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Digital startups and the adoption and implementation of Lean Startup Approaches: Effectuation, Bricolage and Opportunity Creation in practice

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ABSTRACT

Digital startups launching original value propositions can test out and validate their business model using a recent and emerging set of practices known as Lean Startup Approaches (LSAs), which consist of Customer Development and the Lean Startup. While LSAs are gaining momentum in the ecosystem surrounding digital startups, they still suffer from poor theoretical foundations and operational issues that hinder their adoption and implementation. The aim of this study is to go beyond recalling anecdotal and single-case examples and, through mixed-methods research involving 227 digital startups, provide a first large-scale analysis of: (i) if and how digital startups apply Lean Startups Approaches; (ii) the ensuing results; (iii) the main advantages and disadvantages that stem from adopting and implementing LSAs; and (iv) how digital startups connect and combine the LSAs with other entrepreneurial approaches and tools for launching startups. The findings reveal that most of the sample has adopted LSAs and obtained several benefits from their use. A list of practical guidelines on how to solve the existing drawbacks and enhance the effectiveness of adopting and implementing LSAs is hence proposed. To conclude, a framework for organizing the empirical findings is put forward, where LSAs are inserted into the entrepreneurship theory debate on Effectuation, Entrepreneurial Bricolage and Opportunity Creation. Suggestions are then provided on how to sequence and bridge effectuation and causation logics and decision-making tools in an "entrepreneurial opportunities space".

1. Introduction

> "*There are three principal means of acquiring knowledge… observation of nature, reflection, and experimentation. Observation collects facts; reflection combines them; experimentation verifies the result of that combination*".
>
> (*Denis Diderot, 1753*)

1.1. Reasoning behind the study

Entrepreneurial endeavours carry with them an abundance of activities that entrepreneurs must perform in order to acquire tangible and intangible resources (Barney, 1991, 2001) and transform them into new ventures or startups. As the French philosopher Denis Diderot (1966) wrote, there are three principle means of acquiring knowledge available to us: observation of nature, reflection and experimentation. These mirror what is also required from entrepreneurs, as they need to observe their surroundings closely when trying to identify potential opportunities (Shane and Venkataraman, 2000). Once an opportunity has been detected, these entrepreneurs must think hard about how to combine their resources creatively and originally (Ireland et al., 2003) so that they become heterogeneous – i.e. they create value for customers, yet are rare and costly to imitate (Barney, 2001) – and on how to mould a value proposition and a startup around this unique pattern of resources. After this, entrepreneurs must test their design (Kerr et al., 2014) to see whether their startup is likely to create, deliver and capture value is a way that will be accepted by their target customers and, therefore, be viable. This final action is needed to validate the overall startup business model, in other words, its architecture of value (Ghezzi et al., 2015; Rappa, 2001; Teece, 2010).

This part is particularly complex within the highly volatile context of digital entrepreneurship (Autio et al., 2018; Nambisan, 2017), where opportunities are quick to arise and vanish, combined resources unexpectedly acquire or lose their original value, and testing becomes a vital feature of the startup's learning process (Contigiani and Levinthal, 2018).

Digital startups launching their products and services in this setting can use a recent and emerging set of practices to test out and validate their business model, known as Lean Startup Approaches (LSAs), which consist of Customer Development (Blank, 2007; Blank and Dorf, 2012) and the Lean Startup (Ries, 2011). These pragmatic methods for

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transferring the notions of Lean Manufacturing (Womack and Jones, 1996) to the startups' environment are built upon a set of key principles: (i) formulating falsifiable hypotheses about the business idea; (ii) embedding these hypotheses into a designed business model (BM); (iii) developing a Minimum Viable Product (MVP) to replicate the product's functions and test the business model; (iv) identifying the target audience or "earlyvangelists" from whom to receive feedback; and (v) running tests with multiple iterations to make decisions about persevering with the business idea, letting it perish or pivoting, that is, undertaking a structured course of correction (according to the "build-measure-learn" feedback loop).

Although these approaches are gaining momentum within the startup community (Breuer, 2013; Kerr et al., 2014; Kiura et al., 2014; Frederiksen and Brem, 2017), and sometimes are even penetrating the corporate world as they are adopted by incumbents (Power, 2014; Ries and Euchner, 2013), they still lack the necessary theoretical foundations (Ghezzi and Cavallo, 2018; Yang et al., 2018), with specific reference to the extant theories on Entrepreneurship. Moreover, as the largely practitioner-oriented literature on LSAs builds on recalling past cases and anecdotal evidence, little is known concerning: (i) the actual adoption and effectiveness of these approaches in terms of assisting in the digital startups' launch; (ii) their connection to other traditional entrepreneurial tools such as business plans; and (iii) their inclusion within more established entrepreneurial theories and logics.

1.2. Purpose and research questions

This study hence sets forth as its objective to go beyond recalling anecdotal and single-case examples and offers a first large-scale analysis of four aspects. These are: if and how digital startups apply Lean Startups Approaches (Research Question 1); the ensuing results (Research Question 2); the main advantages and disadvantages they feel come from the adoption and implementation of LSAs (Research Question 3); and how digital startups connect and combine the LSAs with other entrepreneurial approaches and tools for launching startups (Research Question 4).

Using a mixed methods approach, the study builds on the results of a survey on 227 digital startups launched between 2012 and 2017 contained in an original database; it further informs these results through a qualitative research method based on 32 semi-structured interviews, to disclose additional insights.

1.3. Contribution

According to the study's findings, Lean Startup Approaches are largely adopted in the sample of digital startups investigated, and digital entrepreneurs gain significant benefits from their implementation, mostly referring to the following aspects: (i) reducing time and costs to test the startup; (iii) aligning business idea to customer needs; (iii) verifying and pivoting all business model parameters; (iv) receiving rounds of financing; and (v) offering alternatives to traditional intellectual property protection. When setting up their digital startups, however, the entrepreneurs found that the work to implement LSAs was not as straightforward as they had expected, having often underestimated the true complexity of putting in place the relative processes and tools. More specifically, digital entrepreneurs claim that they encounter issues concerning: (i) defining and designing MVPs; (ii) identifying and engaging earlyvangelists and trial users; (iii) defining testing priorities and designing experiments and tests; (iv) missing other market opportunities and threats; and (v) obtaining information about the startup's sources of competitive advantage.

As a conclusion, this study suggests that LSAs could be positioned in the debate on entrepreneurship as an operational and scientific approach to the behavioural theories of Effectuation (Sarasvathy, 2001) and Entrepreneurial Bricolage (Baker and Nelson, 2005), within an Opportunity Creation setting (Alvarez and Barney, 2007).

These findings could help to properly address and amend the downsides of LSAs, encouraging digital startups to adopt this promising - but still scientifically under-investigated - approach.

1.4. Structure

This study is structured as follows. After this introduction (Section 1), Section 2 contains the theoretical background in which the study is positioned (i.e. the discovery and creation theories of entrepreneurial opportunity and action, and Lean Startup Approaches); the study method is described in Section 3, leading to the results given in Section 4. These results are discussed in Section 5, and the conclusions concerning the study's contribution are drawn in Section 6, together with its limitations and the avenues for future research.

2. Theoretical background

2.1. Discovery and creation theories of entrepreneurial opportunity and action

Entrepreneurship is commonly defined as the act of discovering and pursuing profitable opportunities (Shane and Venkataraman, 2000); once such opportunities are spotted, the entrepreneur should move towards them, to build a new venture or startup around them. In this phase, entrepreneurs engage in "opportunity-seeking" behaviour, subsequently followed by strategic or "advantage-seeking" behaviour, in order to integrate the opportunity with competitive advantage (Hitt et al., 2001; Ireland et al., 2003).

While the literature shows consensus on the centrality of the concept of opportunity in entrepreneurship, different approaches emerge concerning the nature of these opportunities and the process through which they become apparent. As Alvarez and Barney (2007) argue, two alternative theories of entrepreneurial action indicate that opportunities can be discovered or created.

According to the discovery theory of entrepreneurial opportunity (e.g. Shane and Venkataraman, 2000), opportunities exist independently of the entrepreneurs, who should nurture alertness (Kirzner, 1973), that is, the ability to become aware of opportunities and discover them before others. A discovery view of opportunities hence advocates the use of data collection and analysis techniques and methods framed in a business plan (Delmar and Shane, 2003), to make decisions in a risky context.

The creation theory of entrepreneurial opportunity takes a different stance (Gartner, 1985; Weick, 1979). Starting from the assumption that opportunities are not objective phenomena formed by exogenous shocks and that they do not exist independently of entrepreneurs, the creation theory posits that opportunities are social constructs endogenously created by the actions, reactions and enactment of the entrepreneurs' exploring ways in order to create value in an uncertain context (Alvarez and Barney, pp. 13–15). With regards to enactment, the proceedings entail an iterative, inductive and incremental decision-making process, supported by heuristics and based on the notion of affordable loss rather than expected return.

Different entrepreneurial opportunity theories and decision-making contexts led to the advancement of parallel approaches and logics behind the entrepreneurial action. Sarasvathy (2001) restates this apparent dichotomy in her study comparing traditional causation logics with what she calls "effectuation". While causation sees the future as a continuation of the past, and entrepreneurial actions as goal-oriented undertakings that strive to avoid potential contingencies through accurate predictions and careful planning, Effectuation considers the future as shaped by entrepreneurs, who act on the basis of the means at hand – rather than the goals – and plan for the unexpected, leveraging contingencies as they arise (Yang et al., 2018).

As in the case of Effectuation logic, Entrepreneurial Bricolage (Baker and Nelson, 2005) argues that entrepreneurs operate in a condition of

extreme resource scarcity, and have, therefore, to "make do" by combining the resources at hand and applying them to new problems and opportunities that arise. Making do hence implies making the most of limited resources, by engaging in experimentation, the early and frequent interaction with customers and subsequent iteration (Fisher, 2012).

Although the logics of Effectuation and Entrepreneurial Bricolage can describe the actual behaviour of entrepreneurs involved in the process of creating and developing startups (Fisher, 2012), little is still known concerning about how they can be placed in a systematic operational frame to enhance opportunity formation through the entrepreneurs' enactment process. Although recent studies (Frederiksen and Brem, 2017; Yang et al., 2018) have come up with the suggestion that Effectuation could be put into practice through the Lean Startup (Ries, 2011), these contributions are still scattered and unconnected, and show either a largely conceptual stance, or some misconceptions about the different steps included in the Lean Startup and its precursor, Customer Development (Blank, 2007).

2.2. Lean Startup Approaches

The Lean Startup Approaches (LSAs), named originally by Ghezzi and Cavallo (2018), include two main methods to develop startups, with enough similarities to couple them within the same framework: Customer Development (Blank, 2007) and the Lean Startup (Ries, 2011).

Steve Blank (2007) was the pioneer of LSAs when he introduced the concept of "customer development" and described the process that entrepreneurs should follow to test and refine their business hypotheses through customer interaction. In his seminal book "The Four Steps to the Epiphany: Successful Strategies for Products that Win", he argued that a startup is a temporary organization looking for a scalable and replicable business model. Therefore, the primary aim of any startup should be to test whether the overarching hypotheses of its business model are indeed verified, thus making the BM scalable and replicable.

Based on Karl Popper's concepts of conjectures and refutations (Popper, 2014), which form the core of epistemology, the customer development approach states that, rather than developing products or services, startups should develop customers and, to do so, they must go through a process consisting of two steps and four sub-steps (see Fig. 1).

The first is the "search" step, when startups need to find "earlyvangelist", that is, early customers or trial users with specific characteristics – i.e. they have a problem or need, they are aware of having a problem, they are actively looking for a solution, they have even tried to put together their own solution, and they have or can acquire the funds to buy a good solution once they find it (Blank, 2007). After the earlyvangelists have been discovered, the startups should work closely with them to create iterative feedback cycles that allow new solutions to be tested and the business idea to be improved incrementally, so that it gains customer validation.

Testing and the subsequent validation are based upon a set of assumptions and/or hypotheses set by the startup to postulate how its business idea will work and create value for customers, how value will be delivered to these customers and how a share of such value will be captured to ensure the startup's sustainability. This means that the startup will need to design an overall business model, that is, an architecture of value (Ghezzi et al., 2015; Rappa, 2001; Teece, 2010), around its idea.

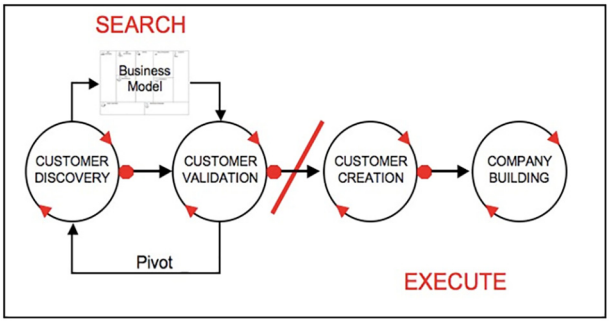

Fig. 1. Customer development (Blank and Dorf, 2012).

When testing out their business models, entrepreneurs should introduce what is known as the "business model canvas" (Osterwalder and Pigneur, 2010), according to which three pillars and nine parameters are assigned to a business model, as shown in Table 1.

During its search phase, Customer Development, therefore, helps the startup to obtain early insights about its prospective customers. At this point, the startup must prove that there is a potential market for its products/services and verify that there are customers willing to acquire them.

By introducing this approach, the startup can reduce the likelihood of it failing. This is because the initial business model and the assumptions on which it was based, which in the main stem from the entrepreneur's personal perception of reality, have been tested and possibly verified in the field through repeated interaction with potential customers, and the learning outcome derived from these tests comes from the real world – in line with the directive to "get out of the building" advocated by Blank (2007).

The "execute" phase follows the search phase. Once the business model and the customers are validated, the startup can create its market demand through investments in marketing and sales spending, and it can scale up its business by structuring its functional units and introducing customer development teams (Blank and Dorf, 2012).

The Lean Startup, a term coined by Eric Ries (2011), revisits Customer Development and consists of a business approach where the aim is to change the way companies are built and new products are launched.

As with Customer Development, the formulation of falsifiable hypotheses plays a critical role in triggering the Lean Startup process. The two key assumptions made by entrepreneurs are: (i) the value hypothesis – testing whether a product or service really delivers value to customers once they are using it; and (ii) the growth hypothesis – testing how new customers will discover a product or service (Ries, 2011; Hartman, 2013 – p 6).

The Lean Startup introduces two new concepts: Minimum Viable Products (MVPs) – artefacts used for the fast and quantitative market testing of a product or product feature – and pivots, where certain BM elements are changed in response to failed hypotheses tests. According to Ries, a MVP is "that version of a new product which allows a team to collect the maximum amount of validated learning about customers with the least effort" or, in a simpler way, "the smallest thing you can build that lets you quickly make it around the build/measure/learn loop" (Ries, 2011).

Unlike other methods for managing early stage ventures, the Lean Startup Approach also balances the strong direction imposed by a founder's vision with the need for redirection following market feedback (Eisenmann et al., 2012), thereby introducing a third element.

In addition, when Ries describes LSAs, a central part is given over to the Build-Measure-Learn feedback-loop, which in turn is influenced by the Observe, Orient, Decide and Act (OODA) loop developed by the military strategist John Boyd as a tool for winning battles. Behind the feedback loop is the idea that entrepreneurs should get their products into the hands of customers – in the form of a MVP – as fast as possible in order to test it out and receive feedback that can be used to reject or validate their assumptions. The goal of Lean Startup is to minimize the time spent going through the feedback loop, the implication being that the startups need to build faster, measure themselves faster and learn faster (Ries, 2011). Experiments and tests within the loop can also be iterated, as startups should formulate and validate their problem hypotheses, create and validate their solutions to this problem, and

Table 1
The business model canvas (Osterwalder and Pigneur, 2010).

Pillar	Parameter	Description
Value infrastructure	Key activities	Describes the most important things that a company must do to make its business model work
	Key resources	Describes the most important assets required to make a business model work
	Key partners	Describes the network of suppliers and partners that make the business model work
Value proposition	Value propositions	Describes the bundle of products and services that create value for a specific customer segment
	Customer segments	Defines the different groups of people or organizations that an enterprise aims to reach and serve
	Customer relationships	Describes the types of relationship a company establishes with specific customer segments
	Channels	Describes how a company reaches and communicates with its customer segments to deliver a value proposition
Value formula	Cost structure	Describes all costs incurred to operate a business model
	Revenue stream	Represents the cash that a company generates from each customer segment (costs must be subtracted from revenue to create earnings)

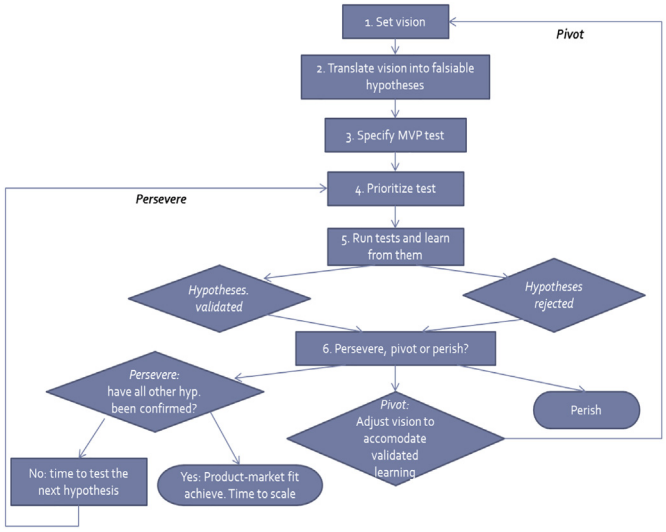

Fig. 2. Lean startup process steps (Eisenmann et al., 2012).

conclude by validating the remaining elements of the business model built around the solution, as well as seeing how to scale it up and acquire customers (Gustafsson and Qvillberg, 2012; Heiramo, 2013).

Fig. 2 depicts the process faced by an entrepreneur when following the Lean Startup Approach.

Customer Development – with specific reference to its "search" phase – and the Lean Startup together make up the Lean Startup Approaches (LSAs), used by entrepreneurs when validating their digital startup business model. Ries (2011) and Blank (2013) both concur that, while traditional methods for New Product Development largely focused on testing products, services and value propositions (Brown and Eisenhardt, 1995; Krishnan and Ulrich, 2001), LSAs should help to experiment on all elements of the startups' BM.

Recent attempts were made to frame the Lean Startup and Customer Development in the academic literature, with somewhat unconnected or partly inconsistent results. Frederiksen and Brem (2017) were involved conceptually in looking for theories that possibly back the Lean Startup, while not addressing the advantages and disadvantages of applying the method. Yang et al. (2018) investigated the entrepreneurial reasoning behind the Lean Startup – which they divide into the phases of search and execute – and find that search actions are associated to effectual logics, while execution actions are instead associated to causation logics. Nevertheless, in their hypotheses, they appear to equate the Lean Startup with Customer Development, as search and execution are phases of the latter rather than the former. Contigiani and Levinthal (2018) carried out research into the Lean Startup's theoretical roots and antecedents, but largely without mentioning entrepreneurial theories. Ghezzi and Cavallo (2018) discussed the Lean Startup and Customer Development jointly because of their similarities and partial overlapping, introducing the notion of LSAs. They relate LSAs to Agile Development and Business Model Innovation, although any detailed discussion of LSAs having roots in Entrepreneurship theory lay outside their scope and aim. Despite the growing interest in LSAs, extant studies still show only limited consensus about the origins of these approaches and their related tools; moreover, scholars often adopt a conceptual stance (e.g. Contigiani and Levinthal, 2018; Frederiksen and Brem, 2017) that needs to be backed by empirical investigation.

3. Methods

This study is based on a mixed-method approach where quantitative and qualitative studies follow one from the other (Castro et al., 2010; Johnson et al., 2007). In mixed-methods research, qualitative methods are often employed to help explain and expand quantitative findings (Creswell and Clark, 2011; Molina-Azorin, 2012).

More specifically, this study uses a sequential approach by combining a quantitative questionnaire-based survey on a sample of digital startups (step 1) with qualitative semi-structured interviews on a subsample of digital startups representing polar or highly relevant cases – identified by their answers to the questionnaire (step 2).

3.1. Survey on digital startups

In the quantitative step of this research, our aim was to collect large-scale information to address the following broad research questions: if and how do digital startups apply Lean Startups Approaches (RQ1); what are the results obtained (RQ2); what do they perceive to be the main advantages and disadvantages stemming from the adoption and implementation of LSAs (RQ3); and how do digital startups use the LSA in conjunction with other entrepreneurial approaches and tools for launching startups (RQ4).

The sample was obtained from an original database of digital startups based and operating in Italy that received funding from formal investors – i.e. independent venture capital funds, corporate venture capital funds, government venture capital funds – and/or informal investors – i.e. business angels, angel networks, crowdfunding platforms, family offices and venture incubators (e.g. see Bruton et al., 2010, 2015; Kerr et al., 2011) between 2012 and 2017. This database was set up within a broader research project and, since 2012, has been mapping Italian-funded digital startups by triangulating data from all actors in the entrepreneurial ecosystem – e.g. formal and informal investors, incubators and accelerators, governmental institutions, startups associations and the startups themselves.

Formal and informal investors mostly differed in terms of whether the organization backing them was structured or largely unstructured, as well as whether they used a systematic or unsystematic approach to carry out the startup's due diligence before making an investment (Drover et al., 2017). We decided to focus on funded startups and include both sources of equity capital financing because this meant that our study looked at high-quality startups that had passed either a

formal or an informal due diligence process, allowing us also to potentially contrast and compare the different roles that LSAs play in enabling or hindering the funding process.

The original database, as of January 10th 2017 (when the survey was launched), held 484 digital startups that were still active and were or had been funded by formal and/or informal investors.

To collect data, an e-mail based survey was sent to the personal or business e-mail addresses of a representative digital startup founder, which had previously been collected and archived in the original database, together with information about the contact person in the founding team to be interviewed for research purposes. It was important to interview the startups' founders since they were the people behind the business ideas to which the LSAs were being applied, and they had control over the development processes enabled by LSAs.

A pilot survey was submitted to three digital startup founders who were willing to provide feedback on its structure and the clarity of the questions. This kind of feedback allowed us to revise the order of our questions and the wording of some of them, as well as tweaking the list of items to be included as alternative options, to come up with the final version of the survey.

This final survey was broken into four sections of questions covering the adoption of LSAs, the results, the advantages and disadvantages, and their integration with other entrepreneurial theories, approaches and tools. The full list of survey questions is given in Appendix 1.

Where the answers to the questions were not of a Boolean yes/no type or chosen from a set of items, they were given on a four-point Likert scale, where the mid-points choices were eliminated in order to polarize results and help us to select the startups best suited to a qualitative interview (Garland, 1991).

The initial personalized contact and subsequent telephone follow-ups ran up to March 15th 2017 (Baruch and Holtom, 2008; Porter and Whitcomb, 2003), at which point we had received 235 answers, giving a survey response rate of 48.55%. After cleaning this list by removing incomplete answers, the remaining 227 complete records was used as the basis for our quantitative data analysis.

The respondents belonged to various fields of application in the broad digital industry, which also spans a number of traditional markets (Bharadwaj et al., 2013), and the sample was well-representative of the database's whole population in terms of industry and average startup age. Table 2 shows the distribution of the sample across different fields of application.

Given the rather explorative nature of this first analysis on a wide sample of digital startups engaged in LSA practices (Eisenhardt, 1989), the data analysis mostly relied on descriptive statistics to show the aggregations, means and trends that could be further explored through qualitative analysis. On this point, quantitative analysis provides the means to inform theoretical sampling in qualitative analysis (Creswell and Clark, 2011; Molina-Azorin, 2012): as such, by leveraging on the contribution by Johnson et al. (2007) on the qualitative-quantitative continuum, this mixed methods research can be defined as “qualitative dominant”.

Table 2
Sample characteristics.

Field of application	Number of startups	% of sample	Average age (in years)
Mobile applications and services	49	21.59%	4.1
Internet of things	38	16.74%	3.6
eCommerce and retail	29	12.78%	3.8
Industry 4.0	26	11.45%	2.4
Big data	23	10.13%	3.1
Social media	19	8.37%	3.5
Mobile payment	13	5.73%	3.3
Cloud computing	10	4.41%	3
Machine learning	8	3.52%	1.5
Security	7	3.08%	1.8
Digital wearables	5	2.20%	2.2
Total	227	100%	3.3 years (weighted average)

3.2. Interviews with significant digital startups

The qualitative step of the research consisted in gathering insights that could help to explain and expand the findings gained from RQs 1, 2 and 3, while further exploring how to address RQ4, which covered the LSAs and how they connected with other entrepreneurial approaches and tools.

This step was designed as a set of semi-structured qualitative interviews (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Yin, 1984), starting from a protocol of questions similar to those of the survey (see Appendix 2), although these questions were more explorative and open to the informants going off topic or including any new aspects, thus allowing innovative issues to emerge from the open discussion (Walsham, 1995; Yin, 1984).

Case sampling was performed theoretically (Eisenhardt, 1989; Meredith, 1998) and was informed by the outcome of the quantitative research step. The cases were selected according to their heterogeneity in terms of: (i) within-case consistency or inconsistency of answers to the survey; and (ii) cross-case polarities and significant differences.

By carrying out multiple qualitative interviews, it was possible to generalize the results more firmly (Meredith, 1998) and undertake a comparative analysis of the findings, because the theoretical sample potentially contained extreme cases, polar types or niche situations (Meredith, 1998). Hence, in order to include the digital startups and associated informants in the qualitative research, they needed to show a high level of consistency or inconsistency in terms of their internal positioning towards the adoption of LSAs, or strong similarities or differences when compared to other startups.

The face-to-face, semi-structured interviews were, therefore, the primary source of information when collecting data in this research step. Between May and October 2017, 51 digital startups which had answered the questionnaire were contacted to ask for a follow-up interview. Of them, 37 startups agreed, and 32 of them were eventually interviewed (14% of the sample of respondents, and 62.7% of the subsample of startups contacted in the qualitative research step).

The interviews were held in a semi-structured format with the digital startups' founders and lasted on average 1 h and 8 min.

For the data analysis, the interviewees' responses were first recorded and fully transcribed. If any information was still unclear and/or more data was needed, the informants were later contacted by telephone to ask for clarification.

Then, following the recommendations set by Eisenhardt (1989), a within-case data analysis was carried out, so as to generate the necessary insight into the issues under scrutiny. A subsequent cross-case analysis made it possible to compare the various responses from informants belonging to the different digital startups.

Interview content analysis was performed for both the within-case and the cross-case analyses, borrowing the use of open coding from Grounded Theory methodology (Glaser and Strauss, 1967; Strauss and Corbin, 1998), as this method is suitable for studying complex phenomena as it applies a clearly defined procedure based on coding – i.e. using labels, concepts and words to produce theory from interviews, rather than the mere finding of facts (Glaser and Strauss, 1967). The empirical material was codified through textual analysis, and stored in a software archive.

In accordance with Eisenhardt (1989), as virtually no research can be based on a completely “clean theoretical slate” (p. 536), coding was guided by the few extant studies where there was the explicit attempt to frame LSAs in theory (Contigiani and Levinthal, 2018; Frederiksen and Brem, 2017; Ghezzi and Cavallo, 2018; Yang et al., 2018). The literature streams seen as plausible antecedents or theoretical roots for LSAs

Table 3
Codes, concepts and themes.

Selection of codes and concepts	Theme
E.g. proactivity, shaping reality, iteration, experimenting, testing, resource scarcity, leveraging contingencies, accepting change, options, limiting investment	Effectuation
E.g. resource scarcity, bootstrapping, challenging the status quo, resource recombination, creativity, new opportunities, customer interaction, feedback	Bricolage
E.g. proactivity, shaping reality, creating data and information, uncertainty, iteration, experimenting, testing, limiting loss	Opportunity creation
E.g. value creation (products, services, solutions, bundles), value delivery (channels, marketing, sales, customer relationship), value capture (revenue model, pricing, cost)	Business model innovation
E.g. waste reduction, customer value, customer perspective	Lean
E.g. iteration, feedback, loops, customer interaction, cross-functional teams, incremental delivery of features	Agile
E.g. product/service innovation, new solutions, launching, experimenting, testing, prototyping, feedback	New product development
E.g. learning, knowledge, build-measure-learn, learning from failure, learning to fail, evolutionary path	Organizational learning
E.g. options, alternatives, limiting upfront investments, keeping opportunities open, valuation	Real options

were used as the lenses through which to interpret the empirical results of the interviews.

"In vivo" and constructed codes were collected for each interview (Glaser and Strauss, 1967), recording the exact wording used by informants to describe the processes for adopting and implementing LSAs, as well as the constructed wording introduced by the researcher. By contrasting and comparing the content of different interviews iteratively, we were able to identify any idiosyncratic positions as well as the aggregated clusters of concepts (Clark et al., 2010), and these helped us to deepen our understanding and gain further insight into the quantitative research results. The results of the coding process, which consists of identifying a selection of codes and concepts and the broader themes derived from them, are given in Table 3. Beyond the themes determined straightforwardly through the various sections of the questionnaire – i.e. LSA adoption, results, advantages and disadvantages, complementary entrepreneurial methods and tools (not shown in Table 3) – other themes connected with Entrepreneurship, Strategic Management and Innovation Management research emerged from the interviews. These themes are further elaborated in Section 5 – Discussion.

To conclude, the interviews' results were reviewed and confirmed by the interviewees, to correct any potential errors or bias and ultimately enhance the correctness of our interpretations.

4. Results

The results from our mixed-methods research are presented as a combination of quantitative findings derived from the survey on digital startups and the qualitative findings derived from the semi-structured interviews conducted on a subsample of the survey's respondents.

The results are aggregated around the four broad research questions addressed in this study.

4.1. Lean Startup Approaches - adoption

The results concerning RQ1 about LSA adoption are given in Table 4 below.

With regards to whether digital startups had adopted Lean Startup Approaches, a striking 93% of the sample of founders declared that they had explicitly adopted and implemented LSAs with the purpose of driving the launch and development of their startup.

Startups where these approaches have been adopted do so mostly to achieve a fast product-market fit: they are well-aware of the need to run experiments on their original version of the business model and to verify whether their business model is aligned to the market's needs; alternatively, it could even drive or cater to new latent needs. The founders also know that timing and speed are instrumental in achieving and sustaining competitive advantage in such a crowded and dynamic environment as that of digital industries.

As the founder and CEO of a mobile applications startup put it: "*All of our apps look great to us and to our developers – because we came up with them and sweated over them for months. So it's pretty obvious, isn't it? What is way less obvious is knowing if users are ultimately going to like them as much as we do and we need to test that out*".

Table 4
Quantitative results on RQ1 – LSA adoption.

Research item	Results
Adoption of LSAs by digital startups	93% Yes 7% No
Main reasons for adopting LSAs	1. Need to achieve product-market fit fast (33%) 2. Need to avoid waste of scarce resources (21%) 3. Need to organize startup's development process (17%) 4. Need to find alternatives to traditional Business Planning (8%) 5. Need to please investors (3%)
Main reasons for not adopting LSAs	1. Product-market fit already achieved (45%) 2. Perceived inability to apply to the startup's business idea (25%) 3. Perceived complexity of the process (20%)
Sources of information and training on LSAs	1. Incubators/accelerators (32%) 2. Workshops (22%) 3. Universities (19%) 4. Own reading (16%) 5. Investors (5%)
Main concepts, tools and models*	1. Business Model Canvas (91%) 2. MVP (64%) 3. Build-measure-learn loop and pivoting (38%) 4. Earlyvangelists and trial users (14%) 5. Falsifiable hypotheses (11%) 6. All LSA tools (11%) **tot. % > 100% as up to 5 alternative selectable*
Stages of LSA adoption*	1. Early stage (58%) 2. Late stage (32%) 3. Early and late stage (25%) 4. Seed stage (6%) 5. Seed, early and late stage (3%) **tot. % > 100% as up to 3 alternative selectable*

Another founder and marketing president of an Internet of Things startup said that "*[…] there's no such thing as a good idea if there's no market for it: we need to find out whether there is a market out there or not ASAP and lean startup is just what I need*".

The founders of digital startups also rely on LSA to address another traditional critical issued faced by any startup: resource scarcity. The founder in a machine learning startup claimed that "*LSAs give our team clear guidelines and a process to minimize the resources we need in the product-testing phase, which is what we need to burn less cash*".

LSAs are also seen as a way to put the complex and often

unstructured launch and development stages of a startup into a common and formal framework. As a cloud computing startup's founder claimed: "*our startup is a living organism in its early years… just like a baby. How can you sum up your early years with one word? I'd say: messy. Many things are going on, you want to be part of them all, and you still cannot figure out what to do or how to do it, and sometimes why you have to do it. Well, lean approaches tell you what should be done first and what's next, while allowing you to keep your flexibility. It's a kind of step-by-step flow that allows iterations but helps you to put order into a messy environment*".

A limited number of informants also declared that they had adopted LSAs to find more recent alternatives to traditional business planning. In the words of the CEO of a mobile payment startup, LSAs were implemented "*[…] in order to avoid mere desk research, as Blank said*". On this point, others also found that adopting LSAs was something investors pushed and evaluated positively. The marketing manager in a mobile applications startup said that "*when I and [co-founders] first met a business angel, she asked: 'Did you use lean startup approaches to see if your ideas make sense?'. We said we hadn't, and she told us to come back after we had got some test results – which is what we did, and she became our first investor*".

When it comes to the decision not to adopt LSAs, the main reason seems to be that the startup had apparently already achieved product-market fit, so no other processes were required to verify this point. Interestingly, when these startups were analyzed in detail through the qualitative interviews, what emerged was that almost all of them had been financed through Corporate Venture Capital (CVC) funds, with the mother company already providing a sort of "captive market" for the startup to tap into. Their answer was hence probably unconsciously biased, as there was this pre-existing corporate-startup relationship, although the literature claims that even CVC-backed startups could probably benefit from the adoption of LSAs. The second reason was that startups perceived LSAs either as inapplicable to the startup's business idea and domain or too complex compared to traditional business planning. The founder of a big data startup said that "*Lean Startup is cool but it's not for everyone: we sell business-to-business solutions, so who should our target evangelists be? Incumbent companies? How do you test on companies without jeopardizing your potential partnership with them?*". As another entrepreneur in artificial intelligence put it: "*Lean is only apparently simple, but if you go beneath the surface, there is a lot of complexity, mostly related to what an MVP is and who your trial users should be - and how do you even get in touch with them?*".

With regards to the LSA-related sources of information and training that the digital startups could draw on, most informants claimed that they practiced lean approaches when the startup was being incubated or accelerated. Different founders agreed with the CEO of a mobile application startup, who stated that: "*A good 90% of our training sessions with tutors, coaches and mentors were actually about lean principles applied to our startups*"; and "*here in [incubator's name], lean startup is everywhere… you're literally flooded with lean principles, there's no escaping from it! [Laughing]*". Dedicated workshops were another major source for training, although their results often did not meet the startuppers' expectations: the Chief of Operations in a social media startup claimed that "*lean startup workshops, tutorial and training sessions spring up like mushrooms, but most are just [obscenity] and a total waste of time, so you need to be very careful about who's running and holding them*". In this adverse selection setting, bad choices are set to play an increasing role in the adoption of LSAs, as more and more actors and institutions start holding courses and training sessions – sometimes apparently picking their stuff out of thin air rather than having any real expertise. To solve this matter, many startups are turning to universities and university-based schools of management and/or entrepreneurship outfits. "*Lean Startup courses in a college are rather expensive, but they're becoming more and more hands-on and practice-oriented rather than purely theoretical; so they're a good way to gain professional and certified knowledge*", as an Industry 4.0 founder and marketing manager said.

Several entrepreneurs also declared that they learned about LSAs on their own by reading the books written by Blank (2007), Blank and Dorf (2012) and Ries (2011). A very small number of founders also declared that it was their investors who made the suggestion to adopt LSAs – and this largely overlaps with the informants who claimed that they had adopted these tools to "please investors".

Several insightful considerations emerge on the use of specific LSA concepts, tools and models. The most widely used tool is the Business Model Canvas, whereby "*[…] we easily make our business idea come down to earth*" – as the CEO of one eCommerce startup said – in a "*unified, simple and straightforward way*" – according to the Chief Financial Officer in a security startup. In turn, the startups seemly adopt MVPs to outline the most important functions of their business idea and possibly enable the early interaction with customers. The whole build-measure-learn loop based on the MVP was also applied by startups striving to hear the "*customers' own voices and opinions based on something they touch and feel*" – as a founder of a startup in digital wearables said, and so prepare for pivoting. The least used concepts, according to the quantitative analysis, were earlyvangelists and falsifiable hypotheses, and this finding relates to the disadvantages and criticalities that startups encounter when applying lean processes (see Section 4.3). Surprisingly, a few startups declared that they adopted all the models at the same time, as if they somewhat personalized the LSAs during their implementation processes in line with the startups' specific needs: "*I found the [business model] canvas and MVPs quite useful, while frankly I never used those falsifiable hypotheses and evangelists… they sounded a bit tricky*". Such cherry-picking and piecemeal approach may have significant implications when assessing the LSA results and performance.

The last point concerning the adoption of LSAs referred to the stage of startup development when the practices were leveraged. Here, many startups claimed they employed LSAs mainly in their early stage development, when getting their business model ready for the informal investors' approval; however, the founders also observed that adopting LSAs could prove useful in later stage development, as "*VCs look for indications about market traction, and lean startup approaches can show them your traction*" – as a founder in a mobile services startup put it. It was apparently unusual to adopt LSAs at the seed stage, where the business idea is at its embryonic stage of development, because, at that time, "*the idea is too fuzzy even in your own head, you could probably sketch a canvas around it, but rather than embarking on a full lean startup or customer development process, you ask around for informal feedback, quizzing your network of peers, while you are asking them for pre-seed and seed money*", as noted by an entrepreneur in a IoT-related startup. A number of startups also declared that they continuously used LSAs in cycles and iterations, since, as a CEO in a mobile payment startup said, "*you really never stop pivoting and iterating a digital service*".

4.2. Lean Startup Approaches - results

The findings concerning RQ2 on LSA results and outcomes are given in Table 5 below.

With regards to the duration of LSAs implementation, the founders declared that it took them an average of 8.2 months to go from the first set of falsifiable hypotheses embedded in a business model and a MVP, to achieving a reasonable product-market fit that gave them the go-ahead to proceed with scaling – with a lower bound of 4.1 months and an upper bound of 13.5 months. During the interviews, it became clear that changes to the LSAs' "lead time" depended mainly on the following reasons: (i) ability or inability to find team consensus about the right way to set hypotheses and design an initial business model; (ii) ability or inability to craft the right MVP and to properly prioritize the MVP tests; and (iii) ability or inability to spot the right cluster of earlyvangelists or trial users, engage them and get informed feedback from them. The LSA length was clearly correlated to its cost – in terms of capital expenditure for equipment and, above all, operational expenditure in human resources, materials and advertising – such as

Table 5
Quantitative results on RQ2 – LSA results and outcomes.

Research item	Results
LSA implementation process length	Average: 8.2 months Upper bound: 13.5 months Lower bound: 4.1 months
LSA implementation process cost (total cost)	Average: $ 34,000 Upper bound: $ 180,000 Lower bound: $ 19,000
LSA implementation process cost (% of capital raised)	Average: 24% Upper bound: 43% Lower bound: 18%
LSA adoption overall satisfaction	2.8 on a 4-point Likert scale (1. Dissatisfied – 4. Fully satisfied)

AdWord campaigns – both in absolute terms and as a percentage of the capital raised.

The best performers in the sample, those keeping the LSA implementation length and cost to a minimum, felt that "*the key here was to make all founders agree on one single statement that summarized our view on the startup and its best future*" – as stated by the CEO of a machine learning startup – while "*cutting all features that were making our MVP too 'bulky' and too similar to a real prototype, rather than a pretotype as it should be*" – in the words of an Industry 4.0 CFO. This was coupled with "*a few weeks spent in finding where our target audience actually hung out, to target the right early users. It may have looked like time wasted, but as it turned out it clearly wasn't. It made us save a lot of time repeating tests in different contexts and with different user groups*". The low performers argued that their time and costs went out of control because of several factors, the most relevant being: "*the inability to make plans about when to start and, most of all, end testing*" – as stated by the COO of an eCommerce platform startup; "*our probably inaccurate definition of the right metrics to use and the right prospective clients to include in the experiments caught us up in a never-ending iteration process*" – in the words of the CEO of an Internet of Things startup; and "*our unwillingness to pivot was based on the sunk costs we had already incurred in device development*" – as the CEO of a digital wearables startup admitted.

The last survey question on LSA results covered overall satisfaction. Surprisingly, although most digital startups by far said they used the approaches and that they saw something in return their implementation efforts, the overall satisfaction hit a relatively poor 2.8 in a four-point Likert scale, leading to slightly less than moderate satisfaction. The qualitative interviews revealed that behind this mild satisfaction was the fact that they recognized the complexities and possible drawbacks of the approach (as discussed in Section 4.3), something that even the best performers experienced. "*All in all, I enjoyed applying LSAs and I think they were beneficial for our startup in its early stages of development. Having said this, these apparently pragmatic tools sometimes work great in theory but not so well in practice, and did they make us sweat!*", the founder and general manager of a big data startup said. This was reinforced in an interview with another founder of an Internet of Things startup, who stated that "*lean startup tools, are, let's say, a great start… but they need a lot of work to define, design and refine them before they're ready to tell you something you need to know about your company and its market*".

4.3. Lean Startup Approaches - advantages and disadvantages

Table 6 summarizes the main findings gained from RQ3 on the principle advantages and disadvantages of LSAs.

With regards to the advantages of implementing LSAs, most digital startup informants claimed that these had helped "*significantly in cutting the time and costs we had expected for developing the startup, especially during testing*" – as stated by the CEO of a mobile applications startup. She continued by saying that "*I have experience with previous startups where we didn't use startup and customer development, and I can say that our savings here in time and costs are remarkable. Of course, this happens if you learn to use the right tools properly*". Discovering and validating the alignment between the startup's business model and the needs of its target market was also a key outcome stemming from the adoption and implementation of LSAs: "*before we used LSAs, we really had no clue as to whether customers would actually like and be willing to buy our products. This changed radically after they sent us their feedback and we learnt from it*", as said by the founder of an Industry 4.0 startup.

Another advantage felt by founders implementing LSAs was that of verifying and/or knowing when to pivot, all the business model canvas parameters, which is something that goes well beyond the bundle of products and services embedded in the value proposition. As the CEO of a cloud computing startup explained, "*we thought that LSAs were meant to help us verify our value proposition, but we found that it's a good set of tools to test other parts of our business model, like its channels and its revenue model*". The COO of a mobile applications startup added that, "*by applying Lean Startup and Customer Development, not only did we pivot six of the nine parameters in our canvas, we also changed two of them so radically that our launched startup looked very little like our original idea*".

Interestingly, the founders also noted that adopting LSAs made it easier for them to receive rounds of funding from formal and informal investors alike. The CEO in an eCommerce startup explained that "*the evidence, metrics and figures first shown to business angels, and later to venture capitalists, were so real and backed by testing, that they certainly helped us to demonstrate our business potential and its growth traction*". Another entrepreneur in a mobile applications startup said that "*the tools and metrics championed in lean approaches, like cohort analysis, are something investors really like. If you use them, you are showing them you really know your stuff. That's when they start trusting you and probably think: 'I could give this guy my money'*".

A last, yet insightful, hidden advantage of adopting and implementing LSAs concerns their ability to force entrepreneurs to rethink traditional Intellectual Property (IP) protection logics. In the words of the CEO of a machine learning startup, "*when I read the books, the first thing I thought was 'ok, nice, but once I launch my MVP and run experiments, aren't I putting my ideas out there for competitors to steal?' Yet, as I deep- dived into the lean startup philosophy, I understood that being lean doesn't mean being dumb, and rather than IP protection, it's all about speed*". Another COO in a mobile applications startup added the following: "*If you go for build-measure-learn loops and experiments, it's key to being fast. You can't just run the experiments and sit there and wait: once you get the green light, you must be ready to pivot, develop and launch at full throttle. By then competitors know you're there, but you will still have the advantage by being first in learning what counts for your customers, and can act fast accordingly*". Coupled with IP protection, the informants also addressed the matter of reputational risk associated to poor MVPs. Our interview with the founder of a mobile application startup shed light on a view common among digital startups: "*Of course launching a sloppy MVP on your market could harm your brand: that's why you should definitely use 'fake brands' when doing your experiments. Prospective customers may get upset by the fake brands' products, but, at the end of the day, they will turn to your brand's final product once it's been thoroughly LSA-tested and is ready*".

As anticipated in the previous sections, many insights were derived from the discussion of the main disadvantages of LSAs. By combining quantitative and qualitative data and information, a clear and true picture emerges of the weaknesses in LSAs, and this could lead to improving these processes.

First, many founders encountered severe problems when defining and designing their MVPs, and also when designing MVP-based tests. The founder of a mobile applications startup said the following: "*In line with the lean rationale, we interviewed customers as early as possible, using an online survey to ask them about the features of the would-be product they liked the most. We also asked how much they were willing to pay for each feature. The results were rather disappointing: as they said they liked all the functions, we learnt nothing about customer preferences… and to compound*

Table 6
Quantitative results on RQ3 – LSA advantages and disadvantages.

Research item	Results
Main advantages of LSAs	1. Reducing time and cost for startup testing (74%) 2. Aligning business idea to customer needs (68%) 3. Verifying and pivoting all business model parameters (52%) 4. Receiving rounds of financing (39%) 5. Offering alternatives to traditional intellectual property protection (28%) **tot. % > 100% as startups could select up to all 5 options*
Main disadvantages of LSAs	1. Defining and designing MVPs (82%) 2 Identifying and engaging earlyvangelists and trial users (69%) 3. Defining testing priorities and designing tests (52%) 4. Missing other market opportunities and threats (39%) 5. Obtaining information about the startup's sources of advantage (36%) **tot. % > 100% as startups could select up to all 5 options*

it, they were so unwilling to pay, there was no justification for our investment in any of these functions… practically speaking, that test was useless". This statement is revealing, as it shows how entrepreneurs still confuse MVP and MVP-based testing with marketing research: according to its original proponents, MVP-based testing is not about market research, but is should enable the experimenting on customers' natural behaviour; tests should not refer to willingness to pay, but rather simulate an environment where customers believe they are actually making a purchase (Blank, 2007; Blank and Dorf, 2012; Ries, 2011; Ries and Euchner, 2013).

Another entrepreneur in a social media startup complained that "*In the first version of our MVP, we created a video showing how our application should work. That's something we learned from other popular lean startup cases, like Dropbox. However, beyond counting the number of times the video was watched, we learned little from the process*". This statement shows that, when applying MVPs, it is crucial to create an MVP that is actionable, in the sense that it should trigger the customer's natural behaviour and actions that carry useful information and evidence for startups – like registering to a beta waiting list, as in the case of Dropbox.

A third point, stated by a founder in an IoT startup, showed how apparently difficult it can be to place MVPs within a business-to-business environment: "*We serve companies with complex systems, so it's kind of hard for us to isolate key functions and test them on their own; what happened when we applied the lean approach was that we ended up by creating a full prototype – and its budget was far from being cheap or lean…*".

A concluding remark on MVPs from a COO in another Internet of Things startup is also worth mentioning: "*Lean tells you to build a MVP, but gives you no clear guidelines or indications whatsoever on how to do so!*".

Spotting earlyvangelists and trial users is another excruciating difficult exercise for many startups. As a founder in a mobile applications startup noted: "*We kept on asking ourselves 'who, which customers, should we test our business model on?', but we never came to a definite conclusion. We eventually launched our MVP after testing indiscriminately across our target market, with mixed results*". Another marketing manager in a machine learning startup highlighted a further issue relating to identifying and engaging with trial users: "*we identified our target segment and actively engaged with several influential users, receiving interesting feedback from them. We then found another potential target segment, engaged with those users too, and received totally different feedback compared to the first lot. What were we meant to do with all this assorted feedback? And how were we to know when to stop*?"

Many of these drawbacks, which on the surface were connected to LSAs, stemmed from the fact that startups seldom see the need for setting assumptions and hypotheses about themselves, their market and their customers (this was highlighted in Section 4.1, where we saw that, among the lean concepts, falsifiable hypotheses were the least used). Hypotheses were often taken for granted, or defined too broadly. Some founders did not address the most penetrating questions about their customers and what they want, their pains and gains (Osterwalder and Pigneur, 2010), which ultimately made it difficult for them to find out who their earlyvangelist actually were. This emerged from the words of a CEO of a mobile payment startup, who admitted honestly that: "*The problem was never the process. It was us. We never really accepted that we had to fully adopt it in all its steps, with an open mind and true commitment: that's why it did not pay off as we had expected*".

In line with this sometimes limited commitment to adopting and implementing LSAs as a whole, the findings of both the survey and the interviews revealed a common misconception about lean approaches, their reach and their role in supporting startup development. The informants pointed out that the LSAs gave very little support in spotting industry-related opportunities and threats hidden in external trends or in the market's structural determinants; or they received poor indications about the startup's sources of competitive advantage, and about whether such sources could actually help to beat the competition. Both of these arguments show that entrepreneurs may tend to have unrealistic expectations about lean approaches and overestimate their own ability to support startup development. In actual fact, analyzing the features of the external industry – alongside those of potential customers – as well as the startup's internal sources of differentiation goes well beyond the scope of LSAs. This interesting finding also indicates that digital entrepreneurs must complement LSAs with supplementary strategy analysis models and an overall business strategy.

4.4. Lean Startup Approaches and other entrepreneurship methods and tools

The findings that relate to RQ4 - how digital startups connect and combine the LSAs with other entrepreneurial tools for launching startups, as well as their overall business strategy – are given in Table 7.

A first, significant finding emerged concerning the approach most widely used in conjunction with LSAs, with a striking 91% of the founders saying that they use Business Planning. This result may seem surprising, as Customer Development was proposed as an alternative to business plans, as the latter kept the startup's development too far removed from reality for too long (Blank, 2007). Nearly all the startups

Table 7
Quantitative results on RQ4 – LSA and other entrepreneurship and strategy tools.

Research item	Results
Other models/tools/approaches used to complement LSAs	1. Business Plan (91%) 2. Agile Development (82%) 3. SCRUM and Sprints (53%) 4. Feature-Driven Development (FDD) (44%) 5. SWOT Analysis (41%) **tot. % > 100% as startups could select up to all 5 options*

declared, however, that they had solved this false dichotomy by fruitfully integrating LSA-derived data into the first versions of their business plan, thus combining a "get out of the building" stance with a well-structured document describing their strategic, marketing, operational, economic-financial, organizational and human resource-related plans (Delmar and Shane, 2003). "*Lean startup testing data and metrics proved a useful input to our business plan, where data came from our experiments with customers rather than from secondary sources*", claimed the marketing manager in a mobile applications startup. This arrangement also helped founders to raise capital, since "*[…] angels first, and VCs later, seemed to really appreciate the combination of real-world data from the LSAs and the traditional business plan structure*".

The informants also emphasized the fact that they could combine LSAs with Agile methods (Beck et al., 2001; Nerur et al., 2005; Holmström et al., 2006; De Cesare et al., 2010; Cram and Newell, 2016), to fill some of the gaps in Lean Startup and Customer Development. More specifically, the founders were keen to introduce methods such as SCRUM and sprints (Schwaber and Sutherland, 2011), as well as Feature-Driven Development (Abrahamsson, 2003). The COO in an Internet of Things startup said that "*sprints gave us timelines for iteration cycles in the build-measure-learn loops*", while another founder in a security startup observed that "*Feature-Driven Development helped us to define the features to be embedded in the MVPs*".

Moreover, digital entrepreneurs appeared not to underestimate the role of the traditional Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis (Lorange, 1980) in feeding the LSAs: "*Before you even start any lean development process, you should be well-aware of what is going on in your target market, its trends, opportunities and threats, as well as of what you can offer in that market, what really makes you different from your competitors and will make you win in the long run*", as the CEO of an Industry 4.0 startup explained.

5. Discussion

This study examines how digital startups' adopt and implement Lean Startup Approaches, pointing to a number of opportunities and issues that could be addressed to enhance the value of LSAs for digital entrepreneurship theory and practice.

5.1. Framing LSAs within entrepreneurship theory

With its insights, this research indicated a number of contact points between LSAs and other theories that are worth discussing and clarifying.

With regards to the theoretical foundations of the Lean Startup Approaches, the empirical findings of this study back the claims made in the few recent works that looked into the antecedents of LSAs (Contigiani and Levinthal, 2018; Frederiksen and Brem, 2017; Ghezzi and Cavallo, 2018; Yang et al., 2018). As shown in Table 3, our qualitative research brought up nine themes that form the theoretical roots of LSA, namely: (i) Lean; (ii) Agile; (iii) New Product Development (NPD); (iv) Real Options; (v) Organizational Learning; (vi) Business Model Innovation (BMI); (vii) Effectuation; (viii) Bricolage; and (ix) Opportunity Creation.

From a comprehensive overview, LSAs can hence be framed in a theoretical model where these approaches stand at the crossroads of the above research streams and disciplines (Fig. 3). These streams are far from being stand-alone silos and some of their key elements often partly overlap, as our empirical research shows.

While the LSAs' relationship with themes (i) to (vi) had already been discussed in the recent works mentioned previously, the findings of this study mostly contribute to the debate on the role of LSAs with reference to Effectuation, Bricolage and the whole theory of Entrepreneurial Opportunity.

When discussing Lean Startup Approaches, the interviews with our digital startup founders largely revolved around their standpoint and reasoning, and their actions to interpret their own role of entrepreneurs in a resource-constrained and uncertain environment.

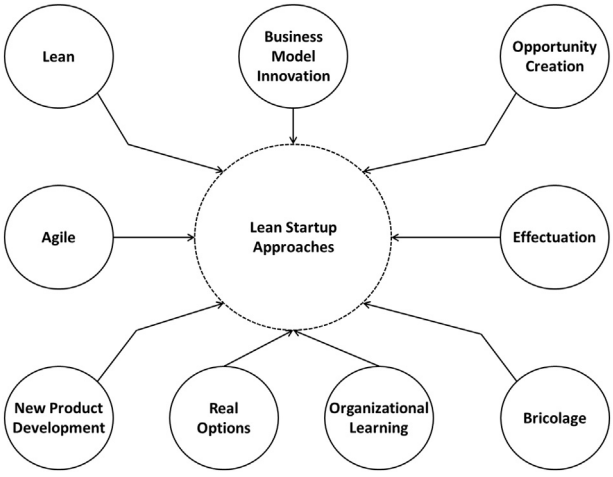

Fig. 3. Antecedents and theoretical roots of the Lean Startup Approaches.

With regards to the logic behind entrepreneurial behaviour, the entrepreneurs showed how adopting and implementing LSAs drove them to take an "effectual" (Sarasvathy, 2001) or "bricolage" (Baker and Nelson, 2005) stance on many occasions, underscoring how these logics are, in essence, connected to LSAs' main steps and constituting elements.

Formulating hypotheses about the world's evolution and the startup's role in influencing it is similar to the Effectuation principle stating that the future is shaped by entrepreneurs, rather than being a mere consequence of the past.

Moreover, building a minimum viable product to experiment and test hypotheses on the market and argue for or against the viability of the startup's business model reflects an effectual and bricolage-oriented logic, in the ways in which resources are perceived and used, goals are set and learning is achieved.

Despite operating in a resource-constrained environment, entrepreneurs can take full advantage of their extremely scarce resources by combining them originally into low-cost - yet highly informative - pretotypes of their value propositions – the MVPs – and then deploy them to test their BM assumptions.

In addition, experimenting and testing efficiently though iterations and short startup-customer loops that provide valuable feedback is also consistent with Effectuation and Bricolage, in terms of having the flexibility to handle and even exploit unexpected contingent events and information brought up by the experiments. At this stage, the startup's paramount objectives boil down to minimizing upfront investments during the initial learning phases, in line with the concept of affordable loss, while making do with limited bootstrapped resources (Baker and Nelson, 2005; Fisher, 2012; Sarasvathy, 2001).

This study hence empirically supports the conceptual claim that LSAs provide operational support to Effectuation and Bricolage in a systematic and scientific way, overcoming in this manner the heuristic approach to problem solving – based on intuition, unclear paths and somewhat casual attempts – that traditionally went hand-in-hand with these logics and, to some extent, limited their effective implementation.

On a bigger picture, another insightful contribution emanating from this empirical research concerns the theory of entrepreneurial opportunities implicitly embodied by LSAs.

Assuming that there are two alternative theoretical settings where opportunities can be discovered or created, entrepreneurs using LSAs take up a creational stance towards entrepreneurial opportunities, since the strategic tasks for entrepreneurs in a creational setting are to ask customers the right questions, design new experiments, remain flexible and learn (Alvarez and Barney, 2007).

LSAs seem to implicitly address one of the research questions for creational theory anticipated by Alvarez and Barney (2007 – p. 22): "How can entrepreneurs use incremental, iterative and inductive processes to make decisions?". This study provides empirical evidence to answer this creation theory question, claiming that LSAs are the operational, systematic and essentially scientific processes that enable opportunity creation through enactment.

Positioning the investigation of LSAs within the debate on opportunity discovery vs creation helps to bring about empirical contributions for advancing entrepreneurial opportunity theory.

Alvarez and Barney (2007) present these two internally consistent theoretical perspectives on opportunities as dichotomous: while discovery theory assumes that the environment is risky and entrepreneurs recognize and exploit opportunities by means of risk-based decision-making tools, such as the business plan (Delmar and Shane, 2003), creation theory considers the environment to be uncertain and states that entrepreneurs form opportunities through enactment based on alternative iterative and incremental processes – like LSAs, as this study contends. However, what we found empirically is that, although LSAs lead entrepreneurs to adopt a creational and effectual approach, other actors in the entrepreneurial ecosystem still expect them to follow a largely discovery and causation approach, at least in terms of the output they produce and present (once again, the business plan), since the latter approach is more closely aligned to and compliant with their traditional "due diligence" process based on risk assessment and management (Drover et al., 2017).

The digital entrepreneurs interviewed solved this contrast pragmatically by, in essence, *sequencing* the creational and discovery processes and tools. They first iterate and experiment through LSAs to create opportunities and generate data, information and knowledge; they then feed such knowledge into a well-structured business plan, to discover opportunities for the scaling, market penetration and company building of their startups. The turning point for moving from a creational to a discovery setting is achieving a "product-market fit", in other words, the alignment between the startup's validated business model and what customers demand (Blank, 2007; Blank and Dorf, 2012; Ries, 2011).

The findings of this study suggest that, while LSAs fall into the domain of creation theory, their output – i.e. data, information and knowledge created with reference to an uncertain environment – could provide the basis for a discovery approach by being fruitfully used as input to a business plan – i.e. a collection of risk-based decision-making tools.

As a result, these findings also offer an answer to the question of how uncertainty can be best converted into risk and managed by entrepreneurs (Frederiksen and Brem, 2017). LSAs' iterations, interactions and experiments can help in the transition from uncertainty, where knowledge about opportunities is created, to risk, where knowledge is further elaborated to discover opportunities through planning. This is also in line with the assertion by Brinckmann et al. (2010) that entrepreneurial planning must be appropriate to the circumstances.

This contribution concerned with how entrepreneurial approaches, models and tools are connected, empirically bridges the two theories on entrepreneurial opportunities (creation and discovery), by positioning them within an "*opportunity space*" that helps to explain the empirical findings emerging in the study (Fig. 4).

The first wave of opportunities is created by entrepreneurs through an enactment process based on experimenting and iterating on the startup's business model and its elements. The underlying cognitive logic driving opportunity creation in an uncertain environment is the same as that found in Effectuation and Bricolage; and the operational decision-making tools to create opportunities systematically and scientifically is embodied in the Lean Startup Approaches.

Iterations proceed in incremental loops until the product-market fit is achieved, and the business model is proven to be viable, replicable and scalable (Blank, 2013; Ries, 2011). At this time, the decision-making context is converted from uncertain to risky, setting the scene

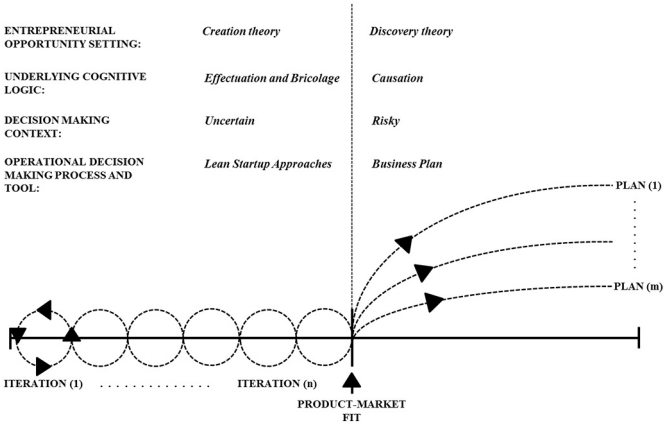

Fig. 4. The entrepreneurial opportunity space.

for entrepreneurial cognition based on causation. Entrepreneurs can then discover a second wave of opportunities through planning, where the set of decision-making tools encompassed by the business plan are such that the expected returns and the probability distributions of such returns can be estimated. These, in turn, lead to different alternative scenarios and related plans.

As the opportunity space helps to bridge the alternative approaches to entrepreneurial opportunities, cognitive logics and operational decision-making tools, it is useful to note that the gap between the opportunities created and those discovered is not clear-cut – as indicated by the vertical dotted line in Fig. 4. Iteration and planning can sometimes alternate or coexist in specific stages of startup development, as the context changes from uncertain to risky and calls for different entrepreneurial logics and tools. As Alvarez and Barney (2007 – p. 19) suggested, entrepreneurs are required to make decisions using context-appropriate tools, which will help them to form and exploit opportunities more effectively.

Recognizing that entrepreneurial opportunities are, in essence, a doubleheader also helps to explain why both discovery and creational theories are internally consistent (Alvarez and Barney, 2007). They are so because they can adequately depict a different evolutionary stage for the new venture within the opportunity space; and all the actions that determined the evolution of the startup could be attributed *ex post* to one or the other theory depending on the stage that the entrepreneur or the external observer wishes to emphasize or can recollect.

5.2. Enhancing the practical adoption and implementation of LSAs

The combined results of this mixed-methods study into digital startups helped us to make sense of the practice of adopting and implementing LSAs, and so provide practical guidelines that are backed by theory and can help digital entrepreneurs to set this LSA process into operation. The unexpected result indicating that digital entrepreneurs are only modestly satisfied by the outcome of the LSA implementation shows that these approaches are still burdened by many limitations and need to be amended.

A first guideline to direct the adoption and implementation process examines the kind of digital startups that are encouraged to adopt these approaches. Startups backed by informal investors or independent venture capitals benefit from LSA adoption, but not just them, as even CVC-backed startups find Lean Startup and Customer Development useful for verifying and validating their business ideas – despite maybe already having a captive market for their products and services. With regards to the stage in the startup's development lifecycle when LSAs are used, although most startups implement LSAs in their early stage, the introduction of a continuous adoption cycle that takes into fair account the different goals and metrics at the various stages of startup development is beneficial in supporting iterations and validations, as

the internal and external contexts vary and can turn out to be uncertain, this being in line with Agile principles (Beck et al., 2001). Not starting too late also helps startups to avoid those sunk costs that make it much harder to pivot, as emerged from the qualitative interviews.

Making bad choices in an adverse selection setting also appeared to play a role in hindering the adoption and implementation of LSAs (Jullien, 2000), caused at least in part by the digital startups' difficulty in finding the right suppliers providing courses and training, indicating that there is a strong case for properly assessing the quality of their suppliers before the training starts. This result shows that universities, colleges and research institutions will play a growing role in the digital startups' ecosystem, as the certified means for obtaining LSA-related knowledge. To some extent, this finding also goes against some recent claims that entrepreneurship cannot be taught and a college degree does not really help people to become a startupper (e.g. see Forbes, 2012). As Frederiksen and Brem (2017) sharply pointed out, Eric Ries (author of The Lean Startup) has a degree himself, and his background more than likely informed his work in generating the Lean Startup.

Another key suggestion for digital founders embarking on the process of LSA implementation is to place the right focus on phrasing falsifiable hypotheses. These assumptions provide the basis for testing, since entrepreneurs should build their business model around them and their MVPs should stem from them. Assumptions were, however, too often taken for granted or defined too broadly. Digital entrepreneurs have to realize that defining hypotheses is not a mere exercise, but acts as the operational trigger for the whole scientific method behind LSAs.

With regards to the work behind crafting the MVP, designing MVP-based experiments and running the build-measure-learn loop, several takeaways emerge from this study. Startups should spend enough time in actually understanding who their target customers are, together with their pains, gains and needs (Osterwalder and Pigneur, 2010), and so properly identify the earlyvangelist and trial users able to provide informed feedback and stimulate useful learning.

Once the earlyvangelists are identified, the MVPs should be built and placed in their hands. This research highlights a significant distinction that makes LSAs different from traditional approaches to startup development. MVPs are not related to marketing research, as instead they should enable experiments on the customers' natural behaviour. MVPs are artefacts that should have the following key characteristics: (i) resemble and embody the business idea; (ii) be actionable, as they should activate customer response and actions to learn from; (iii) be measurable through the MVP testing outcomes; and (iv) be less wasteful than prototypes. When possible, entrepreneurs are also encouraged to make the MVP a paid-for product rather than just a free version, to further qualify the input from early adopters who become paying customers (Ries, 2011). This was seldom the case in the sample analyzed, thus impairing the measuring and learning stages of the loop.

To design MVPs, our findings suggest that entrepreneurs can leverage Agile methods such as Feature Development Design (Abrahamsson, 2003) to provide guidelines on how to identify and design the minimum features and run iterations. In addition, when it comes to running iterations, digital products and services could be run through Scrum sprint cycles (Schwaber and Sutherland, 2011) to control for time and budget.

When the digital startup operates in a B2B context, our results suggest that these startups should find their right evangelists among existing business customers by carefully assessing their customer companies' purchasing processes – as decisions about buying into the startup's digital solution can come from different stakeholders. Additionally, MVPs in a B2B environment cannot be overly “minimum”, in the sense that they should incorporate a sufficient number of features at a satisfactory level to compete with existing offers.

MVP-based testing should even lead digital founders to radically rethink their views on IP protection and their approach to launching the startup. Rather than fighting to control, hide and defend their business idea, LSAs place significant emphasis on collaboration and openness, where the key to competitive advantage is not the original know-how, but the startup's learning speed. This point is inherited from an effectual-type logic, which favours partnership and cooperation rather than competition (Sarasvathy, 2001; Yang et al., 2018).

Insights were also derived from the span and width of the process of validating and, when appropriate, pivoting the business model. This research underscores how LSAs support innovation to the whole value architecture of the digital startup's business model, including value delivery and capture as well as value creation. Changes to such value parameters can be incremental or radical, resulting in slight modifications or even dramatic changes to the original business idea. Although Ries and Blank themselves argue that the business model of a startup is up for experimenting on (Ghezzi and Cavallo, 2018; Gustafsson and Qvillberg, 2012; Hartman, 2013; Heiramo, 2013), a common misunderstanding among entrepreneurs is to place the focus of LSAs on testing product features. Our findings strengthen the belief that digital entrepreneurs should, instead, take entire business models as their units of analysis for experiment purposes and as the entity to which any pivoting should apply. Moreover, and remarkably, informants often declared that testing on the startup's go-to-market strategy and its execution was even more important than validating the product itself.

For digital entrepreneurs wishing to embark on LSAs, a major takeaway of this study is that a piecemeal approach, where founders cherry-pick concepts and models they like and ignore other parts, is fundamentally flawed. Several founders used LSAs in a personalized, unsystematic and disconnected fashion, maybe due to poor training or to the heuristic intuitive approach they were accustomed to. They should, instead, have been fully committed to adopting the whole process: for entrepreneurs, LSAs are the means to go beyond mere heuristics and embrace a scientific method towards entrepreneurial opportunity and action.

The opposite of a piecemeal approach is what is needed, and rather than adopting bits and pieces, entrepreneurs should combine all of the LSAs' process with other tools, one of which is certainly the business plan. In line with existing studies that claim that the business plan plays an important role in linking entrepreneurship and strategic management (Delmar and Shane, 2003; Kraus and Kauranen, 2009), and building on our discussion on the entrepreneurial opportunity space, our argument is that Blank's (2007) famous motto “*instead* of writing an intricate business plan, design a business model [and apply customer development]” should be altered to “*before* writing a business plan […]”. LSA experiments and tests, together with their real-world results and metrics, should be used as input to the planning operations in a well-structured business plan that can be easily assessed by both formal and informal investors.

As a concluding remark, this research shows that digital entrepreneurs sometimes blame LSAs for pitfalls that fall outside the domain and scope of these approaches, and instead relate largely to the process of formulating an overall business strategy, which startups tend to overlook. Reflecting on the startup's vision and mission, and strategically analyzing its internal and external environment, can better inform the way entrepreneurs formulate their falsifiable hypotheses and design their preliminary business model.

Table 8 contains practical guidelines that entrepreneurs will find useful to follow when adopting and implementing LSAs.

6. Conclusions

This study presented a first large scale research into if and how digital startups adopt and implement Lean Startups Approaches. The findings emerge from a mixed-method combining quantitative and qualitative analyses, and the contributions are relevant for both the theory and practice of entrepreneurship.

In terms of value for theory, the empirical evidence shows that the entrepreneurs' behaviour when applying LSAs mirrors that described in the theories of Effectuation and Entrepreneurial Bricolage. Looking at

Table 8
Practical guidelines for LSA adoption and implementation.

Issue	Practical guidelines
Type of digital startup	• All startups, including those that are CVC-backed, benefit from adopting and implementing LSAs.
Stage of startup development	• Startups are to adopt LSAs in their early stages of development, while continuously implementing them following Agile principles whenever the context turns out to be uncertain.
Bad choices concerning the provision of LSA-related knowledge	• Startups are to carefully assess and select suppliers for LSAs courses and training sessions. • Startups are to rely on certified and experienced actors – e.g. universities, colleges and research institutions, top-ranked incubators and accelerators.
Formulation of falsifiable hypotheses	• Entrepreneurs must think carefully on how they can accurately formulate falsifiable hypotheses about their startup's business model (a step they often neglect). • Falsifiable hypotheses constitute the operational trigger for the scientific methods embedded in LSAs.
Identification of earlyvangelists	• Entrepreneurs are to properly evaluate who their earlyvangelists and trial users are and where they "hang out", in order to target the right prospects and receive informed feedback. • In B2B settings, evangelists are found among existing business customers by carefully assessing the customers' purchasing processes and identifying the key decision-makers.
MVP design	• MVPs are artefacts with these key characteristics: they (i) resemble and embody the business idea; (ii) are actionable; (iii) are measurable through the MVP testing outcomes; and (iv) are less wasteful than prototypes. • MVPs as paid-for products increase the amount of information they carry when tested upon. • MVP design can leverage Feature Development Design (FDD) to provide guidelines on how to identify and design minimum features and run iterations. • In B2B settings, an MVP cannot be too "minimum", as it should incorporate a sufficient number of features at a satisfactory level to compete with existing offers.
Experimenting and testing	• Experiments are to be MVP-based, which in turn means they are BM-based. • Digital products and services can be run through Scrum sprint cycles, to control for time and budget. • Entrepreneurs are to radically rethink their views on IP protection, embracing openness and collaboration through fast experimenting and learning.
Business Model validation and pivoting	• Startups are to experiment and test on all elements of their business models, not just their value proposition (product, service, solution, bundle). • Executing a go-to-market strategy often requires more testing than the value proposition itself.
LSA broad adoption and implementation process	• Entrepreneurs are to adopt LSAs comprehensively, rather than cherry-picking the steps and elements they perceive as most useful. • Entrepreneurs are to go beyond heuristics and apply a scientific method by means of the LSAs. • Entrepreneurs are to integrate LSAs with business planning, thus altering Blank's motto to: "*before* writing a business plan, design a business model and apply LSAs". • Entrepreneurs are not to overlook the process of strategy formulation and strategy analysis which can inform the formulation of falsifiable hypotheses and design of a preliminary business model.

the bigger picture, the findings support the claim that LSAs are a set of operational, systematic and scientific decision-making tools for supporting entrepreneurial opportunity creation: entrepreneurs use LSAs to make sense of the opportunities they create, rather than to discover and plan around them.

Empirical evidence, however, shows that entrepreneurs solve the creation vs discovery dichotomy pragmatically by sequencing their use of LSAs and business planning. This suggests that there is an "opportunity space" that can bridge the various alternative theoretical views on entrepreneurial actions, cognitive logics, decision-making contexts and decision-making processes and tools.

In terms of value for practice, this study can provide a set of guidelines and real-world insights into the adoption and implementation of LSAs, and this can extend the anecdotal evidence currently available about common practice among digital entrepreneurs, while suggesting a move towards combining these approaches with other agile, entrepreneurial and strategic models.

This study's limitations mostly refer to the following: sampling bias – i.e. focus on a specific country and on funded digital startups – which could have influenced the statistical and theoretical samples selected; and observer bias (Yin, 1984), which could have distorted the interviewees' perception of the interviewer's questions, and/or the interviewer's interpretation of the interviewees' answers. While the sound research design may have helped to amend these limitations, future studies could explore different samples of startups - e.g. non-digital startups, or non-funded ones – and other countries, while investigating how to combine Lean Startup Approaches systematically with the other theoretical and practical streams indicated in this study.

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Appendix 1. Survey sections and questions

Survey section	Questions	Values
1. LSAs adoption	1.1 Did your digital startup adopt Lean Startup Approaches (LSAs)? – i.e. Customer Development, Lean Startup	Boolean (Yes, No)
	1.1.1 Which of the LSAs did you adopted the most?– i.e. Customer Development; Lean Startup; both	List of items
	1.2 What are the main reasons and motivations behind your choice to adopt/not to adopt LSAs?	List of items
	1.3 How did you get to know about LSAs?	List of items
	1.4 What are the steps you followed to implement LSAs?	List of items
	1.4.1 What LSA concepts, tools and models did you use?	List of items
	1.5 At what stage of the digital startup's development did you use LSAs?	List of items
2. LSAs results	2.1 How long did the LSA implementation process last?	Open-ended
	2.2 How much did the LSA implementation process cost?	Open-ended
	2.3 Overall, are you satisfied or dissatisfied with the results obtained from adopting LSAs?	Likert scale
	2.3.1 Are you satisfied or dissatisfied with the results obtained from the adoption of specific LSA concepts, tools and models?	Likert scale
3. LSAs advantages and disadvantages	3.1 What are the most significant advantages you experienced relating to the adoption of LSAs?	List of items
	3.1.1 What are the most significant advantages you experienced relating to the adoption of specific LSA concepts, tools and models?	List of items
	3.2 What are the most significant disadvantages you experienced relating to the adoption of LSAs?	List of items
	3.2.1 What are the most significant disadvantages you experienced relating the adoption of specific LSA concepts, tools and models?	List of items
4. LSAs combined with other entrepreneurial theories, approaches and tools	4.1 Did you use any other models, tools or approaches in combination with LSAs to develop your startup?	Open-ended

Appendix 2. Interview sections and questions

Interview section	Semi-structured questions	Values
1. LSAs adoption	• How would you describe your LSA adoption and implementation process? What were the steps you and your startup followed? And when did you adopt and implement LSAs? • Can you comment further on your reasons for adopting/not adopting LSAs? • How extensively did you use LSA concepts, tools and models? Is there any particular element of the LSAs that you mostly used/mostly did not use? Why?	Open-ended
2. LSAs results	• Can you describe or justify the reasons that determined the length of your LSA implementation process? • Can you describe or justify the reasons that determined the cost of your LSA implementation process? • Can you further comment on the results you obtained from the adoption and implementation of LSAs as a whole? And of the results related to specific LSA concepts, tools and models? • Can you further explain why you were satisfied/dissatisfied with the adoption and implementation of LSAs?	Open-ended
3. LSAs advantages and disadvantages	• Can you discuss in more detail the main advantages you feel you obtained through the adoption and implementation of LSAs? • Is there any specific LSA concept, tool or model that determined such advantages? • Can you discuss in more detail the main disadvantages you feel you suffered from because of adopting and implementing LSAs? • Is there any specific LSA concept, tool or model that determined such disadvantages?	Open-ended

4. LSAs relation with other entrepreneurial theories, approaches and tools	• Can you discuss in more detail whether you used any other entrepreneurial model, tool or approach in combination with the LSAs to develop your startup? • Why did you use these additional models? What benefits did you gain from this combined use?	Open-ended

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