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Status of the Lean Startup Methodology (2021): From Theoretical Foundations to Practice Experience and Current Academic Discussions

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Abstract

The lean startup method, an extremely popular methodology designed to help ventures navigate uncertainty and improve their odds of success, embraces a hypothesis-driven process for developing successful new enterprises by identifying and validating scalable products and business models. This paper seeks to address relevant questions: (1) what is the current state of understanding of lean startup concerning its foundations; (2) what empiric literature describes the recent experience with the lean startup; (3) what does the literature reflect regarding the impact of lean startup outcomes and performance; and (4) what can we learn from the current academic contributions regarding lean startup and areas to explore further. This review identifies multiple antecedents and theoretical concepts, along with an examination of the scientific evidence that solidifies the underlying foundation for this methodology. While anecdotal pieces (e.g., books, periodicals, web) pervade much of the early experience, academics and practitioners provide a more robust mix of empiric evidence over the past five years. Such contributions highlight various lean startup experiences, offer insights from use in the educational setting, raise issues around the methodology and its use, and set forth boundary conditions for using the methodology. Empiric studies find mixed results concerning the influence of lean startup on performance and business outcomes, with only one study emphasizing the importance of a rigorous approach standing out as significant. The current academic conversation provides diverse perspectives and opinions. Contributions range from a severe review to papers identifying multiple avenues to explore and opportunities to bridge the existing divide between academics and scholars concerning the lean startup. This discussion leads to many further management questions about the setting, sector, startup stage, rigor, training, impact, and outcomes measurement. To this end, these areas indicate that both academic and practical questions do exist, and more work needs undertaking to solidify the understanding of the methodology's foundations and its practical impact on new ventures.

Keywords: Business model • Business model innovation • Disciplined entrepreneurship • Discovery-driven planning • Hypothesis-driven entrepreneurship • Innovation approaches • Iteration • Lean canvas • Lean startup• Pivot • Probe and learn • Scientific-driven entrepreneurship

Introduction

The lean startup is a concept developed by Eris Ries through his blog and bestselling book, "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" [1]. It describes a hypothesis-driven process for developing successful new products and businesses.

The lean startup's purpose is to help ventures navigate uncertainty and improve their odds of success rapidly and efficiently [1]. This methodology embraces a hypothesis-driven process for developing successful new enterprises by identifying and validating scalable products and business models. The lean startup consists of several essential practices, including entrepreneurial vision, hypotheses generation, experiments using a minimum viable product (MVP), and learning that de/validates the original assumptions and drives action (iterate, pivot, pursue, or exit) [2]. Individuals utilize this specific methodology, along with customer discovery [3] and a business model (or lean) canvas [4,5]. To this end, some scholars group these pieces together, labeling them as lean startup activities (LSAs) [6,7].

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This methodology enjoys a tremendous following. Tech startups in Silicon Valley, entrepreneurial ventures throughout the world, schools of business, accelerators, and government programs (e.g., National Science Foundation Innovation CORPS™ [I-CORPS™]) utilize LSAs as part of their entrepreneurship and commercialization training programs [2,8-11]. Corporations (e.g., Dropbox, General Electric, Intuit, and Proctor and Gamble) employ the lean startup methodology [8,12,13]. Lean startup meetups globally engage 20,000 regular participants.

This paper aims to offer an extensive review of the methodology. This discussion seeks to address several relevant questions: (1) what is the current state of understanding of the lean startup methodology concerning its foundations; (2) what empiric literature describes the recent experience with the lean startup; (3) what does the literature reflect regarding the impact on outcomes and performance; and (4) what can we learn from the current academic contributions regarding the approach and areas to explore further.

The flow of this paper takes on the following organization. It begins by identifying the lean startup's roots in lean manufacturing and several other antecedent product development practices (e.g., probe and learn discovery-driven planning and disciplined entrepreneurship). The discussion then segues to explaining the core components of this scientific approach to entrepreneurship and extends into practices and tools that practitioners and scholars intertwine with its build-measure-learn approach. This narrative then explores the theoretical foundations involving multiple concepts and examines the scientific support for the methodology. The discussion then transitions to cover empiric studies, boundaries, and studies evaluating the methodology's impact on performance and success. Finally, it closes with highlights from recent literature contributions, which capture some of the existing issues and opportunities in the current academic discussion.

Antecedents to lean startup

The lean startup draws on several antecedent practices to provide its basis. Most notable is the concept of lean manufacturing [1]. Also, product development practices, including that of probe and learn, discovery-driven planning, and disciplined entrepreneurship, provide elements that set the basis for experimentation and customer discovery activities used as part of the methodology.

Roots in lean manufacturing

This pragmatic approach emanates from the Toyota Production System and lean manufacturing philosophies [10,14-16]. It draws on the core principles, methodology, and tools of the lean framework. This methodology identifies the value stream from lean manufacturing, creating value and flow, producing only what the customer pulls, and pursuing perfection [17]. The most notable commonalities involve feedback-based learning through experimentation, rapid iteration, small batches, short cycles, and a minimum viable product to improve processes [2,17,18].

Thus, the lean startup's value proposition centers on product and business model development speed and minimizes wasteful activities through experimentation and validated learning [2]. This methodology allows entrepreneurs to develop their ideas efficiently by resolving ambiguities and identifying scalable products and business models. The goal is for firms to achieve product/market fit (P/MF). This concept specifies the right product for the market with demonstrated early-adopter demand and attractive market potential or a good market with a product that can satisfy the space quickly, efficiently, and cost-effectively [2,19,20]. To this end, the lean startup focuses on shortening the cycle to develop products and business models. It employs a scientific method using hypothesis-driven experimentation, iterative product releases, validated learning, and customer feedback [2,12,21]. Such efforts aim to mitigate the uncertainty that entrepreneurs face and to eliminate products that customers do not want.

Roots in product development practices: probe and learn, discovery-driven planning, and disciplined entrepreneurship

Part of the experimentation process is that of product development. The probe and learn process, introduced by Lynn and colleagues [22], represents a relevant and similar product development predecessor to the lean startup [22]. This process relies on feedback to reinforce actions that lead to success and avoid those that lead to failure [22,23].

Discovery-driven planning, published by McGrath in the *Harvard Business Review*, offers a similar look to exploration and learning preceding the lean startup [24]. This technique centers around planning in areas of significant uncertainty [24]. It promotes plan adaptation as the firm obtains new information from the market, its partners, its competition, or within the company [24]. Further, the firm's achievement of milestones prompts the release of project funds. Furthermore, this Columbia University scholar ties this process into business model development and entrepreneurship experimentation in a *Long Range Planning* paper [25]. To this end, Steve Blank credits this approach as a foundational concept for customer discovery and the lean startup [8].

Furthermore, the concept of disciplined entrepreneurship, published by Sull in the *Sloan Management Review*, touches on similar concepts [26]. This Sloan School of Management scholar builds his concepts from case research and grounded theory drawn from multiple disciplines and Karl Popper's work [27]. He highlights the critical challenge of managing uncertainty inherent in the entrepreneurial experience [26]. He emphasizes similar learning concepts that lay the foundation for the lean startup, particularly related to formulating hypotheses, running staged experiments, and iteration (reflective of learning) [26].

A contrast to agile and design thinking approaches

It is important to recognize that some individuals may relate the lean startup with other methodologies. The sharing of some common values, focus, and methods make these practices appear interchangeable. The most notable are agile development and design thinking methodologies. However, the lean startup and these approaches are not the same. Users (and scholars) should not confuse the methods and how to use them. Thus, it is critical to highlight how the lean startup differs from these methods.

Agile development refers to multiple practices associated with software development [28]. Paluch and colleagues [28] observe that agile represents a stark contrast to the traditional structure characterized by the systems development life cycle (SDLC) or waterfall development approach. Thomke and Reinertsen [29] explain that agile refers to development flexibility, testing, and learning. These scholars add that this flexible approach responds to unstable and varying customer needs [29]. Kumar and Bhatia [30] explain that the agile approach typically exists within the software product development and corporate context. These scholars and others characterize the agile effort as self-organized, cross-functional teams and their customers (or end-users) who identify requirements and develop solutions [30-32]. Further, Beck and colleagues [31] and Ilieve [33] emphasize that the agile philosophy in software development encompasses adaptive planning, evolutionary development, early delivery, continual improvement, and flexible responses to change [31-33].

Ghezzi and Cavallo [34] examine agile business model innovation related to digital entrepreneurship and define a strategic agility framework that includes agile development, business model innovation, and lean startup approaches. These authors define agile development based on several common philosophical concepts in software development [34]. Such concepts include the centrality of individuals and interaction, the incremental delivery of a working product, the practice of customer collaboration, and the venture's response to change [34]. These authors remark that it is not surprising to see lean as an agile practice, based on similar overarching values and principles, practices, learning, benefits, and challenges [34]. Both tie in value creation, delivery, and capture [34]. Hence, it is no wonder why many lean startup use cases involve software and digital startups [1,12,34,35]. To this end, Ghezzi and Cavallo [34] tie together both practices, along with business model innovation, within a unifying framework in which lean startup situates within the agile development space. However, while these methods share some commonalities, differences exist. The most notable relate to experimentation, testing, and innovative use cases beyond software.

Design thinking represents another user-driven innovation strategy sharing commonalities with the lean startup [36]. However, the two methods remain distinctly different. Developed by the design firm IDEO in the late 1990s [37], design thinking uses design-based methods and principles [37]. In reviewing the literature, Muller and Thoring [36] compare it with the lean startup and find similarities and differences between the two methodologies. Both share a common focus on innovation, identifying user needs to create relevant solutions, prototyping, testing, failing fast, and iteration [36]. However, these authors find differences between the two methods [36]. Design thinking is distinct from lean startup, respectively, as to scope (general innovations vs. high-tech for startups), approach and target (user-centered vs. customer-oriented), uncertainty (wicked vs. customer problems), ideation (present vs. product vision), methods (qualitative vs. quantitative), business model (not a focus vs. focus), and the adaptation of deployments (not a focus vs. five whys) [36]. Most notable, like the comparison with agile, the focus of hypothesis development and testing differentiates the lean startup from design thinking as a methodology. Mansoori and Lackeus [38] add that the two methods share the dimensions of knowledge expansion via stakeholders (users vs. customers), redirection via experiments, continuous learning, and iterative processes. However, they contrast that design thinking focuses on product development, whereas lean startup engages business model development and addresses uncertainty and resource management [38].

Core principles and activities

Five principles define the lean startup: (1) entrepreneurs are ubiquitous; (2) entrepreneurship is management; (3) validated learning; (4) build-measure-learn; and (5) innovation accounting [1]. These principles underlie the essential activities involves with this methodology [1,2,9].

Entrepreneurial vision

Initiating this process is a clear entrepreneurial vision for the problem on which the business focus [1,2,9]. This phase involves ideation [1,2], which comprises the creative efforts to generate ideas and the business the entrepreneur wishes to address, such as design thinking [36,37]. Interestingly, while the lean startup does not explicitly define this phase, the vision remains essential to the starting process [1,2,9].

Vision to falsifiable hypotheses

The next phase involves the translation of the vision to several falsifiable hypotheses. This concept underlies the scientific process to guide entrepreneurial decision-making using the Popperian approach [27]. This effort requires the entrepreneur to identify the underlying assumptions towards a business vision. This aspiration includes a business model representing an integrated array of choices that defines the firm's customers, value propositions, and activities to generate, deliver, and capture the envisioned worth [5]. From these assumptions, the entrepreneur will develop falsifiable hypotheses around the business model [3,8].

Experimentation (Build-measure-learn)

Following the initial development of hypotheses is the experimentation stage [1,2,9,39]. Ries [1] fashions the lean startup as a scientific approach using the testing of these hypotheses to provide validated learning to guide decisions (Figure 1). This phase centers on the build-measure-learn cycle [1,2,9], which draws similarities to the plan-do-check-act [41] and observe-orient-decide-act [42] cycles.

Essential to this experimentation process is the release of a minimum viable product or MVP (Figure 2). The MVP enables the firm to launch sooner and reach early evangelists for initial product feedback [2]. Ries defines it as the product version that can drive a build-measure-learn cycle turn with the most minimal effort and development time but requires extra work for one to measure its impact [1]. The MVP should also contain a 'bare-bones' set of features and capabilities to measure its traction in the market [44]. Finally, it allows the firm to trial its riskiest assumptions and shortening the feedback time [45].

Also tied in with experimentation is the practice of customer discovery, which this section discusses later. In this case, customer discovery involves interviews to gather data to confirm or refute hypotheses around the product, but more significantly around the business model assumptions.

Measurement

Innovation accounting is the outcome of experimentation. A metric-based evaluation with actionable metrics helps measure progress and, more importantly, validate learning [1,2,46]. Startups test their hypotheses and use quantitative metrics to evaluate progress. Examples include thresholds (e.g., a Kickstarter target), web landing page engagement (e.g., click-through rates, sign-ups), A/B tests (comparison of two versions of a product or communication), and MVP responses (e.g., willingness to pay). To be meaningful, the results from these experiments require a threshold metric to achieve (i.e., 50 percent of interviewees will prefer a subscription model or the viral coefficient for messaging will be 0.5).

Learning

The lean startup is about learning and validating hypotheses so startups can efficiently make 'go-forward' or 'fail-fast' decisions [1]. To this objective,

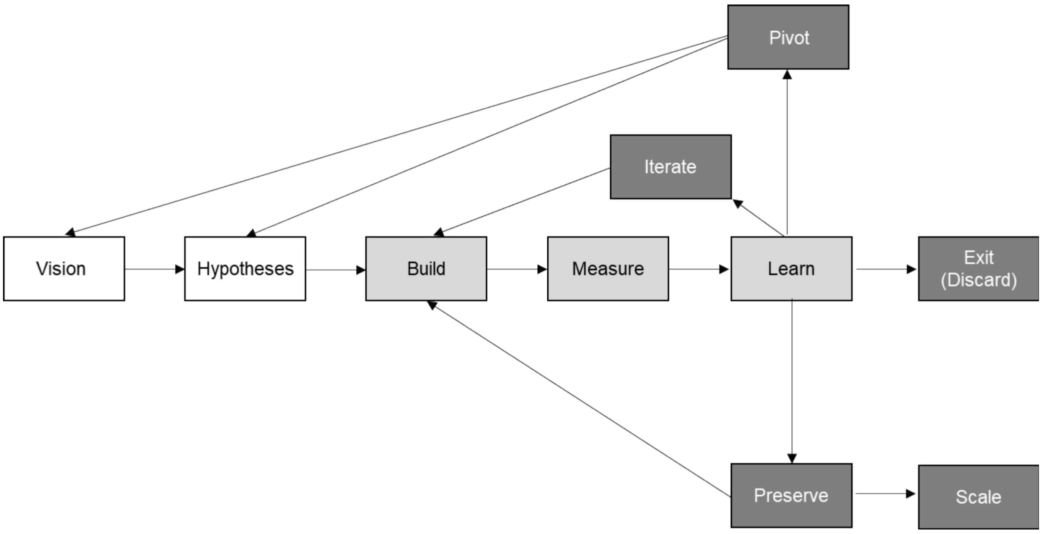


Figure 1: Lean Startup's BML cycle and learning actions (Light Gray: BML, Dark Gray: Resultant Learning Actions) (Adapted [1,2,9,40].

Figure 2: Dropbox landing page and explainer video as an example MVP [43].

the final phase involves learning from these experiments, which Ries calls validated learning [1]. This effort includes confirming or ruling out various hypotheses. Based on these test results, the entrepreneur has several options: pivoting, iteration, escalation, or giving up [9]. The goal of their learning effort is to achieve P/MF [2,3,17].

Such actions draw on Argyris and Schon's single- and double-loop learning processes, where reflection is a hallmark of the latter [47]. Furthermore, MacDonald and Eisenhardt [48] stress the value of a reflective process following experimentation in their parallel play, business model innovation paper. Bortolini et al. [9] and Eesley and Wu [49] characterize lean startup as an adaptive strategy due to such actions.

During this process, learning is essential to ensure that the startup does not scale up prematurely due to a false positive [2]. Work by Camuffo and colleagues [6] highlights the benefit of eliminating false positives when using a rigorous scientific approach. Furthermore, data from the Startup Genome [50] indicates that such startup efforts fall short of those firms that spend the time identifying the appropriate fit of product and business model to the market opportunity.

The most notable are iterations and pivots in the product's design and the firm's business model [2]. In particular, the actions of iteration reflect that of Kaizen (continuous improvement with new processes to achieve an end) [51] and pivoting that of Kaikaku (substantial changes to existing processes) [52]. Customer interviews provide qualitative data, and hypothesis testing supplies quantitative data to inform these decisions.

Iterations require minor changes to the MVP or business model [1,9,53]. Wood and colleagues explain that these actions reflect changes in the existing offering, with the scope being adjustments to the product or business model [53]. These scholars add that cognitive drivers of iteration involve comparisons with rivals and isomorphic thinking [53]. The objective relates to market positioning, with reference points being competitor moves or technological developments [53,54], such as a music format change with a radio station.

Alternatively, pivoting involves a more substantial course correction from the initial hypothesis and MVP to new ones around the product, strategy, and growth engine. Ries [1] defines this practice as when the innovator decides to make a significant change to the offering's (the MVPs) elements, whereas Blank [3,8] refers to the significant change in the business model. Bajwa and colleagues [55] identify ten pivot types and 14 trigging factors in their research. They identify customer need as the most common type of pivot and negative customer reaction and flawed business model most common trigger [55]. Other notable pivots these scholars identify include customer segment and product-related pivots, Z-in, and technology [55]. Most notable from this research is the complete pivot, reflecting the full replacement of the product offering or the business model [55].

Wood and colleagues [53] explain that the objective reference for pivoting is a market entry, with customer feedback and resource availability as the critical reference points [53]. They also highlight that the cognitive driver for this change involves performance vs. aspiration and problemistic thinking [53]. Furthermore, these scholars, using the lens of behavioral decision theory, find that magnitude of the miss (results vs. plan), length of the runway (resources), and attribution for the occurrence (reasoning) significantly influence the decisions for complete pivots, both as individual factors and together [53]. They also note that the entrepreneur's underlying personality (individual grit and impulsiveness) can influence these attributes' effects [53].

Intertwined activities with the lean startup

Academicians and startups employ Ries's lean startup combined with Blank's customer discovery process (Figure 3) and Osterwalder and Pigneur's business model canvas (Figure 4) [9,10,17]. Others will use a variation of Maurya's business model canvas, called the lean canvas (Figure 5) [4]. Such entities engage in business model innovation. The lean startup engages with its setting and testing a minimum viable business model to achieve a sustainable one vis-à-vis an experimentation and reflection process. Accordingly, they refer to customer discovery, the business model's use, and the lean startup as LSAs [8,10,17].

Interestingly, per Ghezzi [57], the business model serves as a cognitive lens for entrepreneurs to make sense and move through the business model innovation process. Based on three digital startup case studies, he explains that startups use the lean startup activities or LSAs in an experimentation process around a minimum viable business model (MVBM) to arrive at a more sustainable one [57]. In this discussion, Ghezzi [57] identifies several business model-generated heuristics: (1) opportunity sensemaking; (2) hypotheses formulation regarding startup viability; (3) mechanism for filtering, selecting, and organizing fuzzy and incomplete information; (4) tool, via MVBMs, for designing multidimensional customer experiments; (5) vehicle to prioritize experiments to validate an early business vis-a-vis analogical arguments; and (6) processing element for experimental/ validated learning and actualizing such insights in the form of pivots [57]. Furthermore, he delineates several associated cognitive processes [57]. These include (1) cognitive imprinting, (2) common language transfer, (3) attention intensity, and (4) scientific and experimental cognition [57]. The last ties into fashioning business model-generated heuristics and explaining how entrepreneurs learn, transfer, enact, and enable a cognitive transition to apply the scientific method to entrepreneurship [57].

Furthermore, McDonald and Eisenhardt [48] explore the business model innovation process. These authors coined it as parallel play, a concept drawn from how children learn by borrowing while playing with toys [48]. This qualitative study examines five startup case studies [48]. Two of the cases achieve significant investment and financial performance [48]. Based on these cases, these scholars define a model depicting the successful startups using parallel play in borrowing ideas, making the ideas their own, testing them, and finally reflecting on what learned before moving forward with a defined business model [48].

Thus, it is critical to characterize customer discovery (Figure 3), a cornerstone activity based on Steve Blank's original work [3]. This process involves a search in which the entrepreneur focuses on identifying the customer, one's needs, P/MF, and a repeatable revenue model. Blank emphasizes that

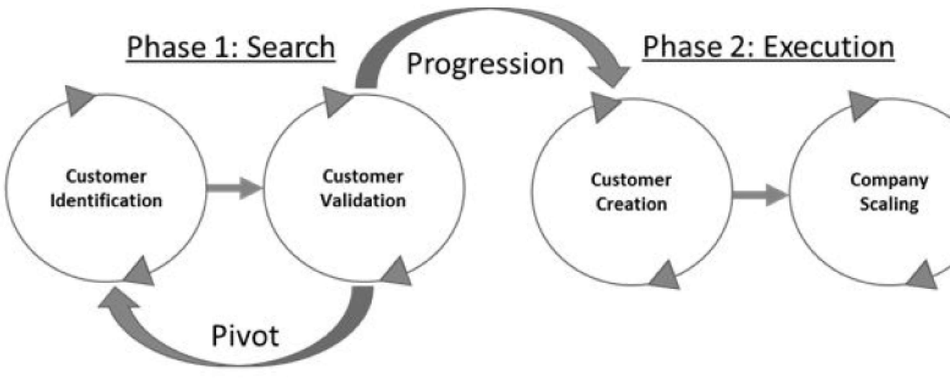


Figure 3: Blank's customer discovery search and execution (Adapted [3,8,56]).

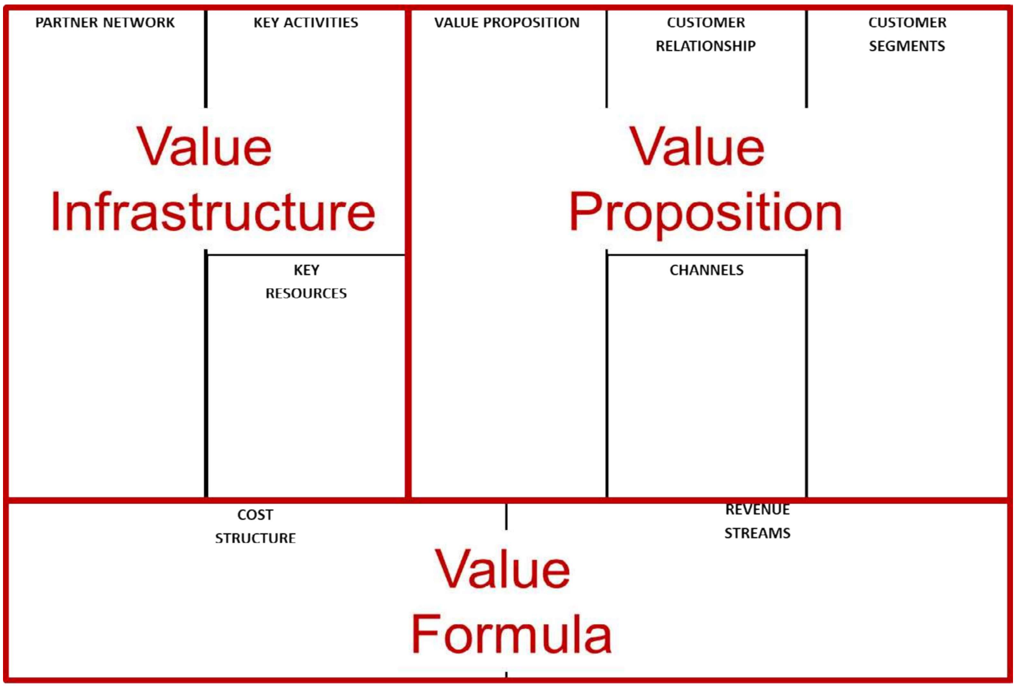


Figure 4. Business Model Canvas (Adapted [5,10]).

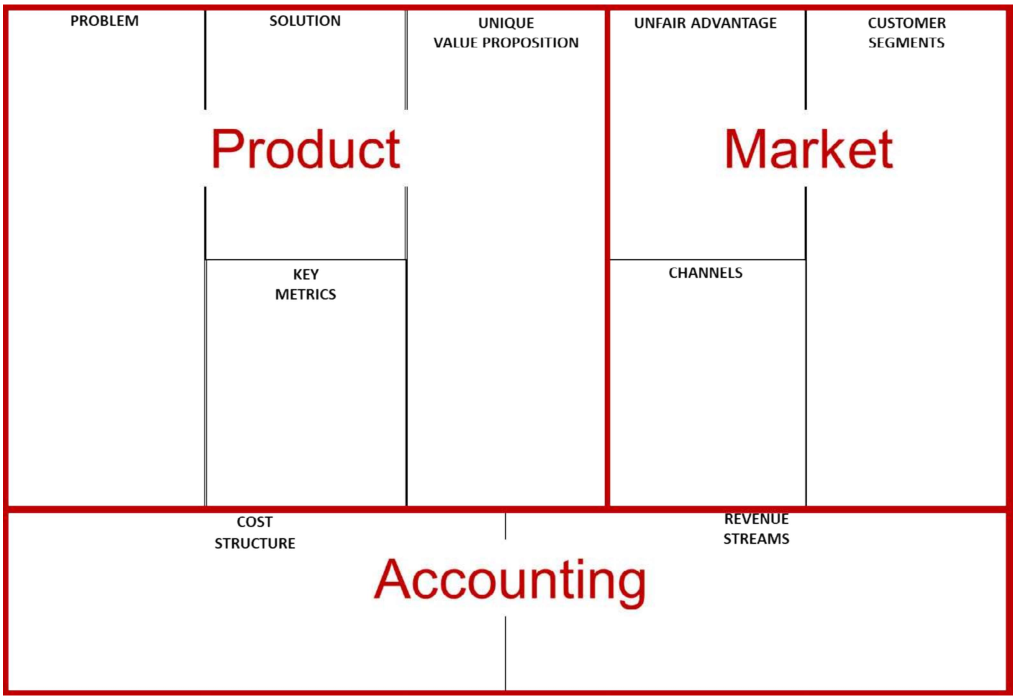


Figure 5. Lean Canvas (Adapted [4]).

customer discovery is as important as product development and should start early [8,20]. He explains that this process involves direct conversations with customers by 'getting out of the building' ('GOOB') to understand their issues and test hypotheses around the problem or 'job-to-do' and the business model [3,8,58]. The entrepreneur's job is to get inside the customer's head to discover and validate (or refute) the problem and guesses around the business model. Then, it is to determine whether the hypothesized solution might work. This activity ties in with Ries's 'build-measure-learn' cycle as the entrepreneur can gather a signal supporting or refuting one's hypotheses via a significant number of interviews [1]. With such data, the startup can build and validate an MVP and a scalable business model.

Underlying theoretical foundations

Due to the lean startup's practitioner-driven genesis and non-peer review literature visibility, entrepreneurial scholars raise concerns regarding the lean startup's underlying foundations [9,10,12,17,18,59]. Nevertheless, others draw in theories, constructs, and scientific literature to situate the methodology [9,10,12,17,18]. Among these, several works provide empiric support [9,12,10,17,60]. Multiple academic theories provide a foundation for the lean startup (Table 1). Notable are the concepts of effectuation, bricolage, creation, organizational learning, dynamic capabilities, and real options.

Effectuation

Effectuation, a theory developed by Sarasvathy [61], represents the inverse of causal logic, a goal-driven approach that uses means to reach the set objective and reflects the future as only a continuation of the past (or that of certainty) [61]. In contrast, effectuation suggests that entrepreneurs engage in uncertain and dynamic environments with many unknowns, including

Table 1: A synopsis of theoretical foundations and application of the lean startup methodology.

Area	Citation	Support of the lean startup	Practices Supported
Effectuation	Fredrickson and Brem [12] Ghezzi [10] Sarasvathy [61] Yang [60]	Direct/ Indirect	Experimentation; Iteration/pivoting. Minimum viable product (MVP) Use of available resources and partners Validated learning
Bricolage	Baker and Nelson [66] Bortolini [9] Dutta and Crossan [70] Fisher [62] Ghezzi [10] Levi-Strauss [67] Senyard [68]	Direct/ Indirect	Experimentation MVP Use of available resources and partners to develop a business model
Creation	Alverez and Barney [69] Ghezzi [7] Ghezzi [10]	Direct/ Indirect	Experimentation and Iteration/pivoting MVP Use of business model
Dynamic capabilities	Ladd et al. [95,117] Teece [94,96,97]	Direct/ Indirect	Experimentation Iteration pivoting Use and development of a business model Validated learning
Organizational learning	Argyris and Schon [47,80] Argote [79] Bajwa et al. [55] Blank [3,8] Bortolini et al. [9] Cohen and Levinthal [92] Contigiani and Levinthal [18] De Cock [93] Frederiksen and Brem [12] Ghezzi [10,57] Greve [54] Huber [78] Kerr et al. [39] Levinthal and March [82] Lynn et al. [22] Mansoori [11,81] McGrath [25] McGrath and McMillian [24] Mintzberg [86] Mitchell et al. [89] Patz [76] Sull [26] Thomke [83] Wood et al. [53]	Direct/ Indirect	Absorptive capacity Bricolage Cognition Emergent strategy Experimentation Exploration and Exploitation Iteration/pivoting Validated learning.
Real Options	Adner and Levinthal [102] Contigiani and Levinthal [18] Camuffo [6] Harvey [103] McGrath [98,99] Myers [100] Trigeorgis and Reuer [101]	Direct/ Indirect	Experimentation Iteration/pivoting Validated learning.

customers buying the product [61]. They will shape their futures' outcomes rather than being a consequence of the past [7]. It is means driven, without a set goal [62]. Effectuation rests on four core principles that contrast causation: (1) affordable loss versus expected returns; (2) strategic alliances or partnerships versus competitive analysis; (2) exploiting contingencies versus that of preexisting knowledge; and (4) controlling an unpredictable future versus attempting to predict one that [61,62]. Furthermore, effectuation is associated with 'search' activities [60] and experimentation [63-65]. This concept embodies both theories to explain past performance. Like the scientific method, this approach can allow entrepreneurs to "fail more effectively," use fewer resources, and gain experience quickly [63].

Concerning the lean startup, effectuation supports experimentation practices to test hypotheses around the business model and the MVP through feedback loops and then validate learning via iteration and pivoting [10]. It also describes how entrepreneurs will draw on available resources and partnerships (the means) to deliver on a value proposition. Both a historical review of the literature by Bortolini [9] and an evaluation of the supportive scientific literature by Frederiksen and Brem [12] highlight strong antecedents to lean startup rooted in effectuation theory. Ghezzi [10] provides significant evidence from a mixed-methods study involving 227 Milanese digital startups to support this theoretical underpinning [10]. Further, Yang and colleagues [60], in studying 160 Chinese small-to-medium enterprises, report that firms up to seven years of age engaging in 'search' (synonymous with effectuation) activities exhibit higher profitability than those that do not.

Interestingly, Mansoori and Lackleus [38] juxtapose the two methodologies and several other approaches (discovery-driven planning, prescriptive entrepreneurship, business planning, and design thinking). These scholars note the difference between that of a scholarly-grounded method with effectuation vs. the practitioner-grounded approach with the lean startup [38] find that effectuation and lean startup, respectively, differ as to 1) logic (future outcomes drive by humans are unpredictable vs. uncertainty reduction via systematic, scientific approach), 2) model (five heuristics and effectual cycle vs. build-measure-learn), and 3) tactics (means inventory, affordable loss, assessment template, effectual ask vs. targeted experiments, customer interviews, prototypes, concierge, A/B tests, fake door tests) [38]. Further, Mansoori and Lackleus [38] compare the theoretical foundations along nine conceptual dimensions. They find that differences exist around multiple aspects [38]. First, there are 1) uncertainty and management strategies to reduce uncertainty (unknowing and emergent vs. uncertain, predictable, and manageable with systematic info gathering and analysis); 2) resource management (stakeholder role to influence goals and results vs. feedback to drive resource commitment); 3) knowledge expansion (founder and stakeholder knowledge vs. improvement of existing knowledge via carefully collect data and reflection); and 4) redirection power (lack of predictability, adaptation, new stakeholder input, and flexibility expands possibilities vs. iterations and pivots driven by data and validated learning). The next three include 1) continuous learning (designing intelligent failures that one can contain locally and add to individual learnings vs. the validity of each assumption grounds in feedback and serves as the core of the process); 2) stakeholder interaction (stakeholders together who contribute resources vs. users and customers who offer feedback and opinions); and 3) team (the focal entrepreneur and network of stakeholders vs. founders) [38]. The final area involves value creation, where effectuation involves both the acquisition and expenditure of resources by all active stakeholders, users, and customers to pursue value creation [38]. In contrast, lean startup situations around P/MF fit in delivering good value to all relevant actors (e.g., customers, partners, employees, investors, and founders) [38]. The most notable differences across these nine conceptual dimensions involves continuous learning [38].

Bricolage

Bricolage is a theory that Baker and Nelson [66] specifies to entrepreneurship, building on Lévi-Strauss's [67] original concept. Bricolage describes resource-constrained firms' behavior and organizational processes, such as startups, creatively using their limited resources [66,67]. It comprises three essential elements: (1) making do to implying a bias to actively engaging a problem; (2) relying on utilizing current resources at hand, including both internal and external resources; and (3) the combination of the resources for new purposes [66]. This creative approach to new problems and opportunities enables ventures to create value, establish themselves, and grow [66]. The actions of a "bricoleur" or handyman differ from that of an engineer. The "bricoleur" would pull from available materials within one's workshop to create a solution, such as a table from blocks of wood, poles, and left-over paint; in contrast, the engineer would build a design and order out specific materials [62].

In many ways, bricolage shares common ties with effectuation [10]. This concept recognizes that many startups are resource-constrained and need to "make do" with present means, capabilities, and relationships. Further, it involves the entrepreneur being aware of possibilities and seeking solutions using or recombining such available resources innovatively.

Concerning bricolage and lean startup, this behavior supports the use of an MVP, the availing of current internal and external resources (e.g., partners) to develop a business model, and bias to action in conducting experiments [10,62,66]. Senyard and colleagues' [68] longitudinal research involving 81 Australian startups suggests significant ties between bricolage and innovativeness. Furthermore, a historical literature review of Bortolini and colleagues [9] identifies antecedents in the bricolage publication history. Finally, evidence from the mixed-methods study by Ghezzi [10] of Milanese digital startups offers empiric support concerning bricolage.

Creation theory

Creation theory, or the enactment approach, specifies that opportunities do not just exist as objective, independent phenomena. Instead, they are constructs resulting from the entrepreneur's actions, reactions, and enactments to develop a value proposition in an uncertain environment [69,70]. The perspective on creation emanates from interpretivism or social constructionist vantage versus a positivist or realist view of reality [69,70].

Creation fits with the Schumpeterian economic view; it is the entrepreneur who facilitates change and 'shocks' the equilibrium of the present system during periods of ambiguity, transformation, and technological advancement [71]. This view sees opportunities emerging via creative destruction [71]. It also considers a broad base of entrepreneurial actions including (1) new products or services; (2) enhance quantities; (3) new production methods; (4) new markets; (5) new supply chains and sources of raw materials and intermediate products; and (5) new organization forms [71].

In contrast, discovery theory implies that entrepreneurial opportunities are omnipresent and exist independently of the entrepreneur [72,73]. It fits with a Kirznerian view (or the Austrian School) of economics [62,74]. The entrepreneur's alertness, imagination, and interpretation concerning information and knowledge gaps in the market lead to opportunities [74]. These prospects await the entrepreneur- who possesses a unique talent to recognize and pursue these opportunities before others- to discover and exploit [7,72,74]. In ways, Felin and Foss's [75] 'poverty of stimulus' argument plays into the discovery perspective, such that the difference lies with the entrepreneur's inherent capabilities.

Creation involves an iterative, inductive, and incremental process, such as seen with effectuation [7,10,72]. Entrepreneurs act and observe how consumers and marketplaces respond. These activities contrast those with discovery, which engages data collection and analysis, along with a business plan, to aid decisions [7,10]. Hence, the lean startup practices of experimentation, iteration, and pivoting with an MVP and a business model embody creation. Once again, research by Ghezzi in Milan provides evidence that supports that opportunity creation underlies the lean startup methodology [10].

Organizational learning

Organizational learning is a broad foundational area on which the lean startup situates [76]. This relationship exists because learning is essential to the lean startup methodology and is requisite to developing knowledge [76]. Several aspects of organizational learning are noteworthy. Fiol and Lyles [77] characterize it with a definition, with which many agree: a change in an organization's knowledge because of the experience acquired. According to Patz [76], organizational learning is an ongoing process that enables a firm to embed new knowledge and capabilities. Such capacity allows the venture to adapt to environmental changes and develop competitive advantages [76]. Huber [78], another leading academic, puts an additional perspective on the concept by citing it as occurring when any organization's units acquire knowledge that the unit recognizes as potentially useful to the venture. He also highlights four major construct or process areas involved: (1) knowledge acquisition; (2) information distribution; (3) information interpretation; and (4) organizational memory [78]. Argote [79] describes organizational learning involving the subprocesses of (1) creation, (2) retention, and (3) transference of knowledge. Similarly, this area considers process improvement and expansion into new spaces by developing new knowledge and understandings and identifying and correcting misalignments [80]. Such activities exist within the lean startup process [1,2,11,81].

Huber [78] explains that knowledge acquisition is the subprocess of experience. This effort to acquire knowledge fits within the exploration as they struggle with balancing the creation (exploration) and exploitation of opportunities, a concept previously discussed by Levinthal and March [82]. Contigiani and Levinthal [18] recognize this dynamic in their discussion of organizational learning to situate the lean startup construct. They highlight the search and experimental learning-intensive phase to which the firm seeks P/MF and the scaling phase once it reaches this critical milestone [18]. These scholars connect the lean startup's learning and scaling phases with the exploitation-exploration tradeoff, a central tenant to the organizational learning literature [18]. However, these scholars contrast lean startup from the exploitation-exploration tradeoff based on survival criteria, feedback to narrow down and terminate the search process, and experimentation refinements due to product traction and value appropriation [18].

Experimentation, an essential lean startup activity, is a noteworthy process. Huber [78] explains that experimentation is a subcomponent of the experience process by which firms obtain new knowledge. Kerr and colleagues [39] highlight the importance of this practice for entrepreneurs and investors. Thomke [83] emphasizes the importance of experimentation in product development. McGrath [25] and Sull [26] recognize the importance of experimentation as they describe their respective discovery-driven planning and disciplined entrepreneurship processes. These scholars recognize the role of running inexpensive experiments vis-à-vis the lean startup [25,26].

Furthermore, organizational learning is essential in the initial phase of the entrepreneurial process. Lumpkin and Lichtenstein [84] outline three approaches to learning: (1) behavioral, a form of adaptive trials and error learning; (2) cognitive, a process that affects cognitive content and ability to absorb knowledge or apply new behaviors; and (3) action, real-time and application-oriented. These scholars also put forth an opportunity recognition model, which characterizes the essential processes in this early stage [84].

In addressing learning processes, Bingham and Davis [85] offer strategies that ventures can use, including the time-consuming, direct (e.g., trial and error, experimental, or improvisational) and the more efficient, indirect (e.g., imitation, observation, or adoption) learning approaches. They continue with two sequences for learning that firms can embrace [85]. These include seeding (starting with indirect, followed by direct) is optimal for long-term efforts (e.g., extensive research and development projects), whereas soloing (starting with direct, followed by indirect) appears ideal for short-term initiatives and startups [85].

Organizational learning considers behavioral theory. Argyris and Schon's [47,80] espoused theory and theory-in-use (real actions), reflecting Mintzberg's emergent strategy [80], represent a significant organizational learning concept that supports the lean startup, particularly validated learning and reflection. Connected to this work are the 'single-loop' (error detection and correction in which the firm does not need to change overarching governing variables) and 'double-loop' (correction requires the firm to reevaluate and address the governing variables) learning processes [47,80]. Such behavioral constructs tie in the feedback process and allow for realignment (vis-à-vis reflection) when set activities miss aspirations, as seen within the lean startup [11,81]. Mansoori and colleagues [11,81] employ the theory-in-use model [47,80] when examining how entrepreneurial ventures in a Swedish prescriptive accelerator acquire, internalize, and practice lean startup methods vis-à-vis both experiential and vicarious learning processes.

The collective cognition and agreement process offers another important organizational learning concept. Notable is Crossan and colleagues' [87] 4Is (intuiting, interpreting, integrating, and institutionalize). This framework provides another organizational learning lens from which to view the lean startup [87]. It includes 'feed-forward' and 'feedback' mechanisms to routinize learning (starting with the individual, moving to the group, and progressing to the organization) to facilitate strategic renewal [87]. Such observations emphasize the importance of collective cognition in advancing new knowledge, such as the entrepreneurial product idea or business model [87].

Interestingly, Harms and colleagues report observations around the group's significance in team learning and performance (as judged by real-life entrepreneurs) within an entrepreneurship class using the lean startup methodology [88]. Such observations tie nicely to the importance of social cognitive factors when considering entrepreneurial cognition [89]. Leatherbee and Katilia [90] add to this point by sharing data based on studying National Science Foundation I-CORPS™ teams. Their research identifies the importance of team diversity and its ability to coalesce around hypotheses to test and advance a business based on customer probing and feedback [90]. In his study of founder responses to feedback, Grimes identifies qualities, such as engaging team diversity and openness to feedback, critical to collective sensemaking [91]. This scholar reports that the founder's ability to relinquish the idea's psychological ownership and engage in collective sensemaking leads to creative revision, clearly defined team roles and responsibilities, and compression of the time between idea work and identity work [91]. Such qualities lead to a more efficient and effective process to advance or 'feed-forward' new knowledge and innovations, embed them into the venture's commercialization practices, and move towards exploiting the innovations [91]. Finally, Ghezzi [57] highlights the cognitive role that the business model and business model innovation play. This scholar connects the point around business model-generating heuristics and how entrepreneurs advance and translate knowledge to entrepreneurial action [57].

Absorptive capacity proffers another relevant organizational learning concept. Patz [76] notes that entrepreneurial ventures tend to greater flexibility and absorptive capacity, promoting learning and innovativeness. Cohen and Levinthal [92] define absorptive capacity as a firm's ability to recognize the value of new, external information, then assimilate and apply it to commercial ends. Leatherbee and Katila [90] refer to it as a more heterogeneous collective knowledge-base, ranging from law to medicine to engineering and business. Cohen and Levinthal recognize that it is intangible and its benefits are indirect [92]. However, they argue that learning, knowledge, and advanced capability are critical to a firm's innovative capacity and performance [92]. These scholars note that such ability is history and path-dependent, and investment in expertise is requisite for developing technological capabilities [86]. Their research proposes a model to explain research and development investment [92]. From their research, these scholars conclude that firms are sensitive to the operational learning environment and use absorptive capacity as part of the decision calculus for resource allocation to spur innovation activities [92]. However, they note that firms cannot quantify it, leading to the optimal investment question [92].

Work by De Cock and colleagues [93] addresses this capability by examining the role of prior market knowledge in early-stage firms and using the lean startup methodology to achieve venture funding. They show how new ventures can develop absorptive capacity by learning from customer feedback [93]. These scholars find that prior market knowledge as an internal absorptive capacity (or external from social resources) enhances the venture's ability to use such market knowledge to advance its product and business model to secure funding [93]. Also, they note that the external social resources can enhance the internal absorptive capacity [93]. Adding to this work, Leatherbee and Katila recognize that the educational diversity of I-CORPS™ translates to a broader absorptive capacity and find that this characteristic is significant to the team's convergence on a primary business idea [90].

Finally, there are connections between the Learning School of strategy and the lean startup. Bortolini and colleagues [9], in their historical literature review, find that the lean startup principles, methods, and practices overlap significantly with those from the Learning School of strategy. These scholars identify that both approaches employ experimentation, adaptation, learning, incrementalism, continuous change, and emerging strategies in managing projects in complicated and ambiguous situations [9].

Dynamic capabilities

Per Teece and colleagues [94], dynamic capabilities describe a firm's ability to integrate, build, and reconfigure internal and external competencies (e.g., resources, skills, capabilities, and strategies) to address a rapidly-changing environment and provide for competitive advantage. Used as a corporate strategy element to explain how firms can pursue a sustainable competitive advantage, these attributes arose in response to a firm's resource-based view's inability to address rapidly-changing surroundings [94]. Ladd [95] explains that these abilities can guide the entrepreneur- who collects, interprets, and absorbs new information- and then aid this actor in reconfiguring resources and strategies to improve the probability of success. According to Teece, dynamic capabilities, combined with a strategy, influence a defensible business model's development as the venture progresses from sensing opportunities to seizing a construct to transform the organization [96]. In many ways, one can consider organizational learning a part of a firm's dynamic capabilities. Notably, it allows the firm to develop set routines that translate to renewal and aid competitive advantage [87,97].

The lean startup practices of experimentation, feedback, and validated learning actions (e.g., iteration, pivoting, pursuing, and giving up) related to a firm's product and business model reflect this underpinning. Ladd and colleagues' [95] work, involving a clean-tech accelerator and online lean startup-related tool, reflects this theory's underlying support. Their research illustrates how experimentation and hypothesis testing (to a point) to validate business models can lead to emergent and repeatable learning routines [95].

Real options

This theory describes an approach to investments when the future is uncertain due to dynamic economic, technological, or market conditions [18,98,99]. According to Contigiani and Levinthal [18], real options entail investing initially into an endeavor to provide access to a future opportunity, but it is not dependent on follow-on information. Myers [100] explains that these options are real as they reflect projects with some tangible asset (e.g., real estate, machinery, inventory). Trigeorgis and Reuer [101] add that they are not options that investors use, such as stocks or other financial instruments. Adner and Levinthal [102] emphasize that real options are a manager's or entrepreneur's choices around a project. These scholars add that they usually involve a bi-model, go/no-go choice to exercise or abandon [96]. Harvey [103] clarifies that real options involve the right, not a commitment, to engage a business initiative that requires capital investment. Trigeorgis and Reuer [101] explain that they include one of the five core options- (1) defer or stage, (2) grow, (3) alter scale, (4) switch, or (5) abandon/exit- and consider the factor of time.

Camuffo and colleagues [6] propose that running experiments using lean startup is a real option. The design and conduct of a good experiment using the scientific method can provide valuable insights and direction to the next course of action related to the product and business model. These researchers posit that entrepreneurs can influence outcomes through such activities and avoid uncertainty problems [6]. Thus, through experimentation, these options are not dependent on time but rather on the entrepreneur's actions to mitigate the risk associated with uncertainties involved with starting a new venture. With this new information gained from experimentation, the entrepreneur can decide to pursue the next course of action, such as an iteration, pivot, move forward, or abandonment action. However, other scholars do not necessarily agree with this view concerning lean startup as a real option [18]. This perspective is due to the multiplicity of options, the ability to run multiple experiments to provide many simultaneous bets, and the aptness to iterate or pivot [18].

Scientific literature supporting lean activities

Finally, a scientific review of the antecedent scientific literature by Frederiksen and Brem [12] supports the foundation of the lean startup and Ries' claims [12]. Overall, they find support in the literature for all practices [12]. However, these scholars highlight gaps and places where the underlying publication base could be more substantial [12].

Frederiksen and Brem [12] delineate evidence specific to five essential pieces with lean: (1) user and customer involvement in product or business development; (2) iterative new product development; (3) effectual thinking; (4) experimentation in new product development; and (5) early prototyping (i.e., MVP) for proof-of-business. Based on their subjective review and grading, these authors rate the evidence for customer involvement as very strong and discuss support from the open-innovation literature [12,104]. For iterative new product development and effectual thinking, they rate the evidence as strong [12]. These authors note the role of effectual logic and highlight that while the path with effectuation takes longer, it does lead to a higher probability of success [12]. They feel the evidence is not substantive for experimentation and early prototyping and offers a medium rating for these activities [12]. Interestingly, they do note with experimentation that with incremental hypothesized solutions, one can fail inexpensively and, thereby, gain more attempts at finding the match between product and customer [12]. However, they add that the solution space might not be all-encompassing because of the process's incremental nature [12].

Published experience with lean startup

Being a practitioner-driven methodology, Ries [1] and other authors document the experience with lean startup through examples within non-empiric sources. Such publications include books [1,3,4,46], non-peer review reports [50,105], and non-peer business magazine articles [8,13,106].

Within the literature exists a mix of empiric studies. Such published papers or theses use diverse methods, including action research, case studies, interviews, literature evaluation, and surveys [11,81,107-115].

Multiple scholars document awareness and usage in diverse settings. Lalic and colleagues [107] describe the Croatian experience based on a survey of 23 startups. They note that while most firms are familiar with the methodology and implement most practices, they do not change their business model (i.e., pivoting) [107]. Dewobroto and Siagian [108] share a case experience in Indonesia using lean startup and the business model canvas that provides inconclusive results concerning a tourism bus venture's feasibility. Jureen [109] reports mixed findings, including the methodology's non-applicability in the project's early stage and the conditions to enable success, based on 53 interviews of individuals developing a self-managed post-stroke rehabilitation. From 13 qualitative interviews, Racolta Paina and Andries [110] find that most Romanian entrepreneurs embrace more traditional and exploitive approaches. They also learn that those open to the methodology tended to have more experience and education, and lean, if used, would best fit in the information technology space [110]. Leoveanu [111] finds similar observations from his interviews with Romanian entrepreneurs. In a quantitative survey of 100 Romanian university students, Ciobanu and Nastase observe that lean startup appears to fit Generation Y (i.e., millennials) entrepreneurs' profile to build a sustainable business [112]. Gbadegeshin and Heinonen report [113] that fifteen of the eighteen teams surveyed are aware and use the methodology to test ideas and innovations in their mixed-methods study of Finish startups. They find such use in multiple industries (though tech predominated) and in different sequences [113]. Based on qualitative work with three Canadian and three Danish firms, Tanev and colleagues [114] identify that such firms use lean startup practices (e.g., pivots) to manage uncertainty and internationalize their business vis-à-vis two paths: lean-to-global and lean and global. Finally, Still puts forth a case study involving a Finnish university that offers an innovation acceleration model and defines applicability to the front-end activities proposed in the construct- customer and solution discovery [115].

Lean startup and learning

Some research offers fascinating insights into the entrepreneurial learning process. Through 22 semi-structured interviews with 11 new ventures, Mansoori [11,81] explores how teams acquire, understand, internalize, and operationalize the instructions with the lean startup within the auspices of a prescriptive accelerator. He identifies that both vicarious and experiential learning occurs within the accelerator program [11,81]. More significantly, using the 'theory-in-use' model (i.e., 'single-loop' and 'double-loop' learning processes) in the analysis, this researcher finds entrepreneurs progressing through changes that modify governing variables and action strategies [11,47,80,81]. In essence, he observes [11,81] that entrepreneurs engage in double-loop learning processes as they challenge their underlying assumptions for their ventures [11,81].

Mansoori and colleagues' second study uses mixed methods with 17 teams and 41 entrepreneurs [116]. Their research evaluates the entrepreneur-coach relationship via vicarious and experiential learning experiences [116]. They find that using the methodology influences the dynamic by facilitating (1) trust, honest exchanges, and vicarious learning, and (2) behavior changes effects for both entrepreneur and coach [116]. However, they note that the entrepreneur-coach relationship can run at odds with the methodology, particularly relating to conflicts between customer data and advice from the coaches [116].

A Dutch study by Harms and colleagues [88] adds to Mansoori and colleague's findings. These researchers evaluate self-regulated learning, group learning, and psychological safety in the context of a lean-startup-based undergraduate entrepreneurship class involving 194 students in 41 groups [88]. Data sources include individual grades, self-assessments, and team evaluations by the instructor and an external entrepreneur [88]. As expected, Harms and colleagues [88] discover that self-regulated learning impacts individual exam scores; however, team learning influences both the individual perception of learning entrepreneurial skills, group performance (which psychological safety also affects), and team assessment by an outside entrepreneur [88]. Such team-based learning efforts situate well with developing strong social cognition skills, enabling diverse views, and filtering individual biases when interpreting feedback from experiments and customer discovery activities [88,89].

Furthermore, Ladd and Kendall [117] from Hult International Business School describe lean startup's effect on entrepreneurial cognition. These investigators use a pre/post-class survey from 99 students applying the lean startup to their ideas as part of a graduate school entrepreneurship class [117]. Their findings reflect that using lean startup influences cognition by enhancing entrepreneurial intention and self-efficacy in searching for promising ideas and risk-averseness concerning the venture [117].

Boundary conditions

Other works highlight potential boundaries and limits. This consideration is essential due to the diverse array of business sectors in the startup space. Hence, one consideration is whether the lean startup applies to a broad mix of industries and applications. Ries and Blank tout the successful use of the lean startup in multiple settings [1,8,12,106]. Ries cites over thirty firms in his book [1,12]. Notable examples include General Electric, Hewlett Packard, Intuit, PayPal, Proctor and Gamble, Telefonica, Toyota, and Zappos [1,2,12,106].

However, considering its Silicon Valley roots, lean startup appears to fit well with software-driven ventures that address a business-to-consumer market [1,12,36,46,118]. Multiple authors point to software and application-based businesses as the most common types of firms using lean startup [7,12,36,46,118]. Kressel and Winarsky [118], two Silicon Valley investors, highlight specific practices (e.g., experimentation, MVP, and iteration/pivoting) most applicable to software development.

Bortolini and colleagues [9] highlight that the lean startup movement paralleled the 'boom' period for mobile and web-app development that began around 2009. Multiple investigators focus on mobile or webspace studies in evaluating lean startup [6,7,10]. Kressel and Winarsky [118] argue that the methodology makes the most sense for software- or web-related companies with modest startup operating expenses. Finally, Croll and Yoskovitz [46], the authors of *Lean Analytics*, describe six digital models that use lean startup practices to highlight innovation accounting.

Nevertheless, it is crucial to consider what type of business might benefit (or not) from using the lean startup or using an adaptive strategy. Andries and Debackere [119] reflect this consideration in their survival analysis of 117 firms from independent and large-firm new ventures in the biotech, automation, and environmental sectors. These scholars observe that not all industry sectors enjoy survival benefits with adaptation [119]. They note that some firms confront barriers in shifting their business models due to significant investment needs for research and development and other organizational and inventory requirements [119]. Andries and Debackere [119] highlight the impact (and context of) multiple factors: sector maturity; technology advancement; dynamics or industry pace (rapid vs. slow); capital intensity; financial support; and economic cycle (e.g., recession.) [119].

Interestingly, König and colleagues [120] find that the type of business sector-digital versus non-digital- influences the firm's use of lean startup, along with survival and success outcomes. Using a content analysis of business plans and interviews, they find that non-digital ventures that show higher survival (93%) and success rates (86%) obtain early financing to set up a product ready to be tested on the market [120]. In contrast, these investigators note that higher-performing digital ventures incorporated lean startup practices and use the business model canvas [120].

Another European group weighs in concerning boundary conditions. Harms and colleagues [35] consider different circumstances around fit with the lean startup methodology. They highlight materials ventures (e.g., chemical, materials, semiconductor, silicon chips) [35]. Such verticals need to address technological uncertainty and, in some cases, legal/regulatory, financial, and operational risks [35]. These researchers explain that materials and science-based ventures (1) operate under a high degree of technological uncertainty to resolve so they can develop the actual products in a specific timeframe, and (2) often serve business markets [35]. They observe that the close link of product and process innovation in such ventures makes the lean startup less suitable for resolving market uncertainty and creates challenges for an MVP [35]. These researchers note that process changes impact the product (and vice versa) [35]. Harms and colleagues add that feedback loops may take too long and be too expensive in such firms [35]. They note that iteration or pivoting on a product might also require the resubmission of intellectual property (IP) protection due to the changes in both products and manufacturing processes that a patent, for example, would cover [35]. These scholars continue that any change would lead to firms returning to the starting point, costing significant firm time and capital in its development and commercialization processes [35].

Within this analysis, Harms and colleagues [35] frame lean startup and other approaches within a two-by-two matrix (low to high) from the lenses of the market (Y-axis) and technological (X-axis) uncertainty perspective (Figure 6).

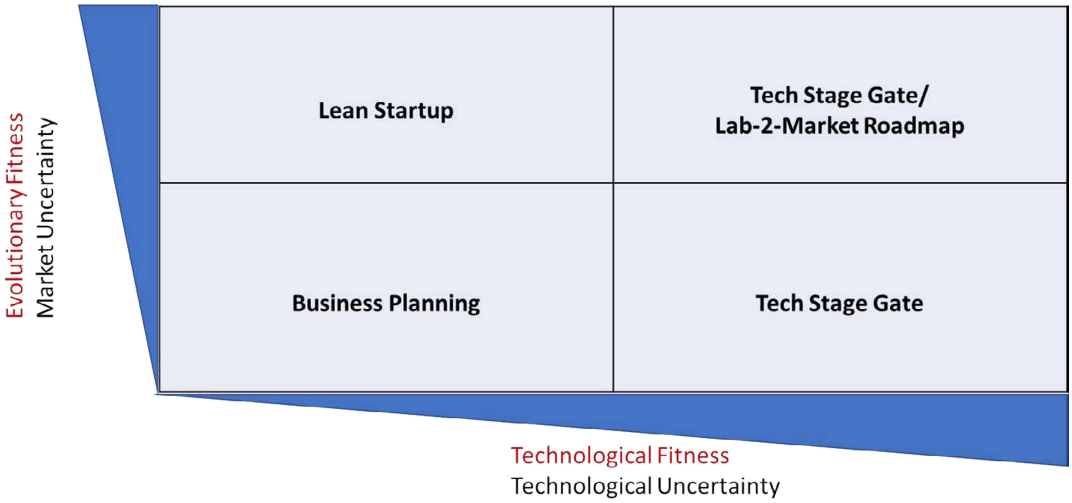


Figure 6: Areas of risk mitigation to where LS fits (and does not fit) well (Adapted [35]).

These Dutch researchers explain that the lean startup fits well as a tool to address the scenario of both high market and low technological uncertainty [35]. They explain that for settings where uncertainties for both are low, such as low-tech, replicative businesses (e.g., retail, traditional services), where an abundance of information is available, business planning would be more appropriate [35,121]. These authors continue with low market and high technological uncertainty settings and highlight that a stage-gate approach makes the most sense [105]. Finally, Harms and colleagues [35] advocate for the setting of high market and technological uncertainties (i.e., a new technology platform to new applications) using a combined stage gate/ lab-to-market approach [35,121].

However, it is noteworthy that Harms and colleagues [35] focus on product development and not business model innovation. This focus primarily on the product and not the business model highlights a limitation of their work relative to appropriate fit relative to a relevant sector. Interestingly, it is Croll and Yoskovitz [45] who highlight that startups can use the methodology with established technology to identify an appropriate customer, market, and model, coining the term market/product fit (M/PF).

Besides the above works, several other studies identify barriers or limits to the method [122-125]. In a case study involving a business-to-business sector startup, Nirwan and Dhwanto [122] identify several barriers: accessing customers to interview, finding big problems, pivoting, addressing regulatory and administrative boundaries, and discovering only incremental solutions a highly competitive market. Gustafsson and Qvillberg [123], using 59 semi-structured interviews and diary data with early-phase Swedish manufacturers, identify multiple challenges. Such issues include customer access, significant problems, MVP development, gaining feedback, and pivoting [123]. In another study, Blomberg [124] shares learnings from focus groups and field research in Denmark. He discovers limitations with the methodology, including personal biases; however, he suggests improvements for the methodology's use (e.g., questioning assumptions, talking to the right customers, iteration, pivoting, and virtual MVP for testing) [124]. In a conference report of an action research study with software startups in Banglore, Rao [125] cites three gaps concerning the use of the MVP: narrow intellectual property base, low budget for iteration, and absence of early adopters. He adds that these startups engage with demanding Indian customers used to Western 'readymade' products, not innovative early-stage products from local startups [125].

Furthermore, Gbadegeshin and Heinonen [113], in their mixed-methods study of Finnish startups, find that the ventures apply the methodology differently. They note that factors such as industry, type of product or service, stage of development, number of entrepreneurs, and entrepreneurs' experience influenced the four different use patterns [113]. Leoveanu reflects on interviews with Romanian entrepreneurs around the methodology that the tradition and labor culture can be impediments [111]. Lalic and colleagues [107] find that Croatian entrepreneurs' interviews fail to change their business models, despite their awareness and usage of the methodology. Vlaskovits [126] comments about user issues concerning experiments and pivots, specifically around developing meaningful experiments in complex or chaotic environments, the efforts to conduct a proper evaluation to provide meaningful data, and the motivation to be resilient when learning one's initial direction fell short of expectations. In Finland, Still [115] finds, in her case study of an academic institute evaluating her accelerating research innovation model, that this lean startup-based approach fails to effectively address the 'go-to-market' elements of value proposition discovery and growth discovery.

Others cite issues with founders' and teams' capabilities in obtaining and managing information during the process. Based on interviews with six German startup founders, Ghorashi [127] highlights multiple challenges with experimentation and analysis. He identifies organizational capability issues for successful knowledge management around the experimental design and execution, data collection, unbiased analysis, resource investment, and the frequency of testing new product features [127]. In an unstructured study examining National Science Foundation I-CORPS™ teams and associated supportive literature, Batova and colleagues [128] identify a significant gap concerning qualitative methods around customer discovery. Based on their observations, these authors suggest that the teams using lean startup could benefit from user research in professional communications and user experience design [128].

Further observations provide additional insight supporting specific limitations or barriers to the methodology's use, particularly in the software space [12,129,130]. Two other Danish researchers, Warberg and Thorup [129], find issues with the lean startup MVP development process in the software space. They argue that it devalues the proper architecture with simplistic code (e.g., 'junk code') at the start [129]. Warberg and Thorup [129] explain that such code leads to wasteful rework and hinders technological development due to a limited solution space and incrementalism, a limitation Frederiksen and Brem identify in their scientific review [12]. Within the auspices of an accelerator training program using mentors, Mansoori and colleagues [116] see that the lean startup methodology and interview findings can be at odds with mentor guidance, creating confusion and leading teams to follow the perceived authoritative figure's direction. Finally, Harms and Schwery [130], in an analysis of 100 software startups from the Startup Genome in Berlin around the relationship of lean startup capabilities and project performance, find that the degree of innovation is a negative moderator.

More recent literature highlights other boundaries such as knowledge and experience. Notable is the influence of prior market knowledge within a space. A longitudinal study involving four startup cases by De Cock and colleagues [93] investigates early-stage, growth-oriented ventures related to venture experimentation and absorptive capacity, an organizational learning characteristic. These researches examine how these firms apply the lean startup method and what conditions moderate success [87]. Of these four cases, two successfully obtained venture capital funding, a proxy the authors use for P/MF [93]. These scholars find that prior knowledge or experience or drawing on outside expertise within the current market space made a difference in these ventures' ability to optimize their use of the lean startup methodology and achieve early venture success (venture funding) [93].

Interestingly, other scholars find that prior experience and educational background can affect venture success with the lean startup [64,127,131]. Reinforcing this point, Ghorashi [127] highlights the relevance of internal organizational capabilities for knowledge management and the need for external inputs to the preparation, examination, and evaluation loop, based on his six German founders' interviews. Deligiani and colleagues [64] find this influence in a quantitative study of 129 Greek new ventures using the lens of effectuation. In a quantitative evaluation of 316 midwestern American entrepreneurs, Marvel and colleagues [131] also identify this positive relationship of prior experience as a significant factor on customer and market learning and three-year sales following launch.

However, all backgrounds are not equally favorable to the use of the methodology. Leatherbee and Katilia [90] discover, in a quantitative evaluation of 152 American teams over 18 months using the NSF I-CORPS™ version of the lean startup (emphasizing customer discovery for hypothesis testing), that individuals with a masters in business administration (MBA) exert a negative moderating effect. Due to their learning by thinking vs. learning by doing training, these individuals initially resist the method's use, the generation of hypotheses, and the coalescence around an idea [90]. The authors highlight that the MBA exists as a critical boundary condition since this training emphasizes a learning-by-thinking orientation and resists the lean startup's learning-by-doing orientation [90]. However, they observe that MBAs appreciate the lean startup's value later and add to the process of analysis and business idea convergence within a mixed team [90]. These scholars also discover that team diversity exerts a positive influence on performance [90], an observation the Startup Genome [50] observes in its survey of +650 web startups.

Success and performance

Anecdotal experience

A relevant question concerning the lean startup focuses on whether its use translates to success. One particular area of interest relates to the concept of new venture performance (NVP), or the extent to which a new venture meets its goals concerning market share, profit margin, and return on assets [132-134]. Most lean startup experiences involve anecdotal experiences (e.g., reports, examples in books, cases) [1,12]. The General Electric FastWorks program, as discussed by Lashinsky [13] and Power [106], offers a notable example in which two divisions experience significant success. In this case, General Electric's use of the lean startup methodology appears to translate to success: (1) gas turbine (product development cycle two years faster and 40% less expensive, along with $2 billion in revenues); and (2) appliance (product development at half the cost and twice the rate and a doubling of its sales growth rate) [13,106].

The Startup Genome [50,105] project offers further unpublished insights. In analyzing survey responses from 650+ web startups, Marmer and colleagues [50] report greater success with startups in two specific areas. The first involves teams that learn [50]. Marmer and colleagues' [50] research indicates that these individuals raise seven times more money and realize three and a half times more time user growth. The second involves startups who pivot once or twice [50]. This research by Startup Genome observes that these teams raise two and a half times more funds, three and six-tenths times more substantial user growth, and 52% less likely to scale prematurely [50]. However, they identify other factors, such as founder experience and team mix, influence outcomes [50].

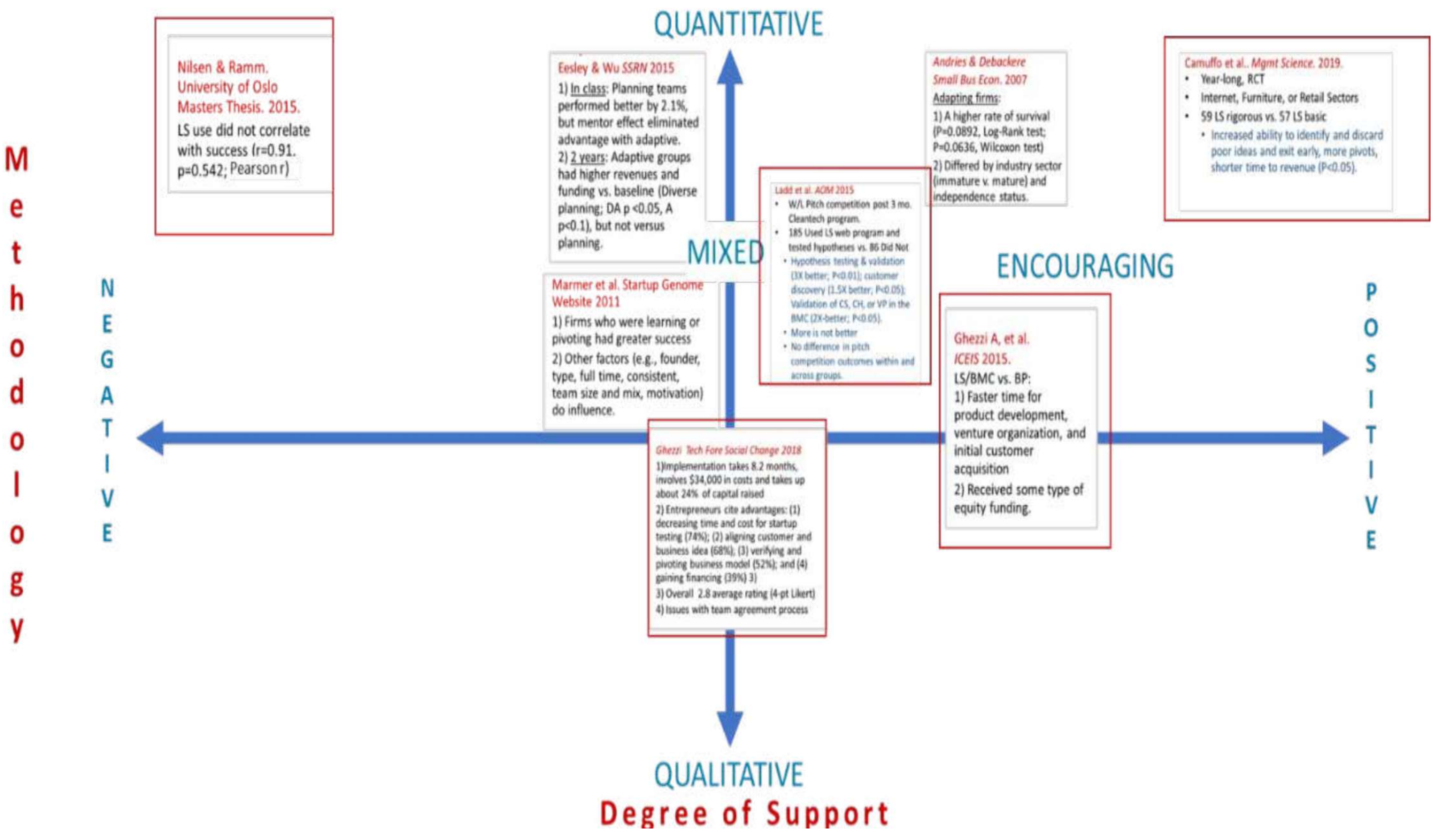
The I-CORPS™'s program, which utilizes customer discovery as its base process, represents another significant experience. Nnakwe and colleagues [135] from the University of Michigan highlight results as of March 2017 within a review paper on the I-CORPS™: 973 teams from 222 universities and leading to 320 startups (30% of teams) and $83 million ($259 thousand/team) in follow on funding [135]. VentureWell [136], a funding organization supporting the program, provides updated numbers: 1,450 teams from 230 universities and 600 startups (41% of teams) and $210 million ($350 thousand/team) in follow-on funding. Unfortunately, neither group offers a rigorous analysis in the empiric literature.

Empiric experience

The empiric literature around success or performance with the lean startup is nascent [18]. Several studies are beginning to shed some light on the impact of using a lean startup or lean startup-like practices (e.g., adaptation). These studies range from exploratory action-learning cases to mixed-methods approaches to more quantitative assessments (Figure 7).

Camuffo and colleagues [6] from Milan (Bocconi) provide some of the most rigorous data to date. The study evaluates a set framework and theory that a scientific approach improves the precision of entrepreneurial decision-making. Those who do so are more likely to exit and pivot [6]. This work involves a randomized control trial of 116 Italian early-stage startups (59 treatment, 57 control) on the Internet, retail, and furniture space, and 16 data points over a year. The treatment group engages in a more intensive training program on frameworks for predicting performance and conducting rigorous hypothesis tests. The investigators report significant effects (P<0.05, cross-section, panel, and survival analyses) in the treatment group versus the control group, concerning pivots from original ideas and revenue [6]. They also observe a significant effect (P<0.05) in the cross-sectional analysis (not the panel or survival case analyses) in 'Exits,' reflecting the ability of the firm to identify and discard poor ideas.

Also, Camuffo and colleagues observe the effects on time_to_acquisition (customer) (P<0.1) and time_to_activation (customer) (P<0.05) when considering the treatment groups with pivot, compared with the control group [6]. Finally, these investigators note a positive effect on time_to_revenue (P<0.05) when considering the treatment groups without pivots, as compared with the control group [6]. Such findings emphasize the importance of structured training and follow-up using a more rigorous scientific approach to the lean startup. It translates to much more effective entrepreneurial



Note: LS: Lean Start-up. The number of studies that evaluates LS (5), makes a comparison (3), includes over 100 teams, (2), and involves a randomized control trial (1).

Figure 7: Analysis of evidence supporting success with the lean startup (including adaptive or search strategies) [56].

decision-making and outcomes as a result [6]. Most significantly, they show that rigorous use of the methodology supports the lean startup's underlying premise related to speed [6].

Ghezzi and colleagues (Politecnico di Milano) offer additional insights from their work with the mobile space's use of the lean startup [7,10]. The first study involves a conference paper that describes a comparative case assessment using action research methods [7]. These investigators compare early-stage startups using the lean startup and the business model canvas (two teams) versus those using business plans (two teams) [7]. They find that the teams using the lean startup/ business model canvas realize better outcomes than those using the planning methods. In comparing lean startup/business model canvas versus business planning, respectively, these include: (1) shorter times for product development (3 and 4 mo. vs. 8 and 15 mo.), shorter venture organization (3.5 mo. vs. 9 mo. and 1.5 yr.), and the first customer acquired (1 and 2 wk. vs. 2 mo. and none); and (2) equity funding (2 lean startup, 1 business plan) [7]. This study is limited due to sample size and verticle. However, these observations prompt further investigation into the influence of using the lean startup methodology with the business model canvas on achieving critical milestones.

In a second study, Ghezzi conducts a comprehensive mixed-methods investigation of 227 early- to late-stage startups in the mobile space [10]. Data support the underlying theoretical foundations related to effectuation, bricolage, and creation [10]. This investigator reports that, on average, the lean startup's implementation takes 8.2 months, involves $34,000 in costs, takes up about 24% of capital raised [10]. Notable is that entrepreneurs cite several advantages that align with the value propositions around speed and product/market for the lean startup: (1) decreasing time and cost for startup testing (74%); (2) aligning customer and business ideas (68%); (3) verifying and pivoting business model (52%); and (4) gaining financing (39%) [10]. However, on a 4-point Likert scale, he notes that participants rate the approach 2.8 on average, raising some considerations about satisfaction at the individual level.

In the United States, Ladd and colleagues (Weatherhead) [95,137] share another experience involving 271 teams who self-select their use of an online platform using lean startup and business model canvas concepts (185 selected, 86 did not) in the clean-tech space. These investigators assess performance using a bimodal endpoint (award/no award) to assess pitch competition performance at the end of a six-month accelerator program [95]. In comparing users' and non-users' performances, they represent 13% and 7% of the successes within the whole group and 19% and 22% successes within each group, respectively [95]. However, those users validating their hypotheses (a significant hypothesis in the study) fare three times better in the competition ($P<.01$), and customer discovery is significant in enhancing success ($P<0.05$) [95]. Teams focusing on validation within the customer segment, value proposition, and channel pieces of the business model canvas are twice as successful than those who do not ($P<.001$) [95]. Such findings suggest that the methods and several essential areas of actual use appear to influence short-term outcomes [95]. Unfortunately, the number of validated hypotheses and concurrent hypothesis testing and customer discovery does not necessarily improve outcomes, suggesting decreasing returns with more extensive testing [95].

Interestingly, Ladd [138] extends his prior work with Kendall [117] around entrepreneurial cognition to highlight the effect of entrepreneurial self-efficacy (or ESE) on performance. In this more recent work surveying entrepreneurs, this scholar identifies that founders with high ESE levels bring more effective traits in defining, confirming, and rejecting hypotheses, with the latter translating significantly to realizing successful performance [138].

In another contribution, Harms and Schwery [130] offer insight into the lean startup capabilities' operational construct and their operationalization impact on project performance in meeting time and budget requirements by avoiding costly failures through early intervention [139]. These researchers use quantitative methods involving 100 software startups in Berlin (Startup Genome, 2017), including factor analyses, to identify essential capabilities: iterative experimentation, customer insight, validation, learning, and hypothesis testing [130]. A regression analysis of these data tests four hypotheses around the lean startup-performance relationship [130]. These researchers find that the use of these capabilities exerted a positive effect on project performance ($P<0.05$) but not on long-term performance (not tested) [130]. They also find that the venture's age influences performance; however, the degree of market or technologic uncertainty or innovation does not [130]. These investigators also confirm that moderating effect of the degree of innovation [130]. Finally, these researchers see a positive influence of mixed business-to-business and business-to-consumer business types on the lean startup-performance relationship [130].

In another study, König and colleagues [120] use a multidimensional quantitative content analysis to investigate relationships between stakeholders (e.g., customers, suppliers, people, and financiers) and performance indicators (e.g., survival and growth) in German digital and non-digital startups. These researchers engage 837 business plans from 242 ventures (and qualitative interviews) and examine the high-performing cluster of 23 digital ventures (average survival chance of 78% and a growth rate of 65%) [120]. They find that these ventures iterate their businesses early and search for ventures later. These investigators discover that the management team builds, tests, and supplies a digital product to the market that immediately creates revenue and uses the business model canvas [120].

In considering an adaptive (lean startup) versus a planning approach, Eesley (Stanford) and Wu (Wharton) [49] provide further insights on performance. These researchers examine students' short-term and two-year performance randomized to adaptive or planning-based approaches (with and without diverse mentoring) in an entrepreneurship class taught as a MOOC [49]. In the short term ($n=942$), students using the business planning approach perform better in course grading by 0.552 points ($P<0.05$) than those in the adaptive-only group. However, the diverse adaptive group closes the gap by an additional 0.538 points [49]. A two-year follow-on survey ($n= 554$) finds that those using both adaptive approaches fare better concerning revenue ($P<0.1$) and funding ($P<0.05$) [49].

Another study from Europe provides further insights into the adaptive approach. Andries and Debackere (University of Leuven) [119] offer additional insight into the adaptation-performance hypothesis. These scholars examine the survival rates in 117 entities (65 independent new ventures and 52 business units of established firms) [119]. Their survival and multiple variate analyses (Cox) of data from the annual CorpTech directory offer insight into the influence of adaptation (defined as at least one significant change in one's business model) [119]. They report that firms adapting their initial business models (i.e., pivoting or an adaptive strategy) experience higher survival versus non-adapting firms ($P=0.0892$, Log-Rank test; $P=0.0636$, Wilcoxon test) over the 15 mo. analysis period [119]. However, these researchers note that this benefit does not apply to all firms [119]. Further analysis reveals that survival benefits vary with types of business [119]. Adaptation benefits less mature, capital-intensive, and high-velocity industries versus more mature, stable industries [119]. Also, it benefits business units of established firms more favorably than independent firms [119].

In another study involving lean startup-like practices (effectuation and search), Yang and colleagues provide quantitative insights on profitability [60]. This investigation involves analyzing survey responses from 160 Chinese small-to-medium firms representing a mix of businesses and ages. In evaluating the dependent variables of profit growth and profitability, they find that more search activities translate to higher profitability in firms less than seven years of age ($P<0.05$) but not in older firms [60].

Finally, Nilsen and Rahm's research at the University of Oslo report a lack of correlation with success [140]. Their survey of s Norweigen startups includes information around the lean startup and the company's knowledge and use [140]. Using firm-specific data, they calculate a success score based on several questions clustered to define this variable [140]. These scholars report that the respondents are knowledgeable about the methodology [140]. However, these authors do not see the translation from knowledge to practice to success [140]. First, the analysis finds no significant correlation between knowledge and use (r=0.093, p=0.535, Pierson's r) [140]. More significantly, the analysis fails to identify a correlation between the use and the success score (r=0.091, p=0.542, Pierson's r) [140].

Current scholarly dialogue

The revisiting of the lean startup and experimentation: A *Long Range Planning* critique

Closing this discussion on the lean startup literature are a few papers that capture the recent academic conversation. Most notable is a critique by Felin and colleagues [59], who share their views in a *Long Range Planning* essay. This publication raises multiple concerns and critiques with the methodology [59]. This piece argues that the approach incorrectly characterizes a hypothesis generation basis and fosters experiments that translate to an incremental value generation [59]. These scholars proffer several challenges to the essential elements that underly lean startup, or the methodology uses [59]. Such a discussion makes for an extremely interesting paper; it problematizes and challenges some of the methodology's underlying assumptions and foundations but falls short of advancing a novel research question or agenda [141].

These scholars offer three critiques related to the methods and associated tools. These are mainly related to methodology's inability to develop a proper entrepreneurial theory to guide the process and lead novel, radical innovations, and businesses [59]. These critiques set up their arguments for entrepreneurial theory development and planning.

The first involves the application of lean manufacturing tenants to the entrepreneurial setting [59]. These underscore the existence of a mismatch with underlying principles of lean [59]. They argue that the methodology produces incremental improvements; such does not facilitate novel and radical breakthroughs, products, or industries [59].

The second highlights the lean approach's reliance on experiments with customer discovery and validation processes [59]. Such efforts use hypotheses (which they label as a fancy word for guesses) to gather external signals and validate learning via customer feedback [59]. They believe that learning from customers is overstated [59]. Further, Felin and colleagues [59] highlight problems with experience and learning, particularly relating to the incorrect learnings, myopia, and deceptions that can lead the startup and its investors astray (i.e., false positives or false negatives) [59]. These scholars add that such customer data do not lead to radically new products or innovation [59]. To this end, they emphasize the importance of the entrepreneur knowing what to look for and how to interpret the data [59]. These academics see this issue as a major limitation of the lean startup. It guides startups to product and business model ideas and opportunities that they can rapidly and transparently test with customers [59]. They underscore the tenant of having an anchoring entrepreneurial theory and an appropriate mechanism (tool) to sample, filter, and understand the incoming data to use [59].

However, Leatherbee and Katila [90] countervail this point by highlighting that probing relates to the formulation of new hypotheses positively and motivates new business ideas not previously considered (their hypothesis 2). Further, these researchers observe how I-CORPS™ teams formulate fewer new hypotheses via probing when converging on a business idea (suggesting a natural stopping mechanism) [90]. Finally, they observe how the teams utilize analytic input from their MBA member to guide analysis and more relevant assumptions to test [90].

Felin and colleagues' [59] third point aims at the business model canvas and experimentation [59]. These scholars raise concerns with the business model canvas's reality, as it lacks an apriori approach for generating exceptional hypotheses [59]. Further, they tie in the problems existing with the business model literature in that the concept and its definitions lack specificity and unity [59]. These authors do not find value in using the business model as a starting point for hypothesis-driven experimentation; rather, it should be the endpoint [59].

Nonetheless, Felin and colleagues [59] reveal their biases and their underlying thesis for their idealized startup strategy that they believe lean startup misses. This underlying view is the basis for the initial critiques. It sets up their argument that the most valuable ideas require almost an academic-like process of careful problem formulation, solution theory, and designing expensive experiments to exam the theory [59]. They add to this point the requirement for a significant commitment to a specific direction versus low-cost experiments [59]. Thus, rather than a demand-pull vantage that the lean startup brings, they proffer more of a supply-side view and rationalize the need for planning and a committed execution to the plan [59].

These scholars close by highlighting the value of research streams that stress the concepts of theory-development, problem-solving, and belief and commitment, along with their roles in guiding experimentation and strategy for startups [59]. They refer to a more rigorous, scientific approach of using lean startup Camuffo and colleagues [6] to exemplify their point [59]. However, it is critical to note that the lead author supports a more endogenous approach, as his poverty of stimulus argument exemplifies [75]. The overall thought with this piece is that experts in the space see weaknesses in the methodology's rigor and implementation and offer alternative views to develop innovative businesses [59]. Such points open up essential questions about the role lean startup plays, its implementation, its boundaries, and its overall value (vis-à-vis the definition and documentation of success) within the entrepreneurial process.

A scholarly response Felin et al. [59]: A *Long Range Planning* retort offering positive prospects for future application and research

However, Felin and colleagues' [59] essay does not stand alone without its critique. In addition to Leatherbee and Katila's [90], a recent paper by Bocken and Snihur [142] offer a counterpoint to Felin and colleagues' [59] critique. Furthermore, these scholar posits several opportunity areas and ideas for future research in their recent *Long Range Planning* piece [59].

In this essay, Bocken and Snihur [142] respond to three of Felin and colleagues' [59] comments. Their first addresses Felin and colleagues' [59] concern that the lean startup and the business model canvas lacks specificity to aid startups in creating unique, focused hypotheses (i.e., novelty) and critical experiments to test their theories [142]. Certainly, Bocken and Snihur [142] agree with Felin and colleagues' [59] that search for novelty is important. These scholars, however, retort that both Ries and Osterwalder, respectively, developed the lean startup and the business model canvas specifically for ideation purposes [142]. They argue that relative to ideation, these the methodology and the tool 1) do not suit the creativity needed and 2) fulfill the needs following the idea or opportunity identification with experimental design and testing. The second response centers on Felin and colleagues' [59] concern that lean startup reliance on customer feedback and immediate validated learning undersells the central task of composing novel theory and hypotheses, leading to a value and validation search in areas easy to observe. Bocken and Snihur [142] explain that the lean startup promotes experimentation as a low-cost, iterative, collective learning process involving customers and other stakeholders to reduce uncertainty. They support this point with three arguments [142]. These include 1) the need to test assumptions before committing to expensive execution; 2) the need to inexpensively refine and update unique value creation hypotheses with various stakeholders to attain significant novelty and impact; and 3) experimentation diminishes inertia and promotes continuous innovation [142]. In their third response, Bocken and Snihur [142] address Felin and colleagues' [59] point about promoting incremental experiments and value. These scholars emphasize that the lean startup is not associated (and should not be) with incrementalism. They explain that 1) the initial business-model idea, independent of the method's use, can be incremental or radical; 2) radical innovation can occur by chance during experimentation; and 3) incremental innovation might eventually lead to radical innovation [142].

Finally, Bocken and Snihur [142] use their paper as a platform to offer multiple opportunities in the context of business model innovation and impact. They posit several areas in which lean startup could function as an enabler for continuous experimentation, societal issues to explore, novel and impactful business models built collaboratively, and integrating other decision-making approaches into the entrepreneurial process [142]. These scholars conclude by embracing the importance of experimentation and business models and their relationships to innovation and value creation [142]. They advocate the lean startup as a critical advance to help firms develop business models for novel and impact. Further, they point to the need for further research, specifically around boundary conditions, the process itself, concurrent examination of environmental and societal goals, and moving from experimentation to scaling [142]. Hence, both these works proffer the opportunity for further empiric exploration to understand the methodology further, enhance and broaden its applications and value, and translate its benefits to scalable and meaningful efforts relative to new venture creation and society.

Closing the academic-practitioner divide: An *Entrepreneurship, Theory and Practice* contribution

Another relevant paper is by Shepherd and Gruber [143]. In this publication, these scholars highlight the academic-practitioner divide around the lean startup [143]. To bridge this gap, they describe core building blocks that make up the lean framework [143]. Shepherd and Gruber [143] proceed to outline the lean framework by tying in contributions from Blank (customer development, agile engineering, and MVP) [3,8], Osterwalder and Pigneur [5] (business model canvas), and Ries (build-measure-learn feedback loop) [1]. Using these elements, these authors propose a discovery-focused model consisting of five core building blocks: (1) finding and prioritizing opportunities; (2) designing business models; (3) validated learning; (4) building minimum viable products; and (5) persevere or pivot [143]. They explain that these building blocks engage with each other and several boundaries and modifying factors that influence the framework, such as the community of inquiry, environmental context, natural environment, and society [143].

Shepherd and Gruber [143] use this discussion to introduce the market opportunity navigator (Figure 8), a market identification and prioritization tool by Gruber and Tal [144], as a new addition to the framework [143]. This tool consists of three worksheets: (1) a market opportunity set, (2) an attractiveness map, and (3) an agile focus dartboard [144]. The navigator aids entrepreneurs in identifying, situating, and prioritizing market opportunities [144]. These scholars see it as an initial point to start the customer-development process by enabling entrepreneurs to select the most promising market opportunity to initiate the startup journey [143,144]. While this useful tool brings a nice addition to the lean startup package, it might require further work. Such efforts would enable it and its associated processes to connect more directly with the lean startup's core practice involving experimentation (i.e., Blank's testing of business model canvas assumptions via customer interviews [3,8] and Ries' use of the build-measure-learn loop to test hypotheses around the MVP [1]).

These scholars propose a research agenda within their discussion, which draws on the antecedent literature and blends practitioner knowledge with current and future academic research [143]. They highlight several key areas, including performance, imprinting effects, and considerations around applicability and achievement results. While these scholars acknowledge the vetting of some of the building blocks, they recognize that the performance effects of the framework as a unit remain to be more clearly defined [143]. Their discussion continues about imprinting decision rules, practices, and routines [143]. They note that such aspects may apply early but may not be relevant to the venture's performance and growth over time [143]. Finally, these authors delve into considerations or contingencies that may influence the framework's applicability or influence on performance [143]. Per Shepherd and Gruber [143], such examples can include available capital, parallel experiments, contextual factors, or degree of uncertainty and environmental dynamism. As part of this conversation, they raise internal and external contextual factor considerations, such as stakeholders and the environment [143].

Their discussion of the building blocks and framework sets the foundation for scholarly research engaging practitioners and meaningfully translating theory to practice [143]. Further, they find that the output of such efforts can lead to relevant deliverables [143]. Such outputs include practical implications sections in journal articles, published research in practitioner journals, and practice-focused books [143]. Their most notable outpoint from such academic work and insights involves developing and promulgating ready-to-use tools (e.g., Osterwalder and Pigneur's business model canvas and Gruber and Tal's market opportunity navigator) to enhance practitioner learning and efforts through their entrepreneurial journeys [144].

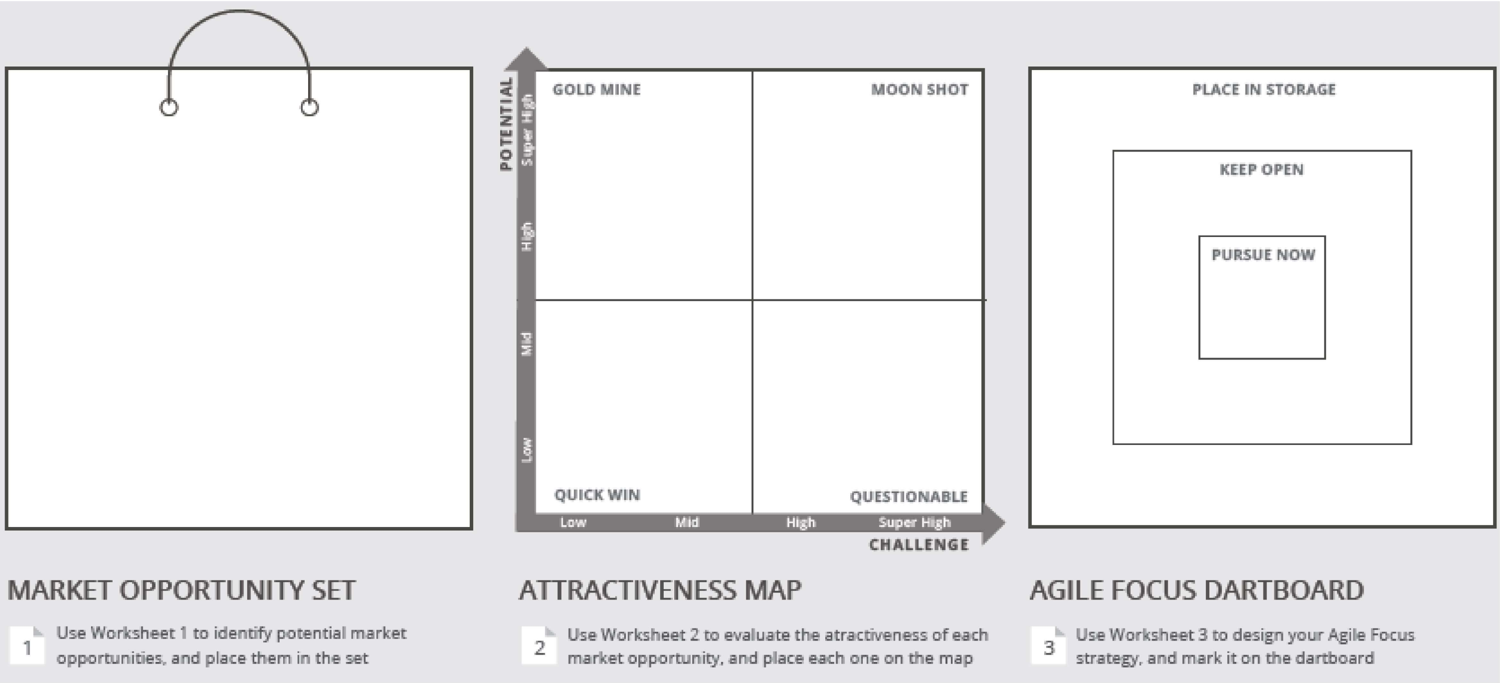


Figure 8: Market Opportunity Navigator Tools to Enable Entrepreneurs to Identify, Situate, and Prioritize Market Opportunities- Market Opportunity Set, Attractiveness Map, and Agile Focus Dartboard (Permission via Creative Commons License [144]).

Situating lean startup among several strategic themes- adjacent conversations and possible future directions: *An Industrial and Corporate Change* treatise

Finally, Contigiani and Levinthal [18] examine several lenses to view the lean startup methodology and proffer a research agenda. Their paper's goal seeks to link the lean startup concept with the management and strategy literature [18]. These scholars discuss several thematic areas: organizational learning, real options, new product development, and technology evolution [18]. Contigiani and Levinthal [18] chose these literature streams as they believe that these bodies offer the strongest conceptual association with the lean startup. First, they focus on organizational learning, as they link lean startup to experimentation and applying the scientific method to business development and the exploitation-exploration tradeoff [18]. Second, they compare real options versus the lean startup related to go or no-go vs. iterate, pivot, preserve, or discard decision options and simultaneous versus linear, sequential experiments [18]. Third, product development highlights the importance of integrating customers, experimentation, and flexible new product development (versus traditional) [18]. Finally, in examining technology evolution, these scholars comment on three areas [18]. These include 1) the competing forces of demand-pull of the market and technology-push from the supply side, 2) the process and patterns of technology evolution (via market spaces, applications, and users, and products), and 3) the iterative nature of both technology advancement with market feedback that leads to enhanced capabilities and the selection of winners to advance for in the marketplace [18].

The paper continues by comparing the five approaches and discussing various drivers and boundaries. These authors situate lean startup related to the unit of analysis, initiatives, feedback, selection criteria, and flexibility (Table 2) [18]. This comparison highlights lean startup's unique attributes as related to these criteria [18]. They continue by identifying tech and economic drivers favorable to lean startup key characteristics: experimentation, flexibility, and market feedback [18]. Notable examples are the rise of web-based applications with updates, cloud computing, the open-source movement, the decreased cost of experimentation, and democratic forms of financing such as Kickstarter [18]. These scholars also identify boundary conditions, including the cost of experimentation, the nature of technology and business settings, and disclosure of strategic information [18]. Further, they highlight issues with experimentation: obtaining significant samples target for early adoptors, representativeness of tested population, the time to financial payoff, the business implications of feedback, the team's continued motivation and engagement with multiple experiments reputational considerations [18].

In closing this paper, Contigiani and Levinthal [18] raise research considerations for entrepreneurial and established ventures. The first areas include a performance threshold of experimentation using an MVP and feedback [18]. Related to this area involves defining fit, as in P/MF, appropriately, such as customers and needs, financial returns, founder aspirations, and societal considerations [18]. They continue to discuss considerations related to a startup versus an established firm related to P/MF and investment [18]. Finally, these scholars highlight the consideration of lean startup's singular, shapable development trajectory versus having a backup plan [18].

Situating lean startup versus other methods- a *Small Business Economics* juxtaposition of effectuation and several entrepreneurship methodologies

Like Contigiani and Leventhal's [18], Mansoori and Lackleus [38] situate the lean startup, among other approaches. In their recent *Small Business Economics* paper, these scholars examine effectuation and several common entrepreneurial methods [38]. They juxtapose effectuation with discovery-driven planning, prescriptive entrepreneurship, business planning, design thinking, and the lean startup. These authors propose a three-tier framework of logic, model, and tactics [38]. They then offer a three-step conceptual framework- 1) analysis of the methods across the three levels, 2) compare the methods across levels of logic, model, and tactics, and 3) develop a framework of nine conceptual dimensions to compare entrepreneurial models [38].

Mansoori and Lackleus [38] discussion provides a comprehensive analysis of the different methodologies among the nine dimensions: 1) uncertainty management; 2) resource management; 3) knowledge expansion; 4) redirection power; 5) continuous learning; 6) iterative process; 7) stakeholder interaction; 8) team collaboration; and 9) value creation. Table 3 summarizes the comparisons. Overall, Mansoori and Lackleus [38] observe that these methods share some similarities but maintain distinct differences. While their analysis focuses on effectuation, one can compare the different methods with the lean startup.

This paper already discusses lean startup comparisons with design thinking and effectuation relative to the nine conceptual dimensions (Table 3) [38]. In juxtapositioning these different approaches, Mansoori and Lackleus [38] find that lean startup shares commonalities with several of the methods (denoted as a +). Discovery-driven planning aligns relative to knowledge expansion and redirection power. Design thinking also partakes in iteration, continuous learning, and stakeholder interaction. For iteration, it embraces an iteration process and stakeholder interaction like the lean startup. Prescriptive entrepreneurship shares similarities around continuous learning.

These researchers then provide a further visual analytic comparison based on grading of weighted criteria and radar charts [38]. This analysis that the lean startup shares similarities among the nine dimensions with effectuation (except for continuous learning), design thinking (except for resource and uncertainty management, and team collaboration), discovery-driven planning (except for redirection power, stakeholder interaction, and team collaboration), and prescriptive entrepreneurship (except for redirection power and resource management). The lean startup did not share any commonalities with business planning.

These scholars close this paper recommend going beyond effectuation as

Table 2: Comparison and situation of the lean startup characteristics with those from relevant literature streams (Adapted [18]).

	Unit of Analysis	Initiatives	Feedback	Selection Criteria	Flexibility
Lean Startup	Entrepreneurial Venture	Single	Product Markets	Product/Market Fit	Pivot
Organizational Learning	Individual Group Institution (Firm)	Single	Focal Performance Dimension	Aspiration Level	Local and Distant Search
Real Options	Institution (Firm)	Multiple	Signal (Tech or Product/ Market)	Anticipated Economic Payoff	Across Options, Not Within
Product Development	Research and Development Team	Multiple to Single (Funnel)	Technical Performance	Gating	Iterative Refinement
Technology Evolution	Technology Trajectory	Ecology of Possible Trajectories	Product Markets	Iterative Refinement	Iterative Refinement and Shift in Application Domain

Table 3: The situation of the lean startup with effectuation and other entrepreneurship methodologies among nine conceptual dimensions. – No characterization exists (-) No commonality with the lean startup. (+) Shares commonality with the lean startup. (Adapted [38])

Dimension	Lean startup	Effectuation	Discovery-driven planning	Prescriptive entrepreneurship	Business planning	Design thinking
Uncertainty management	Test present vision to shape the future	Manage the present to create the future (-)	Continuous data collection for better decisions (-)	Proactive search for a consideration set matching previous knowledge/ experience (-)	- (-)	- (-)
Resource management	Reduce waste via iterative, incremental processes	Expand resources and leverage slack via stakeholders (-)	Mix existing and slack resources. Define resources needed to acquire. (-)	Resource reorganization based on environmental signals. (-)	Anticipate all require resources for plan execution. (-)	- (-)
Knowledge expansion	Hypothesis formulation and testing	Start with what you know, who you are, and whom you know. (-)	Reduce assumption-to-knowledge ratio before commitment. (+)	Prior knowledge to select info channels. (-)	Compile self and historical data into a plan. (-)	Observe what individuals do, think, want. Document insights. (-)
Redirection power	Pivoting based on new data pointing to changing direction.	Leverage contingencies. Let stakeholders help shape the direction. (-)	Systematic redirection with the conversion of assumptions to knowledge. (+)	Revise consideration set if one does not find environmental signals. (-)	- (-)	Empathy with users to identify new directions with prototypes. (-)
Continuous learning	Analyze and learn from customer interaction data.	- (-)	Maximize by reducing the assumptions-to-knowledge ratio. (-)	Update consideration set in response to learning while searching. (+)	- (-)	Insights from frugal prototypes. (+)
Iteration process	Build-measure-learn cycle	Iterative effectuation cycle (+)	Cycle back the process via reverse income assessment and revision. (-)	Revise preferred info channels based on feedback. (-)	- (-)	Cycle with idea refinement and the surfacing of new directions. (+)
Stakeholder interaction	Interact with as many individuals as possible to obtain feedback.	Search for by "asking" individuals to contribute. (+)	-	-	- (-)	Observe people. Use insights to build prototypes and test on real users. (+)
Team collaboration	-	Let committed stakeholders join the team. (-)	- (-)	Use a team-based consideration set to maximize information access. (-)	- (-)	Involve people with interdisciplinary knowledge from the beginning. (-)
Value creation	Before resources comitted, ensure the idea solves the customer problem.	Transform means into something valuable for stakeholders. (-)	Reverse income statement points to profit objectives. (-)	Appropriation of venture idea value to create wealth. (-)	- (-)	Ensure your prototype creates user value. (-)

the dominant logic and embrace terminology of entrepreneurial methods, of which lean startup exists as one, to narrow the existing rigor-relevant chasm between scholarly- and practitioner-grounded methods [38]. Such an approach can enhance the teaching, understanding, and successful implementation of the entrepreneurial process by drawing on and leveraging the strengths of each method [38]. Further, they advocate an ontological change, moving from observation-based research to involve more active academic-practitioner collaborations to collect rigorous data around what methods work, for whom, and under what conditions [38].

A valuable examination of the lean startup's peer-review publications offers valuable considerations and a research agenda: An *International Journal of Entrepreneurial Behavioral Research* systematic literature review

Silva and colleagues [145] published in 2020 a systematic literature review analyzing 71 publications to address questions on (1) the existing research covering lean startup, agile, and customer discovery regarding business model innovation; (2) complementary practices and tools; (3) organizational impacts of implementing; and (4) critical success factors for execution. This review reflects the current scope of conference papers and publications in the peer-reviewed literature, with significant journal contributions growth over the last five years [145]. Their descriptive analysis reports that the predominant number of contributions emanating from European nations (28%), involving multiple case studies (30%), and covering information and communication technology (59%) [145].

Their content analysis reflect research questions specific to (1) integration with other methodologies (or propose a new model/framework); (2) impacts on organizations; and (3) critical success factors [145]. Regarding integration, they note how the lean startup methods tie with design thinking or agile approach, how most studies are descriptive, offer little empirical application, and lack results, examples, guidelines, and theoretical lenses to future research and contribution [145].

Concerning the impact on organizations, this section offers the most robust discussion [145]. These scholars focus on both established firms and startups and highlight benefits (e.g., saving time and costs, aligning business ideas with customer needs, verifying/pivoting business ideas, obtaining financing, alternative to traditional intellectual property protection, reducing uncertainty and fear about innovation) [145]. Further, they point to that many established small-to-medium, and large firms do not use such venture experiments but could benefit from such practice. These scholars also discuss the implications around pivots (e.g., understanding, metrics) but highlight gaps regarding the impact of multiple pivots and their sequence (parallel or sequential) [145]. These authors offer an example of social impact [145]. Finally, they cite work arguing that the methodology and user involvement hinders breakthrough innovation [145]. Such observations highlight the need to understand the organizational learning process involved, the mechanics to optimize consolidation around a sustainable product or business model (i.e., P/MF), and the need to quantify effectively such actions on performance vis-a-vis empiric-driven research.

Moving to critical success factors, Silva and colleagues [145] find limited contributions. The citations they high discuss several areas, including customer interactions, the MVP (relevance of interface, diving into different learning objectives), experiments (size, objectives, selection), co-creation and involving multiple stakeholders, organizational structure, and short- and long-term priorities [145]. Surprisingly, this section fails to provide concrete critical success factors that practitioners and scholars can use. This observation reflects a significant gap in the literature.

In closing this review, these scholars proffer a lean startup staircase roadmap reflecting specific build-measure-learn objectives spread over time [145]. They also note that the literature falls short in guiding the adoption and researching of the methodology [145]. Furthermore, they raise multiple questions based on the thematic analysis of the lean startup, agile, and customer discovery concerning business model innovation [145].

Discussion and conclusions

The lean startup is an extremely popular methodology designed to help ventures navigate uncertainty and improve their odds of success rapidly and efficiently. This approach embraces a hypothesis-driven process for developing successful new enterprises by identifying and validating scalable products and business models. The lean startup's value resides in its ability to help entrepreneurs resolve marketplaces and business sectors where significant uncertainty exists. This methodology consists of several essential practices ranging from defining a vision and hypotheses to setting up experiments and learning from these trials. It is one that many in academics, incubators, government-sponsored programs (e.g., I-Corps™), and corporations (e.g., General Electric) use [1,2,13,106,135,136].

The lean startup academic conversation is evolving as it engages a more scholarly perspective and contributions continue to provide more robust empirical evidence. This paper examines four relevant questions concerning this methodology. These include: (1) what is the current state of understanding of lean startup concerning its foundations; (2) what empiric literature describes the recent experience with the methodology; (3) what does the literature reflect regarding the impact on outcomes and performance; and (4) what can scholar and practitioners learn from the current academic contributions regarding the approach and areas to explore further.

This paper summarizes many of the important considerations related to the lean startup's foundational underpinnings in considering these questions. Such influences range from its antecedents to concepts that provide more of a theoretical foundation. This discussion identifies several important antecedents. These include the ideas of lean manufacturing, discovery-driven planning, disciplined entrepreneurship, and probe and learn. It also delves into several theoretical concepts. These include effectuation, bricolage, creation theory, dynamic capabilities, organizational learning, and real options theory. Finally, one review of the scientific evidence finds support to multiple lean startup practices [12]. This work cites the degree of evidentiary support concerning: (1) user and customer involvement in product or business development (very strong); (2) iterative new product development (strong); (3) effectual thinking (strong); (4) experimentation in new product development (medium); and (5) early prototyping (i.e., MVP) for proof-of-business (medium) [12].

These contributions help to solidify the foundation underlying the methodology. As a practitioner-driven approach, the experience with the lean startup involves a significant amount of anecdotal evidence. This consideration leads to the examination of empiric contributions to the literature. While this literature is nascent, it is evolving and adding valuable insights every year. Academics and practitioners provide a mix of empiric experiences. They are using and evaluating the methodology globally. Some highlight practitioner experiences, while others offer insights from their use in the educational setting.

Furthermore, both practitioners and scholars raise some issues associated with the methodology related to interviewing, experimentation, the MVP, the business model canvas, team consensus, and scaling. Such issues may not necessarily be related to the methodology alone. Instead, other factors (e.g., use in practice and influence of culture, educational training, business sector) may either exert a moderating effect, limit optimal use, or influence performance outcomes. Such considerations may set forth boundary conditions for using the methodology, particularly in low technological/high market uncertainty (e.g., software).

Empirical studies find mixed results relative to the influence of the methodology on performance and business outcomes. This literature is nascent, with eleven studies culled during this review. Of these, only one significant investigation stands out. This year-long study by Camuffo and colleagues [6] highlights the importance of a rigorous approach to training and implementing this scientific-driven methodology in enabling the entrepreneur to discard, pivot, and achieve revenue [6]. Such findings highlight the need for ensuring its rigorous and consistent use.

Finally, the current conversation among academics offers a mix of perspectives and opinions. Some, such as Felin and colleagues [59], are harsh in their review, in which they challenge the method's underlying assumptions and practices. Some, such as Contigiani and Levinthal [18], Brocken and Snihur [142], and Shepherd and Gruber [143], see opportunities and avenues to explore further. Silva and colleagues [145] pull together a systematic review of the literature, with three significant themes, including (1) integration with other methodologies (or propose a new model/ framework); (2) impacts on organizations; and (3) critical success factors. This work also finds that the literature falls short in guiding the adoption and researching of the methodology [145]. Furthermore, Shepherd and Gruber's [143] recent publication highlights multiple opportunities to bridge the existing divide between academics and practitioners concerning the lean startup. It also provides an additional tool (the navigator) that practitioners and scholars should explore to integrate with the lean startup's core venture experimentation-based activities [143]. Finally, in juxtaposing the lean startup with several other methods, Mansoori and Lackeus [38] share Shepherd and Gruber's [143] perspective to narrow the academic-practice divide. These scholars advocate embracing multiple approaches, including the lean startup, to narrow this chasm and to seek more active academic-practitioner collaborations to collect rigorous data around which work, for whom, and under what circumstances [38].

To this end, such discussion leads to many interesting questions to pursue. Such queries include the setting of use, the business sector of use based on risks to mitigate, the extent of rigor for its use, training, and the ideal stage of a venture for use. Furthermore, provocative queries exist around the influence of the methodology on the entrepreneur, organization, and venture ecosystem and what parameters to use to define its impact, including mid-to-long term performance outcomes (e.g., survival, growth, three-year revenues). Such areas only indicate that while the literature is starting to mature, questions do exist. Further work needs to solidify the methodology's foundations and define its practical effects on new ventures, including organizational learning and performance.

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