PART IV

Emerging Themes and New Research Domains of POM
13
BUSINESS STARTUP OPERATIONS

Nitin Joglekar, Moren Lévesque, and Sinan Erzurumlu

1 Introduction

Entrepreneurial business startups have been the lifeblood of the private economy sector with varying degrees across countries (Acs et al. 2008). Some of the most entrepreneurial countries exist in the developing world. For instance, the Global Entrepreneurship Monitor (GEM) ranks the top three countries as Uganda, Thailand, and Brazil, with China ranked 11th and the U.S. ranked 37th (GEM 2014). A 2015 study by the Kauffman Foundation shows that approximately 530,000 new businesses were started in the U.S. each month (Kauffman Foundation 2015). According to the U.S. Small Business Administration, small businesses have provided 55% of all jobs and 66% of all net new jobs since the 1970s (USSBA 2015). Amidst high activity and heightened interest in business startups, these businesses face severe organizational and fiscal constraints causing the failure of most within five years of their starting up. However, some exceptional startups, referred to as unicorns (CB Insights 2015), have shown spectacular valuation growth. Unicorns are defined as firms reaching well over $1 billion in valuation in a short period of time and becoming major economic/social entrepreneurship successes.

This chapter describes the contribution of the operations management (OM) field to entrepreneurship and startup practices. As examples of unique operational innovations (OIs) in startup settings, readers may recall well-documented news stories about two unicorns: the transportation firm Uber with its yield management strategies (Surowiecki 2014) and the hospitality firm Airbnb with its quality management practices (Pfeffer 2014). We define business startup operations as a configuration of resources and activities at nascent organizations that are geared to create, organize, and grow businesses based on the manufacturing of a product or delivery of a service.

We address several aspects of business startups in this chapter. First, startups are subject to three distinctive operational constraints on, or lack thereof, resources, routines (or processes), and reputation—also referred to as 3Rs in this chapter—that are affected by the capabilities of entrepreneurs as well as the uncertain, dynamic, and complex environment in which they operate (Zahra et al. 2011). Asset acquisition and process configuration also take shape as the startup progresses from opportunity discovery to commitment to organization growth—i.e., through the entrepreneurial value chain (Joglekar and Lévesque 2013)—contingent upon marketing acceptance, technology evolution, and execution efficacy. We explain these stages (i.e., discover, commit, organize, and grow) in detail in Section 2.
Second, the emerging operational structure of startup adds a unique layer of complexity and risk to activities associated with market development, technology development, and execution, whereas “established” firms already may have easy access to resources and well-organized routines. While lack of resources and routines generates inherent uncertainties, such uncertainties may not be easily overcome by startups that have not established a reputation or business history, making them highly vulnerable to vagaries of the venture lifecycle. Lack of reputation limits access to capital and startups may be unable to raise cash as needed. Their operational decisions are hence restricted by debt and other financial considerations (Berger and Udell 2003).

Third, while startups’ efforts may be typically examined within small and medium-sized enterprises or SMEs—a glossary of relevant terms is provided in Table 13.1—we do not ignore entrepreneurial activities within large firms, which has also been referred to as intrapreneurship or corporate venturing. Family-owned businesses are a major segment of the SME literature (Sharma 2004), but we exclude specific startup issues related to such businesses for brevity. Lastly, akin to the domain of international entrepreneurship, we consider startups that create future goods and services through the discovery, enactment, evaluation, and exploitation of opportunities across national borders (Oviatt and McDougall 2005).

This chapter’s organization and resulting contribution follow a two-part setup: what we know about startups and what we observe as emerging trends. We open by exploring the body of knowledge in the OM-entrepreneurship interface regarding venturing creation and technology commercialization throughout the entrepreneurial value chain. To establish what is already known about startup operations, we summarize published reviews covering the 2001–2011 period and then augment this summary with publications from the 2011–2015 period. This review effort has yielded five overarching principles—termed as the 3R Principles for startup operations—that we describe in the next section.

In the later part of this chapter, we take a close look at recent developments in lean operations, data analytics, and intelligent robotics that have pushed the boundaries of business practices and created opportunities for startups in new contexts (e.g., digital technologies and platforms) and new economies (e.g., circular economy—i.e., supply chains involving almost zero waste and pollution, either by design or intention). We use this evidence to argue that a central idea of entrepreneurial thinking involving constant improvisation and adaptation requires a tight alignment between evolving business model innovations (BMIs) and OIs. BMI refers to the way a firm generates revenues, limits costs, and provides its customers with a unique value proposition in a competitive marketplace (Girotra and Netessine 2013). OI refers to practices of solving problems and creating new opportunities through non-traditional applications of OM decisions such as inventory management, quality management, and supply chain design. These innovative operations based on novel technologies, such as digital connectivity-based capacity management practices in

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<td>BMI</td>
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<td>CBA</td>
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emergent firms like Uber, are yet to be codified systematically through a body of formal studies in OM journals. We thus lay down anecdotal evidence on OIs in emergent businesses including the transshipment optimization model at Zipcar, yield management strategies at Uber, quality management practices at Airbnb, the reconfiguration of manufacturing systems at Rethink Robotics, and the reconfiguration of supply chain delivery at Kiva Systems.

We use this anecdotal evidence to point to potential research opportunities associated with 3R-related principles through the alignment between OIs, digital technologies, and platforms; connectivity-based analytics; and evolving business models and then discuss managerial implications of our findings in the startup operations context.

2 What We Know about Business Startup Operations

2.1 Review Articles

We draw upon a body of knowledge from mostly, but not limited to, OM-related research on how to create, organize, and grow business startup operations. We highlight two review articles featured in recently published special issues with focus on OM and entrepreneurship in the *Journal of Operations Management* (JOM) and the *Production and Operations Management* (POM) journal. We also draw upon a third review article from the *Journal of Management* on entrepreneurial decision making in order to provide perspective.

In the *JOM* 2011 special issue “Operations Management, Entrepreneurship, and Value Creation,” Kickul et al. (2011) took a cross-disciplinary lens to OM and entrepreneurship. They highlight four issues for further consideration. First, OM may offer the best means to improve the efficiency of startups that produce or sell a good or service that is already available to other sources through supply chain management techniques. Second, large and small firms can explore comparative advantages to exploit: While large firms can offer the advantages of economies of scale and scope, smaller firms can be agile in creating new products or services. Third, OM can examine the viability of startups in terms of operational efficiency, customer service, and risk-management process analysis. Fourth, startups must also deal with governmental and administrative bureaucracies, which can be explored with the role of human behavior in OM.

In the 2013 special issue of the *POM* journal, “Technology Commercialization, Entrepreneurship & Growth Driven Operations,” Joglekar and Lévesque (2013) provide a comprehensive review of research that brings out differing operational decisions specific to the discovery, commitment, organizing, and growth stages that form the entrepreneurial value chain. During the discover stage the entrepreneur can discover and assess the opportunity. At the commit stage, s/he begins committing her/his and other’s human/financial resources to the newly formed venture. The organize stage is where ongoing and future needs are established and activities are organized to reach these needs and enable the opportunity to transform into a business that can release a product. At the grow stage, the product achieves some market success, and the venture itself must grow. They propose an evolutionary path for the use of resources, routines, and reputation—the 3Rs—that are often lacking in the four stages of the entrepreneurial value chain. Based on their literature review, they take a comprehensive view of operational decisions. They further identify threats and opportunities for emergent firms’ decision making and unique operational tradeoffs, due to shortages of the 3Rs through the entrepreneurial value chain.

In addition to these focused issues on the operations-entrepreneurship interface, Shepherd et al. (2015) provide a review from mainstream entrepreneurship journals on judgment and decision making. Their focus is on key decisions in the primary activities of the entrepreneurial process and the entrepreneur’s choices including opportunity-assessment, entrepreneurial-entry,
opportunity-exploitation, and entrepreneurial-exit decisions; heuristics and biases in the entrepreneurial decision-making context; characteristics of the entrepreneurial decision maker; and environment as a decision context. In particular, entrepreneurs are diverse in terms of their background (i.e., knowledge, experience, abilities, attitudes, self-perception) and more biased towards taking risks in their decision making than non-entrepreneurs. They also operate in complex and dynamic environments and are heterogeneous in their perceptions of the environment, including industry, market, competitive, and institutional factors.

Therefore, conventional operational decisions, such as ordering capacity, must be adjusted by operations managers in startup settings to include 3R constraints and behavioral biases. These findings, with suitable adjustments to 3R decisions, are also applicable to intrapreneurial efforts in established technology and service firms such as 3M and Disney (Li 2008; Kenney et al. 2010). Antoncic and Hisrich (2001) have argued that intrapreneurship increases productivity, thus supporting a stronger work ethic and instilling pride in accomplishment. It can engender new products and services that are vital to economic survival and growth.

### 2.2 Findings in Recent Publications

To provide an update on how scholars in the OM and entrepreneurship fields have investigated business startup issues, we extend the 10 × 4 framework in Joglekar and Lévesque (2013: 1325–1326) by adding articles published between 2011 and 2015. We assemble a dataset of 38 articles at the OM-entrepreneurship interface published in seven journals (and after the review articles featured in Section 2.1): Management Science, Production and Operations Management, Journal of Operations Management, Manufacturing & Service Operations Management, Entrepreneurship Theory & Practice, Journal of Business Venturing, and IEEE Transactions on Engineering Management. We then offer (see Table 13.2) selected (i.e., one example per cell) questions and tradeoffs in a 10 × 4 matrix whose categories are consistent with the Joglekar and Lévesque’s (2013) review. The ten rows represent well-established decision categories in the OM literature:

(i) Technology commercialization and adoption  
(ii) Location, market selection, and network design  
(iii) Product/service design and launch  
(iv) Lean operations, flexibility, line balancing, and process design  
(v) Scheduling, batching, and task design  
(vi) Inventory and supply chain management  
(vii) Quality, reliability, and process improvement  
(viii) Aggregate, capacity, workforce, and integrated planning  
(ix) Project, portfolio, and risk management  
(x) Environmental sustainability.

The number of articles that fit in the “discover,” “commit,” “organize,” and “grow” stages (the 4 columns of the 10 × 4 matrix) amount to 7, 5, 12, and 14, respectively. We categorize these articles into product- and/or service-oriented startups. For brevity, articles examining the manufacturing and/or supply chain associated with a product are included within product-oriented startups. For articles on software and information technology, we categorize them as either a product- or service-oriented startup depending on how the proposed technology serves customers. In this sample of thirty-eight articles, we classify twenty-nine as product-oriented and eight as both product- and service-oriented, with the remaining article classified as purely service-oriented. Each of the forty cells in Table 13.2, except for two cells where no relevant article is
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<tr>
<th>Topics and Review Articles</th>
<th>Entrepreneurial Value Chain</th>
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<tr>
<td><strong>Technology commercialization &amp; adoption</strong></td>
<td><strong>Discover</strong></td>
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<td>Schmidt &amp; Druehl (2005): When can a new technology substitute an existing product, based on depth and breadth (with respect to the reservation price curve) considerations?</td>
<td>Habib et al. (2013): What are the implications of the decision to spawn or to retain a new product for the nature and evolution of the firm?</td>
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**Location, market selection, & network design**

Dahl & Sorenson (2012): What are the performance implications of entrepreneurs’ location decisions?

Kouvelis et al. (2004): What are the tradeoffs in selecting global facility locations, while incorporating logistics, government subsidies, trade tariffs, and taxation issues?

Musteen & Ahsan (2013): What is the conceptual model of offshoring of knowledge-intensive, complex work by young, entrepreneurial firms?

Giloni et al. (2003): What are the tradeoffs in designing distribution systems to maximize profit with multiple time periods, with growing demand for capacity, while accounting for pricing and competition in various channels?

**Product/service design & launch**

Erat & Krishnan (2012): What are the drivers of outside agent’s search dynamics? How do the awards, problem specification, and structure of the design space influence the number of searchers and breadth of induced search?

Lim et al. (2001): What are the conditions under which an entrepreneur can penetrate an established market via channels other than authorized distributors (a.k.a. gray marketing)?

Anderson & Parker (2013): How does a startup integrate its service or product with one or more complementary technologies in market entry?

Deligianni et al. (2014): What is the relationship between innovation and product diversification as growth strategies for new ventures?

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<td><strong>Lean operations, flexibility, line balancing, &amp; process design</strong></td>
<td><strong>Discover</strong></td>
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<td>No article found in our sample of journals.</td>
<td>Atwater &amp; Chakravorty (2002): When is 100% utilization of a primary constraint in drum-buffer-rope system not optimal?</td>
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<td><strong>Scheduling, batching, &amp; task design</strong></td>
<td>Komish &amp; Ulrich (2011): When efforts to generate ideas are conducted in parallel, how likely are the resulting ideas to be redundant and how large are the opportunity spaces?</td>
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<td>No article found in our sample of journals</td>
<td>Swinney et al. (2011): When the size of the market is unclear, how does a survival probability maximizing startup choose how much capacity to build?</td>
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<td><strong>Inventory &amp; supply chain management</strong></td>
<td>Girotra et al. (2010): Can the quality of ideas be increased by managing the idea portfolio (e.g., size and variance) and teaming process sequence?</td>
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Aggregate, capacity, workforce, & integrated planning

Chwolka & Raith (2012): What is the value of business planning before startup, or should the entrepreneur even bother to plan before making the decision of whether or not to enter the market?

Tatikonda et al. (2013): What is the role of operational capabilities in enhancing new venture survival during different phases of a venture's life cycle?

Azadegan et al. (2013): What is the role of operational slack on firm survival during its venture stage when its survival is significantly challenged by environmental threats?

Goodale et al. (2011): How do operations control variables act in concert with the determinants of corporate entrepreneurial activity to promote the innovation outcomes that facilitate long-term organizational success?

Project, portfolio, & risk management

Marion et al. (2012): How can large firms start “thinking small” to instill entrepreneurial spirit in their R&D teams?

Fairchild (2011): What are the effects of economic and behavioral characteristics on an entrepreneur's choice between a business angel and a venture capitalist?

Haeussler et al. (2011): How can new firms maximize the benefits of strategic alliances to gain access to knowledge, resources, and capabilities while reducing their risks?

Levesque et al. (2012): In their attempt to grow, how do firms invest in resources (i.e., R&D and SG&A) while considering variations in these resources' growth rates?

Environmental sustainability

Girotra & Netessine (2013): How can a manager identify new business models by understanding the context of decision making in existing models and the associated inefficiencies?

Debo et al. (2006): How do firms plan for substitution between new and remanufactured products, subject to a constraint on the diffusion of remanufactured products due to the limited supply of used products that can be remanufactured?

Erzurumlu et al. (2014): How can operations design hedge risk and enhance project valuation in technology development and deployment stages for clean tech startups?

Noori & Chen (2003): How does one conduct scenario planning for the evolution of the demand for environmental products involving technology and operational uncertainty?

*indicates an article from *Journal of Business Venturing* or *Entrepreneurship Theory & Practice.*
available, lists a research question on that particular OM topic at a specific stage of startup. The key issue associated with each of these questions is to demonstrate how the context for startup operations can yield managerial insights that are different from conventional findings for established firms. We refer the reader to each cited article to look for further insights. We next offer five 3R-related principles about the assembly and deployment of resources, operating routines, and (brand or market) reputation emerging from our review; we deploy the term “principles” to suggest that these observations apply across multiple cells.

**Principle 1: Startups operate on the basis of multiple objectives and constraints in non-traditional ways.** While startups establish stable routines and processes to meet conventional demands of institutional environments for growth, they explore non-traditional ways of utilizing operational resources and routines to overcome constraints and improve performance. For instance, startups can overcome capacity constraints with pricing (Shen et al. 2014), financial and technical constraints with co-development partnerships (Savva and Scholtes 2014), and fairness perception by involving experienced entrepreneurs (van Burg and van Oorschot 2013). Startups also deploy multiple objectives and constraints. For instance, at the commitment and organizing stages, a 3R-constrained startup can improve its performance by mobilizing resources (Villanueva et al. 2012), invest in process improvement and production (Tanrisever et al. 2012), develop capabilities with resources such as inventory and employees (Tatikonda et al. 2013), complement shortages with supplier involvement (Song et al. 2011), and seek to enhance survival likelihood by altering capacity investment timing (Swinney et al. 2011).

**Principle 2: Startups utilize alternative and relatively unique sources and processes for idea generation at the discovery stage when compared to their established counterparts.** A startup may, for example, use at the discovery stage an incremental OI to fine tune a product offering or a radical idea to reposition the revenue model (i.e., the manner in which it generates its revenue), while also looking for idea generation and validation through crowdsourcing. In fact, Mollick (2014) as well as Wooten and Ulrich (2015) discuss Kickstarter.com and 99designs.com as examples of idea generation and validation through crowdsourcing platforms. OM scholars have examined multiple ways of idea generation externally, especially in terms of the likelihood of redundancy when idea generation is conducted in parallel (Kornish and Ulrich 2011), strategic ambiguity in problem specification (Erat and Krishnan 2012), and breadth of solution space searched by outside agents (Franke et al. 2014). Research has shown that the characteristics of the external agents and search design could guide startups as they emerge.

**Principle 3: Startups are nimble in the sense that they are likely to exhibit higher levels of flexibility, responsiveness, agility, and innovativeness than their established counterparts.** Startups tend to be more agile in their responses to both internally and externally (market-based) tasks than established firms (Swinney et al. 2011; Marion et al. 2012) because uncertain, complex, and dynamic environments require more flexible and agile organizational structures. In the context of sustainability, Girotra and Netessine (2013) introduce a framework to facilitate such agility and innovativeness for BMIs. Taking production, demand, and competition uncertainties into consideration, startups can guide their agility and responsiveness with probabilistic survival analysis based on cash flow consideration (e.g., Tanrisever et al. 2012). Startups use manufacturing flexibility to decouple activities required in task environments from those required in institutional environments (Patel 2011) and operational slack in processes to lower the likelihood of venture failure (Azadegan et al. 2013).

**Principle 4: External partnerships and brand/reputation stock can enhance the performance and growth of startups.** Startups can obtain resources from strategic alliances (Haeussler et al. 2011) and knowhow from diverse external connections (Larraneta et al. 2011).
Regarding the configuration of routines, startups can manage technology selection and investment decisions with a strategic competitor (Bhaskaran and Ramachandran 2011); integration with a complementary technology (Anderson and Parker 2013); establishment of platform technologies (Huang et al. 2013; Bhargava et al. 2013); exploration and exploitation activities with suppliers (Chiu 2014); and offshoring complex activities (Musteens and Ahsan 2013).

**Principle 5: Startups adjust their objectives and constraints to the particular stage of the entrepreneurial value chain.** Startups not only employ a variety of operational decisions depending on their goals and operating environment but also pivot or, in other words, change these decisions as they grow due to the dynamic nature of their environments and operational demands (Tatikonda et al. 2013). Startups can elect not to maximize profit in the interest of conserving cash to maximize their survival likelihood or valuation. Such objectives yield operating policies that are incompatible with profit maximization-based mental models. In dynamic environments, startups can evaluate the commercialization potential of their technology not only with financial parameters (Galbraith et al. 2012), but also operational design (Erzurumlu et al. 2014) and control (Goodale et al. 2011) for each stage. Therefore, business planning can improve startup strategies by evaluating alternative actions (Chwolka and Raith 2011).

For those themes and decisions that are uniquely operative in either product- or service-oriented startups, we also identify four key operational considerations:

- **A dynamic resource strategy, particularly for capacity, elasticity, and flexibility, can impact the product-oriented startup’s survival and productivity** because startups build their resources over time under the uncertainties surrounding the product, market, and associated growth rate. Swinney et al. (2011) finds an earlier timing of capacity investment for startups than established firms due to the threat of bankruptcy. Tatikonda et al. (2013) show that different constructs drive survival at different stages: Inventory flexibility is critical at the start, then profitability drives growth and operational productivity drives stability. Lévesque et al. (2012) consider the elasticity of accumulated resources to assess conditions where these resources might serve as substitutes for rather than complements to the cost of goods sold during periods of growth.

- **Startups that accomplish a fit between their distribution channel system and transaction cost-, product-, strategy-, and competition-related variables perform better** (Brettel et al. 2011). Erzurumlu et al. (2014) show that, in highly uncertain environments, startup valuation is higher when the startup can show proof of deployment feasibility. Hence, **product-oriented startups can increase valuation by designing their operations for the supply network or target markets.** While risk-minimizing startups can manage survival with vertical integration (de Figueiredo and Silverman 2012) and subsidies (Wei et al. 2013), performance-focused startups can improve their prospects with operational flexibility and slack, such as keeping cash on hand (Patel 2011; Azadegan et al. 2013); distribution channel choice (Brettel et al. 2011); manufacturing capabilities (Terjesen et al. 2011); resource elasticity (Lévesque et al. 2012); and product diversification (Deligianni et al. 2014). Reputational risks can be overcome through downstream alliance partnerships with mainstream industry players (Hora and Dutta 2013).

- **Product- and service-oriented startups can better understand the market by engaging in experimentation while incorporating the end consumer into the problem definition and development process at the discovery stage.** For instance, ideas can be generated through innovation contests open to the general public that are hosted on digital platforms like 99designs.com (Wooten and Ulrich 2015). This requires setting up open-ended design problems by employing a contest approach in which a search over a
solution space is delegated to outside agents. This approach can increase the innovation space (Erat and Krishnan 2012; Kornish and Ulrich 2011) and improve the solutions for highly intangible service innovations.

- **Service-oriented startups can improve their prospects at market entry by focusing on platform-based strategies or by integrating their service with one or more complementary technologies with uncertain cost-reduction potentials.** Anderson and Parker (2013) find that startups generally achieve higher expected returns by channelling their integration investment to only one complementary technology. In this instance, the main technology featured wind power plants, and the complementary technology to enhance the performance could be either storage batteries or gas turbine-based capacity for supporting the plant when the performance of the main plant degraded owing to low wind speed. This argument for focusing on the plant relates to, but is somewhat different from, the logic supporting the need for focus in conventional OM literature (Skinner 1974). This focus—i.e., on a single, complementary, technology-based plant strategy—is less applicable with increased transferability from one technology to another or when favorable financial conditions allow dual sourcing of complementary technologies.

### 3 Emergent Opportunities

New and specialized technologies have emerged rapidly and massively across multiple industries, ranging from clean energy (e.g., battery for clean energy storage; Erzurumlu et al. 2014) to healthcare and biotechnology (e.g., ways to sense and track the condition of a dialysis patient; Trisolini et al. 2004), that are altering conventional operations subject to 3R shortages. Some of these technologies have been the driver of unicorn firms’ successes. Novel digital technologies, allied business models, and their implementation practices are changing the operating paradigms in startup operations and in some instances creating new startup opportunities within established firms. Therefore, we can draw upon evidence on OIs and BMIs by focusing on emergent startup best practices built on new digital connectivity and robotics. We study how these practices might shape or add to the five principles associated with the 3Rs of startup operations. We then touch upon ideas in relevant disciplines (e.g., information economics research) related to this evidence that point to germane theoretical questions in a broad class of startup operations.

#### 3.1 New Digital Technologies

In order to illustrate the change driven by the OIs at startups, we identify two types of digital technologies that are altering operational practices in startups in a broad set of industries: (i) connectivity-based analytics (CBA) and (ii) low-cost intelligent robotics (LCIR). The usage of the former is more prevalent in services/IT-based startup operations while the latter is more evident in manufacturing/supply chain startup operations.

#### 3.1.1 Connectivity Based Analytics

We consider two distinctive and highly regarded startup operations in the transportation service sector involving CBA: Zipcar and Uber. (Netessine and Tang 2009 offer a compendium of mainstream operations models using consumer-driven demand and information-technology-enabled sales mechanisms.) During its startup phase around 2000–2001, the key technology challenge at Zipcar (Hart et al. 2003) involved enabling a customer to pick up and drop off a
rental automobile at geographically distributed locations. This was accomplished through a combination of digital technologies (e.g., web-based booking software along with the deployment of the Zipcard—a digital authentication-based connectivity capability that allows a customer to access the rental without the presence of service personnel and real-time updates on operational status based on individual transactions tracked through connectivity technologies); analytics (e.g., rental car tracking and capacity management); and physical operations (e.g., driving cars from a location with excess capacity to another location that needed this capacity). The startup phase created a number of operational challenges that can be viewed in terms of some of the operational decisions in Table 13.2, such as location selection and cost tradeoff during the acquisition of parking locations within selected cities, and the acquisition of different types of rentals (sedans versus vans) depending on demand.

Zipcar also had to deal with these operational challenges while facing 3R shortages: (i) dealing with resource constraints in terms of capacity acquisition and cash-flow-driven survival considerations, (ii) prioritizing in terms of choices that would build its reputation, and (iii) figuring out a process (routines) to setup and leverage high-frequency information generated by its CBA technology. Consistent with the startup strategy of pivoting around 3R shortages, Zipcar refined its operating model. Zipcar was highly cognizant of a classic operations tradeoff: the need to keep up utilization without increasing service delivery costs. It also had to solve a new class of transshipment problems (i.e., optimal shift of cars across locations in real time) based on CBA. In the initial business plan, Zipcar did not focus on specific market segments. After the initial years, Zipcar had to adjust these analytics during the scale up of its operations as it pivoted into specific market segments (e.g., specific geographies, corporate versus weekend customers).

Another example is the San Francisco-based transportation startup Uber, which has focused CBA technology toward the delivery of an on-demand taxi service. Unlike Zipcar, Uber does not face a transshipment problem but deals with its own 3R-related problems. Uber must track and classify geographically dispersed capacity while accounting for alternative pricing models and yield management considerations in real time, present the choices to discerning customers, and build its brand (Cachon et al. 2015). The deployment of the CBA technology based on 3R shortages thus offered new OIs and subsequent value to its customers. Although capacity tracking and yield management are classic operations problems, OIs emerge from the company’s handling of high frequency of data gathering, managing dynamic consumer and driver interactions, and marshalling and optimizing geographically distributed information.

Similar to Zipcar’s adoption of a successful operational model, Uber’s model is spreading rather rapidly. Uber faces CBA-fueled competition in many locations (e.g., Lyft in the U.S., Didi Kuaidi in China, Ola in India, and GrabTaxi in Malaysia). This geographic heterogeneity brings up location specific legal and financial considerations that translate into unique operating challenges for yield management problems (e.g., the rise of Lyft has resulted in real-time order cancellations for Uber; Bradley 2015). Moreover, Uber’s operational model and their use of CBA have rapidly spilled into many other industries ranging from home services (e.g., veterinarians) to food (e.g., groceries) (Schlafman 2014), making the “uberfication” of an industry a phenomenon. Both Zipcar and Uber are examples of companies identifying conventional operational challenges for a 3R-constrained startup and handling them with OIs built on a novel technology like CBA. Whereas Zipcar improves resource utilization and productivity with CBA, Uber becomes a highly flexible and resource-light transportation company. These two examples pose interesting questions for researchers and entrepreneurs. Which aspects of Zipcar’s model and “uberfication” alter the entrepreneurial value chain’s four stages? Which types of unique operational challenges might these models bring? We explore these questions in Section 3.3.
3.1.2 Low-Cost Intelligent Robotics

Now we turn our attention to the rapidly developing and highly influential LCIR technology. Its emergence and impact on employment and productivity, particularly in manufacturing and distribution networks, has created a lively debate (Brynjolfson and McAfee 2012). We describe two startups—Rethink Robotics and Kiva Systems—that have developed LCIR effectively to allow for OIs for flexibility, precision, quality, agility, and responsiveness in conventional manufacturing and distribution operations.

Boston-based Rethink Robotics provides affordable industrial robots to clients in a diverse set of industry sectors such as healthcare, manufacturing, university, and corporate R&D. The robots are human like in size, configured with two arms, a display screen face powered by tactile force sensors, and vision capability, at a $25,000 price tag (WSJ 2015). Rethink has built a series of elastic actuators into the robots to measure and control forces on their joints with greater precision, allowing these robots to perform tasks like placing a part into a machine by “feeling” when the part is at the right place (Guizzo 2015). With the deployment of artificial intelligence technology to learn new tasks with no programming, Rethink’s LCIR technology is being positioned for OIs to automate complex assembly (e.g., automotive manufacturing) and serve SMEs’ manufacturing operations (e.g., manufacturing operations can move away from low labor-cost-dominated sourcing considerations; Foroohar 2013).

The LCIR technology offered by Kiva Systems is also a source of OIs. Kiva is changing the supply and distribution chain dynamics by introducing mobile bots—an LCIR capable of locomotion—to replace conveyers and human-operated assembly and packing operations (Mountz 2012). Kiva’s LCIR technology has enabled it to dramatically cut down cycle time and quality problems for third-party logistics and distribution. The acquisition of Kiva by Amazon in 2012 (rebranded as Amazon Robotics in 2015) changed the delivery operations of Amazon and allow for novel changes in the operation of customer order and delivery. The success of LCIR technology in this marketplace has spurred a number of similar startups. For example, SWISSLOG has done so in hospital logistics with a product set including Automated Tablet Packaging Systems, Automated Pharmacy Storage and Inventory Management Systems, and TransCar Automated Guided Vehicles.

3.2 Business Model Innovations

Although new technologies indicate innovation, they require change in firms’ operational models. The implementation of OIs has led to BMIs in firms such as Zipcar, Uber, Rethink Robotics, Amazon Robotics (the revised brand name for Kiva Systems), and their SME partners. Recall from the introduction that BMI refers to the way a firm generates revenues, limits costs, and provides its customers with a unique value proposition (Girotra and Netessine 2013).

Amazon Robotics faced the challenge of not only proving the feasibility of its LCIR technology, but also the riskiness with the delivery of a reliable solution from an end-to-end supply chain perspective and one where potentially hidden costs can be limited. To convince major e-commerce firms such as Amazon, Gap, and Walgreens that its LCIR technology fits with their operating model of system reliability and cost containment, Amazon Robotics implemented a BMI by internalizing the acquisition and integration of all its offerings’ components (i.e., hardware, software, and operational consultation) while guaranteeing customers a full refund if the projected logistics results did not materialize. Thus, one of the major challenges with new technology adoption is the alignment and updating (or pivoting) of operating decisions with the business model, and OIs associated with the underlying technologies must be examined in this
context. Business startups often involve operational practices and OIs that become central to their survival, growth, and profitability. Business models regarding the formulation, handling, and adaptation of startup operations are thus central concerns to entrepreneurs, potential investors providing resources, suppliers formalizing the operational routines, channel partners affected by reputations, and customers.

Responsive fulfillment of medical prescriptions and containment of their cost have received considerable attention in a number of countries (Crow and Ward 2015). Startups funded in this space (PillPack, TinyRx, and ZappRX) have been leveraging OIs using CBA and LCIR technologies. PillPack is a pharmacy and packing distribution service that deploys CBA technology to collect data on individual patient prescriptions, to confirm medication prescriptions in real time, and to gather updates on refills. It creates small packages that bundle all the medicines a particular patient needs to take at a given time of the day. Assembled in a small box using LCIR technologies (see www.pillpack.com/how for an illustration), these packages are then mailed to the customer. In PillPack’s business model, this service is delivered to the patient at the same cost as that charged by a regular pharmacy. PillPack does not receive any additional payment from the health insurance provider. Thus, management of operational issues such as conformance quality (i.e., putting the right medication into each package), distribution speed, and cost containment are the focus of CBA and LCIR technologies. They are also central to this startup’s business model in order to solve a new class of 3R problems that extend beyond inventory and distribution.

Supply chain (i.e., packaging and distribution) design and oversight are not the only high leverage points for startups as they setup their business models. Other levers are design and branding. Song et al. (2015) describe methods to inform the evolution and launch of product design choices, subject to risk and innovation balance, based on crowdfunding. These design considerations that can alter design routines and resource acquisition balance have yet to be addressed in the literature. Similarly, a sharing-economy startup like Airbnb, which is a force in the hospitality and tourism industry, has instituted a distance education-based training program to teach its host families principles of service quality (Pfeffer 2014) because customer reviews affect reputation.

### 3.3 Research Implications

From a theory building perspective, three key implications emerge from the evidence presented in Sections 3.1 and 3.2: (i) OIs are becoming core differentiators for these emergent business models, and some of these innovations coevolve with adaptations/pivots in the business model, and (ii) since these BMIs might aim to create Uber-like platforms, an opportunity exists to draw upon the emergent platform economics literature to enrich the 3R principles in the startup operations domain. A platform in this context refers to intermediary based-on-software technologies that control information exchanges between demand and supply.

#### 3.3.1 Alignment between BMIs and OIs

BMIs, especially in startup settings, are dynamic entities as shown in our proposed causal loop diagram (Sterman 2000) in Figure 13.1, where the sign of an arrow represents the sign of the correlation between the two constructs that it connects. One way to understand the loop in Figure 13.1 is to begin with a stock of BMIs (e.g., use of pricing to manage demand yield at Uber) and then trace the loop in the clockwise direction. A constant set of moves and countermoves exists that creates a gap between the extant BMIs and the competition’s business model (e.g., as seen in the case of Uber and Lyft), resulting in a gap that engenders unique operational problems.
(e.g., shorter expectation of wait times by the customers). Over time, intensification of these problems creates opportunities for unique OIs (e.g., capacity management by surge pricing versus marshalling of extra capacity at prime time). However, lifecycle risks reduce the efficacy of such OIs. For instance, when Uber decided to grow its operations by adding new geographies, there was a sizable rise in the form of social media “horror stories” about surge pricing in many cities (Allan 2015).

Such risks have resulted in reconsideration of the approaches towards customer and driver satisfaction (i.e., created pivots) on the part of both Uber and Lyft. For instance, surge pricing might allow a driver to enjoy a higher rate, but Uber has instituted BMIs that forbid drivers control over when it is a surge and when it is not. These BMIs have accompanied OIs such as the design of Lyft interface that allows customers to tip the drivers, presumably based on service quality. When taken collectively, the linkages described here form a reinforcing loop that captures the co-evolution between BMIs and OIs. Many OIs leverage new information technologies, connectivity-based data and analytics, thus offering opportunities to develop new types of decision support models (e.g., transshipment and yield management models).

This alignment between BMIs and OIs has research implications. For instance, Amazon Robotics’ decision to internalize all aspects of LCIR technology, based on the need to guarantee end-to-end service, requires commitment to multiple types of resources. Since Amazon Robotics did this, what are the implications for the organize stage of the entrepreneurial value chain

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**Figure 13.1** Dynamic View of the Alignment between Business Model Innovations (BMIs) and Operational Innovations (OIs)
(Joglekar and Lévesque 2013) in terms of hiring service professionals and setting up a distribution network? Amazon Robotics' business model was retail industry centric, whereas some of its competitors (e.g., SWISSLOG) focused on the healthcare industry. Is the decision to vertically integrate instead of sourcing components the optimal choice in such alternative business models? Will regulatory bodies approve of such information integration and supply chain choices instead of pushing for open standards promoting entrepreneurial activity?

3.3.2 Platform Economics

Given the selective nature of the technological opportunities described in Section 3.1 and 3.2, the theory implications we offer are a subset of a large class of research opportunities. In the case of CBA technology, we focus on the issue of platform economics (Eisenmann et al. 2011). In many BMIs associated with “uberification,” startups are interested in becoming a platform of choice for suppliers and consumers. Salminen (2015) lists a number of dilemmas faced by platform startups that are summarized in Table 13.3. This list is evolving over time. For instance, Airbnb has attempted to manage the role of reviews in shaping its reputation for quality by deploying 100 employees devoted exclusively to safety such that “hosts verify their IDs by connecting to their social networks and scanning their official ID or confirming personal details” (Hill 2015). Airbnb’s quality management practices are now subject to public scrutiny and the efficacy of such practices offers a research opportunity that is yet to be analyzed in the POM literature.

This list is not exhaustive and several of the underlying tradeoffs have been studied in entrepreneurship literature (e.g., see Table 13.3 for the Peter Pan dilemma, where the decisions associated with this dilemma represent a classic dilution problem; Bhide 2000). However, these dilemmas are yet to be studied in the context of two-sided network dynamics. Moreover, from the perspective of startup operations, these dilemmas must be unpacked into a number of detailed decisions that have not been fully examined. If we take the Pioneer’s dilemma, entry timing

<table>
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<tr>
<th>Table 13.3 Dilemmas Faced by Platform Startups</th>
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<td><strong>Pioneer’s dilemma</strong>: If the startup launches too early, it will pay the pioneer’s cost and is likely to fail due to insufficient resources; if it launches too late, it is unable to capture users from incumbents.</td>
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<tr>
<td><strong>Cold start dilemma</strong>: Without content, users are unwilling to join and generate content.</td>
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<tr>
<td><strong>Lonely user dilemma</strong>: Without other users available at a given time, users are unable to use the platform.</td>
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<tr>
<td><strong>Monetization dilemma</strong>: If access and usage of a platform is provided for a fee, users are unwilling to join; if access and usage is free, the platform is economically non-viable.</td>
</tr>
<tr>
<td><strong>Remora’s curse</strong>: If users or content is sourced from a host platform, the cold start problem can be solved; however, at the loss of power relating to customer relationships, monetization, and so on.</td>
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<td><strong>Pivot dilemma</strong>: If the startup accommodates its user’s wishes in product development, it loses focus; if it does not, it loses the user.</td>
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<td><strong>Peter Pan dilemma</strong>: If the startup accepts external funding, it loses decisive authority and becomes vulnerable to hasty decisions; if it does not, it loses against competitors with funding.</td>
</tr>
<tr>
<td><strong>Juggernaut dilemma</strong>: Due to lack of legitimacy, the startup is unable to convert enterprise clients which would grant it legitimacy.</td>
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Source: Salminen 2015
decisions have been studied in the startup literature (Armstrong and Lévesque 2002), but the consideration of network effects either on the supply side (Anderson and Parker 2013) or demand side (Bhargava et al. 2013) has only been studied at the growth stage. What are the implications of network effects using CBA technologies in the discovery, commit, and organize stages of the entrepreneurial value chain?

For instance, CBA technologies provide real-time updates on either supplier or customer choices. When should a fledgling startup commit to resources to develop analytics-driven features on the supply side and demand side? When do the resulting operational choices (e.g., either speedier access to SKU data or more types of SKUs offered in a retail operation) align with different stages of the startup’s business model? An online retail customer at the commit stage may be happier with more detailed analytics on fashion or color trends, but will the suppliers also find the growth of such expertise among end customers to be useful? If they do, what are the implications for the organize stage of platform evolution in terms of showcasing the outcomes of the analytics-based findings?

### 3.4 Managerial Implications

We have identified five 3R-related principles in Section 2.2 in terms of what we know about startups operations. For ease of reference, these are summarized in Table 13.4. We now draw upon the alignment framework shown in Figure 13.1 to illustrate the implementation implications of these 3R principles.

Principles 1 and 2 call for identification of alternative objectives and resource deployment options, while Principle 3 calls for flexible routines. As an example, imagine a food supply chain and delivery startup with a BMI revolving around “uberification.” We assume that this startup’s BMI is predicated upon both keeping low costs and promoting direct interaction between customers and supply chain partners that may use Uber-like mobile interfaces to order food. The need for exploring alternative objective functions for such a startup would imply either conservation of cash to increase its likelihood of survival, or investment in growth (by acquiring customers rapidly), rather than maximizing profit. Customer acquisition may require expanding resources for experimenting with specific product features, setting-up flexible operational routines, making commitment to low overhead processes, and outsourcing of infrastructure (e.g., plant and properties or logistic capabilities). The key OI at such a discovery stage might focus on experiments matching demand and supply through a low-cost food delivery (e.g., kiosks) mechanism. Customer acquisition and external partnerships may grow the brand’s reputation, consistent with Principle 4. Principle 5 suggests that the startup may need to pivot and alter its objective function (e.g., move from cash conservation to profit maximization) after the initial discovery stage, while getting into the subsequent commit stage shown in Table 13.2. A key question around the pivot involves the types of OIs—e.g., setting up a wider distribution network and yield management routines that will enable this realignment of objectives.

This example offers a high-level description of pivots through the co-evolution of BMI and OIs based on the 3R principles, while going from the discover stage to the commit stage. Figure 13.1 also shows that BMI might sometimes be disrupted by competitive factors at any one stage—and such disruptions may require additional OIs (e.g., a reduction in unit cost through process improvement). Appropriate choices must also develop beyond the commit stage and into the organize and grow stages. Entrepreneurial managers might then have to focus on, for instance, detailed data (e.g., through CBA) and manage some of the operational decisions (e.g., location selection or network design) and allied tradeoffs shown in Table 13.2 until the next pivot in the entrepreneurial value chain comes about. Table 13.2’s studies indicate that entrepreneurial
managers should not manage these transitions between lifecycle stages using a conventional OM
decision model (e.g., setting up the network to minimize cost, regardless of the startup’s lifecycle
stage) and waste the opportunity to leverage the alignment between BMI and OIs.

4 Conclusion

Economic and social opportunities associated with business startups’ operations are large. These
opportunities offer potentially high risks but also high rewards. Startup operations ought to be
thought of differently in terms of available resources, organizational routines, and the need to have
established reputations—the 3Rs. Moreover, an analysis of 3R ideas across the lifecycle of startup
stages (a.k.a. entrepreneurial value chain of discover, commit, organize, and grow) yields different
types of operating principles than pursued during steady state operations at established firms.
Among others, survival constraints associated with cash flow considerations yield different capac-
ity acquisition and process improvement strategies. The need for finding business models that
are enabled and revised through operations innovations is growing. Novel digital technologies,
particularly those involving connectivity-based analytics and deployment of low-cost intelligent
robotics, provide fertile grounds for developing such operational-innovation-enabled startups.

References and Bibliography

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