working on app development and tailor-made services for their users and customers. SMEs engage in developing an **open learning environment** involving all the interested stakeholders: learners, educators, content providers, and application developers, thereby generating an educational ecosystem.

Cluster 7 firms use the latest technologies, virtual and AR to provide **outsourced services to clients**. They offer innovative digital services with educational and learning content on complex platforms equipped with personalised programs. These SMEs constantly develop and update their product and services and often **innovate their business models** in order to stay competitive on the market adjusting their pricing strategy. They can have many partnerships, which usually take the form of close-knit relationships with their clients.

Figure 22. Characteristics of firms in Cluster 7
(avg. age, size and no of patents)

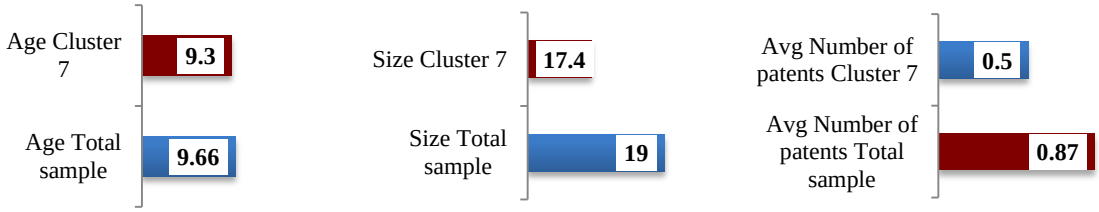
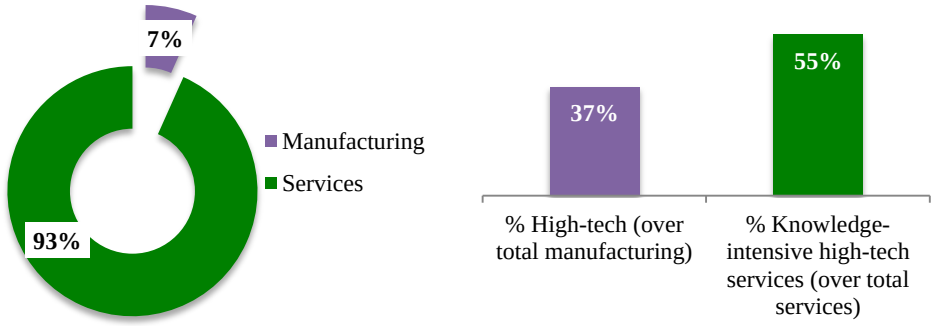


Figure 23. Distribution of firms in Cluster 7 by industry and technological content



3.8 Cluster 8: Transport, Smart Cities, Urban

Keywords: Transport; Public; Cities; Services; Local; Mobile; Car; Citizens; Travel; Platform; Tourism; City

The largest part of the proposals in Cluster 8 deals with topics concerning urban needs, tourism increment, public transportations and smart cities.

The cluster analysis shows that a significant part of proposals aims to meet the travellers' needs. They develop, for example, platforms that meet travellers' business needs. Sometimes business travellers feel frustrated by the time waste at the airports, especially in connecting flights. Millions of people transit in airports on a daily basis but their time is often wasted and their stay can be improved, making better returns on investment for business travelling. The goal of these innovative platforms is to allow business travellers to improving the planning of their flights by making better use of their time to meet existing or new potential partners.

Other proposals aim to improve the **public transportation** field. The public transportations field counts more than 1 million vehicles, producing 25% of all CO_2 emissions, consuming 30% of all available fossil energy and being the cause for more than 1.200.000 casualties, every year. Consequently, some proposals suggest the use of platforms for promoting best practices also in commercial road transportations, collecting data, sharing information and promoting a new driving behaviour.

The cluster analysis also shows that some projects focus their attention on proposals related to **cities' cultural heritage**. Some projects suggest the use of innovation to preserve the cultural heritage by using digitisation and 3D models' techniques in order to create realistic 3D models capturing reality in a very precise way.

SMEs' profiles

Cluster 8 on "Transport, Smart Cities, and Urban" includes 683 digital SMEs, of which only 30 resulted to be non-active. No active company fell only within Cluster 8, while all the other firms presented a proposal falling under more than one cluster (Table **8**). 42 active companies submitted a proposal that was included only in Cluster 8, excluding the general Cluster 1. Almost the totality of proposals falling within the "Transport, Smart Cities, Urban" cluster (676 out of 683) was also included in the general Cluster 1 on "Data Services and Market Analysis for Digital Business". The only other noticeable overlapping is between Cluster 8 and Cluster 2 on "Health and Biomedical (320). Just 12 companies out of 683 submitted more than one proposal (between 2 and 4) always falling within Cluster 8.

Cluster 8 company age is on average 9.2 years (almost equal to the 9.7 years average of the total sample of digital SMEs). Across all the other Clusters, SMEs included in "Transports, Smart Cities, Urban" Cluster are the **smallest in terms of number of employees** (**15.8** employees, against a total sample average of 19). These SMEs **own fewer patents** if compared with other Clusters SMEs, with an average of **0.5 patents** against a total sample average of 0.87 (Figure 24).

94% of SMEs in this cluster operate in the Service sectors while only 6% is active in Manufacturing sectors, with the Knowledge-Intensive High-tech being the majority of services companies (55%) and High-Tech about one third (35%) of the total manufacturing firms in Cluster 8 (See Figure 25).

SMEs in Cluster 8 develop applications, software and platforms in the transport and smart city environment to enable the **smart revolution at the urban level**, building on innovative technologies for logistics, security, and traffic management. These SMEs generally develop platforms to make it easier to access and use their products and services and introduce functionally-advanced solutions on the market. SMEs in Cluster 8 derive their competitive advantage from offering quick, cheap, and easy solutions to their customers. Cluster 8 SMEs pursue the goal of producing impact for companies by **triggering individual behavioural changes** and **enabling informed business**

decision-making. They work with their customers to develop additional features of their product and services, meeting users' requirements and needs. They generate revenues **through licences and support fee models** on their platforms.

Figure 24. Characteristics of firms in Cluster 8.
(avg. age, size, and no of patents)

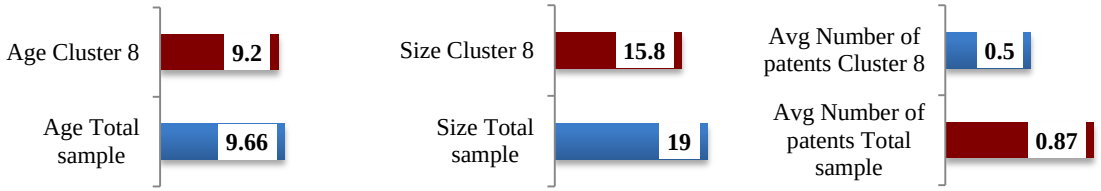
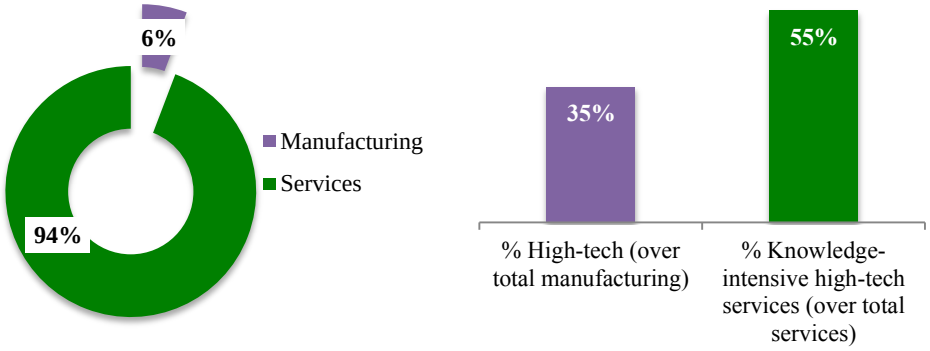


Figure 25. Distribution of firms in Cluster 8 by industry and technological content.



4 Evidence from case studies: characteristics and business models of digital platform SMEs

The qualitative analysis was based on 9 case studies of SMEs operating through different types of digital platforms and types of business models.

Using a story-telling approach, in-depth case studies of each of the 9 SMEs were conducted (Eisenhardt, 1989; Eisenhardt and Graebner, 2007). The objective was to identify the challenges that digital SMEs face in capitalising on the opportunities offered by digital affordances. Every case was chosen for the potentially relevant information it might add to the research framework.

The information collected through case studies was complemented through desk research. This way, a comprehensive picture on a set of the analysed firms was created. It offers rich insights into the following aspects of the analysed digital platform SMEs:

- The nature of digital platform SMEs and their business models,
- Company's structure, offering and value proposition,
- Financial performance and employment figures[4].

4.1 Overview of the selected digital platform SMEs

As shown in Table 9, the SMEs taken into consideration for the case-study analysis are young SMEs. They are on average less than 7 years old, with the oldest being 21 and the youngest 5 years old. All of them are small companies, employing between 4 and 41 employees, except for one firm with a head count of 85 employees. They are established across six different European Member States and represent the different European socio-economic and geographical areas: Northern Europe (Norway); Eastern Europe (Slovenia and Estonia); Mediterranean Europe (Spain, Italy, and Portugal). Moreover, this geographical distribution also reflects countries with different levels of innovativeness according to the EC classification: Innovation Leaders (Norway), Strong Innovators (Slovenia); Moderate Innovators (Estonia, Italy, Portugal, Spain,) (European Commission, 2017).

[4] Source: Bureau Van Dijk Amadeus database.

Table 9. Basic data on digital platform SMEs in the sample.

Company name	Country of origin	Year of incorporation	Trade description	Number of employees	Operating Revenue - Turnover (USD)
King of App S.L.	ES	2013	Online mobile application developing Software-as-a-Service (SaaS) provider	30	4,943 (2015)
Cynny S.p.A.	IT	2013	Software platform manufacturer; Social Cloud services; Hardware manufacturing; Computer programming services	15	1,402,505 (2017)
GoOpti D.O.O.	SLO	2008	Online airport transfer booking service	41	6,110,813 (2017)
Shotl S.L.	ES	2006	Computer consultancy activities	20	N/A
Mosaicoon S.p.A.	IT	2009	Video community marketplace operator; Marketing consultancy services; Video production services	85	4,144,878 (2016)
Mazemap A.S.	NO	2013	Digital services based on geographical position and map, including individual navigation	21	1,255,000 (2017)
Sensefinity L.D.A.	PT	2013	Solutions, hardware, software, protocols and services for the interconnection of computer equipment and systems	9	290,000 (2016)
Socialdiabetes S.L.	ES	2012	Computer applications for technological devices	15	38,000 (2016)
Cybernetica A.S.	EE	1997	Computer Systems Design and Related Services	4	11,639,620 (2017)

The main selection criterion of digital platform SMEs for case study analysis was to cover all the clusters of digital platforms identified among the digital proposals submitted to the SME Instrument (see Section 3). As discusses in Section 3, *Cluster Data Services/Market Analysis for Digital Business* is the most inclusive one. Allowing for overlapping between different clusters, shows the possible application of generic technological capabilities, e.g. data services, within particular sector of activities, e.g. health.

Table 10 shows the distribution of the SMEs across the clusters. All 9 digital platform SMEs that were selected for in-depth analysis fit into *Data Services/Market Analysis for*

Digital Business cluster. A closer look reveals that they are active in distinct sectors of activities, e.g. healthcare (Socialdiabetes) or transportation and smart cities (GoOpti, Shotl, Mazemap). The presence of such combinations hints on versatility of digital technologies.

Table 10. Distribution of selected SMEs across the clusters.

Company name	Data Services/Market Analysis for Digital Business	Health /Biomedical	Energy / Manuf.	Mobile, Apps and IOT	Data Security, cloud, cybersecurity	Marketing, Advertising/other services for digital platforms	Online content platforms	Transport, Smart cities, Urban
King of App S.L.	✓			✓				✓
Cynny S.p.A.	✓	✓		✓		✓		✓
GoOpti D.O.O.	✓				✓			✓
Shotl S.L.	✓		✓		✓			
Mosaicoon S.p.A.	✓				✓		✓	
Mazemap A.S.	✓			✓				
Sensefinity L.D.A.	✓		✓	✓				✓
Socialdiabetes S.L.	✓	✓						
Cybernetica A.S.	✓		✓		✓	✓		

4.2 The nature and business model of digital platform SMEs

The aim of this study was to explore innovation and value creation patterns of European digital platform SMEs. In order to address these questions, two elements digital platforms are considered: 1) the nature of the digital platform; 2) the business model applied to create and capture value from this platform (see Section 1.2). The 9 digital platform SMEs analysed were classified according to these two dimensions. Table 11 shows the nature of their platform and the business model they operate. Subsequent sections present a detailed analysis of the selected SMEs according to these criteria.

Table 11. Nature of Platforms and Platform Business Models of the analysed SMEs.

		Platform Business Models		
		Integrator Platform	Product Platform	Two-Sided Platform
Nature of Platforms	Platform for Platform	King of App	King of App	
	Digital Tools for Platform and Market Places	Mosaicoon		Mosaicoon
	Platform Mediating Work	Cynny		
	Retail Platform			
	Service Providing Platform	Mosaicoon Cynny Mazemap Sensefinity Cybernetica	Drivania/Shotl	GoOpti Shotl Socialdiabetes

4.2.1 The nature of digital platform SMEs

According to Table 11, the analysed digital platform SMEs mainly developed Service Providing Platform. Except for King of App and Mosaicoon, 7 out of the 9 SMEs had developed platform technologies that, according to the literature, could have high disruption effects on the traditional services companies in the market of transportation, healthcare counselling, advertising, and software as service. Out of the companies developing Service Providing Platforms, only Cynny showed the ambition of further developing its platform to target different markets, potentially becoming a Platform Mediating Work offering its technology for the recognition of micro-facial expression to the development of tailored learning experience.

Concerning the other two companies, King of App developed a Platform for Platform technology, offering a space where all the tools to build other platforms and apps can be found in the same place and with different templates available. Mosaicoon is the only company in the sample that throughout its life applied changes in the nature of its platform. The company changed its business model many times and evolved from a Service Providing Platform to a Digital Tool for Platforms and Market Place. The initial technology developed by Mosaicoon was a platform for the distribution on the web of advertising contents created by the company itself. Later, it started involving content creators and dedicated its technology platform to integrate these contents into other websites.

4.2.2 Business models of digital platform SMEs

Four SMEs in our sample developed an Integrator Platform Business Model, two companies developed a Product Platform Business Model, and 3 developed a Two-Sided Platform Business Model (See Table 11).

Integrator Platforms Business Model: Cynny; Mazemap; Sensefinity; Mosaicoon. The SMEs engaged in developing this business model aims at integrating external innovations or products on top of their platform technology, but closely monitoring the activities of external contributors to innovation and/or customers. They provide a technological standard that platform users have to use if they want to benefit from the platform offerings. This is particularly clear in the case of Cynny. The brands involved in Cynny's platform are the content sources for advertising videos distributed to viewers; however, Cynny does not leave the brands any space in the use of viewers' data or its protected technology, which is only applied to the contents provided by the brands. Mosaicoon is another example of a company that has been testing different business models, always in connection with technological evolution. Its last step was to pass from an Integrator to a Two-Sided Platform business model, in order to alleviate the work

conducted in-house of controlling contents creation and/or creating the contents itself, and on which creators could just develop the advertising contents desired by client brands. However, the company closed few months after launching the two-sided platform.

Product Platform Business Model: King of App; Cybernetica. King of App offers to developers the possibility of selling their contents and template for app building directly to the users (clients), and only covering a small mark-up to gain revenues from the mediation. However, King of App is now investing the funds received from the European Commission in the SME Instrument competition to develop a new business model and scale its platform. The project involves the creation of an academy for users on how to use the King of Apps technology in the development of new templates for apps. This way, the company aims at setting a new standard in app technology development. It is expected that this would increase the user retention level and allow it to experiment with a new Product Platform-based business model.

Two-Sided Platform Business Model: GoOpti, Shotl, Socialdiabetes. Most of the SMEs operating a Two-Sided Platform business model have not introduced major changes to their business models during their lifetime. Shotl together with its parent company Drivania went through several business model evolutions. Despite remaining (just as Shotl) a Service Providing Platform, Drivania started operating under a sort of franchising business model, centred on customer service and ride offers. Subsequently, it evolved towards developing a technology platform for chauffeur services bookings and related driver ID- and criminal record-checking. In this scenario, the technology platform became the core of the company and customer service is only the added value of Drivania. As far as Shotl is concerned, it was conceived as a multi-sided platform in which several stakeholders would have been involved (i.e. Government and local institutions, private vehicle fleet companies, users). However, the company rapidly understood that the Spanish business environment was not the right one to start a business involving all the stakeholders from the beginning, and it went back to pursuing a Two-Sided Platform as a starting point to sustainably scale its business model and activities.

4.3 Case-studies' take-aways

Moreover, we conducted a cross-case analysis to observe the drivers and the obstacles posed by the types of business models identified by the literature, highlighting patterns of emerging digital platform business models across the sample. The results of the within-case analysis are summarised in Table 12 and detailed findings are reported in subsequent sections.

Table 12. Findings from the within-case analysis.

King of App S.L.: ***A platform for platforms***	Value creation: shifted from B2C to B2B market through the disintermediation of traditional actors.
	Value Capturing: two-sided digital platform wedged between two sides of the market
	Scale-up: API integration with other platforms and engagement of additional communities of developers
	Strategies to enter as an ecosystem: leveraging on indirect network effects
GoOpti D.O.O.: ***Disrupting the transportation services***	Shift from a traditional business to a digital marketplace
	Dynamic pricing algorithm underpinning the online activities of the platform to mediate between different market segments
	Business model evolution for value capturing
SocialDiabetes: ***Bringing communities together***	Increasing competition pushed value traditional value capture mechanisms
	VC and Public funding are complementary funding methods and provide different types of support to digital platforms, depending on the stage of development.
	Facing resources constraints for further technology development
Mazemap: ***Navigating indoor***	Access to complementary assets has enormous importance for the market-entry
	Market expansion in Europe is hampered by cultural and bureaucratical differences.
	Lack of "soft" complementary assets, managerial skills and tools needed to scale up
Sensefinity: ***IoT for the Masses***	Previous work experience can be an enabler to create value
	Growth and scale up can be amplified through another form of revenue stream.
Cybernetica: ***Secure digital democracy***	The niche of cybersecurity is crowded, and constant progress must be made, advancing technology and disintermediating R&D
	To scale up, exploration of other markets is required but it implies higher costs
Cynny S.p.A.: ***Capitalising on emotions***	Entrepreneurial expertise and technical background of the entrepreneur gained investors trust.
	Balancing Technology Push and Business Pull Approaches in different phases of innovation (from ideation to commercialization).
	Scaling the platform requires business model evolution: the company went from B2C to B2B, becoming an integrator platform.
	Crowdfunding is a valuable funding tool. It complements investors and public funding. The European VC is not suitable to the digital platform needs.

Shotl/Drivania: ***Serial entrepreneurship***	Outbound Open Innovation Strategy: establishment of CaminaLab, a corporate venture builder that allows diversifying its business through a spin-off activity
	One Platform, Multiple Business Models Evolution, from a service platform to a technology company and tech-incubator, purely focused on technology
	Appropriation strategies: internal development, from outsourcing to in-house development through collaboration-learning -hiring
	Group's ventures are self-funded with reinvestment of profit coming from the business. Shotl is the first one that involved VC, which was fund to accelerate timing in a start-up
Mosaicoon: ***Scaling-up is not enough***	Drivers: - role of the founder as pivotal in the company - Appropriation strategy is crucial for gaining investors' interest, enhance company's value and protect the technology in complex markets - Business models need to be tested and constantly adapted
	Barriers: - Generalist VC can be inappropriate for the specific needs of digital platforms - Peripheral location jeopardise development and growth because impedes testing and lack complementary assets - Lack of clear business model: creating value is not enough when value capturing mechanisms lack

Case study results were reported through a "takeaway" table for each company based on the following dimensions:

- Role of the entrepreneur/founder
- Funding
- Appropriation strategies
- Platform development
- Business model evolution

Details on the profiles of the analysed digital platform SMEs and key takeaways from the case studies are reported below.

4.3.1 King of App: A platform for platforms

King of App is a textbook case of digital platform innovation providing digital tools to support the creation of other platforms, a phenomenon becoming increasingly common in the web environment (Kenney and Zysman, 2015; 2016). As a start-up, it developed and launched the first Open Source Mobile Content Management System (CMS) as an online tool to create mobile applications for iOS and Android allowing developers, designers, and even users with little coding experience to build mobile apps faster and more economically than in the traditional advertising market.

Case takeaways:

- **Value creation**: The platform creates value in the marketing, advertising, and design industries resulting in a dramatic lowering of the price and the time to develop mobile applications for small companies. The platform disintermediates traditional actors shifting the focus from the B2C segment to a new B2B market where developers can build, programme and share modules. In this perspective, this type of platform has reduced the transaction costs (e.g. search efforts, customer lock-in) of the mobile app market and has an integrator platform business model.
- **Value capture mechanisms**: King of App as a two-sided digital platform wedged between two sides of the market. On one side, it provides the developers' community (external innovators developing their own items using the free platform features) with additional paid services, such as professional technical support, training, form filling. On the other side, it maintains an online store allowing firms to create their own projects and build communities.
- **Scaling up**: to increase its market impact, King of App is also developing its business through API integration with other platforms, facilitating the connection with the tools on which other platforms are built. The company is now engaging the developers' community to scale up and prove itself in the market.
- **Strategies to build an ecosystem**: To engage the developers' community the company is actually leveraging on indirect network effects through an academy programme (online training) aiming at shifting customers from the user side to the developer's side of the platform. Marketing activities and business development processes are resource-intensive: the company's growth rests on public funds.

4.3.2 GoOpti: Disrupting the transportation services

GoOpti is a case of digital platform innovation intending to transform service industries (Kenney and Zysman, 2015). The nature of GoOpti digital platform innovation is recognised in the literature as one with a most disruptive power. Coherently with Christensen's theory of disruptive innovation (Christensen and Rosenbloom, 1995; Christensen, 1997), service-providing platform innovations initially target small market segments (which are typically unattractive for traditional services companies) and, through the development of a different value proposition (based on new functionalities typically offered at a lower price) are able to move upmarket delivering the performance that mainstream customers require. The GoOpti platform targets a market segment of demand-responsive transportation (shared and private transfers) to displace the traditional public and private transportation and the use of a personal car.

Case takeaways:

- **A shift from a traditional business to a digital marketplace for shared transfer**. The ecosystem created by the platform allowed developing a new value proposition based on convenience and affordability of long-distance shuttle services, as two performance dimensions meeting the low-end travel needs in this segment.
- The dynamic pricing algorithm underpinning the online activities of the platform allows to mediate between different market segments:
    - On the demand side, the platform combines passengers with similar travel time limitations on the same vehicle and allows to set up the lowest price possible (demand aggregator).
    - On the supply side, the platform supports contractual relationships with local franchisees (i.e. transportation companies) in the different countries in which it operates. The platform supports suppliers also with risk management, routing, and payment transaction services.
- The nature of the digital platform innovation also supports multiple business models, allowing setting up different value capture mechanisms. GoOpti grew through an evolution in the business model. From that of a typical transportation company

owning the vehicles and allowing other transportation companies to join towards a franchising business model allowing multiple transportation companies to sustain expansion in local markets, to the "pure" digital business model of a multi-sided platform in some cities, which proved to be extremely challenging and resources intensive.

4.3.3 SocialDiabetes: Bringing communities together

Socialdiabetes is a digital health platform making available to anyone an online tool to facilitate diabetes management. It provides an infrastructure enabling the interactions between the patients and the doctors giving everyone the necessary knowledge to be empowered and take control of their diabetes. The two-sided platform acts as an intermediary between the community of patients and the doctors coordinating communication more efficiently than bilateral relationships and therefore minimising transaction costs (search costs and communication costs).

Case takeaways:

- This case contains both the features of the digital economy and those of the sharing economy (Kenney and Zysman, 2015). Being disconnected from any industry, the platform was born to grant to the community of patients free access to the tool. The increasing competition among health apps pushed the platform owners to appropriate the value created by building the community of patients through traditional value capture mechanisms (freemium version).
- **Finance**: VC and SMEi are seen as complementary tools, since different types of funding provide different types of support to digital platforms, depending on the stage of development. In the pre-start-up phase, VCs in the field of digital healthcare require the development of patents and clinical trials and fund set up costs and internal technology development. The relationship with the EU commission is fundamental in the stage of market entry, enabling organic growth (e.g. it allowed the development of the business model and the recruitment of a team)
- **Barriers:** resources constraints for further technology development. The company still depends on its own funding for internal R&D activities.

4.3.4 Mazemap: Navigating indoor

MazeMap is an exemplar of the service-providing platform that disrupts the service sector by providing new values to a small segment of the market. They provide services for indoor maps, designed for large building complexes and mainly public organisations, such as universities, hospitals, conference venues, shopping malls, offices, and airports. Their services revolve around indoor positioning and navigation using enterprise wireless networking. They are backed by a Norwegian VC and in some occasions they have made the platform accessible to their customers and innovators, therefore moving from a product platform business model to multi-sided platform business model (Boudreau & Lakhani, 2009).

Case takeaways:

- The Mazemap case implies that access to complementary assets (e.g. university networking, academic knowledge, relationship with the investors) for a (serial) entrepreneur has an enormous importance for the market-entry. Thomas Jolle, the founder, has been an adjunct assistant professor while finding Mazemap and claims that accessing the ecosystem resources had a big impact and helped him with the new venture.
- The Mazemap founder believes that for expanding their market within Europe, the cultural and bureaucratical differences for each country are barriers to their efforts. In

addition, they lack the "soft" complementary assets (i.e. non-technology related aspects) for scaling their market.

- Mazemap case demonstrates that start-ups lack some essential managerial skills and tools, which drives communication problems affecting their ability of accessing resources and funding from different investors. Indeed, start-ups often invest huge amount of money to prepare the applications for public funds with no guarantees of success.

4.3.5 Sensefinity: IoT for the Masses

Sensefinity's offer consists of a stack solution from the hardware to a secured cloud with an API, to tailor-made mobile and web applications. In addition, they created a sensor device for size, temperature, and humidity to transmit the location of the item. They claim to connect all the goods and to enable businesses to succeed their IoT transformation for companies. Their offer is modular and is a complete chain of the solution and that is why their customer audiences can be varied independent of their company's size. However, their cloud offering is merely provided to increase the performance of their customers and is not considered a platform to use with other platforms (Kenney & Zysman, 2016) but to help with the creation of other platforms.

The company follows a product platform business model (Boudreau & Lakhani, 2009) by providing a complete and modular solution from hardware to software, hardware-as-service, integrated into clients' clouds and applications, such as Salesforce. They also provide tailor-made solutions to connect goods, enable businesses to succeed in their IoT transformation and bring them added value.

Case takeaways:

- Among the firms that we studied, the case of Sensefinity clearly shows that previous work experience can be an enabler to create value through a venture that covers some unserved market that the entrepreneur spotted during a different entrepreneurial activity. Previous experience is a source of inspiration for people that wish to become entrepreneurs. Thanks to low costs necessary for entering into this sector, it is easy to test the value proposition. Then the entrepreneurs apply and adjust the business model through their test results.
- Sensefinity is an example of digital platform firms, which is seeking to leverage on other alternative revenue streams once having sufficient data received from their customers. In other words, the growth of this digital platform can be amplified through another form of revenue stream.
- As a prevailing concern for the start-ups within our studied firms, Sensefinity is also searching for ways to scale up their business.

4.3.6 Cybernetica: Secure digital democracy

Cybernetica is a platform to provide digital tools and support the creation of other platforms (Kenney & Zysman, 2016). They are a key player in several e-Government projects and radio communication solutions for Maritime Authorities. For example, Cybernetica worked to develop the electronic voting system used by the Estonian Electoral Commission. Their activities involve research and development in information security. In other words, they are an R&D intensive ICT company that researches, develops and manufactures software solutions, maritime surveillance and radio communications systems as well as investigating and applying theoretical and practical security solutions.

The company follows a product platform business model (Boudreau & Lakhani, 2009) and they have ongoing collaborations with top universities from Europe, and institutions from the USA and Japan.

They enhance the use of data for data-driven decision-making. Cybernetica developed a technology that collects and share customer/citizen information without compromising privacy and provides a distributed, Web-services based inter-organisational data exchange framework.

Case takeaways:

- The niche of cybersecurity is crowded, and constant progress must be made. The founder of Cybernetica believes that due to the constantly evolving industry, cybersecurity needs to get updated with the progress of technology and a strong disintermediated R&D is required.
- In order to scale up, they should expand to other markets. This is, however, resource intensive. So, Cybernetica also finds it hard to expand internationally and, thus, it is mainly focusing on the Estonian market.

4.3.7 Cynny: Capitalising on emotions

Cynny S.p.A. works on the interaction between machines and humans. It is at the centre of a group of four companies, namely Cynny Inc., established in 2012 in California (100% stake); in 2013 the group also acquired a 2% stake of a hardware engineering company, Ambedded Technologies Co. Ltd, based in Taiwan, and in November 2015 it established Cynny Space S.r.l. in Florence (Italy, with a 72% stake). Cynny group currently employs a well-experienced team of more than 35 individuals including 3 CDA experts and 24 engineers within the technology team, out of which 17 work full time to develop special algorithms of artificial intelligence. In 2017 it had a turnover of €1.4M. The company has filed 7 patents and obtained 3 so far.

Cynny has been developing its MorphCast® technology starting from the passion of its Founder and CEO. The MorphCast® is based on blockchain technology and AI and runs on the M-roll platform and servers. It allows the fruition of online stored pictures on users' mobile phones in the form of a video clip that adapts to the viewers' micro-facial expressions: the video contents change according to the emotional reactions of the viewer. After trying to develop its own MorphCast® app, Cynny understood that the best way to spread this technology was through the integration of its MorphCast® into existing platforms and apps to enable the MorphCast® player working as an advertising spot for partners' platforms.

The company is still conducting R&D activities and, hiring a new CFO, it is also exploring further business opportunities to expand its activity. It is already designing new potential applications for its MorphCast® in the online content management (i.e. e-learning and parental control systems). In doing so, Cynny is pursuing EU funding to support its continuous R&D activities and business model innovation. The company believes strongly in the EU programs and policy for innovation, especially the ones supporting the digital market in which it operates. According to the CEO, the EU already started to ease the path of EU SMEs simplifying the bureaucracy for accessing capital (e.g. the regulation of crowdfunding), the ones related to equity and savings transparency. Simplify EU regulation is the most important action that the EU could deploy because it would push Member States (such as Italy) that might result slower than the others in catching up with innovative legislation and tools.

Case takeaways:

- The company benefits from the strong **entrepreneurial expertise** and technical background of its founder and CEO, Stefano Bargagni. Not only is he a businessman but also an inventor gaining the trust of investors thanks to his reputation and previous business experience.

- **Balancing Technology Push and Business Pull Approaches**: innovation comes from inventing in isolation but, at one point or another, it is necessary to relate to the market and listening to the customer is a must.
    - At the beginning of the venture, Cynny developed a purely technological approach that was then shaped by a market strategy based on the needs and market expertise of potential customers.
- **Scaling the platform requires business model evolution**. Cynny is evolving its business model from B2C to B2B, becoming an integrator platform. The company wants to integrate its technology with partners' platforms and in order to do that, it is connecting the dots of the entire advertising value chain and orchestrating the interests of involved stakeholders.
- **Financing**: Cynny raises its capital among more than 600 stakeholders and investors. This makes Cynny a public company, subjects to all the rules and obligation of listed companies. Investors' trust is gained thanks to strong corporate governance and the experience of the founder, but also a high-level managerial and technical team, and large R&D investments (80% of the capital).
    - The strategic choice of excluding VC as a source of funding relates to Bargagni's previous experiences and entrepreneurial attitude: he wanted to write a success story in the Italian business scenario and linking its company to VC was not what he envisaged. Moreover, the European VC market would not be adequate for Cynny, both in terms of amount of funding usually offered and timing of business development.
    - Relying only on public money (as the SME Instrument) is wrong because it is not a reliable source of funding: the competition can be high, and success not always guaranteed
    - Cynny had 4 successful crowdfunding campaigns. The company believes in crowdfunding as a modern and democratic innovation tool that involves the people in building the future of their Country and eliminates intermediaries in the businesses' fundraising.

4.3.8 Shotl & Drivania: Serial entrepreneurship

Shotl On-demand Shuttles is a mobility platform that matches multiple passengers headed in the same direction as a moving vehicle. Shotl is the last venture resulting from a long entrepreneurial experience and it is part of a family business centred on CaminaLab, a corporate venture builder that allows the mother company (Drivania) to de-risk business diversification and spin-off establishment. Through CaminaLab, the family launched three venture projects Dzpatcher, FourRide, and Shotl. The case focussed on Drivania and Shotl.

The mother company is Drivania: lift services for high-end customers, not on-demand, pre-arranged, booked it in advance on a platform, checking the ID of the drivers, chauffeur service. And then Shotl is on-demand, is a real-time, to manage transportation for the local authorities, like a bus-service but more intelligent. It is a secure service, available in 927 cities worldwide, with criminal record and background checks available in the US.

The goal of Shotl is to improve the transport system by reducing private vehicles on the road by 50% in the next 10 years, and enhance and encourage access to public transportation (bus, train, underground) that provides ride solutions based on collective ridership system.

The group managed by the Martret brothers (including Drivania, CaminaLab, Shotl, Dzpatcher and FourRide) has been running for more than 15 years now, and faced all the challenges of capital shortage and loss of trust from the markets, due to the economic and financial crisis in 2009 that particularly affected Spain. Nonetheless, it currently

includes 45 employees and is hiring more. Out of the current 45 employees, one third works in technology R&D, while the rest works in customer service and administration activities.

Case takeaways:

- **Family Business and Serial entrepreneurs**: Outbound Open Innovation Strategy. Shotl is the last venture experience by the Martret brothers. They first established Drivania. Then realised that developing the ideas stemming from that business was costly and risky. Therefore, they established CaminaLab, a corporate venture builder that allows diversifying its business through a spin-off activity. Drivania pursues new businesses and markets through its spinoff and does not bear the risks and costs of these entrepreneurial journeys.
- **One Platform, Multiple Business Models Evolution**: The Martret brothers evolved their entrepreneurial activity going from a service platform to a technology company and tech-incubator, purely focused on technology.
    - Drivania evolved from a service company, cantered around the customer service, to a technology company in which customer service is an added value.
    - Two-sided Platform BM: Drivania then implemented a sort of franchising BM for its ride services worldwide, which offered to the company flexibility and reliability.
    - Shotl was conceived with a multi-sided platform business model to allow the platform for hosting multiple transportation service companies. Due to capital lack, the multi-sided platform business model revealed to be not sustainable for go-to market strategies.
    - Two-sided platform Business model: Shotl went back to the Two-sided model to achieve business sustainability.
- **Appropriation strategies**: Drivania and Shotl develop everything internally, from outsourcing to in-house development through collaboration-learning -hiring. Everything is internally developed and proprietary. Both Shotl and Drivania worked with external technology developers, outsourcing software development. The collaboration worked poorly when the partners were located in the US and not in Spain. Therefore the brothers started working with a local company of developers and ended up hiring many of them.
- **Finance**: Drivania and all the other ventures are self-funded with reinvestment of profit coming from the business. Shotl is the first venture experience of the Martret family involving VC funds. Working with VC is a totally new game: the company went from dealing with customers and employees only, to include a new actor that implies a cultural change in the organisation. Entrepreneurs need to talk to VC as investors and not as entrepreneurs, but then go back to the company as an investor in order not to lose the business focus. Working with VC is awkward for people like the Martrets, who are used to work for themselves and not for someone else, but it is good because with start-ups everything is about learning and going out of one's comfort zone. Moreover, VC accelerates timing in a start-up, and the Martret are considering the possibility of looking for VC funding even for the other ventures in order to speed up their development.

4.3.9 Mosaicoon: Scaling-up is not enough

Mosaicoon was a service providing platform – Content management solution provider. It offered a video content platform incorporating high-quality, original video projects which can be readily procured and customised for customer brand campaigns.

Mosaicoon's integrated tracking tool aimed at verifying the performance of the content and enabled brands to pay only for guaranteed views, thanks to its unique pricing model—CVPplus.

Established in 2009, Mosaicoon closed in mid-2018. Its last available data reports (2016) reports €3,932,150 of operating revenues; and 85 employees. At that moment, Mosaicoon was managing a marketplace to buy and sell original video projects easily and swiftly.

On the platform, creators could express their talent and easily monetise their original videos without an initial brief from a client. Brands got thousands of high-quality creative videos with 85% reduction in production time. Videos could be directly distributed on social media channels with an integrated tracking tool.

The initial idea was a display of videos on the Internet but this was not working because it was impossible to scale in terms of the number of users and contents and compete with other content platforms such as Facebook or YouTube. The second phase of the idea development was the integration of the contents within other players' websites on which Mosaicoon was making its contents available to users. In doing so, the number of users increased but it was still impossible to mix content and advertising without a server. The third and last phase of Mosaicoon's activity was the creation of a real advertising platform. The company grew through offering contents and distributing these contents.

Mosaicoon Ambidexterity: the company started working on the internal production of content as a side business while still selecting the contents from 'creative outsourcing'. Next step would have been to make the creation of the content the core business of Mosaicoon, but the company failed before being able to accomplish this part of the plan and it is now in liquidation.

Company's Drivers

- Exemplar business platform case: platforms integrator of services and tools. On Mosaicoon platform creatives develop advertising video projects for brand customers.
- Ugo Parodi, entrepreneur and founder of Mosaicoon, was the soul of the business: with his skill of transposing graphics arts passion on the digital world, he could gain interests and trust of the investors.
- Appropriation strategy can be crucial for gaining investors' interest, enhance company's value and protect the technology in complex markets.
- Business models need to be tested and constantly adapted to the market strategy needed.

Company's Challenges

- Mosaicoon struggled in dealing with Italian VC, which are the generalist and not experts in the media/advertising/digital world in which the company was operating.
- The case of Mosaicoon suggests that the platforms in the periphery struggle to develop and grow. This is due to the fact that the value propositions need to be tested and in order to do so, this requires finance and skills and complementary assets.
- Mosaicoon didn't manage to get competitive on many aspects: its prices were too high, scaling up the platform and the business was hard and the content on the platform lacked customisation.
- Mosaicoon lacked a clear business model. It was hard to find the right market balance within the platform: creating value through the technology is not enough, what is hard is to capture value.

When Mosaicoon tested the business model of a two-sided platform, starting from an integrator platform business model and it immediately faced the challenge of achieving the required number of users and creators involved in the platform marketplace. The company closed few months after the launch of the two-sided platform.

5 Innovation and business strategies of European digital platform SMEs

The digital sector offers several examples of technological platforms (Gawer and Cusumano, 2002; Kenney and Zysman, 2015; 2016).

Platforms provide a set of shared techniques, technologies and interfaces to a broad set of users, contributors (e.g. individual innovators, third-party app developers) and complementary businesses. Within this network, digital platforms play a core, orchestrating role that results in the formation of an "innovation ecosystem" (Adner and Kapoor, 2010). In this study, we analysed the characteristics of European SMEs developing platform innovations and the potential mediation role of this innovation across different markets and segments, to shed light on the adaptation processes of European SMEs and their innovative responses to the evolving digital platform economy.

Despite the cases under analysis featured different circumstances, they presented some recursive elements that let to identifying the following common features of SMEs digital platform business.

In this section we present the results of the cross-case analysis, offering an overview of **how new and original business strategies are emerging among European SMEs applying to the SMEi and catching the opportunities of digital platforms/digital markets**.

1. **Disintermediation/transformation of traditional industries.** Digital businesses create value through the **disintermediation** or the **transformation** of entire industries, in the cases with higher disruptive.

    a. Digital platforms **disintermediate traditional industries** wedging themselves between different sides of the market and supporting interactions among different and converging communities (e.g. producers, consumers, users). From a technology perspective, the digital platform provides a central infrastructure on which participants co-create and exchange value based on the content/goods/services created on the platform. From a market perspective, the platform is more efficient than bilateral relationships in facilitating coordination among multiple actors. Pricing models supported by digital platforms are often able to dramatically reduce the transaction costs of existing markets, crowding out traditional channels. As platforms supplying digital tools and contents, **King of App** and **Mosaicoon** are instances of digital platforms that disintermediate traditional advertising service, lowering the efforts, the price, and time to develop mobile applications and advertising videos for small companies and individuals.

    b. Platforms intending to **transform service industries** (Kenney and Zysman, 2015) are recognised in the literature as the potentially most disruptive ones. This perspective is connected to two dimensions: entrepreneurial and technological. From an entrepreneurial perspective, platforms serve small market niches that are typically unattractive for traditional services companies. In these niches, platforms offer value through services with better price/performance ratio, target small and demand-responsive market segments. From a technological perspective, the algorithms underpinning platforms' online activities are able to mediate between different and previously unconnected market segments, allowing to move upmarket and potentially displace traditional actors. The dynamic pricing algorithm developed by **GoOpti** represents an example of key technology allowing developing a new value proposition in the segment of shared transfers between big airports and remote towns. Similarly, the dynamic routing algorithm underpinning **Shotl** on-demand shuttle rides allowed the development of a new value proposition intended to transform the public and private urban transportation system.

Our cases show that different aspects of the digital platform innovations may enable mechanisms of disintermediation, transformation or even disruption of existing industries. The growth opportunities for digital platforms are higher when the power of enabling technology supporting market convergence and coordinating communities' interaction is higher and triggers network effects. Moreover, our cases demonstrate that SMEs are more successful in capturing value when they build on a **proprietary technology**.

2. **External community engagement** is a key managerial task to shape networks of users, contributors, and complementary businesses, whose presence on the platform motivates other members to join. Most of the SMEs included in this study evolved their business model towards two- or multi-sided platforms that act as "catalyst" (Evans, 2003) building thriving innovation ecosystems of different economic agents. In some cases (i.e. **King of Apps, Social Diabetes** and **Cybernetica**), different communities may have different incentives to join the platform, whose main function is to align participants' interests and thrive network effects.

3. **Orchestrating communities to build innovation ecosystems.** Digital platforms often orchestrate networks of external communities across different industries and implement business models presenting elements of both platform and sharing economies. These business models are typical of large companies acting as "platform leaders" (Gawer, 2014). The SMEs in our sample implementing this type of business models (**Social Diabetes, Mazemap** and **Shotl**) strongly benefit from being connected to innovation ecosystems that provide them with complementary assets fundamental for the development of the business.

4. **Managing frictions.** The core business of digital platform companies is to align the interests of different communities converging on the platform. While value creation and experimentation are supported by the development of infrastructures based on digital technologies, value capture mechanisms require the trigger of direct and indirect network effects. Our cases applied different mechanisms of focussing on customer retention (**King of Apps**) or friction creation (**Cynny, Mosaicoon**) even before developing and experimenting on specific business models.

5. **Easy to start-up difficult to scale-up.** SMEs in our sample faced very low barriers to start-up their businesses, but high barriers to scale them up. In other words, while identifying entrepreneurial opportunities was easy, they later incurred in significant hurdles to generate revenue streams to support growth. The start-up/scale-up gap represents a recurring topic in studies on European entrepreneurship (Nepelski et al., 2016; Rossetti et al., 2018; Autio et al., 2018); nonetheless, it needs to be redefined in the specific context of digital platforms. The technological infrastructures of digital platforms act as plug-and-play business models supporting the experimentation of multiple value propositions in the start-up phase. The demonstration of these business models' logic can be simple and straightforward, but their testing implies difficulties related to the resources and time required by the scaling-up activities. SMEs in our sample show that resources constraints are mainly related to business development and marketing activities, lack of specific funding opportunities and, in some cases, to geographical constraints limiting internationalisation opportunities.

6. **Digital platforms are laboratories** where multiple business models are tested at the same time. In most of our cases, SMEs developed digital platform innovations that allow a) experimenting on different and often alternative business models to engage with different communities; b) letting the business model evolve according to the most appropriate value capture mechanism. As laboratories, digital platforms lower the costs of business model experimentations: in some cases, e.g. **Sensefinity**, experimentation can be a source of funding when it allows leveraging on alternative sources of revenue streams. However, choosing a business model that validates and enacts a growth strategy is a crucial managerial challenge where most barriers to growth emerge. **Shotl** mobility platform is a spin-off from the parent

company **Drivania** which, in order to lower the risks of business diversification, established a venture accelerator through which it spins out new companies with new business models conducting business model experimentation.

7. **Multiple funding sources to support growth**. The scale-up phase represents an important aspect of the validation phase of platform business models. The case of **Sensefinity** shows that platform business models succeed when they generate different and complementary revenue streams. In other cases, the interviewees stressed the relevance of SMEi funding opportunities in supporting the validation of the business model(s) developed in the "lab" phase. However, different types of funding with different objectives are relevant in the start-up phase and in the scale-up phase. Our cases provided clear evidence of the fact that private money (VC) and public money act as complementary resources for digital platform businesses, respectively at technological and market levels. Companies also highlighted the need for expertise in combining different forms of funding and "speak the language of different money providers" (**Mazemap, King of Apps**).
8. **Previous experience matters.** As most of our cases showed, past experiences of the entrepreneur are powerful sources of inspiration, since they enable the recognition or discovery of opportunities in the pre-start-up phase. Experience is fundamental when new ideas are tested; knowledge from past experience also helps to focus on the development of effective value propositions in digital markets, as the cases of **Sensefinity**, **King of Apps**, **Mazemap**, and **Cynny** show.
9. **Geographical scale-up.** Geography remains another barrier affecting the development of new businesses through digital platforms in Europe. As some cases showed (**Mazemap, GoOpti, Cybernetica**), cultural, logistic, and administrative distances persist across diversified national contexts, making it difficult to propose, extend, and validate a value proposition beyond the original target market. Such limitations raise actual difficulties and increase the costs of the scale-up phase when growth strategies are based on internationalisation across national contexts.
10. **Digital platforms in peripheral areas.** Some of the analysed cases suggest that the scale-up phase of digital platforms may be adversely affected by being located in a peripheral area. This generally happens in traditional industries. As the **Mosaicoon** and **Shotl** cases show, specific barriers to the development of digital entrepreneurship arise when the company's headquarters are in geographical areas that are peripheral to the core of the innovation system. Testing a value proposition and constantly adapting it to the scaling-up strategy require specific funding opportunities, skills, and availability of complementary assets. Peripheral markets could have great ideas but it is hard to develop them when there is no physical proximity to a fervent environment guaranteeing easy access to the necessary resources and assets.

6 Conclusions

This study analysed the European digital platform SMEs applying to the SME Instrument. The collected evidence allows to draw some conclusions concerning the innovation patterns and characteristics of such companies, the role of the SME Instrument in promoting digitally-enabled business models among the smallest firms and the directions for future research on the ways in which digital affordances are translated into economic benefits.

Digital platform innovation in European SMEs

The study shows that European SMEs are actively pursuing platform innovation through a number of diversified ways. They are present in many sectors including both services and manufacturing and exhibit various levels of R&D intensity. Digital platform SMEs operate in the knowledge-intensive service industries. Only a small number of firms operate in the manufacturing sectors. Their main areas of activity include Health and Biomedical, Energy and Manufacturing, Mobile apps and IoT.

Digital platform SMEs attempt to transform traditional industries through disintermediation or disruption. Frequently, they connect and engage external communities and orchestrate them in order to build innovation ecosystems. These networks need to be managed whenever frictions between different communities arise.

The study confirms that entry barriers for digital platforms are rather low and that the main challenge is to scale-up activities. Digital platform businesses mainly appeared to be start-ups. 41% of the analysed SMEs are less than 5 years old. Being less than 3 years old, 21% are still in early stage of development. Throughout their lifetime, digital platforms SMEs are laboratories that allow experimenting and validating several business models. In addition to experiment with the best strategies and business models to access the digital market; they are also trying to find and test the best ways to scale-up digital platform businesses.

The development of digital platforms can be hampered by limited access to assets, resources, and markets. The fragmentation of the European market additionally increases the difficulty to scale up. Moreover, these SMEs can also be affected by being located in peripheral areas with undeveloped innovation and entrepreneurial ecosystems.

Previous experience of the entrepreneurs can be a source of inspiration for venture activities or business model to be tested on the platforms. It is also a key success factor for scaling-up.

The role of SME Instrument in fostering digital platform innovation

The sample investigated was selected from the population of SMEs participating in the European SME Instrument (SMEi), an innovative funding scheme introduced by Horizon 2020, the 8th Framework Programme for Research and Innovation. The SMEi targets the most innovative European SMEs, with high ambitions of growth and internationalisation, pursuing high-risk innovations with the potential of disrupting the European and global markets.

The study shows that the wide majority of SMEs that applied to the SMEi are using the received the funds for further growth. The SMEi encourages established innovative SMEs to experiment with new business models to explore new business opportunities. These attempts are built on existing capabilities. Therefore, the SMEi provides SMEs with the possibility to diversify their portfolio and to look for new opportunities in distinct business lines and markets.

Firms located in peripheral areas face a number of disadvantages, compared to their peers in technology hot-spots with strong innovation and entrepreneurial ecosystems. Public interventions in peripheral areas can help innovative SMEs not only providing funds, but also exposing them to the international ecosystem and building reputation necessary to seek capital for growth.

Implications for future research

The SMEi is a relatively new funding scheme to promote innovation among SMEs. The target group of the SMEi represents a relevant sample of innovative and entrepreneurial firms in Europe. Most of the beneficiaries of the SMEi are still in the early stages of entrepreneurial development. Further research could be developed through longitudinal studies focusing on companies which are ready in the process of scaling-up.

Consistently with previous studies (see, e.g. Autio et al., 2018) the results show that it is easy to start up as a digital firm, but difficult to scale up. In this context, digital platforms act as infrastructures which hold up the experimentation of multiple types of business models, supporting different growth strategies. Further research could concentrate on the dynamics of digital ecosystems and on the nature and types of resources allowing digital platform companies to connect and develop growth strategies based on collaboration and diversification.

Finally, and consistently with research on nascent entrepreneurship performed on similar samples (Marullo et al., 2018), this study confirms that the nature and the characteristics of entrepreneurs' previous experience represent relevant human capital resources. It is particularly relevant for the shift between the stand-up and scale-up stages. In this perspective, future research on the nature and perspectives of European entrepreneurship should "enter the lab" and engage scientists and engineers in the stand-up stage (i.e. the process of self-selection of individuals into entrepreneurship) and analyse in-depth the characteristics of entrepreneurial orientation and the dynamics of opportunity recognition, discovery and creation.

7 Annex: Methodology

7.1.1 Selection of digital platform SMEs

For the purpose of this study, we used a sample of SMEs selected among the SMEs that applied to the SME Instrument funding scheme under the Horizon 2020 framework programme. These companies took part to a public competition for public funding targeting the "European Innovation Champions", i.e. SMEs with high ambition of growth and internationalisation, proposing innovative entrepreneurial projects. For these reasons, we considered the SME Instrument applicants as an interesting and relevant group from which the sample of the study could be selected, in order to include in the analysis new entrepreneurial initiatives as well as a relevant sample of innovative European SMEs.

From the **33,056 proposals submitted to the SMEi** from January 2014 to March 2017, we selected SMEs whose projects reported clear evidence of digital platform innovation.

A thorough assessment of the proposal abstracts was carried out with the view of selecting the sub-population of SMEi proposals with content pertaining digital markets and digital platforms. To this end, we followed an iterative approach.

In the first instance, we screened the proposal abstracts including the word "digital" and other relevant keywords appearing in the most common descriptions of "digital economy". Out of the population of the 33,056 proposals submitted, we obtained a sample of 3,358 (Table 13).

Secondly, we ran a text analysis of these 3,358 proposals abstracts using the NVivo software, to obtain a dendogram showing the 500 most cited expressions associated with the word "digital". Using the first 100 expressions, we ran a second non-automated screening of the population of proposals submitted, selecting the ones which included the new keywords and did not include the word digital. Excluding duplicates, we obtained 1,926 additional valid results and achieved a sample of **5,284 proposals** (Table 14).

Table 13. Sample selection: preliminary check and step 1.

PRELIMINARY CHECK				
	Query	**String**		**Results**
1	Include	"digital"		2,609
2	Include	"digital" AND "platform"		1,239
3	Include	"digital" AND "market"		2,073
4	Include	"digital market"		137
5	include	"digital platform"		122
STEP 1				
	Include	**Results**	**Duplicated**	**Total**
1	digital	2,609	0	2,609
2	real time monitoring	45	5	2,649
3	sharing economy	90	29	2,710
4	market place	136	36	2,810
5	content creation	32	14	2,828
6	user generat*	33	9	2,852
7	communit* of user*	52	10	2,894
8	digital AND communit*	247	247	2,894
9	collaborative work	20	5	2,909
10	collaborative environment	16	3	2,922
11	exchange platform	30	14	2,938
12	ecosystem AND platform	357	99	3,196
13	web platform	211	60	3,347
14	crowd funding	19	8	**3,358**

Table 14. Sample selection: step 2.

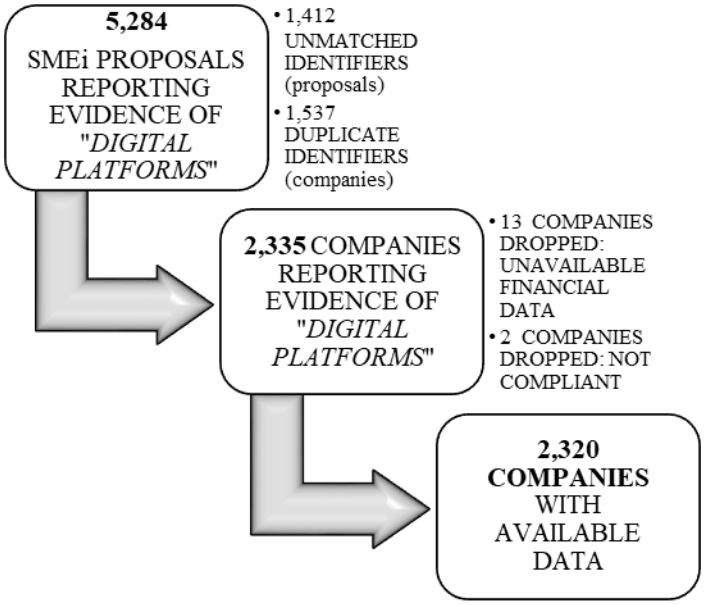
STEP 2				
	Include "15-57" AND don't include "Digital"	Results	Duplicated	Total
15	business analytics	14	0	3.372
16	business intelligence tool	23	1	3.394
17	Business intelligence software	4	3	3.395
18	data-driven automation	0	0	3.395
19	data-driven online	1	1	3.395
20	data mining technologies	0	0	3.395
21	data anal*	528	35	3.888
22	data science solution	1	0	3.889
23	data processing solution	0	0	3.889
24	highly automatised solution	1	1	3.889
25	Bluetooth technology	11	1	3.899
26	RFID technology	26	1	3.924
27	blockchain technology	8	0	3.932
28	big data technology	8	4	3.936
29	time control system	0	0	3.936
30	intelligent system	57	4	3.989
31	automation system	70	5	4.054
32	artificial intelligence system	12	1	4.065
33	service management processes	0	0	4.065
34	service management systems	0	0	4.065
35	new complex service	0	0	4.065
36	information management system	12	1	4.076
37	real time information	42	7	4.111
38	mobile app	728	111	4.728
39	mobile application	393	393	4.728
40	mobile device app	4	1	4.731
41	management of artificial intelligence	0	0	4.731
42	integrated information management	0	0	4.731
43	software system	87	10	4.808
44	business intelligence software	4	4	4.808
45	software as a service	184	42	4.950
46	digitised content	1	0	4.951
47	content management system	26	9	4.968
48	virtual content	4	0	4.972
49	web app	158	36	5.094
50	web application	142	142	5.094
51	smart analysis	6	0	5.100
52	smart analytics	3	2	5.101
53	cloud computing	167	41	5.227
54	cloud technology	20	8	5.239
55	disruptive hybrid cloud	0	0	5.239
56	multiplatform application	4	0	5.243
57	smartphone application	56	15	5.284

7.1.2 Quantitative analysis

For the purpose of quantitative analysis, we drew on an original database matching the information from the SMEi and the financial details of the applicant companies[5]. Among the **5,284 project proposals included in the sample**, 1,412 proposals were rejected due to an unsuccessful matching procedure[6] of the names of applicant companies. Out of the remaining 3,872 proposals submitted from an identifiable applicant company, 1,537 identifiers were duplicates (that is, firms presenting more than one proposal in either of the two phases of the SMEi). For the resulting sample of 2,335 SMEs reporting evidence of "digital platform" activities, financial data were extracted on 15 December 2017. Out of these, financial data were not found for 13 companies at the time of the extraction and 2 additional companies were dropped from the sample due to inconsistencies with the official definition of SMEs (number of employees >250)[7]

As a result, the final output of the matching procedure consisted of **2,320 firms** (Figure 26).

Figure 26. Output of the matching procedure.



Prior to analysing their characteristics, we explored the activity status of the companies in the sample, as reported in the legal information provided by Amadeus – Bureau van Dijk (Table 1). The overwhelming majority (95%) of the firms populating our sample was active, with only a minor portion being dormant or under insolvency proceedings. Interestingly, out of 117 inactive firms, almost half (54%) had dissolved, while 8 had declared bankruptcy and 23 were under liquidation.

(5) Financial data were retrieved from the Amadeus – Bureau van Dijk Database.

(6) Amadeus does not include data for Israel, which is one of the participants to the Horizon 2020 Program despite being outside the European Union. Moreover, we experienced some particular difficulties in matching the names of Turkish firms, given that their transliteration to the Latin alphabet contained in Amadeus rarely matches with the name contained in the proposals.

(7) EU Commission Recommendation 2003/361.

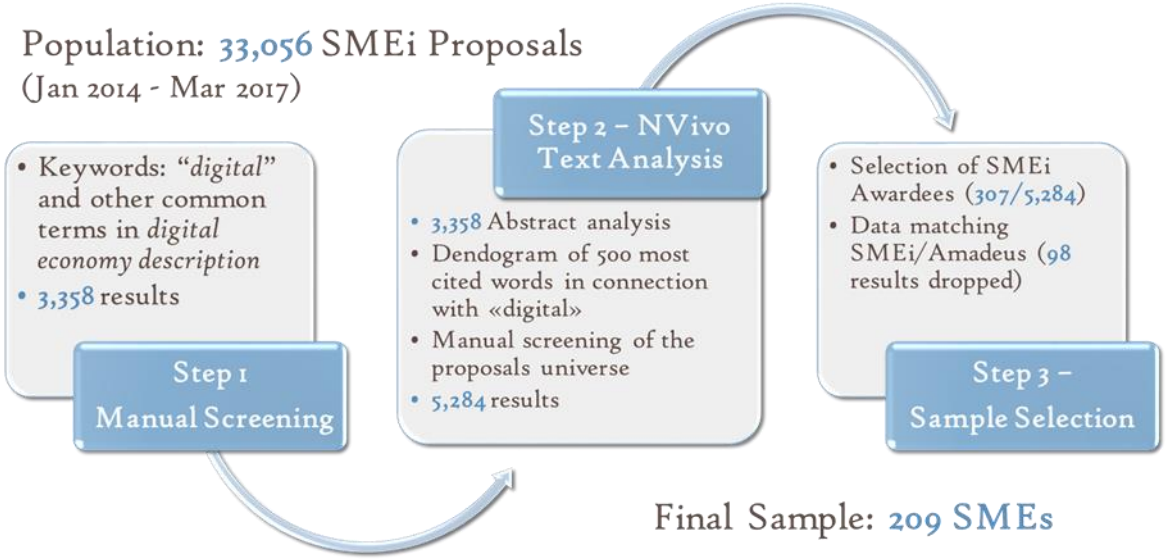
Table 15. Analysis of companies' status.

Status	**n**	**%**
Active	2,167	93.4%
Active (default of payment)	5	0.2%
Active (dormant)	13	0.6%
Active (insolvency proceedings)	15	0.6%
Active (reorganisation)	2	0.1%
Active (rescue plan)	1	0.0%
Active (total)	**2,203**	**95.0%**
Bankruptcy	18	0.8%
Dissolved	54	2.3%
Dissolved (bankruptcy)	5	0.2%
Dissolved (demerger)	1	0.0%
Dissolved (liquidation)	2	0.1%
Dissolved (merger or take-over)	7	0.3%
In liquidation	23	1.0%
Status unknown	7	0.3%
Other statuses (total)	***117***	***5.0%***
TOTAL	**2,320**	**100.0%**

7.1.3 Cases analysis

For the purpose of the cases analysis only SMEi awardees were selected. Drawing on the initial sample of 5,284 SMEs, we identified **307** proposals that had received the SMEi award, 922 that were awarded the Seal of Excellence (i.e. evaluated as above the threshold but below the available budget), and 4,055 proposals that were evaluated below threshold. After discarding duplicates (i.e. SMEs that submitted a proposal to the SMEi more than once), we obtained **297** awarded SMEs. Using the companies' legal name, we matched the records with the Amadeus database to collect the SMEs' contact harmonised data. Due to unsuccessful matching, we dropped 108 SMEs. The final selected sample included **209** SMEI awardees. This final sample was used as source of selection for the case studies to be developed for this project (Figure 27).

Figure 27. Sample selection for cases analysis.



The 9 European digital SMEs included in the research whose results are summarised in this report were selected from a list of 42 candidate European digital SMEs, identified from the sample of 209 companies.

In order to capture the variety of our sample and enhance the robustness of our findings, 42 SMEs were identified and contacted from the sample of 209 companies following a multidimensional approach that considered the different markets of operation, country of origin, type of platform, and platform business model. This selection criterion aimed at guaranteeing a full representation of the heterogeneity in dimensions among European Member States, industries and firms. The 42 SMEs initially identified were contacted through email and phone calls providing an overview of the research and its goal and collect preliminary consent to the participation in the study. After a second email contact, only 5 companies agreed to take part in the research. In order to reach the target of 9 case studies, in September 2018, 29 additional SMEs were further contacted and 4 of them accepted to participate in the study. This produced a sample of 9 SMEs that were analysed in-depth.

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