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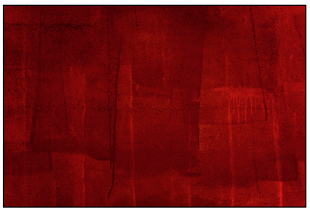

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Celebrating the World of Innovation

Welcome to the March issue of the Technology Innovation Management Review. We invite your comments on the articles in this issue as well as suggestions for future article topics and issue themes.

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Overview
The Technology Innovation Management Review (TIM Review) provides insights about the issues and emerging trends relevant to launching and growing technology businesses. The TIM Review focuses on the theories, strategies, and tools that help small and large technology companies succeed.

Our readers are looking for practical ideas they can apply within their own organizations. The TIM Review brings together diverse viewpoints —from academics, entrepreneurs, companies of all sizes, the public sector, the community sector, and others —to bridge the gap between theory and practice. In particular, we focus on the topics of technology and global entrepreneurship in small and large companies.

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About TIM

The TIM Review has international contributors and readers, and it is published in association with the Technology Innovation Management program (TIM; timprogram.ca), an international graduate program at Carleton University in Ottawa, Canada.

Editorial: Celebrating the World of Innovation

Stoyan Tanev, Editor-in-Chief, Gregory Sandstrom, Managing Editor

Welcome to the March issue of the *Technology Innovation Management Review*. This month features papers from the ISPIM Connects Global Conference "Celebrating the World of Innovation" held on December 7th–8th, 2020. This special issue continues our ongoing fruitful cooperation with the ISPIM society in promoting and spreading knowledge and experience in innovation management research around the world.

This issue opens with **Helle Alsted Søndergaard, Mette Præst Knudsen,** and **Nicolai Søndergaard Laugesen's** paper, "The Catch-22 in Strategizing for Radical Innovation." They point out that "Corporate strategy development is a well-oiled and recurring process in most established companies. Innovation strategy, however, especially for radical innovation, is new and unknown territory. This creates challenges for companies with radical innovation ambitions" (pg. 4). The authors identify two main challenges to enable radical innovation: gravitation and alignment. They suggest a framework aimed at asking questions necessary to raise awareness about inherent business challenges. Their aim in the paper is to help companies overcome, alleviate or mediate the "catch-22's" that sometimes arise when facing or driving radical innovation at the intersection between corporate and innovation strategy work.

Then **Patrick Brecht, Daniel Hendriks, Anja Stroebele, Carsten H. Hahn,** and **Ingmar Wolff** address "Discovery and Validation of Business Models", looking at "How B2B Startups can use Business Experiments". They provide a case study report on low-cost paid business experimentation by a German B2B agricultural startup company. The paper aims to demonstrate how business experiments (ad, press article, brochure, interview) can help startups discover and validate their business model's desirability in a quick and cost-effective way. The authors follow an iterative design thinking approach to focus on two main experimental steps: build and evaluate. They conclude, "Practitioners should consider a sequence of business experiments that are run to improve the company's learning effect, to better explain negative outcomes, and to use a mixed data collection approach" (pg. 31).

This is followed by **Mika Westerlund, Diane A. Isabelle,** and **Seppo Leminen's** "The Acceptance of Digital Surveillance in an Age of Big Data". This paper covers a range of topics in examining digital and mass surveillance, digital identity, citizen privacy, personal data, biometrics, and intelligence activities. They note the implications of their results after focusing on links between privacy perception, intelligence activities on the nation-state level, and the rise in surveillance using big data. The results of their research point out that during the COVID-19 pandemic recent advances in digital technologies have been intensifying and now contribute to a major increase in digital surveillance. They propose a balanced approach to sharing, collection, and use of personal data in digital form, given the communications technology doors that have opened up with state-corporate collaboration to fight the pandemic.

Sara Abdalla and **Koichi Nakagawa** present the final paper on "The Interplay of Digital Transformation and Collaborative Innovation on Supply Chain Ambidexterity". They investigate the impact of digital transformation on supply chain (SC) efficiency and adaptability and explore the role of collaborative innovation as a catalyst. They use survey data from Japanese manufacturing companies with a hierarchical multiple regression analysis to test multiple hypotheses. The results show that collaborative innovation between suppliers and customers in a SC strengthens the impact of digital transformation on adaptability, but not on efficiency. They conclude that, "firms can achieve SC ambidexterity through widening the scope of collaborative innovation by including different types of partners" (pg. 52).

The TIM Review currently has a Call for Papers on the website for a special edition on "Distributed Ledger Technologies and Smart Digital Economies" (June 2021). For future issues, we invite general submissions of articles on technology entrepreneurship, innovation management, and other topics relevant to launching and scaling technology companies, and for solving practical business problems in emerging domains. Please contact us with potential article ideas and submissions, or proposals for future special issues.

Stoyan Tanev
Editor-in-Chief
&
Gregory Sandstrom
Managing Editor

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The Catch-22 in Strategizing for Radical Innovation

Helle Alsted Søndergaard, Mette Præst Knudsen, &
Nicolai Søndergaard Laugesen

> *"The enterprise that does not innovate ages and declines. And in a period of rapid change such as the present, the decline will be fast."*
>
> Peter Drucker

Corporate strategy development is a well-oiled and recurring process in most established companies. Innovation strategy, however, especially for radical innovation, is new and unknown territory. This creates challenges for companies with radical innovation ambitions. We followed the innovation strategy work of nine large organisations, finding that they all struggle with the process and how to link innovation with corporate strategy in a meaningful way, while at the same time not hampering the innovative ambitions of the organisation. We identify two main challenges of *gravitation* and *alignment*, and develop a framework aimed at asking the questions necessary for increasing awareness about inherent business challenges, and how to overcome them at the intersection between corporate and innovation strategy work.

Introduction

Strategy concerns explaining what enables firms to enjoy sustainable performance advantages over their competitors. The pressure to innovate nowadays is higher than ever, while companies struggle to focus on identifying and targeting the right opportunities to pursue continued competitive advantages. While adequate resources, the right people, an open innovation process, and effective market orientation have been stressed as core elements for successfully pursuing innovation opportunities (Barney, 1991; Sirmon et al., 2011; Carnes et al., 2017), less attention has been given to innovation strategy. As innovation is a key driver of a firm's performance advantages, it becomes natural to ask how strategies can be formulated and implemented to drive innovation. The ambition to innovate with radical new offerings for the market can be especially challenging (Hill & Rothaermel, 2003; O'Connor & DeMartino, 2006; Sainio et al., 2012). This article addresses the challenges by proposing a framework for formulating a radical innovation strategy.

Corporate strategy serves as an indispensable tool for management to ensure direction for the entire organization (Feldman, 2020). It is less clear, however, what specifically shapes an innovation strategy, what its boundaries are, and how often it is to be adjusted or re-shaped. As innovation orients towards capturing future opportunities, which continuously change in multiple possible directions, we find it worth considering what can and cannot be captured with existing strategy tools.

This article explores the relationship and differences between corporate strategy and innovation strategy, especially when radical innovation is being strategized. Our main argument is that the severity of the uncertainties associated with radical innovation necessitate an approach to innovation strategy which is based on a managerial mindset that not only accepts, but embraces these inherent uncertainties. This fundamentally differs from the well-established and widely-shared corporate strategy approach (Kuratko et al., 2014). We thus argue that existing corporate strategy tools actually impair a company's chances of succeeding with radical innovation.

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Corporate strategy develops based on a well-known and familiar set of tools used by top management. It aims to provide direction for the organization and guides a company's current efforts and corporate activities. At the same time, corporate strategy involves a series of transactions as opposed to single events, and hence strategy unfolds dynamically across time, rather than as a mythical single strategic plan (Feldman, 2020). Managers may find an innovation strategy hard to understand especially if it targets radical innovation, involving how the strategy ensures that innovation activities are turned into value for future competitiveness, and how it relates to corporate strategy.

In a study of nine large Danish firms that we conducted, we found that they all experienced difficulties in crafting a radical innovation strategy. They had years of experience and go-to tools for their corporate strategy work, while radical innovation strategy, for them, was outside of their normal playing field of strategic work. They experienced two main challenges, and in their efforts to deal with these challenges, they ended up finding themselves in a catch-22: if they ignored one challenge, they ended up facing another. In response to this dilemma, we contribute to the innovation management literature by offering a framework that addresses the central questions firms tend to forget when crafting radical innovation initiatives. The framework's aim is to help alleviate this catch-22 of strategizing for radical innovation.

Theoretical Framework

We start with a basic definition of "strategy". *A strategy is nothing more than a commitment to a pattern of behavior intended to help win a competition* (Pisano, 2012). When developing corporate strategy, managers therefore have a fairly straight-forward task to formulate plans that drive the organization with focus on efficiency and long-term goals. Feldman (2020) identifies the core question for corporate strategy as *what enables firms to enjoy sustainable performance advantages over their competitors*. Hence, corporate strategy formulates a commitment to the best possible path for obtaining a desired performance advantage. Pisano (2012) argues for three core principles of a good strategy: consistency, coherence, and alignment. One path for realizing these strategic principles may be through cost optimization and lean management, while another may be through proactive innovative efforts ideally resulting in pre-emptive radical innovation. As the achievement of future performance is not based on one single decision, a good overall strategy rests on a complex web of decisions and possibilities in continual flux.

We see "innovation" as a multi-faced concept that covers R&D and technology development, and ultimately results in new products and services introduced in the market. It is sprinkled with uncertainty, clouded by conflicting opportunities, driven by the unknown; and rests on desires more than knowledge. However, when innovation becomes a core driver to achieve higher future performance, concern involving the need for a strategy of innovative efforts results.

If corporate strategy is connected with efforts towards formulating innovation strategies, then we observe that corporate strategy works well as a guiding tool to directly promote incremental innovation. The principles of coherence and consistency align well to exploitation, which includes such things as: *refinement, choice, production, efficiency, selection, implementation,* and *execution* (March, 1991). Hence, strategy formulation focuses on managing the current business, and "doing what we do today, but better" (Tidd & Bessant, 2018). Pisano (2015) supports this, noting the importance of alignment between the business core and the innovation strategy. A clearly articulated innovation strategy must therefore be "closely linked to a company's business strategy and core value proposition. Without such a strategy, most initiatives aimed at boosting a firm' capacity to innovate are doomed to fail" (Pisano, 2015).

On the other hand, we cannot overlook March's second dimension of exploration, which he helpfully explains, includes things captured by terms such as: *search, variation, risk taking, experimentation, play, flexibility, discovery,* and *innovation* (March 1991). This translates into radical innovation. We know from the literature that radical innovation is difficult for established companies (Hill & Rothaermel, 2003), while at the same time the fascination with exploration and radical innovation remains strong. As mentioned by Wilden et. al. (2018), "exploration is being mentioned most frequently ahead of exploitation and ambidexterity" in the extant literature, and successful exploration leads to searches

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outside the familiar competencies and markets. Linton (2009) describes two key dimensions for radical innovation: a significant leap in technological development, and a potential for entirely new features and improvements. In many studies, this has led to the formulation of products that are *new to the world*. Consequently, the capability to make radical innovation can be regarded as *a firm's ability to explore, adapt, tolerate, and experiment with new products, processes and services for non-mainstream businesses* (Chang et al., 2012).

Even though corporate strategy addresses expectations for a firm's long-term future business opportunities, it remains unclear on which new technologies or products such opportunities are or should be based, and how these are to be realized through *radical innovation*, that is, *"doing things differently"* (Tidd & Bessant, 2018). The core observation is therefore that corporate strategy cannot and does not act as a "light house" for radical innovation work. This means management can either navigate locally within their own business units to search for ideas and opportunities or leave the radical innovative agenda untouched. This indicates the huge difference in current strategic frameworks for corporate strategy and radical innovation strategy, which potentially constitutes an enormous challenge for companies when they attempt to align radical innovation strategy with corporate strategy for future long-term opportunity capture (Demir, 2018; Dobni & Sand, 2018). In this paper, we thus aim to explore and shed light on how companies are currently experiencing and managing the paradox of developing innovation strategies for radical innovation.

Methods

This article is based on interviews with nine large companies across a range of industries. All the companies have international activities and vary in size, three companies from logistics, facility management and finance have yearly global revenues of more than 10 billion EUR, while six companies from transportation, insurance, healthcare, facility management, pharmaceuticals and waste management have yearly revenues from 1-10 billion EUR.

The research focused on the challenges companies face when aligning corporate strategy and innovation strategy, and how to establish alignment between these. Interviews were conducted in 2017 and all company respondents were high-ranking, with detailed insights into the companies' strategic processes, primarily Vice Presidents, Heads of Strategy and Directors of business units. The interviews were semi-structured with focal themes on corporate strategy process and radical innovation strategy. The first part of the interview focused on company corporate strategy, both the strategy process and context, including competitors, turn around, growth, etc. The second part of the interview focused on three themes regarding radical innovation strategy: the company's strategic process, the elements of the radical innovation strategy, and how their strategies in reality are carried out.

As strategic alignment is a relatively unexplored subject, we based the analytical design on an explorative methodological approach. The analysis was separated into two consecutive steps. The first step distilled the companies' strategic approaches and characterized their radical innovation strategies, and how they were integrated into corporate strategy. In the second step, the information collected from the interviews was coded, categorized, and thematized. The analytical process revealed the companies' central challenges related to corporate strategy and radical innovation strategy.

Findings

While corporate strategy is well-known and based on a familiar set of tools for top management, the vignette and quotes below show it is much less evident for top management what an innovation strategy is, especially if it targets "radical innovation". We found that successful innovation was achieved when a company's strategy ensured that innovation activities got turned into value for future competitiveness.

> *"The questions that companies ask when developing corporate strategy are well-known to all, but questions for the innovation strategy are not well-known, if known at all" (Head of Strategy).*

> *"Agility and high intensity are really central for the way we work with innovation, but this has nothing to do with the typical McKinsey-strategy questions; questions that are well-known and often used in the*

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strategy process. But when working with innovation we don't know what the questions are before we get started" (Vice President, X-lab)

Vignette on challenges of radical innovation strategy work

The deadline was approaching, but the innovation strategy was still a big question mark. Before the upcoming board meeting, Mary, Head of Strategy was given the task of crafting an innovation strategy that could mitigate the fast-changing business environment. The company concern was all about disruption, radical innovation, how new competitors were popping up, and markets constantly changing, disappearing, and developing at the same time. The company had seen its market share dwindle, and even though the product portfolio had been updated over the years, the company was losing its position. Mary was commissioned to craft an innovation strategy to be presented at the board meeting and the mandate was clear: an innovation strategy was needed that could secure long term growth and keep the company in front of competitors by means of radical innovation. The question, however, was how to craft a radical innovation strategy?

Mary had in previous strategy development processes reached out to the business units closest to the customers, which provided input that all pointed towards solutions for the current market – and some of these ideas were already being provided by new and agile competitors. Would these inputs give the company the competitive edge that she was mandated to craft an innovation strategy for? This was, more or less, what the company had always done, but she was well aware that radical innovation was needed this time. If the company needed radical change what could it be? Mary had spent a decade working with strategy and she had never felt shorter of answers from her strategy toolbox than with this task. How could she define the potential markets if she didn't even know what the product was? A product that was expected to move the company ahead of competition – a radical new offering – unlike the offerings of the current business units. How to nail a strategy for a fast moving and elusive target; a target yet to be imagined? What were the core challenges she needed to identify and address? (Inspired by real events)

The lack of familiar questions and common vocabulary for innovation strategy are apparent across the case companies studied. They explained that for developing a corporate strategy, they have a common understanding of what it is, what it looks like, and of the process for crafting the strategy. But for a radical innovation strategy, the companies do not have the same grounded experience and understanding, but rather grope in the dark.

"With strategy, we have a fundamental understanding of how the process should be run and we may even have 100 years reflection to lean on. But with innovation and disruption, which have appeared only within the last 4-5 years, no one has a clear idea of what the strategy should look like. That's why it's so difficult to connect the two" (Vice President, Head of Innovation).

Two Central Radical Innovation Challenges Identified

Apart from the lack of tools and experience discussed above, we observed two main recurring challenges experienced in the companies as they strive to develop and formulate strategies for radical innovation. The mechanisms built into these challenges imply that any attempt to align corporate and radical innovation strategy is at best very difficult and will inevitably drive down the realization of ambitions formulated in the radical innovation strategy. These are the central dynamics of the catch-22 when strategizing for radical innovation.

Challenge 1: Alignment kills strategy work processes for radical innovation

The complexity of large organizations has been known to hinder efforts to coordinate and align their activities and strategy. This may also be the case for aligning radical innovation strategy with corporate strategy. One consequence of complexity is that it leads to two parallel strategy processes that are out of sync. Although different strategy cycles can be considered as just another challenge to be solved in large and sometimes bureaucratic organizations, most companies struggle with synchronization. The corporate strategy process typically follows the same flow, with minor updates of the strategy from the previous year, while the strategy is more thoroughly revised only every 3 to 5 years (Wessel, 2012). This process secures continuity and coherence of strategic goals and respects the fact that implementing strategic goals in large international organizations takes

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time to cascade and work, like changing ERP-systems for strengthened operational efficiency or building up a new sales organization to address new markets. In this way, continuity is required in large companies. Hence, large change projects will fail if major new strategic revisions are rolled out every year. Radical innovation strategies, on the other hand, need to capture and address exactly those uncertainties that are foundational when working with radical innovation; a process that is by definition earmarked with trial and error. If everything in the radical innovation process is known from the beginning, the outcome can hardly be expected to be either novel or radical.

Radical innovation is a much messier and emergent set of processes compared with other corporate processes, such as supply chain management or financial operations. Although companies have developed and implemented stage-gate models for guiding innovation activities, these models do not deal with uncertainties at the strategic level. The front end of stage-gate models usually includes detailed templates for business cases, which are applied when assessing the value of new innovation opportunities before they can be turned into projects. These models and templates do not promote radical innovation. For this purpose, companies alternatively implement x-labs that are high-risk endeavours for seeking radical innovation. One risk of implementing x-labs is that business cases typically overestimate the market size and underestimate required time and costs.

Innovation textbooks advocate for a fit between corporate strategy and radical innovation strategy. However, current frameworks for innovation strategy are unable to handle the uncertainties of radical innovation, and stage-gate models are not created to tackle these uncertainties. When the innovation strategy is squeezed to fit into the typical short-term incremental framework of corporate strategy, some companies see no other option than to accept friction, that is, little or no alignment with current corporate strategy. The case companies would rather accept friction than to promote an overly structured approach and too closely align innovation strategy to corporate strategy, which it was believed would ultimately suppress radical innovation efforts.

> *"We have a clearly defined threat from being disrupted and it is on the top of our strategic agenda – but our strategic response differs from our intention" (Director, Operational Development).*

In brief, the core challenge for firms was to isolate or distance their radical innovation strategy in order to avoid getting it caught in the cross-fire of short-term corporate strategy and long-term innovation horizons. Their requirement is to deliver business value, before their competitors disrupt the market. Indeed, this forms a challenging set of corporate dynamics to bring together. The central questions are: What happens if corporate and innovation strategy are not aligned and radical innovation strategy becomes decoupled from corporate strategy? And how can managers align corporate strategy and innovation strategy work without jeopardizing the company's radical innovation ambitions?

Challenge 2: Gravitation kills radical innovation strategy ambitions

Radical innovation is difficult to achieve, impossible to predict and schedule for, and especially so when existing business units are the immediate "customers" of these innovations.

> *"Our claim to fame is radical innovation, but the only things, we can transfer to the business, are innovations that are ready for the market and just minor adjustments to our current products" (Vice president, X-lab).*

The organizational reality in the quote is clear. If the innovation lab wants to succeed and prevail, it must show, within a short time-frame, results that even depend on the willingness of the business units as the receiving end in the organization to adopt the innovation. Thus, it must accept an innovation that may directly outcompete its existing offerings.

The trouble is that independent innovation labs are founded on an ambition to present radically new offerings and these take (an uncertain amount of) time and money to achieve. However, if the success of the lab depends not directly on the lab's ability to produce radical innovation, but rather on the business units' accepting the innovation outcomes, then this creates a fundamental paradox. *The radicality of the new offering itself may be counter-productive to its actual adoption by the business unit.* On the one hand, new products and services should, at some point, be accepted and

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"owned" by the business units, and at the same time, the radical innovation should create offerings that aim to bring the business substantially forward (or even disrupt the market). This will often challenge the existing offerings of the business unit and in this way, radical innovation becomes mission impossible! Thus, even when a company's innovation strategy focuses on long-term radical innovation followed by organizational initiatives, the demand for short-term gains or products that fit with the existing business model will challenge efforts to plan and achieve a radical innovation strategy.

Even when the strategic ambition for radical innovation is set and pursued, an organization may (over time) get impatient and start to question the (lack of) progress and results. The innovation lab managers will then be inclined (or pressured) to present innovations of a more incremental and predictable nature as a way to prevail against and overcome the pressures for short-term gains at the cost of potential future radical innovation.

If, on the other hand, the innovation lab does manage to produce and present radical innovations, these are then often challenged by the business units themselves, as radical innovations are unlikely to be in accordance with current business units' perceptions of market needs. Hence, when radical innovation is achieved, it is likely that it will be dismissed and seen as "a cuckoo in the bird's nest", a certain path to blocking the innovation. It is not only a matter of asymmetric powers in the organization, it is also a matter of asymmetric knowledge where corporate innovation labs are experts in future trends, technology, and innovation methodologies, whereas the business units have first-hand knowledge of current customers and markets. The incremental innovation strategy and the short-term business-oriented approach is not a problem per se, rather the problem occurs when the strategic intent is initially more radical, but instead ends up being altered because of an asymmetric power relation between the business units and the innovation lab. In such cases, the radical innovation strategy gets challenged by short term strategic goals that contradict and even prevent the radical innovation strategy from being realized.

To summarize, even when companies formulate breakthrough innovation strategies, they may end up only with incremental outcomes. The business units in large organizations exercise a strong pressure through their operational needs, which gravitates the power from headquarters to the decentralized local level in such a way that business unit interpretations alter the innovation strategy to a more comprehensible short-term market-focused strategy. This strategic focus is distinct from the long-term radical innovation strategy that the corporate level stimulates and pursues. The gravitation therefore shifts attention away from any radical innovations towards incremental innovation, which can more readily be adopted.

The two challenges demonstrate that even though a radical innovation strategy states one ambition, implementation of the strategy (often) takes a very different route, and a route that diverts attention more towards achieving incremental innovation. To enable long-term strategic gains from innovation, the innovation strategy process requires more risk willingness (in the business units), acceptance of extended time that may be needed to realize the gains, and recognition in the organization that gains cannot accurately be predicted in business plans prior to engaging in an innovation process for radical innovation. Again, while this may and often does seem paradoxical, it also appears to be the only way to get the business of radical innovation done.

Various organizational approaches can be applied by companies as a way of attempting to secure radical innovation. While some have integrated this work in the business development function or formed internal cross-functional units, others have created independent and separate innovation labs or established spin-off business units (O'Connor & DeMartino, 2006). A popular current way to seek a radical outcome is by organizing part of the strategic efforts in physically separated external organizational units like x-labs. Others again choose to be "fast followers". Here is how one company formulates the strategy:

> *"The choices are too many and the uncertainty too high – so where to place the bet? We don't know and instead we choose to follow the trends in the market" (Director, Operational Development).*

Interestingly, in this company, the board originally aimed for a blue ocean strategy, but the innovation department ended up with a much more incremental

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maneuver, because they did not have the tools to handle the uncertainties associated with a radical innovation strategy.

Zooming in on the different ways of organizing for radical innovation, companies with separate innovation units usually have intentionally formulated more radical and long-term oriented strategies, in order to avoid the gravitation challenge. However, they then face stronger challenges in aligning corporate and innovation strategies. These conflicting forces represent a built-in catch 22 for strategizing and realizing radical innovation. If a company strategizes to pursue radical innovation, it must first secure the freedom to deviate from current corporate strategies. Hence, we acknowledge that while a certain level of coordination between corporate and innovation strategy is needed, if a firm aims for radical innovation, management must also accept that the two cannot be fully aligned.

Development and Discussion of a Strategy Framework

Radical innovation is about developing new solutions for new business opportunities, rather than responding to already recognized opportunities (Kim & Mauborgne, 2019). Hence, the formulation of a radical innovation strategy must address different questions than those used for guiding the development of corporate strategy. The premise for the radical innovation strategy is very different from that of typical corporate strategy, as the former concerns how the company handles unknown questions about the future while the latter is about securing immediate and realizable growth opportunities. Radical innovation involves experimentation and testing of multiple paths to the market and these uncertainties must be accepted as part of the strategy process. Hence, it also requires other additional key strategic questions.

Based on our understanding of the challenges experienced and how innovative efforts are carried out in the companies studied, we were able define two central questions linked to radical innovation strategy work that we believe need to be addressed: what *level of ambition* is its aim? What is the *search direction*? The level of ambition translates into the degree of (potential) radical innovation, while the direction means the proposed or conceptualized business opportunities, markets, or technologies to search for.

How radical do we want to go?

Key question: What is the desired level of novelty of our radical innovation efforts?

As innovation is by definition characterized by uncertainty and ambiguity, the level of ambition also embraces the level of uncertainty. Considering the level of ambition in a radical innovation strategy creates a way to embrace the expected level of uncertainty, but also to manage the potential gravitation towards incremental uncertainty. Maintaining focus on the ambition is crucial for avoiding the gravitation challenge.

Case 1: Facility management company

In Company A, the starting point was to establish a corporate garage and then let possible themes for innovation emerge by collecting input from customers and business units. The corporate garage was established to develop radical innovation, whereas incremental innovation was the responsibility of the business units. In this way, the level of ambition was chosen before the direction.

When the starting point was the innovation ambition, and in this case had a clearly defined strategic objective of radical innovation, the firm faced the challenge of possible misalignment with the corporate strategy. That is, if the corporate garage were to explore other directions than what the corporate strategy defined, this ultimately would cause friction unless the corporate strategy was explicitly open for exploration.

For the corporate garage or x-lab to succeed or even survive, it was equally important that the long-term time-horizon for the radical innovation be well-known because radical innovation takes time. It can be tempting to show results by presenting new, but only incremental innovations to the business units. One solution, as described above, is to link the level of ambition with an innovation direction that resonates with corporate strategy, but still keep the level of ambition intact.

The level of a company's ambition thus describes how far away from the current position the company wants to explore new territory (Anthony et al., 2008; Nagji & Tuff, 2012; Pisano, 2015). The typical way to describe level of ambition is using the radical versus incremental. The

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more radical, the higher the level of ambition required, whereas incremental reflects a lower level based on achieving minor changes to current products or solutions. Despite being formulated explicitly as "radical innovation", efforts may be in continuous danger of being pushed towards innovation that resonates with the current position or business model (see Challenge 2: Gravitation kills radical strategy ambitions). In the literature on managing innovation portfolios, the level of ambition is a question of choosing how to distribute investments into, for example, current core offerings, adjacent opportunities, or new territory (Nagji & Tuff, 2012). This is illustrated by how new and unknown the products and markets are compared to existing offerings.

Where do we want to go radical?

Key question: Where do we want to focus our radical innovation efforts?

The second dimension provides the direction of innovation efforts and points to areas in which the company chooses to innovate. The strategic question for this dimension starts with the current position and compares this to the coordinated direction in which the efforts will or should take place for market, product or technology, and whether it is related to, for example, the business model or process innovation (Sawhney et al., 2006; Tidd & Bessant, 2018).

Case 2: Logistics company

Company B has initiated a long-term radical innovation strategy. The innovation strategy is focused to build on their core business of container transportation. This entails first choosing a direction and then defining the innovation ambition. In this case, the company chose radical innovation within container transportation with a long-term horizon. The path is thus defined by starting with the innovation direction and Company B clearly has a strategic advantage in knowing the product and market that are subject to innovation. But this directional path also has the embedded risk of gravitating towards incremental innovation.

When the direction involves the core products and market of the company, then the innovation effort will ultimately challenge the current business. This means that prioritizing corporate strategy vis-à-vis radical innovation must be sustainable. Alternatively, the firm may risk facing both challenge 1 and 2.

Some companies choose to innovate around their core products or services, limiting the possible radical innovation directions to take. Another choice is to deliberately search in totally new growth areas, letting the direction be driven, for example, by an emerging technology. Whenever new technologies, such as 3D-printing, augmented reality, or any other fast-growing opportunity from the plethora of technologies that surround us, become available for exploration, some companies choose to engage with these technologies to identify if, and how, the technology can support their existing business, or become a viable new part of the company. In this case, exploration means that it is yet to be established if the technology will be applied to existing or new markets, or whether it holds any commercial value.

Direction is not only a question of product and technology, but can also be related to customer and market. Instead of starting with new technology, some companies start with the customer and via customer journeys and observations, try to distill unidentified needs that they can innovate to meet (Brown & Martin, 2015). In this way, the solution and technology are yet to be defined, but the company has to some extent narrowed down customer needs for the market segment. Each dimension represents different perspectives for strategy, including search direction, level of ambition, timeline, and alignment, all of which have strategic choices embedded. These dimensions seem to only make a coherent strategy when considered in concert, and thus choices across the dimensions must be considered together, as they may otherwise contradict each other.

Looking back at this paper, we have added to the existing literature by illustrating a paradox involving strategy work when it comes to crafting a radical innovation strategy while juggling it alongside corporate strategy. We identified two recurrent challenges of alignment and gravitation and showed how they form a catch-22 for companies as they are intertwined and interlinked. Core trade-offs, important choices, and questions have been already mentioned in the literature, some of which were highlighted here (Shawney et al 2006; Nagji & Tuff, 2012; Pisano, 2015; Tidd & Bessant, 2018). The novelty of this research lies in the clearer formulation of a paradox,

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based on the underlying dynamics of strategies as they are developed and particularly implemented, leading companies into catch-22s.

Hence, the ambition to strategize for radical innovation requires much more than only a corporate strategy or "new awareness", and especially more than just the three principles of coherence, consistency, and alignment (Pisano, 2012). In fact, it is our conclusion that these principles are or at least can be counter-productive towards succeeding with radical innovation. In the research we conducted, the principles became strong fences that prevented radical innovation from being targeted and developed. Hence, we were surprised by finding how easily radical innovation strategy can lose its feet when confronted with strongly established corporate strategy practices. Rather than being a guidepost, corporate strategy has the potential to become a straight-jacket for radical innovation efforts in that it can prevent the capabilities for radical innovation from securing adequate innovation performance, and thus ultimately interfere with or impede long-term sustainable growth.

In response to this, we propose below a managerial framework. The elements of this framework are not in themselves new, but we added the overlooked challenges and dynamics identified in the research above to enhance the chances of successful corporate strategic work. We believe that this contribution is important for innovation scholars and managers as it challenges pre-existing conceptions and notions about how innovation strategy is specifically related to, and should take its point of departure from corporate strategy (Pisano, 2015).

A Managerial Framework

As shown above, the premise for a radical innovation strategy, as experienced by the companies in this study, is very different from that of a corporate strategy. Innovation strategy work is currently, in practice, based on strategy approaches that do not recognize the contradiction between these two different strategies. We therefore propose a framework that recognizes the contradictions and accompanying uncertainties. We base the framework for making a radical innovation strategy on evidence from the companies studied in our research, coupled with central concepts from management theory, such as exploration and exploitation (March, 1991), along with more recent managerially-inspired strategy frameworks (Sawhney et al., 2006; Pisano, 2015; Dobni & Sand, 2018; Prange & Schlegelmilch, 2018).

Through consideration of the identified two main challenges and two central questions, as well as their underlying decisions, a radical innovation strategy should connect the company's innovation ambition with their innovation direction. To avoid the pressures exerted by current business logic and corporate strategy, radical innovation strategy should focus on the strategic choices of both ambition and direction. Current attempts at creating innovation strategies

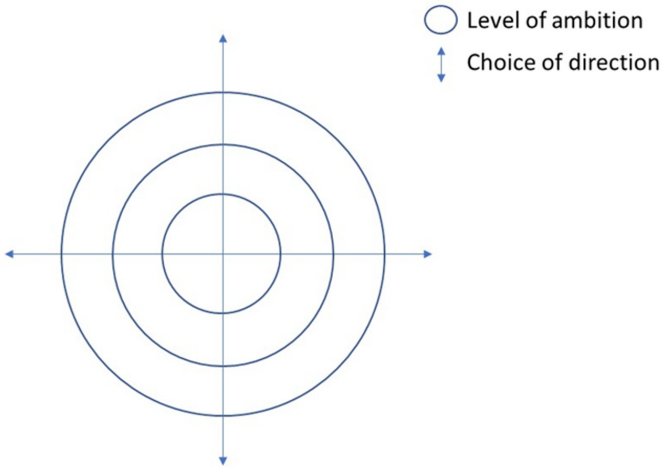

Figure 1. Innovation ambition and direction in conjunction

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often focus on one of the dimensions in isolation or do not even specify the dimensions that the innovation strategy should work on. Yet a chosen focus on a new technology, for example, is not in itself a coherent innovation strategy and other additional choices need to be made (Prange & Schlegelmilch, 2018). Figure 1 shows a stylized illustration of how the two central dimensions of ambition and direction have also been interlinked in the current literature (Shawney et al 2006; Tidd & Bessant, 2018).

The centre of figure 1 illustrates the current offerings, abilities of the firm, its competencies, human resources, technologies, and other endowments. The search space for new innovative opportunities are then defined around this core. The closer the firm searches around its core, the more likely it is that the firm's innovation activities will result in incremental innovation. Radical innovation strategies should consist of a combination of ambition (for example, new product in new business area) and direction (for example, identifying new ways of utilizing a specific technology in the firms' products). The innovation strategy can have the starting point or offset in either of the two dimensions described. If the offset is a direction, then the company identifies the product,

Table 1. Designing your Radical Innovation Strategy

	Level of innovation ambition	**Choice of innovation direction**
Step 1: Asking the right questions	*What is the desired level of novelty of our innovation efforts?* -How high is our ambition? -How far is our aim from our current position, competences, knowledge?	*Where do we want to focus our innovation efforts?* -Which direction(s) do we aim to take? - adjacent to existing product or market, or new territory? -Do we have the right competences for the directions chosen?
Step 2: Understanding the gravitational forces	Current position and market (customer) needs draw innovation efforts towards achievable outcomes. Hence, the level of ambition is constantly in danger of being lowered.	Current corporate strategy departs from existing business areas and offerings: it will draw company efforts in (a) known direction(s).
Step 3: Challenging the degree of alignment	Since current corporate strategy tools prescribe known outcomes and achievable targets, this can lower the innovation ambition. A radical innovation ambition requires deviation from the corporate strategy.	If the chosen innovation direction leads efforts towards entirely new technology or platform opportunities, the current business model may try to ensure that the innovative solutions are built on known knowledge and offerings.
Step 4: Knowing the unknowns and recognizing uncertainties	The time horizon is unknown and succeeding at all is uncertain. It is still necessary to ensure mandate and resources. The business units must embrace risk and accept the time horizon.	Little or no knowledge of customers and markets means that a business case is only provisory or a best guess scenario. Future gains cannot be predicted prior to engaging in the innovation process.

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market, or technology first, and defines the level of ambition afterwards.

For example, in the case of Company B (see Box 2 above), if the company starts with container transportation as the product and market focus, the next step then becomes to define if the company wants to be a fast follower, or first mover with radical innovation as the strategic goal. The path defined by starting with a direction clearly has an advantage of knowing the product and market that are subject to innovation. But this path is simultaneously subject to the embedded risk of gravitation towards incremental innovation, as it is more likely to fall into the safety of known products and current market needs.

To avoid this challenge, an alternative path is to start by defining the level of ambition, and thus not let the current product or market heritage and history constrain the level of ambition. Innovation labs are typically established because companies understand the risk of incremental gravitation and want to make a bolder move more freely of constraints. In Company A (see Box 1 above), the starting point was to establish the corporate garage and then by collecting input from customers and business units, let the direction for innovation efforts emerge. In this way, the level of ambition was established before the direction. However, when the starting point is the level of ambition, and the company has a clearly defined strategic objective of radical innovation, it may become difficult for the innovation lab to succeed and survive in the long term, because radical innovation takes time. In contrast, the way for the new lab to prove its value to the rest of the organization is by developing and transferring innovations to the strategic business units in the short term. One solution that tries to bridge these challenges is to combine the level of ambition with an innovation direction that resonates with the corporate strategy, but still has the level of ambition intact, with a dynamic and regularly updated lab roadmap/timeline.

Thus, irrespective if the strategy work starts with an ambition or a direction, both dimensions are critical for formulating a radical innovation strategy that can survive the uncertainties following from radical ambition and still resonate with the overall corporate strategy. The alignment with corporate strategy is the piece in the puzzle that protects radical innovation strategy from side-tracking the innovation or cancelling the efforts when the timeline is long or there are less visible results.

The framework for developing a radical innovation strategy through the two strategic components can be unfolded step-by-step, as presented in Table 1. These steps reflect the challenges described above starting with *asking the right questions* that are distinct from the questions guiding short term corporate strategy. The next step concerns *understanding the gravitational forces* towards exploitation rather than only exploration. When the right questions are addressed, and the gravitation is uplifted, then a third step relates to deliberately considering how much *alignment between corporate strategy and innovation strategy*, and at what cost? Finally, the fourth step towards a strategy for radical innovation is to *embrace the uncertainties of the unknowns*. We argue that a more deliberate reflection on the unknowns (both known and unknown) ultimately supports the longevity of a company's radical innovation strategy.

Other concerns, beyond the two main challenges, were identified with regard to ensuring progress in strategy implementation. Most importantly, the choices made in each dimension forming a radical innovation strategy can contradict each other, especially if the time horizon is ignored. Some companies work with a sense of urgency and a short timeline. Radical innovation strategies that work with short timelines, however, might contradict their innovation ambition. Similarly, strategies that are born with ambitious revenue targets are difficult to achieve on a short time horizon. Hence, to unfold a radical innovation strategy requires sufficient time and patience to do properly.

Furthermore, limited or no knowledge of future customers and markets following from a change in direction implies that a business case is only provisory and vague. As a business case is an indispensable tool for most companies, the uncertainties following from a change in direction must also tolerate that business cases at this stage can only present images or highly imaginative prospects about future market opportunities.

Finally, the more ambitious the innovation strategy, the more willing business units must be to embrace the risk and uncertainties involved with the radical

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innovation efforts. They will likely not know all that they would prefer to know about the new offerings, regarding what the potentials are, when they can be presented with the new offering, what market needs they may address, etc. Thus, grasping at the unknowns and embracing uncertainties must be a regular part of implementing a strategy for radical innovation.

To sum up the challenges that organizations face when working with radical innovation, we argue that no matter what you do, risks and uncertainties must be faced:

A. If firms create independent/autonomous innovation labs, they risk not being able to re-integrate the work into the ongoing business (alignment challenge).

B. If firms keep their innovation efforts close to the current business, they risk not reaching the intended level of radical innovation (gravitation challenge).

C. Firms have little experience formulating innovation strategy, inadequate vocabulary, and lack familiar processes for discussing the central elements (framework challenge).

As argued earlier, close/tight alignment between corporate and innovation strategies will likely nullify the potential of radical innovation strategy. However, a prerequisite for innovation strategy to work is that choices are made deliberately and not just by coincidence. The choice can be to have a less well-defined strategy formulated, so as to secure autonomy for radical innovation efforts. For example, an x-lab can work with radical innovation without clearly defined end-goals. Some would even argue that working with radical innovation requires that efforts not be tied into specific customer segments or product types.

Even if the degree of alignment is deliberately low, there are still questions to be answered: How much time do we have to develop new innovative products? What is the level of ambition for their development? It is therefore important to acknowledge and deliberately choose a degree of coordination and accept a degree of non-alignment if radical innovation efforts are to have enough freedom to flourish.

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Discovery and Validation of Business Models: How B2B Startups can use Business Experiments

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> *"The true method of knowledge is experiment."*
>
> William Blake
> Poet, painter and inventor
> "The Argument" (1788)

Startups searching for a business model face uncertainty. This research aims to demonstrates how B2B startups can use business experiments to discover and validate their business model's desirability quickly and cost-effectively. The research study follows a design science approach by focusing on two main steps: build and evaluate. We first created a B2B-Startup Experimentation Framework based on well-known earlier frameworks. After that, we applied the framework to the case of the German startup heliopas.ai. The framework consists of four steps (1) implementation of a measurement system, (2) hypothesis development and prioritization, (3) discovery, and (4) validation. Within its application, we conducted business experiments, including online and offline advertisements, as well as interviews. This research contributes in several ways to the understanding of how B2B-startups can use business experiments to discover and validate their business models: First, the designed B2B-Startup Experimentation Framework can serve as a guideline for company founders. Second, the results were used to improve the existing business model of the German B2B startup heliopas.ai. Finally, applying the framework allowed us to formulate design principles for creating business experiments. The design principles used in the study can be further tested in future studies.

1. Introduction

In recent years, a common approach and conventional wisdom has urged founders to create a business plan that describes the size of the opportunity, the targeted problem, and the planned solution (Blank, 2013). It assumes that the target market is known, and the business model is validated (Garvin, 2000). However, these conditions are often not met by startups, which leads to many startups failing when executing an assumption-based business model (Lynn et al., 1996).

To support founders in searching for a business model, frameworks were created with the idea of conducting experiments in business settings. Technological advances in the last decade have lowered market entry barriers and the cost of running business experiments dramatically (Kerr et al., 2014). This has made business experimentation more viable and simpler to execute. Moreover, characteristics specific to the B2B market influence how business experiments are designed. An implication for a B2B business is that more money is generated by fewer customers (Croll & Yoskovitz, 2013). This implies that it is more difficult to provide statistical significance because of small sample sizes. Additionally, the role of decider and user might not come from the same person as usual with consumers, making it harder for a startup to sell a product to a company (Croll & Yoskovitz, 2013). Thus, more research is needed to determine how B2B startups can specifically use business experiments, allowing founders to learn about the business model. Recently, the COVID-19 pandemic has limited personal contact with customers and thus influenced the methodology of this research. These trends demand additional research in the field.

In line with Berglund, Dimov and Wennberg (2018), who call for more research resulting in practical insights for

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entrepreneurs, the goal of this research is twofold. First, the study provides empirical insights on the application of business experiments to the business model development process of B2B companies. Second, we investigate how to run and design these experiments. Berglund et al. (2018) recommended creating context-specific design principles in the form of pragmatic recommendations. Thus, this research focuses on extracting practical design principles that support entrepreneurs in improving their business experiment activities. This research takes a problem-solution approach aimed at extracting practical contributions for B2B startups, instead of focusing on enriching the existing theoretical body of literature. The study answers the following question: How can startups in a B2B market use business experiments to discover and validate the desirability of their business models quickly and cost-effectively?

To answer this question, we followed a two-step process proposed by March and Smith (1995), and tailored the research process by focusing on the case of a real life startup named heliopas.ai. The case of heliopas.ai suits this research well as it is searching for a business model that incorporates selling an application called WaterFox to farmers (a B2B context). The mission of the startup heliopas.ai is to provide farmers with accurate data about soil moisture combined with simple recommendations for more efficient field irrigation. The startup uses machine learning and multiple data sources such as satellite imagery and local weather databases to gather the data. No equipment or high-priced sensors are necessary to use the application WaterFox, an advantage deemed beneficial as it saves customers unnecessary costs and adoption efforts. A framework was created that will serve as a guideline to conduct tailored business experiments for heliopas.ai that consider the limitations of startups regarding time and money. These business experiments would help to discover and validate the desirability of their business model in a B2B market. As the startup is based in Karlsruhe, Germany, the initial market consisted of local farmers in Baden-Wuerttemberg and Rhineland-Palatinate.

This research proposes a B2B-Startup Experimentation Framework with a four-step solution that reduces uncertainty and improves a startup's business model. The framework builds on existing processes and principles, and combines them in one comprehensive framework that serves as a guideline for conducting B2B business experiments. By applying the framework to the context of heliopas.ai, the researchers were able to evaluate the proposed framework's applicability. Additionally during the research, the business and operations of heliopas.ai were adjusted due to the findings, resulting in better understanding of the suitability of channels, value proposition, customer jobs-to-be-done, customer segment, and product performance.

This paper is structured as follows. The next section provides a brief review of theories and frameworks used to develop the B2B-Startup Experimentation Framework. In section 3, we lay out the methodology. In the consecutive parts, we develop the framework and apply it to the startup heliopas.ai. Next, we summarize the findings and further elaborate in the discussion section. Finally, we discuss the limitations of the study, practical implications for startups and researchers, and conclude the paper.

2. Theoretical Framework

Discovery and Validation

Discovery marks the initial step in the search for a business model. The goal is to explore if the general direction of thought regarding a business model is correct and to gain more insights (Bland & Osterwalder, 2020). Discovery suits the early steps of experimentation. Since a startup operates under great uncertainty (Ries, 2011), decision making is done under ambiguity, with little to no knowledge about alternatives and consequences (Cooremans, 2012). Generally, validation activities ensure that customers' needs and the defined requirements are met (Albers et al., 2017). The validation process of a business model determines and ensures a correct direction of thought, and also confirms findings from the discovery step (Bland & Osterwalder, 2020). Thus, validation becomes the second step in the search for a business model (Bland & Osterwalder, 2020).

Business Model and Risk Factors

According to Brown and Katz (2009), an early business model entails three risk factors: desirability, feasibility, and viability. Desirability shows the risk of a business model regarding the market, demand, communication, and distribution. Feasibility defines the risk when a business cannot access key resources, perform key activities, or find key partners (Brown & Katz, 2009). Viability denotes the risk that a business cannot generate

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sufficient revenue or requires too much cost to make a profit; that it won't be viable (Bland & Osterwalder, 2020). This research focuses on reducing the desirability risk in business models. It therefore focuses on the following business model components: customer segments, value proposition, channel, and customer relationship. Additionally, we explore a revenue model in terms of a customer's willingness to pay for heliopas.ai's application offer.

Business Experiments

Business experiments attempt to take a scientific approach for generating insights into a company's business model (Thomke, 2019). They reduce risk and uncertainty by yielding evidence regarding an underlying hypothesis (Bland & Osterwalder, 2020). Experiments can demonstrate a causal relationship by measuring the effect an action has on a situation (Hanington & Martin, 2012). Business experiments in startups are often run cheaply and quickly (Aulet, 2013). For this paper, business experiments can be distinguished based on how they are aligned with their purpose — discovery and validation — as in the previously provided definitions. Discovery experiments test if the general idea behind a concept is acceptable, intending to establish a proof-of-concept. Validation experiments are experiments with higher fidelity. They yield stronger evidence and require more resources, such as time, personnel or money.

Growth Hacking

Growth Hacking aims at fast and sustainable growth through activities in the area of market research, product development, and customer retention (Ellis, 2017). The Customer Acquisition Funnel is a core element of the Growth Hacking framework. It consists of five stages: acquisition, activation, retention, revenue, and referral (McClure, 2007). In the acquisition stage, the goal is to figure out through which channels users, customers, and visitors are coming from, in a way that results in value for a startup (McClure, 2007). Secondly, the activation element shows how many acquired users have a positive first impression of the product (McClure, 2007). Retention measures whether users keep using the product. The revenue stage measures customers' willingness to pay, whereas the referral stage measures if users enjoy the product enough to recommend it to a friend (McClure, 2007).

Customer Development Process

The Customer Development Process by Blank and Dorf (2012) is an iterative, customer-focused approach in the search for a business model. It incorporates business experiments and consists of two steps: customer discovery and customer validation. Customer discovery aims at finding initial customers by deriving testable hypotheses that collect possible experiment designs (Blank & Dorf, 2012), and finally conducting the experiments. These initial experiments determine if the envisioned value proposition matches a targeted customer segment. In the next step, the proposed solution is presented to customers to learn if it serves customer needs, and to assess customer willingness to pay for it. Customer validation requires applying the business model that results from the previous step (Trimi & Berbegal-Mirabent, 2012). The goal is to test whether the business model is repeatable and scalable. This is done by running more quantitative, high-fidelity experiments and acquiring actual sales, which will show how money spent in sales and marketing can generate revenue.

Lean Startup

The Lean Startup aims to reduce waste while creating a business model. It has three key principles: to replace planning with experimentation, the 'getting out of the building' approach by Blank, and lastly, agile development (Blank, 2013). The experimentation process is described by the Build-Measure-Learn feedback loop consisting of three steps: build, measure, and learn. In the step build, it is essential to create a Minimal Viable Product (MVP) quickly after identifying the most important hypotheses (Ries, 2011). The goal of building an MVP is to identify the proposed solution's potential (Kerr et al., 2014) and the target customers' willingness to pay for it. The measure step aims at collecting data that can verify or falsify the hypotheses made about product quality, price, and costs (Ries, 2011). In the learn step, the goal is to learn about the investigated hypotheses from collected data. The learning process shows whether an underlying hypotheses can be verified or not, and indicates if the MVP is a viable solution to the customer problem (Ries, 2011).

Four-Step Iterative Cycle

The Four-Step Iterative Cycle describes a structured procedure of business experimentation that undergoes

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Table 1. Framework comparison

(a) Comparison of Micro Cycle

	Pre-Experiment			Experiment		Post-Experiment
Growth Hacking	Ideate	Prioritize		Test		Analyze
BML* Feedback Loop			Build	Measure		Learn
Four-Step Iterative Cycle		Design	Build	Run		Analyze
B-SEF** Micro Cycle	Ideate and Design		Build	Run and Measure		Analyze and Decide

(b) Comparison of Macro Cycles

		Customer Discovery				Customer Validation			
Customer Development Process		Hypothesis Collection	Problem Testing	Solution Testing	Verification or Pivot	Sales Preparation	Sale	Sales Refinement	Verification or Pivot
Growth Hacking	Measurement System	Experimentation							
B-SEF** Macro Cycle	Measurement System	Hypothesis Collection	Discovery Experiments			Validation Experiments			

* BML = Build Measure Learn. ** B-SEF = B2B-Startup Experimentation Framework.

the design, build, run, and analyze steps iteratively until it achieves desired outcomes. The first step design uses existing insights from observations and previous experiments to formulate testable hypotheses, and design suitable experiments (Thomke, 2003). In the build step, researchers build physical or virtual prototypes or models to conduct experiments (Thomke, 2003). The higher a prototype's fidelity and functionality, the stronger the generated evidence will be (Thomke, 2003). Subsequently, the experiment is run either in a more controlled laboratory setting or in a real-life setting, which produces higher external validity (Thomke, 2003). Finally, the results are analyzed by comparing them to an expected outcome. If the hypothesis addressed by the experiment is answered sufficiently, the experimentation cycle is stopped (Thomke, 2003). Otherwise, researchers reenter the design step with a modified experimental design, adjusted according to new insights gained in the process. Table 1 summarizes the presented frameworks and shows an initial comparison with the framework designed for this research.

3. Methodology

To create a business experimentation framework for B2B startups and gain insights on how B2B startups can use business experiments to discover and validate their business model quickly and efficiently, this research applied a two-step research process based on "design science" insights, as suggested by March and Smith (1995). The two-step research process in design science consists of a build and evaluate step, which can be summarized as follows.

The build step for this paper undertakes a literature review to shape a framework based on existing knowledge and practical experiences of respected practitioners (Thomke, 2003; Ries, 2011; Blank, 2012; Ellis, 2017), as well as previous research conducted in this field (Thomke, 2003). Practical knowledge is very popular among entrepreneurs. Although it is not grounded in theory itself, it is considered a valuable source of knowledge in this field.

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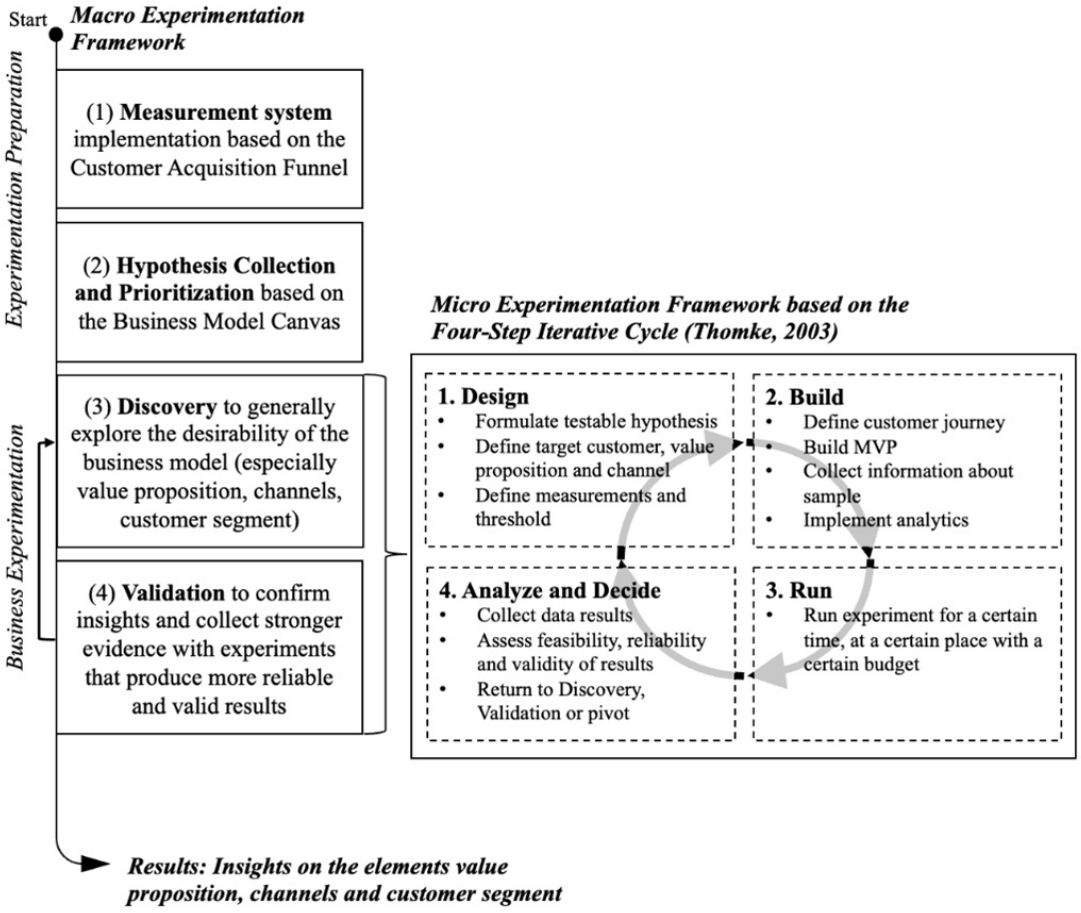

Figure 1. The B2B Startup Experimentation Framework (B-SEF)

Next, we apply the framework to the particular case of heliopas.ai, a real life startup that wants to improve its business model. This constitutes the evaluate step of the two-step process, which aims to show whether the created framework fulfills its purpose. Furthermore, the application allows researchers to deepen their knowledge about how to run business experiments empirically. Qualitative and quantitative data was collected during several business experiments. We used this empirical data to develop insights into heliopas.ai's business model. Also, we describe applying the framework and conducting business experiments, which resulted in formulating design principles that serve as recommendations for conducting business experiments. The design principles can be regarded as a basis for future research that focuses on further investigating the value of business experiments.

4. Design and Application of the B2B-Startup Experimentation Framework

Based on the frameworks described in the theoretical part of this paper, we designed the B2B-Startup Experimentation Framework (B-SEF) and outline it in the following way. It consists of both a macro experimentation and micro experimentation framework (see Figure 1).

The macro experimentation framework consists of four steps. First, it involves designing a simple measurement system to collect data on acquiring and retaining new customers. The idea of implementing such a measurement system originates from the Growth Hacking methodology. Applying it for this research was feasible because the use case startup already has a vision for its business model and technology integrated into a

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Table 2. Tracked metrics in heliopas.ai's measurement system

Stage	Metric	Explanation
Acquisition	Total Traffic	Amount of Visitors on the Facebook and Web Landing-page of the WaterFox Application
Activation	App store Product Site Impressions	Amount of visitors that opened the app store product site in the Google Play Store and Apple App Store
	App downloads	Amount of app downloads from the Google Play Store and Apple App Store
	New User Registrations	Amount of new users registered in the WaterFox application
Retention	Occasional Users	Users that opened the WaterFox application 1-2 days in the past seven days
	Standard Users	Users that opened the WaterFox application 3-5 days in the past seven days
	Heavy Users	Users that opened the WaterFox application 6-7 days in the past seven days
	Observed Hectares	Amount of hectares that were observed by all registered farmers
Revenue	Paying Users	Amount of users that paid for using the WaterFox application

smartphone-application tested by selected customers. The data is used to calculate conversion rates and customer acquisition costs (CAC), as well as estimate customer lifetime value (CLV). Second, the Business Model Canvas (Osterwalder et al., 2010) is used to collect and prioritize hypotheses about the business.

Business experiments are conducted in the two steps discovery and validation (Bland & Osterwalder, 2020), thereby incorporating, specifically, discovery and validation experiments. By doing so, this research follows the recommendation of Blank and Dorf (2012) who suggest to treat the search for a business model as a two-step process of discovery and validation. In the discovery step, business researchers aim at gaining insights quickly and cost-effectively, as timing can be critical for a startup's success. As emphasized by Ries (2011), the goal is to learn quickly about the business model's desirability. In the validation step, researchers design experiments to gather more reliable evidence. By adding a control group and running experiments simultaneously, the effects of external variables will be reduced.

The micro experimentation framework is adapted from the Four-Step Iterative Cycle by Thomke (2003). All business experiments are conducted and presented in a structured manner by following a micro experimentation framework. The Four-Step Iterative Cycle is a core element of many frameworks and methods for startup experimentation. For instance, Brecht and his colleagues (2020) used the Four-Step Iterative Cycle to conduct experiments for platform business models. Ries (2011) and Blank and Dorf (2012) described similar cycles for experimentation in their Lean Startup and Customer Development Process.

The B-SEF was applied to the startup heliopas.ai to gain insights into its business model and to empirically evaluate the framework's applicability. We note as important that restrictions of cost and time were present in this study, based on a budget of less than €100, and less than four weeks to design and run each experiment.

(1) Designing the Measurement System

Growth Hacking relies on experiments, and thus must collect data. A common way to determine how to design a measurement system that suits the purpose of data collection is to use the Customer Acquisition Funnel, described above. Consecutively, we designed the customer journey for potential customers of heliopas.ai based on multiple metrics, which were defined and tracked. Table 1 provides an overview of these metrics, their definition, and their application in the Customer Acquisition Funnel stages.

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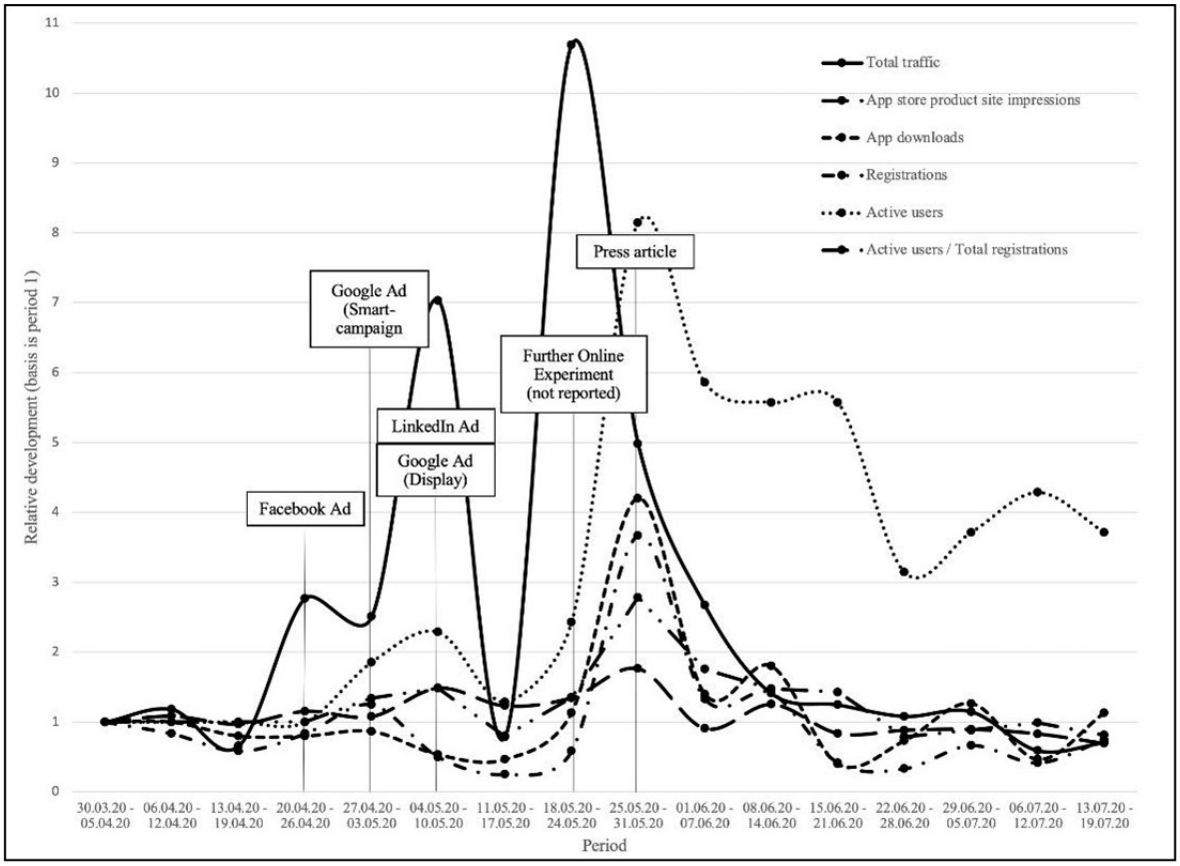

Figure 2. Development of Metrics of the Customer Acquisition Funnel

The acquisition stage consisted of metrics on total traffic generated by sites related to WaterFox. We extracted traffic data on the Facebook landing-page from Facebook's analytics. We tracked traffic on the WaterFox web landing-page with Google's analytics.

The activation stage consisted of metrics from app store product site impressions in the Apple and Google Play app stores. Additionally, we tracked the downloads of the WaterFox application from both app stores and new user registrations in the WaterFox application. Likewise, App store product site impressions and downloads were tracked with the App Store Connect and Google Play Console.

For the retention stage, we defined three metrics. The users were split into the three categories, occasional user, standard user, and heavy user, based on frequency of signing into the application in the last seven days. Since small errors in data had a high impact (for example, activities of developers in the application inflating the data), it was necessary to get data first-hand that was adaptable and transparent. The data from the retention stage was measured by building an Excel sheet that processed data from the startup's database. This data was used to calculate daily retention metrics. Beneficial to this approach was that the researchers could manually filter users, since user names and further contact information were available.

The revenue stage consisted of metrics from paying users, who were paying to use the WaterFox application.

The referral stage was not tracked due to focus on the other stages. The collected data is presented in Figure 2. The three user categories are summarized as active users.

We used the absolute number metrics for a certain period to calculate the conversion rate between customer journey phases via app store product site impressions to app downloads and app downloads to registrations. We used the conversion rate to estimate Customer Acquisition Costs (CAC), since the customer journey could not be tracked after customers leave the landing page and are referred to the app store.

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(2) Hypothesis Collection and Prioritization
To collect and prioritize initial hypotheses, we used the common Business Model Canvas for heliopas.ai. Our focus on coming up with a desirable business model, drew upon the building blocks value proposition, customer segment, channels, customer relationships, and revenue model with greatest interest. We prioritized our hypothesis resulting in a focus on channels according to the founders' vision of selling their application online. This would allow them to distribute the app efficiently at a low CAC and easily reach early adopters. Hence, in the following section, our attention will turn to experiments exploring the channels.

(3) Discovery Experiments
For each discovery experiment, we tracked the number of impressions, clicks on the advertisement leading to the landing page, and download-button clicks on the landing page to evaluate channel suitability. We calculated the Customer Activation Rate (CAR) from recorded data. CAR is defined as the number of active persons on the landing page, divided by the number of visitors. A threshold of 20%, a common value for experiments in a startup environment, was defined for CAR. Additionally, the calculated CAC is going to help to evaluate the channel's viability. Table 2 provides an overview of the discovery experiments conducted.

Facebook advertisement experiment. The Facebook advertisement experiment analyzed whether customers were pulled to the WaterFox application via advertisements on Facebook. In the Facebook advertisement manager, the target customer was set to the current persona. A customer journey was designed, leading customers from an advertisement on landing page, to the app store, and finally to the application. To measure all online activities on the landing page, we

Table 3. Overview of conducted Discovery Experiments

Experiment	Facebook	Google (Smart-Campaign)
Hypothesis	*Vegetable and potato farmers in Germany, Austria and Switzerland can be pulled to the WaterFox application via advertisements on Facebook.*	*Vegetable and potato farmers in Germany, Austria and Switzerland can be pulled to the WaterFox application via advertisements on Google Ads.*
Test	Run Advertisement in Facebook	Run Google Smart-Campaign
Metric	Impressions, Clicks and Downloads	Impressions, Clicks and Downloads
Criteria	$CAR \geq 20\%$	$CAR \geq 20\%$
Run Time	7 Days	3 Days
Budget	€31.20	€27.31

Experiment	Google (Display)	LinkedIn
Hypothesis	*Vegetable and potato farmers in Germany, Austria and Switzerland can be pulled to the WaterFox application via advertisements in the Google Display Network.*	*Vegetable and potato farmers in Germany, Austria and Switzerland can be pulled to the WaterFox application via advertisements on LinkedIn.*
Test	Run Google Display Advertisement	Run Advertisement in LinkedIn
Metric	Impressions, Clicks and Downloads	Impressions, Clicks and Downloads
Criteria	$CAR \geq 20\%$	$CAR \geq 20\%$
Run Time	2 Days	6 Days
Budget	€29.98	€30.00

Experiment	Press Article
Hypothesis	*Farmers in Germany, Austria and Switzerland can be pulled to the WaterFox application by an article in the agriculture newspaper top agrar.*
Test	Release Press Article
Metric	Impressions, Clicks and Downloads
Criteria	$CAR \geq 20\%$
Run Time	7 Days[9]
Budget	€0

implemented Google Analytics and Google Tag Manager. The advertisement was run for seven days from April 22 to April 28, 2020, with a budget of €31.20 resulting in 4.557 impressions, 5 clicks on the advertisement, and 0 download-button clicks on the landing-page leading to a CAR of 0%, which was below the set threshold of 20%. Therefore, the hypothesis was falsified, and we decided to try a different channel in the next discovery experiment.

Google advertisement experiments. The Google advertisement experiment investigated whether customers are pulled to the WaterFox application via Google Ads. It ran as a smart campaign, which means that bidding, targeting, and ad creation were automated by Google Ads (Google, 2020). The landing-page from the Facebook advertisement experiment was reused, providing customers with an almost identical customer journey. The experiment ran for three days from April 27 to April 29, 2020, with a budget of €27.31, resulting in 48.211 impressions, 89 advertisement clicks, and 4 download-button clicks. This resulted in a CAR of 4.49%, which is also lower than the expected 20%. Hence the hypothesis was falsified. The Google Ads manager provides further information about the keyword performance, types of devices by targeted customers, and advertisement networks. The highest CAR in the Google Display Network was 11.11%. Due to this performance indication, we decided to conduct a second Google advertisement in the Google Display Network.

The Google Display Network experiment used a display advertisement that was only shown on certain websites and not in Google Search. The experiment ran for three days from May 6 to May 7, 2020, with a budget of €29.98, resulting in 69.100 impressions, 539 advertisement clicks, and 8 download-button clicks. This led to a CAR of 0.15%, which was below the set threshold of 20%. Therefore, the hypothesis was falsified. Due to this result, we decided to explore other online channels.

LinkedIn advertisement experiment. The LinkedIn advertisement experiment investigated whether customers were pulled to the WaterFox application via advertisements on LinkedIn. Hence, a LinkedIn advertisement was designed to test the hypothesis. The potential customers were sent to a landing page that revealed detailed information about the value proposition of the WaterFox-application. The target audience was defined as persons interested in agricultural topics. The target audience was set to males between the age of 25-34 years, meant to represent the startup's current target customer persona. For this experiment, the customer journey from the previous experiment was again reused, with the only difference that now the customer started at the designed LinkedIn advertisement. Data was collected using LinkedIn's campaign manager connected to the landing page by implementing a JavaScript tag to count conversions on the landing page. The LinkedIn experiment ran from May 5 until May 10, 2020, with a budget of 30 in Germany, Austria, and Switzerland, resulting in 6 clicks on the advertisement, and 2 download-button clicks. The results meet the expectation threshold with a CAR of 33.33%.

Press article experiment. The press article experiment tested whether customers could be pulled via an article in an agricultural newspaper into the WaterFox application. The hypothesis was formed by interviews that the startup conducted with customers during the business experimentation process. To test the hypothesis, we sent a press release to several newspapers. To contact them, we used the network of the local startup accelerator for support. The press release contained important information about the WaterFox-application. Underneath the article, a link referred directly to the landing-page of the WaterFox application. Referrals from this link were tracked using Google Analytics. The newspaper top agar

Table 3. Results of Discovery Experiments.

Experiment	CTR	CAR	CAC
Facebook Advertisement	0.11%	0.00%	-
Google Advertisement (Smart-Campaign)	0.18%	4.49%	€24.39
Google Advertisement (Display)	0.78%	0.15%	€38.36
LinkedIn Advertisement	0.96%	33.33%	€153.85
Press Article	18.80%	27.47%	€15.93

(https://www.topagrar.com) published the article on May 27, 2020. The press article resulted in 484 unique article reads, 91 landing-page visitors, and 25 download-button clicks. This leads to a CAR of 27.47%, which therefore meets our threshold expectations.

(4) Validation Experiments
After identifying suitable channels for the startup to acquire new users, our focus shifted from the discovery phase to the validation phase. In the following, we present two validation experiments, called brochure advertisement and validation interview.

Brochure experiment. The brochure advertisement experiment tested whether customers were willing to pay a price of €9 for the envisioned version of the WaterFox application and whether customers can be acquired via post. Again, a customer journey was set up. To test customer willingness to pay, two versions of the brochure were designed that differed in price. The control group received a brochure costing €3, while the test group received a €9 brochure. If the post-delivery channel was to be a suitable way of acquiring customers, it would be validated or refuted by running the validation interview experiment afterward.

To run this experiment, we needed the addresses of farmers to send the brochures. To solve this, we screened several websites and platforms for contacts. The sample size was 34, equally divided between test and control group. We sent the brochures to recipients at a cost of €47.73 for printing and sending. The brochure advertisement resulted in no responses from the contacted persons. Follow-up validation interviews with five contacted farmers (referred to as interview experiment in the following), revealed a possible reason for non-responses and disclosed valuable information for the business model.

Interview experiment. Besides trying to discover the cause for the non-responses to the brochures from potential customers, the goal of the interview experiment was to validate current understanding of problems and customer work involving farm irrigation management. More precisely, the experiment aimed to investigate the importance of certain tasks to target customers. Importance was defined as the frequency and effort of completing a task or enduring a burden. Additionally, our goal was to investigate the current usage of digital products for target customers. Job inquiries were formulated as statements. Each statement included whether the customer actually worked in the job, how often it was completed in the last four weeks, and how much time and money were required. Additionally, interviewees were queried about several elements of their farm. This was done to place the provided information into the right context and to help avoid biased or misleading results. The interview was conducted via phone. We read out the statements about jobs to the participants and recorded their responses. Of the 34 contacts available from the previous brochure experiment, we contacted 31. Five contacts agreed to an interview. The remaining showed an unwillingness to be interviewed, mostly due to time pressure and a high workload, because seasonal workers were limited due to the COVID-19 pandemic. The interviews were encoded to categorize the answers and systematically extract the results. We present the results from the validation experiments briefly in the following section.

5. Results

We gained insights into the company's channels, value proposition, customer segment, and product performance. Table 3 summarizes the experimental results conducted in the discovery phase of the B-SEF. The collected data shows the Facebook and Google Ads did not reach the predetermined conversion threshold of 20%. In contrast, the LinkedIn advertisement and press article experiment exceeded the threshold. The cost of acquiring one registered user was €153.85 for LinkedIn and €4.13 for the press, based on the measurement system and data collected by running the experiments. We estimated the cost of running the press article experiment based on the average price of using a writing service from a freelancer on the website upwork.com. These results were valuable for the startup to evaluate the desirability of its business model as they showed how the startup can acquire new customers and how much it costs.

The distributed brochures did not result in any acquisitions. The follow-up interviews conducted to investigate the unresponsiveness revealed that customers have limited available time and chose not to allocate it to reading a brochure. Additionally, the interviews yielded insights into software and hardware usage, as well as willingness to pay for the product. These insights helped to evaluate how desirable certain elements of the business model were, such as the value proposition. Figure 3 summarizes key findings of the B-

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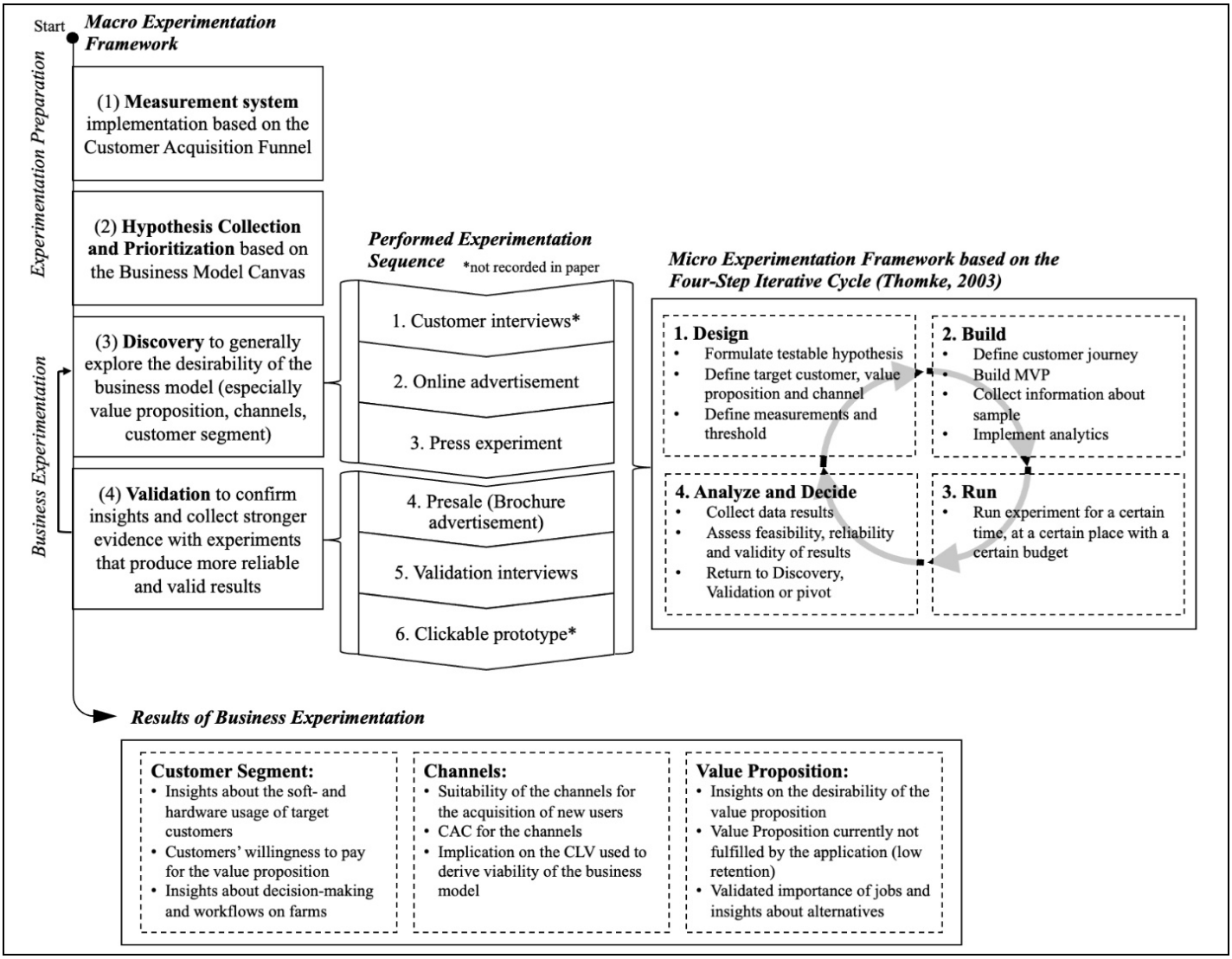
Figure 3. The B2B Startup Experimentation Framework (B-SEF) with Results



SEF application in the startup heliopas.ai.

6. Discussion of Results and Proposed Design Principles

This research set out to assess the business model of heliopas.ai. By conducting a series of business experiments outlined by the B2B Startup Experimentation Framework (B-SEF) with an emphasis on the discovery and validation step of a startup, valuable insights were gained, resulting in improvements to the business model. With only a low budget of €118.49, experimentation showed the desirability of the business model and revealed the presented results which are discussed in the following.

The discovery experiments were run at various times, which led to extraneous variables not remaining constant. This was an acceptable circumstance of the discovery experiments as they were aimed at establishing proof of the channel's suitability in reaching target customers quickly. With a CAR of 27.47%, the press article experiment met our threshold expectations. A possible reason for this performance might be that farmers trust the information delivered by the newspaper top agrar, and are therefore more likely to visit the landing page and download the WaterFox application. If increased trust leads to more landing page

visits and conversions, this article can also be used in future experiments as a reference.

The results of the brochure advertisement emphasize the importance of an existing channel to a customer. The post-delivery channel was not validated and hence the brochure experiment does not provide answers about customer willingness to pay. The validation interview showed that interviewees use different hardware and software, and the difficulty of integrating the WaterFox application into an existing customer workflow. One interviewee stated that they were annoyed by documenting information in several IT systems. Thus, it was an obstacle for helipas.ai to sell its product to other businesses and find innovators.

The result of the interview experiment reveals the benefit of a qualitative approach. This experiment yielded significant insights into customers' jobs, the suitability of the posting channel (used for the brochures), as well as customer willingness to pay. Since all interviewees were tested under all conditions, this was a within-subjects experiment (Price et al., 2017). It provided a high level of control over the extraneous variables, since participants in all control and test groups were the same. This was an advantage of the validation interview experiment's design.

The novelty of the designed framework is that it was tailored to a real B2B startup. Though this in some ways might limit its generalizability, at the same time it also increases its suitability for this particular case of a startup company. By advising the process to begin with implementing a measurement system as the first step, this research stands in contrast to the business experimentation frameworks of Blank and Dorf (2012), Ries (2011), and Thomke (2003). Our measurement system was adapted from the Growth Hacking framework. With heliopas.ai, it was justifiable to build a measurement system at first since the stage and the progress the founders were at with the startup was more advanced at the point of time of this research. Similar to

Table 5. Proposed Design Principles

Case-specific circumstances: B2B startup, high-fidelity MVP existing, software-based product, technology for the application has been developed		
Intention	**Action**	**Recommendation**
Testing online communication and acquisition channels.	Google Ads advertisements LinkedIn advertisement Facebook advertisement Press article	*H1: Online advertisements are less suitable to learn qualitatively about the customer.* *H2: Increase the run-time to one week to improve reliability.* *H3: B2B customers trust the information delivered by the newspaper* top agrar *and are more likely to visit the landing page.* *H4: Consider Customer Acquisition Rate as well as Customer Acquisition Cost as a threshold for experiments.*
Testing the customers' willingness to pay.	Brochure advertisement	*H5: Test the channel to confirm its suitability before running validation experiments.*
Measuring data along the customer journey from a virtual touchpoint to a smartphone application.	Tracking traffic, conversions, app store views, app downloads, registrations, and user retention	*H6: Tools such as Google analytics and Excel spreadsheets enable data collection and derivation of decisions in the startup.*
Exploring the customers' pains.	Customer interview	*H7: Qualitative interviews should be considered for early exploration of the customers' pains.*

research done by Brecht and colleagues (Brecht et al., 2019) that focused on business experiments for platform business models, the B-SEF focuses on B2B market business models. Compared to other frameworks, the B-SEF suggests concrete experiments. This positions our research uniquely among existing frameworks.

Even with restricted generalizability, these business experiments and the design principles derived can provide other startup founders with ideas about designing their own experiments (see table 4). The design principles from this research were formulated using the following structure: "to achieve X in situation Y, something like Z will help" (Berglund et al., 2018). These design principles are currently at hypotheses stage based on applying the framework and require further empirical research to confirm and validate (or refute) them statistically.

In contrast to other frameworks, this research also provided references on the performance of certain experiments, that is, practitioners can compare quantitative results of this research with their results and evaluate the findings. This comparison can be useful in practice when it is not always clear if an experiment has produced satisfactory results.

The separation of business experiments into discovery and validation experiments was proposed to equally satisfy scientific rigour as well as the entrepreneurial desire for speed and efficiency. This mindset was inspired by the Customer Development Process of Blank and Dorf (2012) and by recently published work on business experimentation by Bland and Osterwalder (2020).

As stated previously, businesses tend to be largely regulated and rational in their buying decisions. It is difficult to evaluate what impact customer willingness to adapt to a new product had, given that the customers in this case were other businesses instead of consumers. Based on experience, target customers (farmers) are only open to new products if value is delivered immediately. This makes it hard for startups to penetrate markets with an unfinished product. The limited number of customers in a B2B market such as the agriculture industry, in which the startup heliopas.ai operates, can be a challenge when conducting business experiments. Having available business contacts can be beneficial when running business experiments, which was seen in the validation experiments.

This study chose a threshold of 20% CAR for discovery experiments, a commonly used threshold to determine the success of an experiment in startup environments. However, we recommend relying not only on one metric, but also on monetary metrics, such as CAC or CLV, to assess the success or failure of an experiment.

7. Conclusion

This research proposed the B2B-Startup Experimentation Framework, a four-step solution for how startups can reduce uncertainty and improve their business model. The framework was tailored to the B2B startup case of heliopas.ai. The main contribution of this research lies in having applied a theoretical-based framework to extract insights into the applicability of the proposed framework. The B-SEF guides a B2B startup in how to conduct business experiments. The startup heliopas.ai gained important insights into customer segment, the value proposition, and its business model channel, and reduced uncertainty by following it. However, business experiments might not always be feasible, since requirements might not be available to properly execute them (see, channel for brochure advertisement).

A limitation of the current B-SEF framework is the focus on desirability aspects of the business model during its application. In contrast, other frameworks like the Customer Development Process (Blank & Dorf, 2012) have a process designed to explore and validate the entire business model. The focus on desirability might limit researchers' capabilities of evaluating the framework holistically, and therefore requires further research. It remains an open question whether the B-SEF is only applicable to B2B startups, which likewise leaves room for future research. We recommend applying the framework in a B2C startup to investigate its applicability in that market.

Although online advertisement is a quick and cost-effective way to gain insights into the desirability of the business model, large amounts of data provided by online advertisement tools helped to conclude causality. Limitations arose when investigating why certain events or results occurred. The anonymity of persons was challenging in this case as we were not able to contact people for further questioning. For instance, the Google Display advertisement did not perform as expected and the plausible explanation was merely based on

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assumptions.

Another limitation of this research is that only a narrow understanding of the causal relationship between variables could be gained. Also, the current pandemic poses another extraneous effect. The lack of seasonal workers might have influenced the amount of time farmers spent online and on social media activities. Therefore, running the same experiment at a different time of the year or in a different year might yield different results. This underlines the limitations of business experiments in general, which are usually run with a low budget and in a short period of time. Moreover, it is ambiguous if an increased budget or run-time would have led to similar results. Since the conducted discovery experiments focused on online experimentation, the framework is expectedly limited to businesses that can acquire customers and distribute their products online.

As a conclusion remark, we find that the main challenge is to design business experiments in a way that reveals underlying causality. This can be very challenging in a startup where the business and its operations are not yet defined. Furthermore, operating quickly and cost-effectively implies making trade-offs between the reliability and validity of results. Practitioners should consider a sequence of business experiments that are run to improve the company's learning effect, to better explain negative outcomes, and to use a mixed data collection approach. William Blake stated (1788) that experimentation is "the true method" of gaining insights. This also seems to hold true for business model validation in B2B startups. A systematic experimentation framework along with well-designed business experiments can reduce the need for resources such as time and money and help deal with uncertainty and risks.

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Discovery and Validation of Business Models: How B2B Startups can use Business Experiments

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The Acceptance of Digital Surveillance in an Age of Big Data

Mika Westerlund, Diane A. Isabelle, Seppo Leminen

> *"Those who control the present, control the past and those who control the past control the future."*
>
> George Orwell
> 1984

News media companies and human rights organizations have been increasingly warning about the rise of the surveillance state that builds on distrust and mass surveillance of its citizens. The COVID-19 pandemic is fostering digitalization and state-corporate collaboration, leading to the introduction of contact tracing apps and other digital surveillance technologies that bring about societal benefits, but also increase privacy invasion. This study examines citizens' concerns about their digital identity, the nation-state's intelligence activities, and the security of biodata, addressing their impacts on the trust in and acceptance of governmental use of personal data. Our analysis of survey data from 1,486 Canadians suggest that those concerns have negative impacts on citizens' acceptance of governmental use of personal data, but not necessarily on their trust in the nation-state being respectful of privacy. Government and corporations, it is concluded, should be more transparent about the collection and uses of data, and citizens should be more active in "watching the watchers" in the age of Big Data.

Introduction

Prolific news media such as Bloomberg, Forbes and the Financial Times have increasingly warned about the rise of the "surveillance state" that "aims at preventive mass surveillance on [an] everyday basis" and is connected with potentially coercive use of control against specific people or groups on a political or other basis (Lemieux, 2020). Although Clark (2016) and Sekalala et al. (2020) point out that digitalization could broaden democratic engagement, many states and large corporations are increasingly using digital environments to monitor and direct citizens. The "Snowden leaks" in 2013 revealed the unprecedented scope and magnitude of state-corporate surveillance of our everyday digital activities in pursuit of "datafication" of social life (Milanovic, 2015; Dencik et al., 2016; Hintz et al., 2017). Indeed, Clarke (2019) argues that humanity has entered a period of living in a "digital surveillance economy", where the acquisition and exploitation of large volumes of personal data through digital devices are used not only by governments for security purposes, but also by corporations to target advertisements, manipulate consumer behaviour, and maximize revenues from goods and services.

Evidently, various stakeholders consider data as a booster to innovation (Isabelle et al., 2020; Leminen et al., 2020a). However, advances in technology and the pervasive adoption of social media have dramatically increased the power of states and multinationals to carry out digital surveillance and even abuse personal online data (Taylor, 2002; Odoemelam, 2015; Sekalala et al., 2020). At the same time, public trust in government has declined in most developed countries (Chanley et al., 2000; Job, 2005; Zhao et al., 2017). Digital surveillance by the nation-state has been justified by the argument that such surveillance can protect people by preventing illegal and dangerous activities, thereby contributing to safety, security, and autonomy in society (Clark, 2016; Zhang et al., 2017). However,

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governments across the world have come under sharp criticism for their use of digital surveillance technologies to gather massive amounts of personal information, yet with little evidence of this mass surveillance being effective in improving security for users of digital tools (Zhang et al., 2017; Cayford & Pieters, 2018).

Clarke (2019) argued that the growing levels of digital surveillance may even wash away achievements over previous centuries for individual rights that protect humanity as a whole. Unsurprisingly, a notable resistance to surveillance can be seen regularly in media, political circles, and academia (Martin et al., 2009). Most recently, the debate involving digital surveillance has been intensified by the proliferation of contact tracing apps due to the COVID-19 pandemic, as well as the widespread protests that followed the death of George Floyd (Amit et al., 2020; Keshet, 2020; Maier, 2020; McGee et al., 2020; Ram & Gray, 2020; Sekalala et al., 2020). Also, the increasing remote surveillance of teleworkers by their employers (Rosengren & Ottosson, 2016) and the adoption of proctoring software in the educational sector to monitor online exams during the pandemic lockdowns have sparked fierce reactions and discussions across the world (Asher-Schapiro, 2020; Manokha, 2020a; Manokha, 2020b; Stott & Wiggins, 2020). These advancements bringing surveillance to our private homes beg a question: are there any areas left that are not under surveillance?

State-corporate surveillance certainly raises severe concerns about the invasion of privacy (Cayford & Pieters, 2018). Surveillance may have become a normalized key condition of living in a modern "techno-securitized society", as a way to ensure collective security (Bennett, 2011; Bernal, 2016; Clark, 2016; Petit, 2020). Yet at the same time, individuals' privacy concerns due to the introduction of ever more privacy-intrusive technologies are not unwarranted. The Snowden revelations on WikiLeaks showed that surveillance by the intelligence services of nation-states has not been limited to marginalized and deserving groups of "wrong-doers", but rather digital surveillance can target anyone and everyone in a nation, society or community (Dencik et al., 2016). Organizations are attempting to benefit from data beyond the context it has been collected for to create new businesses (Leminen et al., 2018, 2020b). Further, the risk of inappropriate flows of sensitive data collected in one context and spread to another context has increased along with digitalization (Winter & Davidson, 2019). While public polls show that people are willing to share, for example, their medical data to serve the greater good during the COVID-19 pandemic, people also have reservations concerning governmental use of their personal data (Osborne, 2020). Subsequently, many human rights groups, such as Amnesty International, have warned against the expanding use of government surveillance and data collection during the pandemic. The use of digital technologies such as automated facial recognition to identify protesters on video or tracking of smartphones to collect user and location data for undisclosed purposes has also been flagged as potentially or already problematic (Maier, 2020).

This study addresses the calls in previous literature to better understand concerns that citizens have about the rise of digital surveillance amidst socio-technical changes (see for example, Bernal, 2016; Cayford & Pieters, 2018; Beduschi, 2019; Ram & Gray, 2020). Specifically, the study focuses on investigating whether citizens' concerns about their digital identity, the state's intelligence activities, and the security of biodata have impacts on their trust in and acceptance of governmental use of personal data. In so doing, the study establishes a set of hypotheses and tests the research model on open survey data from 1,486 Canadians. The results contribute to the growing literature on privacy and digital surveillance by showing both what hampers citizens' trust in their government and what impacts their acceptance of the gathering and use of personal data for undisclosed purposes by agencies of the state. Further, the results can help citizens, public servants of nation-states, and corporations to find ways to establish common ground where state-corporate actors' data needs meet citizens' privacy rights.

The paper is structured as follows: Next, we review the literature on privacy and data security, and establish a set of hypotheses on the impacts of citizens' concerns about digital identify, the state's intelligence activities, and security of biodata. We discover it has an impact on their trust in the state respecting their privacy and on their acceptance of government gathering and using their personal data. Then, we describe the data set from the research and the methods of analysis. Thereafter, we report findings from the analysis. Finally, the study concludes by summarizing the key findings, discussing their implications for theory and practice, and suggesting the limitations of the study and avenues for future research.

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Literature Review

Digital surveillance and privacy invasion

While "digital citizenship" refers to increased citizen empowerment in modern societies using digital technologies, digital surveillance has surfaced as a major challenge to this feeling of liberation (Hintz et al., 2017). Surveillance has gradually become so "pervasive and inextricably connected to our everyday activities" (Clement & Obar, 2015) that we unquestionably live in a "surveillance society" (Ibid). This leads us to ponder if there is any room for privacy anymore. Bernal (2016) portrays privacy as an individual right, in opposition to the collective need for security. Indeed, Bennett (2011) interprets privacy as an ego-centric concept that revolves around "the protection of the self, from the state, from organizations and from other individuals". State-corporate actors collecting data from citizens, according to these views and others, should take every effort to protect individual privacy (Amit et al., 2020).

However, the issue of privacy invasion is not necessarily due to the collection of personal data. Instead, the classification and assessment of that data may lead to discrimination based on profiling (Bennett, 2011). Although viewed as being essential for building a data-driven "digital welfare state" (van Zoonen, 2020), the introduction of various "citizen scoring" (Dencik et al., 2019) or "social sorting" systems (Lyon, 2014; Wang & Tucker, 2017) can discriminate citizens in terms of their access to health care, and oppress basic human rights. This can happen, for example, by blocking their ability to travel due to having a lower reputation rating and trustworthiness score on state-wide "social credit systems". Thus, consideration of harms that may arise due to mass surveillance by states and corporations should extend beyond mere privacy issues and incorporate a large variety of society-wide effects (Murray & Fussay, 2019).

Concerns about digital identity

Piecing together an individual's identity, for example, their religious beliefs, based on their social contacts and online behaviour, has become common in monitoring security threats after the 9/11 attacks and other acts of terrorism around the world (Marx, 2015; Odoemelam, 2015; Clark, 2016; Menichelli, 2017). Van den Broek et al. (2017) focus on the increased use of digital "crowd surveillance" technologies to identify individuals involved in public disorder events, such as violent demonstrations and sports hooliganism. Indeed, identifying "individuals in the context" is a key attribute in digital surveillance (Wang & Tucker, 2017), and intelligence authorities commonly use IP address data to obtain user identity information (Forcese, 2015). Digital identity and online behaviour are not just interesting for intelligence authorities, but are also crucial for various online platforms (Budak et al., 2017). According to Clarke (2019), contemporary business models rely on collecting and exploiting massive volumes of personal data to provide markets with improved customer experiences, increased convenience, and time-savings through targeted value propositions. However, the ability of large corporations and governments to monitor and store online behaviour data on a massive scale, actually serves to limit the possibilities of individuals from dissenting and protesting, and supports a form of governance that prioritizes certain social, economic, and political agendas at the expense of others (Dencik et al., 2016).

A recent study by Keshet (2020) suggested that issues of trust surfaced as a major challenge for people involving their government's increased digital surveillance of its citizens in order to monitor the spread of coronavirus and thus in a way control peoples' behaviour in the midst of COVID-19 pandemic. Veliz (2021) notes that the pandemic has accelerated digitalization in society and contributed to widening power asymmetries between consumers and "big tech" companies. Undeniably, privacy has become a critical issue as state-corporate actors seeking to obtain peoples' digital identity information have implemented new technologies and methods to gather that information. Accordingly, as those stakeholders "build on personal data for identification and identity verification, data protection and privacy rights are most clearly affected" (Beduschi, 2019). Taylor (2002) argues that "paradoxically, it is a demand for privacy that drives the need for surveillance and therefore greater privacy and so on," creating a self-perpetuating cycle.

Our starting hypotheses for the research, which we tested with survey data, begin as follows:

H1: Citizens' concerns about digital identity have a negative impact on their trust in the government respecting citizen privacy.

H2: Citizens' concerns about digital identity have a negative impact on their acceptance of governmental use of personal data.

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Concerns about the nation-state's intelligence activities

According to Cayford and Pieters (2018), the purpose of a nation-state's intelligence activities is to provide information to help government officials in their decision-making, while not dictating what actions decision-makers should take. That said, Bernal (2016) pointed out that the information provided by Edward Snowden in 2013 revealed that the nature and depth of Internet and communications surveillance for intelligence and national security purposes differed remarkably from what had up to that point been acknowledged publicly. Traditionally, a nation-state's intelligence activities include "strategic intelligence" aimed at foreign governments to comprehend possible threats, as well as "tactical operations" targeted at specific individuals or groups of interest (Cayford & Pieters, 2018). However, recent state-led efforts to secure its citizens against global threats such as terrorism and espionage have turned almost anyone into a potential threat, and therefore likewise into a possible target of surveillance technologies (Petit, 2020). This has affected civil rights and basic freedoms (Milanovic, 2015), as exemplified by U.S. border agents "rightfully" searching travelers' smart phones, and requests by intelligence agencies for technology firms to install backdoors to encrypted services for the sake of national security.

While foreign surveillance for national security purposes may be legitimized in many countries, the surveillance of a nation's own citizens or, as revealed by Snowden leaks, the surveillance of leaders of allied governments is another matter both legally and morally (Milanovic, 2015). One problem is that, for example in Canada, the government's intelligence activities are somewhat free from parliamentary control. This means that Canadian citizens are left merely to trust the authorities without a possibility of verifying the legality of the government's intelligence activities (Israel, 2015). Cayford and Pieters (2018) thus argue that the government and its surveillance officials need to be more transparent and "lead in education for the public", because democracy and surveillance programs can only work as long as the public trust their leaders and authorities, including intelligence agencies. Such education should address what data are being collected and for what purposes. Public trust in authorities depends heavily on the belief that authorities will not and do not misuse personal data, and act fairly when dealing with the public (Cayford & Pieters, 2018; Veliz, 2021). For example, according to Bernal (2016), people perceive "content" gathering for intelligence purposes as more intrusive compared to gathering contextual "metadata". Consequently, content gathering may be excessive data collection, which can lower public trust in the government. That said, effective algorithmic and artificial intelligence-driven "bulk data" monitoring and analysis nowadays have narrowed down the differences between content and metadata into the information value of data (Murray & Fussey, 2019). Thus:

H3: Citizens' concerns about the nation-state's intelligence activities have a negative impact on their trust in the government respecting citizen privacy.

H4: Citizens' concerns about the nation-state's intelligence activities have a negative impact on their acceptance of governmental use of personal data.

Concerns about biodata security

Biometric technologies are further redefining privacy boundaries, as they "do not just involve collection of information about the person, but rather information of the person, intrinsic to them" (Bennett, 2011). Indeed, biometric data such as facial topographies and fingerprints stored in digital databases for recognition purposes bring about new levels of aggregation involving privacy issues (Martin et al., 2009; Bernal, 2016). For example, biometric security technology used at airports allows for passengers to "clear security based on their unique biometric features" (Kim et al., 2020). Border control services across the world are increasingly adopting biometric security technologies such as fingerprints, iris scanning and facial recognition, to replace or complement passport-based entry management at national borders (Lyon, 2007; Marin, 2017).

However, previous research has shown that perceived risks related to biodata have an impact on passengers' intentions to use biometric security (Kim et al., 2020). Ebelogu et al. (2019) add that such risks are linked to privacy due to security concerns. Public polls have frequently indicated that people may perceive the current legal privacy protection frameworks as insufficient because of deficient implementation of laws and weak control mechanisms (Budak et al., 2017).

Commercial and governmental gathering of personal data are often considered as separate and different, without explicit links between the two. For example, Martinez-Marin and Char (2018) argued that monetization exceeds the altruistic interest in improving

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patient health as a motivator behind private industry development and investment in data-based digital health solutions. However, several scholars (for example, Richards, 2013; Bernal, 2016; Van den Broek et al., 2017) have suggested that public and private surveillance are simply related parts of the same problem, noting that authorities are increasingly being provided with access to biodata records owned by commercial firms. The benefits of such public-private collaboration are evident in solving "cold crime cases", most notoriously the Golden State Killer who was tracked and sentenced to life imprisonment decades after the crimes took place by comparing DNA data from crime scenes with data files on a genealogy website that has over one million DNA profiles from commercial DNA companies (Guerrini et al., 2018). Dedrickson (2018) argues that such DNA databases can be effective in solving crimes, exonerating the innocent, and decreasing racial disparities in law enforcement, thus contributing to social justice and the common good, rather than being a type of "Big Brother" invasion of privacy. On the other hand, access to large facial topography and genetic profile databases could be misused by authoritarian governments to control their own people, potentially focusing on certain ethnic minorities, political movements, or other targeted populations (Wee, 2020; Fox Cahn, 2021).

Without a doubt, the COVID-19 pandemic has accelerated beneficial public-private collaboration regarding data collection and use. Examples include the use of mobile location data to monitor social distancing and quarantine enforcement as well as contact tracing, warning about exposure to COVID-19, modelling patterns, and the flow of coronavirus spread. As well, the creation of new medical databases related to the pandemic, and the use of thermal cameras and wearables to collect relevant biometric data such as skin temperature, heart rate, and breathing (Amit et al., 2020; Kitchin, 2020; Guinchard, 2020). On the other hand, Ram and Gray (2020) argue that policy makers need to consider in a more profound way the efficacy and comparative advantages of tracking apps vis-à-vis more traditional means of controlling and containing epidemic contagion in order to avoid substantial risks to privacy. State-corporate collaboration has likewise served to increase the risks of uncontrolled and illegal sharing of biodata (Guinchard, 2020), privacy violations and abuse of data, either by the government (Sekalala et al., 2020) or for-profit companies due to commercial interests (Klingner et al., 2017). Examples of governmental misuse of biodata include the large number of unauthorized searches by NYPD officers on private facial recognition platforms (Fox Cahn, 2021). Hence:

H5: Citizens' concerns about biodata security have a negative impact on their trust in the government respecting citizen privacy.

H6: Citizens' concerns about biodata security have a negative impact on their acceptance of government using personal data.

Trust in and acceptance of governmental use of data

Surveillance authorities can no longer simply ask people to trust them, while at the same time providing worrisome indications that they may not be trusted themselves (Bernal, 2016). The evermore obvious rise of the surveillance state builds on suspicion and distrust, while society's legal, technical, and bureaucratic systems are designed for extensive surveillance because people are assumed to be inherently untrustworthy (Bernal, 2016). Thus, it is not surprising that citizens may feel distrustful of the government and authorities, since they are being treated with distrust themselves (van Zoonen, 2020). Indeed, Clement and Obar (2015) argued that the growing implementation of digital mass surveillance technologies has hindered "the government's ability to protect the integrity of its communications with citizens", thus undermining citizens' trust in governmental institutions. Bernal (2016) noted that lower levels of citizen trust in the nation-state's intentions to gather and use personal data correlate with a lower level of citizen cooperation with authorities. Further, Cayford and Pieters (2018) suggested that public trust in authorities is linked with the government's ability to run sustainable long-term surveillance programs. Overall, public trust in government has declined in developed countries dramatically over recent decades, while surveillance has not decreased, but rather increased (Chanley et al., 2000; Job, 2005; Zhao et al., 2017).

Technological advances have played a key role in the emergence of the "surveillance state", with rising levels of state surveillance. Surveillance technology has rapidly expanded from cold war era spy technology, such as wiretaps and hidden, or CCTV cameras, to modern spy drones and satellites, as well as various technological and often autonomous systems for targeted and untargeted cyber surveillance. These systems include artificial intelligence technologies to monitor and analyze phone calls, emails, keystrokes, private messaging, social media, videos and photographs,

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digital device use, geospatial data such as mobile phone location, sensor data including audio and other information collected by Internet of Things (IoT) devices such as virtual assistants, as well as internet traffic and online activity such as clicks, browsing history, online searches, downloads and uploads (Hogan & Shepherd, 2015; Odoemelam, 2015; Watt, 2017; Cayford & Pieters, 2018). Marx (2015) notes that state-corporate surveillance has historically involved power imbalance that favours more powerful actors. Given that the contemporary times may be described as "the age of big data surveillance", Hogan and Shepherd (2015) and Odoemelam (2015) argue that there are few options available for citizens to subvert the transcendent power of current governmental surveillance organizations, thus emphasizing the role of trust in adapting to mass surveillance in society. Hence:

H7: Citizens' trust in the government respecting citizen privacy has a positive impact of their acceptance of governmental use of personal data.

Next, the paper discusses the data and methods of analysis used for testing our hypotheses.

Methods

The study makes use of survey data on Canadians' perceptions about privacy in the digital era. A random-digital dialing telephone survey was conducted in 2018-2019 among Canadian residents, 16 years of age or older, by Phoenix Strategic Perspectives Inc. (Phoenix SPI), a research firm commissioned by the Office of the Privacy Commissioner of Canada (OPC). The data set is publicly and freely available as open data through OPC Communications Directorate website (OPC, 2020) under the "Open Government Licence —Canada". The data set includes anonymous responses from 1,516 residents, but we filtered out those who reported that they do not use the Internet or do not own a cell phone, thus resulting in a final data set of 1,486 usable responses. Of note, previous literature discusses Canadian perspectives on mass surveillance. For example, Geist (2015) argues that the issues of privacy and surveillance in Canada remain largely in the public eye, and thus Canada provides a specifically fruitful context for this kind of research, though we make no assessment of Canada's specific suitability for the research conducted here.

Our hypotheses about the impacts of citizens' concerns regarding their digital identity, the nation-state's intelligence activities, and security of biodata on their trust in and acceptance of government's use of personal data were tested using SmartPLS 3.3.2 software (Ringle et al., 2015). It enabled us to use partial least squares structural equation modelling (PLS-SEM), a variance-based statistical modelling technique that is widely applied in business and social science research (Henseler et al., 2016). PLS-SEM is particularly useful for studying new topics in information technology (Henseler et al., 2016; Hair et al., 2017), because of its capacity to test behavioural models with minimum demands regarding measurement scales and residual distributions (Monecke & Leisch, 2012).

Each of the five constructs in our model was measured by 2-3 variables. In order to align all constructs to reflect citizens' concerns, we reverse-coded variables related to the nation-state's intelligence concerns. Item loadings of all constructs were above the 0.70 threshold, along with >0.70 Composite Reliability (CR) (Lindell & Whitney, 2001) and >0.50 Average Variance Extracted (AVE) values (Henseler et al., 2016). These values indicate convergent validity and suitability of the constructs for this analysis (Table 1). The Fornell-Larcker Criterion suggested sufficient discriminant validity (Fornell-Larcker, 1981) and the standardized root mean square residual (SRMR) was 0.088, suggesting an acceptable model fit (Henseler et al., 2016). Finally, the model showed R^2=12.1% of trust and R^2=14.8% of acceptance of governmental use of personal data.

Findings

The results from the PLS-SEM analysis confirm most of our hypotheses. First, the results confirm that citizens' concerns about their digital identity (H1: β=-0.061, t=1.988, p<0.05) and their nation-state's intelligence activities (H3: β=-0.338, t=12.880, p<0.001) have negative impacts on their trust in government respecting privacy. Second, the results confirm that citizens' concerns about their digital identity (H2: β=-0.062, t=2.218, p<0.05), their nation-state's intelligence activities (H4: β=-0.186, t=6.707, p<0.001), and the security of biodata (H6: β=-0.162, t=5.865, p<0.001) have negative impacts on their acceptance of collection and use of personal data for government purposes.

Third, the results confirm that citizens' trust in the government respecting privacy (H7: β=0.211, t=7.396, p<0.001) has a positive impact on their acceptance of collection and use of personal data for governmental

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Table 1. Constructs correlations, reliability and validity

	CR	*AVE*	*Acceptance*	*Biodata*	*Identity*	*Intelligence*	*Trust*
Acceptance	0.853	0.661	(0.813)				
Biodata	0.784	0.645	-0.194	(0.803)			
Identity	0.893	0.807	-0.140	0.374	(0.898)		
Intelligence	0.881	0.788	-0.254	-0.020	0.003	(0.888)	
Trust	0.770	0.626	0.288	-0.061	-0.079	-0.337	(0.791)

purposes. That said, our analysis did not confirm the anticipated negative impact of biodata security concerns on citizens' trust in their government being respectful of privacy (H5: β=-0.045, t=1.578, n.s.). The results, along with information about data and support or lack of support for the hypotheses, are summarized in Table 2.

Discussion and Conclusion

The objective of this study was to investigate concerns that people have about the rise of state-corporate digital mass surveillance amidst rapid socio-technical changes and examine how those concerns affect citizens' trust in and acceptance of governmental use of personal data. Specifically, we focused on concerns people have about their digital identity, the nation-state's intelligence activities, and security of biodata, including iris scans at airports and DNA information stored in databanks of commercial companies such as ancestry tracing firms, which are increasingly accessible to authorities. In so doing, we tested a research model with seven hypotheses on an open survey data about privacy, collected from 1,486 Canadians in 2018-2019. A PLS-SEM analysis confirmed six of the seven hypotheses.

Contribution to theory

Our results have implications for the existing body of literature on surveillance and privacy, by having focused on the links between privacy perception, the nation-state's intelligence activities, and the rise of a surveillance state using big data. The results point out that recent advances in digital technologies, intensified during the COVID-19 pandemic, are major contributors to the increase of digital surveillance. The tightening of state-corporate collaboration to fight the pandemic has opened doors for growing collection, sharing, and use of personal data in digital form.

Overall, the results confirm that citizens' trust in government respecting their privacy and citizens' acceptance of their government's use of personal data with rising levels of surveillance are affected by a number of concerns and cannot be explained by any single factor (see Bernal, 2016), but rather a number of varied factors. This was obvious through the relatively low, yet acceptable R-squared measures. Nonetheless, the study confirms what previous literature suggested regarding the relationship between identity concerns and citizens' acceptance of governmental use of personal data (Beduschi, 2019), as well as between

Table 2. Correlation coefficients and statistical significances

H#	*Hypothesis*	*β*	*t-value*	*Sig.*	*Support*
H1	Identity concerns → Trust (-)	-0.061	1.988	p<0.05	Yes
H2	Identity concerns → Acceptance (-)	-0.062	2.218	p<0.05	Yes
H3	Intelligence concerns → Trust (-)	-0.338	12.880	p<0.001	Yes
H4	Intelligence concerns → Acceptance (-)	-0.186	6.707	p<0.001	Yes
H5	Biodata concerns → Trust (-)	-0.045	1.578	n.s.	No
H6	Biodata concerns → Acceptance (-)	-0.162	5.865	p<0.001	Yes
H7	Trust → Acceptance (+)	0.211	7.396	p<0.001	Yes

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citizen's concerns about biodata security and their acceptance of governmental data use (Ebelogu et al., 2019).

Additionally, the result of an unconfirmed hypothesis about the impact of citizens' biodata concerns on their trust in government respecting privacy has interesting implications to theory. In principle, it suggests that while citizens may not trust their government being respectful of privacy, yet at the same time they can accept the gathering and use of personal data by the government for undisclosed purposes. For example, people across the world are increasingly using private ancestry tracing services that collect and store DNA information, that is, highly sensitive biodata, even though government authorities may be given access to DNA profiles in these databases for criminal investigation needs, either voluntarily by the database owner or through a court order (see Jee, 2019). Dedrickson (2018) argues that the unfettered access state authorities have to private DNA profile databases may raise citizen resistance. However, Guerrini et al. (2018) note that many people simply choose to ignore or even support the state authority's invasion of DNA databases, if the purpose is to catch violent and dangerous offenders. These findings contribute to discussion on digital surveillance by confirming arguments in previous literature that while the surveillance state is built upon distrust that justifies digital mass surveillance of its citizens, people may also be distrustful of their government (Bernal, 2016; van Zoonen, 2020). This bi-directional distrust feeds the reciprocal growth of tensions between the nation-state and its people, suggesting that state-corporate surveillance actors should be more transparent about their collection and use of citizens' personal data.

Implications for practice

It is evident from our study that the more people trust in their government being respectful of citizens' privacy, the more positive they feel about the government and its actions. The findings on the impacts of citizens' concerns about their nation-state's intelligence activities and their trust in and acceptance of governmental gathering and use of personal data highlight the need for government intelligence agencies to be more transparent about what data are being collected and how they are collected. We believe that democracy and the longevity of surveillance programs, as well as the use of citizen's personal data for creating a digital welfare state, rather than an authoritarian surveillance state, require that citizens can trust their leaders and authorities (Cayford & Pieters, 2018). The more secrecy by public servants and deviation in what is being told from various official sources about the matter, the more substantial public reactions will be when information about the extent of digital surveillance leaks to public through whistle-blowers, as evident through the Snowden leaks (see Clark, 2016). Likewise, when people find out that sensitive personal data is being collected from them without their knowledge or consent, through targeted or untargeted digital surveillance. For example, knowing that employers may use surveillance tools such as computer screenshots, recording phone conversations, tracking mobile phone locations, and keylogging activities to monitor their remote workers' productivity, has been found to result in the loss of a sense of safety, as well as alienation of workers from their private homes due to employers' invasion of those personal "safe spaces" (Zhang et al., 2017; Manokha, 2020).

In addition to increasing the transparency of state-corporate surveillance activities, we believe that citizens should have opportunities to choose and resist technologically automated surveillance, such as algorithmic recognition used in machines (Martin et al., 2009). We also agree with the view of Ram and Gray (2020) and Veliz (2021), that only by adopting a diverse set of procedural and substantive safeguards, including regulation and strict limitations on personal data gathering, aggregation, storage, access, analysis, and use by state organizations and corporations, and by subjecting their digital surveillance programs to constant review performed by independent third-parties, can we hope to protect democracy, citizens' privacy, and well-being in the ever-more digitalized world. Additionally, multinational corporations should voluntarily take actions to better support online user privacy, following the example of Google that recently announced they will end sale of ads using individual web tracking data and refrain from developing new ways to follow individual users across the internet, an action welcomed by the global online audience in a time when consumers are more aware and concerned of their data being used unwittingly (Chan & Anderson, 2021). Further, citizens should be encouraged to actively engage in "sousveillance" or "metaveillance", in other words, counter-conduct activities aiming to "watch the watchers" as a way to ensure the fair, respectful, legitimate, and non-discriminative use of state-corporate surveillance data, and to maintain the balance of power by flattening the "hierarchized system of policing" in society and workplaces (see Odoemelam,

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2015; Hintz et al., 2017; Manokha, 2020b; Sekalala et al., 2020).

Limitations and future research avenues

Our study has limitations that could be addressed in future research. First, although the open survey data on Canadians' perceptions about privacy in the digital era were highly useful for the needs of our study, the questionnaire was not designed by us. Thus, there are inevitable limitations regarding what we could perform with the data and what potentially important factors were left out. Future research could build upon our findings from the open data set and conduct a survey with purposefully designed questions related to key points in our study, as well as involve other types of concerns such as communications-related (cf. Friedewald et al., 2013).

Second, the data were anonymous with little information besides the responses to privacy questions. Thus, we were unable to draw conclusions between demographics and privacy perceptions. Future research should examine the links between privacy concerns and trust in and peoples' acceptance of government gathering and use of personal data involving demographics. This would potentially enable identifying links between demographic groups such as by age, gender, or ethnicity.

Third, the data were collected in Canada which gives a specific cultural, political, and geographical research context. Zhang et al. (2017) argues that people in different countries may view surveillance differently due to cultural, political, and social elements. Hence, in parallel with the notions of Zhang et al. (2017) and Clarke (2019), future research should investigate public opinion about digital surveillance not only in one country, but also in other countries, regions, and cultural environments.

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The Interplay of Digital Transformation and Collaborative Innovation on Supply Chain Ambidexterity

Sara Abdalla, Koichi Nakagawa

> *"While opposition in itself might achieve progress, disorder and confusion might also result. Harmony might achieve stability, but without great progress and prosperity. Opposition needs to be aligned with harmony."*
>
> Kōnosuke Matsushita
> Founder of Panasonic Corporation

This study aims at investigating the impact of digital transformation on the efficiency and adaptability of a supply chain (SC). It also identifies the role of collaborative innovation as a catalyst in these relationships. Survey data from Japanese manufacturing companies was examined using hierarchical multiple regression analysis to test the study's hypotheses. According to the results, collaborative innovation with SC members, that is, suppliers and customers, strengthens the impact of digital transformation on adaptability, but not on efficiency. In contrast, collaborative innovation with market participants, such as competitors and partners, reinforces the positive relationship between digital transformation and efficiency, with no evidence supporting its effect on the innovation-adaptability relationship. These findings encourage firms to widen the scope of their collaborative innovation activities to include different types of partners. For firms with limited abilities to conduct such complex collaboration projects, the findings can assist managers in making well-informed decisions to include partners that accommodate prioritized organizational goals.

Introduction

Digital technologies have a profound impact on consumer behavior (Chanias, 2017) and the competitive landscape (Vial, 2019). They create growth opportunities as well as existential threats to companies. By providing the means by which firms can reconfigure their product/service mix, digital technologies allow for the creation of new offerings (Yoo et al., 2010). These technologies can change products and services and create new business models (Loebbecke & Picot, 2015). Additionally, they impact the ways consumers interact with companies and with each other (Karagiannaki et al., 2017).

Several studies (for example, Günther et al., 2017; Svahn et al., 2017) have established positive relationships between the usage of big data, the internet of things (IoT), analytics, and artificial intelligence, and the increased efficiency and adaptability of firms. Thus, balancing traditionally conflicting targets, a vital capability involving the "ambidexterity" of a firm (Gibson & Birkinshaw, 2004), can be enabled by the use of digital technologies (Svahn et al., 2017). Digital transformation, the "transformations in organizations that are driven by new enabling [information technology] IT/ [information systems] IS solutions and trends" (Heilig et al., 2017), is therefore considered as key for firms to survive, since it drives operational performance and enables significant business improvements (Hess et al., 2016; Agrawal et al., 2019).

Despite acknowledged advantages, the mere implementation of digital technologies is not sufficient (Kane, 2014). In a world where talent and valuable know-how are widely distributed, organizations cannot pursue

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innovation independently, no matter how large or capable they are (Burchardt & Maisch, 2019). Firms now realize the crucial necessity of exploring external sources of technology and ideas to augment in-house R&D (Gassmann, 2006). Thus, creating business value requires firms to open up their innovation processes and develop capabilities to combine internally and externally developed technologies (Chesbrough, 2003).

Firms collaborate with external actors, such as suppliers, customers, competitors, and research organizations, for several purposes. These may include improving distribution, broadening the product assortment, and increasing manufacturing flexibility (Najafi-Tavani et al., 2018). A firm's innovation capability can also be advanced by such collaboration. This is due to improved knowledge sharing and market knowledge acquisition that results in the expansion of a company's knowledge base (Zhou & Li, 2012). By inviting other parties to participate in the innovation process, valuable knowledge and experience can be shared among different actor networks, which enable companies to reduce time-to-market and cost, as well as improve development quality (Laursen & Salter, 2006; Swink, 2006).

Building on the resource-based view, dynamic capabilities theory, and organizational ambidexterity literature, we investigate how external collaboration in innovation can impact the relationship between using digital technologies and improved SC performance in terms of efficiency and adaptability. We suggest that the benefits of using digital technologies to manage a SC and improve its performance could be limited without incorporating structural changes of a company's network to include real collaborative innovation activities that transcends its boundaries. We believe this issue is significantly important since the trend towards co-innovation and collaboration across organizational boundaries is intensifying. We thus explore the moderating role of collaborative innovation in this paper using two types of partners: SC members, that is, suppliers and customers, and other participants in the market, such as logistics service providers, consultants, or even competitors.

In the following sections, we first review the relevant literature and touch on the theoretical underpinnings and rationale for the proposed hypotheses. Next, we present the methodology used in the study, followed by an analysis of the results. We conclude with a discussion and reflection on the practical implications of the research findings.

Theoretical Background and Hypothesis Development

Ambidexterity in supply chain management

In the field of supply chain management (SCM), organizational ambidexterity has emerged as an appropriate theoretical perspective for explaining innovation and performance improvement (Lee & Rha, 2016). Ambidexterity, that is, the simultaneous utilization of exploitation and exploration (Gibson & Birkinshaw, 2004), is a controversial topic in the organizational theory and strategic management literature. From a SC perspective, exploration refers to the continuous search for knowledge and solutions that address market changes (Abernathy & Clark, 1993), allowing for enhanced adaptability. In contrast, exploitation leverages current SC capabilities in search of efficiency, and improves them to reach lower cost and greater reliability (Barnes et al., 2004). A SC is deemed "ambidextrous" when it has the "ability to maintain daily operations excellence while looking for constant innovation and the ability to keep balance" (Castorena & Monroy, 2020). Such a capability as ambidexterity enables firms to mitigate the negative impact of SC disruptions and enhance business performance (Lee & Rha, 2016).

However, exploration and exploitation activities compete for organization's scare resources. Thus, some scholars view them as fundamentally incompatible (Hannan & Freeman, 1977; Ancona et al., 2001) while others believe that reconciliation is possible due to the complementary, rather than competing nature of these capabilities (Schulze et al., 2008). Since both exploration and exploitation are vital for firms' survival and competitive advantage, two mechanisms, structural and contextual, have been developed to achieve the desired ambidexterity. Structural ambidexterity calls for creating separate organizational structures to deal with conflicting demands on different units (Duncan, 1976; Birkinshaw & Gibson, 2004). This approach is promoted by scholars who support the incompatibility view of exploration and exploitation as it guarantees that each division or unit pursues their own direction of need without pressure to attend to the other direction. In contextual ambidexterity, rather than creating separate divisions, the activities of exploration and exploitation are viewed as complementary and are balanced within a single division structure (O'Reilly III & Tushman, 2013).

The impact of digital transformation on the SC's ambidexterity

The change introduced by technology advancements brings new opportunities, as well as challenges, for most

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enterprises. The digitalization of the SC offers plenty of solutions to tackle these challenges and allow firms to seize opportunities in the changing market. Improved customer service, more integration with suppliers and partners, increased sales, and overall business development are some of the benefits expected when taking the strategic decision of digital transformation (Agrawal et al., 2019). As digital transformation is being actively discussed in recent literature, several definitions have emerged with essential differences relating to the types of technologies involved and the nature of the transformation (Horlacher et al., 2016; Andriole, 2017). We adopt the definition developed by (Vial, 2019) in viewing digital transformation as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019).

Firms can transform their traditional SC into agile, customer-driven, and demand-sensitive networks by applying emerging digital technologies (Büyüközkan & Göçer, 2018). In this way, firms will be able to improve the visibility of their operations, leading to reduced costs and delivery times, and leveraged efficiency (Büyüközkan & Göçer, 2018; Calatayud et al., 2019). Previous studies found that operational efficiency can be achieved through the use of digital technologies. For example, Pagani (2013) highlighted cost savings as a result of digital transformation. The optimization of business processes can also be achieved using IoT and analytics, which reduce slack resources and improve efficiency (Du et al., 2016; Gust et al., 2017).

An adaptable SC can be reshaped when necessary (Ketchen & Hult, 2007). The use of digital technologies assists firms in this pursuit by sensing and responding rapidly to the shifts in the market since they increase customer proximity and enhance scanning for new consumer trends (Setia et al., 2013; Hansen & Sia, 2015). The enhanced visibility and coordination generated by utilizing technologies such as advanced planning systems (Jonsson et al., 2007) and IT systems (Yoon et al., 2016) are vital for firms' ability to achieve adaptability, as it increases the firm's capacity for sensing and seizing opportunities in external environments. Thus, we consider digital transformation as an antecedent for improved SC performance in terms of efficiency and adaptability.

More precisely, we present the following hypothesis:

H1: Digital transformation positively impacts SCs' a) efficiency and b) adaptability.

The interplay of digital transformation and collaborative innovation on SC efficiency and adaptability

Although the advantages of digital technologies are numerous, their mere implementation will produce little value (Kane, 2014). Based on the resource-based view, rival firms can easily duplicate investments in technologies, which impede the creation of sustained competitive advantage. Scholars and practitioners acknowledge the significance of internal, cross-functional collaboration within a firm for successful digital transformation (Earley, 2014; Maedche, 2016). According to Chesbrough (2003), firms can also benefit from harvesting ideas from external parties, and from sharing their ideas, even with competitors. Thus, for digitization to succeed in creating and sustaining competitive advantage, firms must establish agile and collaborative organizational structures (Desmet et al., 2015; Selander & Jarvenpaa, 2016). In this manner, companies can increase the potential to leverage a larger and more diverse pool of external sources in a rapid, cost-efficient, and flexible way (Gassmann & Enkel, 2004), which improves business performance through increased efficient and effective use of external and internal resources (Monsef & Ismail, 2012). The interplay of digitalization and collaborative innovation facilitates access to big data and the rapid processing of this data using novel tools such as artificial intelligence and machine learning (Burchardt & Maisch, 2019).

Innovation is the result of an interactive process while collaborating with external parties is promoted as an innovation enhancer. In building cooperative networks, firms usually seek either synergies/complementariness, or growth and market power (Tether, 2002; Park et al., 2004). SC cooperation, that is, cooperation with the SC members such as suppliers and customers, is one of the most common complementary agreements (Miotti & Sachwald, 2003). The purpose of these collaborations is to gain access to various types of assets owned by different parties by pooling or exchanging the assets (Arranz & de Arroyabe, 2008). In cooperative agreements with rivals, where resources and problems are relatively similar, economies of scale, experience, and risk diversification are usually targeted to strengthen the competitive position by improving overall efficiency and resource management (Arranz & de Arroyabe, 2008).

Despite their benefits, cooperative agreements are

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usually associated with various challenges, including communication costs, a potential lock-in effect due to specific investments (Heide & John, 1990), and unnecessary knowledge spill-overs (Oxley & Sampson, 2004). Another challenge is choosing suitable partners, since engaging with different cooperative partners results in different innovation outcomes (Hyll & Pippel, 2016). Several studies have investigated the impact of external sources of knowledge on innovation outcomes (Fritsch & Lukas, 2001; Becker & Dietz, 2004; Hyll & Pippel, 2016). For example, Becker and Dietz (2004) found positive effects of engagement with customers and competitors as sources of knowledge on technological opportunities, while cooperation between suppliers yielded adverse effects. In their study, Hyll and Pippel (2016) found that cooperating with suppliers led to higher product and process innovation failure, while cooperating with competitors was associated with process innovation failure only. Cooperating with customers, however, was not linked to any innovation failure.

In line with the discussions of the previous studies, we thus propose the following hypotheses:

H2: Collaborative innovation with SC members strengthens the effect of digital transformation on a) efficiency and b) adaptability.

H3: Collaborative innovation with the market and industry members strengthens the effect of digital transformation on a) efficiency and b) adaptability.

The figure below (Figure 1) illustrates the proposed relationships in this study.

Methodology

Sample and data collection

Data for this research was collected via a survey instrument from a sample of Japanese manufacturing firms. Holding the world's third-largest number of patents (World Intellectual Property Indicators, 2019), Japan's business landscape is an innovation-supported environment accelerated by its firms' R&D capabilities and government regulatory reforms. The Japanese robotics and IoT markets have witnessed robust and continuous growth due to the government's promotion of Society 5.0, a super-smart society largely dependent on technology (Evolving Innovation, 2019). These characteristics qualify the Japanese business environment as suitable for this specific research topic.

We developed a survey instrument to collect data for this study. An English version of the questionnaire was developed first, then translated into Japanese language. In Japan, the postal service is widely used, and it is usually preferred over other types of communication, especially for business transactions. Japanese managers will probably respond better to post mails than e-mails. For this reason, we chose postal mail to contact respondents. We used an address database and random sampling technique to develop a list of 584 manufacturing firms located in the city of Osaka. Cover letters, including a link and QR code to the online questionnaire, were sent by mail to the firms. Three mails were returned due to wrong/invalid addresses, resulting in 581 sent by mail. Over a three-week waiting period, 46 valid questionnaires were filled, yielding around an 8% response rate. Analysis of the respondents' demographic information showed that

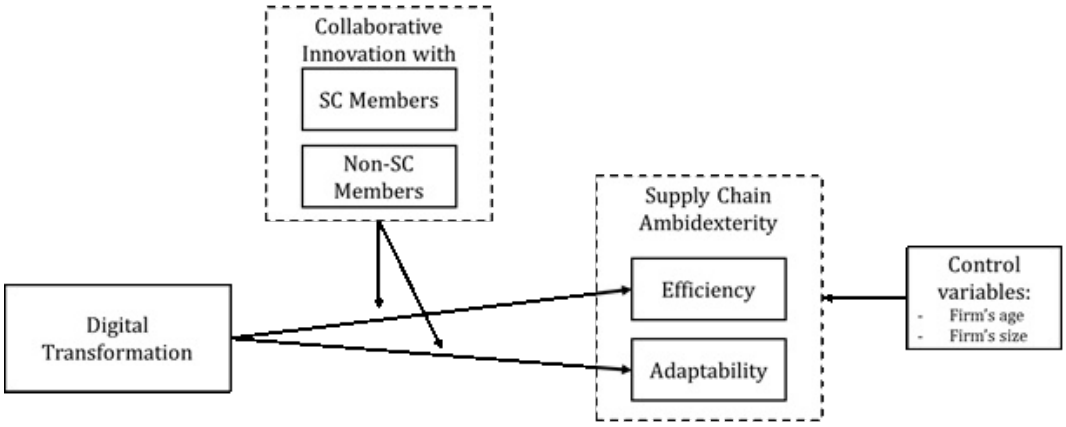

Figure 1. Research framework

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50% of the respondents belonged to the top management level, and 32% had over 10 years of experience. Most firms (76%) were of medium size (100 — 999 employees) and 85% of them were established in the 1970s. The firms belonged to various industries, with petroleum, chemical, and medical (24%), as well as non-metallic products (17%), as the most frequent.

Measures

We used measures pre-validated in extant literature. All variables were measured based on 7-point Likert scales (1= strongly disagree/ much worse, 7=strongly agree/ much better). Digital transformation (DigTrans) was measured using four items adopted from Kim et al. (2006), Kwak et al. (2018), and Stentoft and Rajkumar (2018). The respondents were asked to indicate their agreement with statements reflecting their firms' usage of the most advanced enterprise resource planning (ERP) systems, other advanced IT systems, real-time tracking technologies, IoT, and artificial intelligence, over the past three years. SC Efficiency was measured using three items modified from Sezen (2008), who adopted them from Beamon (1999). The respondents were asked, based on personal judgment, to assess their firms' performance over the past three years in terms of the total cost of SC resources, costs associated with held inventory, and the SC's return on investments. SC adaptability was measured using three items adopted from Pu et al. (2020), who adopted them from Gibson and Birkinshaw (2004), and Im and Rai (2008). The respondents were asked, based on personal judgment, to assess and compare with their closest competitor(s), their firms' performance over the past three years in terms of the ability to adapt SC relationships, business priorities, and activities responding to different changes in the market and external environment. Collaborative innovation was measured using modified items from Stentoft and Rajkumar (2018). The respondents were asked to indicate their agreement with statements reflecting their company's level of engagement over the past three years in supply chain collaborative innovation (SCCI) and market/industry collaborative innovation (MICI). SCCI was defined as innovation with suppliers and customers, while MICI included consultants, logistics service providers, partners, and/or competitors as innovation partners. The two moderators, SCCI and MICI, were then transformed into dummy variables by dividing each into high (one standard deviation above the mean, coded as one) and low (one standard deviation below the mean, coded as zero) levels. Finally, we controlled for the companies' ages and sizes (measured by the number of employees). Table 1 presents descriptive statistics and correlations among the study variables.

Scale reliability and validity

The study constructs were assessed for their reliability, convergent validity, and discriminant validity. We used SmartPLS (Ringle et al., 2005) to run this part of the analysis. The indicator loadings ranged from 0.68 to 0.94 (all significant at the 0.05 significance level). The scores of Cronbach's alfa (α) and composite reliability (CR) were above the recommended level of 0.70 (Hair et al., 2019). The average variance extracted (AVE) scores exceeded the threshold of 0.50 (Hair et al., 2019). These results confirm the reliability and convergent validity of the constructs. The discriminant validity was assessed using the Heterotrait-Monotrait (HTMT) ratio of correlation (Henseler et al., 2015). All correlations were below the cut-off value of 0.90, indicating acceptable discriminant validity.

The variance inflation factor (VIF) values were checked to detect possible collinearity among indicators and constructs. All values were below 5, indicating no presence of collinearity issues. Additionally, the occurrence of a VIF greater than 3.3 is proposed as an indication that a model may be contaminated by "common method bias" (Kock, 2015). None of the constructs' VIF scores in our study exceeded the threshold, indicating that the model is free of common method bias.

Results

We used RStudio® (*RStudio Team*, 2020) to run a hierarchical multiple regression analysis to test the study's hypotheses. In Table 2, we present the results of the analysis. Models 1 and 5 present the base models, including control variables only. For both models, no effects were found. In models 2 and 6, we introduced the independent variable of "digital transformation". We found positive effects of digital transformation on efficiency ($\beta = 0.269$ significant at $p<0.01$) and adaptability ($\beta = 0.395$ significant at $p<0.01$), which predicted 30% and 12% (adjusted R2 of 0.301 and 0.120) of the variance in efficiency and adaptability, respectively. Thus, H1a and H1b were both supported.

To test the moderation hypotheses, we created dummy variables by splitting the moderators, SCCI and MICI, into high values (one standard deviation above the mean) and low values (one standard deviation below the mean). This procedure resulted in a reduction in the sample size because the scores at, and marginally around the mean were excluded. Models 3 and 7 present

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Table 1. Descriptive statistics and correlations

	Mean	*SD*	*1*	*2*	*3*	*4*	*5*	*6*
1. Firm's size	767	1262						
2. Firm's age	71	31	0.36**					
3. Efficiency	3.42	0.91	0.03	0.12				
4. Adaptability	3.46	0.96	-0.06	0.14	0.48**			
5. DigTrans	3.30	1.40	0.12	0.16	0.42**	0.57**		
6. SCCI	3.50	1.50	0.26	0.11	0.37**	0.39**	0.65**	
7. MICI	3.80	1.70	0.40**	0.16	0.35**	0.28	0.58**	0.80**

n = 46, **p<0.05; ***p<0.01

the results of the first set of moderation hypotheses (H2a and H2b), which tested for the effects of collaborative innovation with suppliers and customers on a SC's efficiency and adaptability. As shown in model 3, no effect on efficiency was detected (β = 0.413 nonsignificant at p<0.10). Hence, H2a was not supported. In model 7, however, the moderation effect was significantly positive (β = 0.518 significant at p<0.10). This result means that collaborative innovation with suppliers and customers reinforces the impact of digital transformation on adaptability, providing support for H2b.

Models 4 and 8 present the results of the combined effects of digital transformation and collaborative innovation with the market and industry members on efficiency and adaptability (H3a and H3b). The results show a positive effect on a SC's efficiency (β = 0.714 significant at p<0.05), while no evidence was found to support the effect on adaptability (β = 0.413 nonsignificant at p<0.10). Thus, only H3a was supported.

To better understand the moderation results, we plotted significant results in Figure 2 and Figure 3. Figure 2 illustrates the effect of digital transformation and collaborative innovation with suppliers and customers on SC adaptability. The figure shows that, for firms with high collaborative innovation levels, increased digital transformation leads to significantly higher adaptability than firms with low levels of collaborative innovation. The situation is reversed for firms with higher collaborative innovation levels with market and industry members. As shown in Figure 3, these firms exhibit higher efficiency as their digital transformation levels increase compared to firms that have low collaborative innovation levels with the market and industry members.

Discussion

To survive and remain competitive, companies must be simultaneously efficient and adaptive (Aghina et al., 2015). Extant literature supports the role of using digital technologies to achieve such ambidexterity through a combination of exploring digital innovation and exploiting existing resources (Raisch et al., 2009). By using digital technologies, organizations can alter their value creation processes and uncover new ways to create value in response to changes in the environment (Huang et al., 2017). However, digital technologies alone cannot sustain a competitive advantage and can fall short of achieving the required outcomes. To reinforce its effects, the implementation of digital technologies must be coupled with company changes in strategy, culture, and structure that emphasize the importance of utilizing internal and external knowledge sources.

Previous studies have confirmed the impact of digital transformation impact on several aspects of business performance, including operational efficiency (Pagani, 2013), innovativeness (Svahn et al., 2017), financial performance (Karimi & Walter, 2015), and organizational ambidexterity (Li et al., 2018). This paper contributes to this stream of literature by providing empirical evidence of the role of digital transformation in reconciling the efficiency-adaptability trade-off and achieving ambidexterity in SCs. We further present an explanation of how companies can augment a single outcome, efficiency or adaptability, in conditions where their current resource availability does not allow for the simultaneous pursuit of both targets.

This study's findings have revealed that the interplay of digital transformation, external cooperation, and search of knowledge, that is, collaborative innovation, has varying impacts on SC efficiency and adaptability based

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Table 2. Analysis results

	Dependent variable:							
	SC Efficiency				*SC Adaptability*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm size	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm age	0.004	0.002	0.003	0.013	0.006	0.003	0.010**	0.007
	(0.005)	(0.004)	(0.004)	(0.008)	(0.005)	(0.004)	(0.005)	(0.009)
DigTrans		**0.269*****	-0.074	-0.207		**0.395*****	0.078	0.116
		(0.093)	(0.200)	(0.244)		(0.087)	(0.211)	(0.255)
SCCI			-0.698				-1.541	
			(0.923)				(0.973)	
DigTrans* SCCI			0.413				**0.518***	
			(0.265)				(0.279)	
MICI				-1.525				-0.822
				(1.153)				(1.202)
DigTrans* MICI				**0.714****				0.337
				(0.319)				(0.333)
Constant	3.159***	2.403***	3.155***	2.734***	3.128***	2.017***	2.235***	2.474***
	(0.343)	(0.411)	(0.513)	(0.671)	(0.356)	(0.382)	(0.541)	(0.699)
Observations	46	46	28	23	46	46	28	23
R^2	0.016	0.179	0.428	0.498	0.034	0.355	0.531	0.399
Adjusted R^2	-0.030	0.120	0.297	0.350	-0.010	0.309	0.424	0.223
F Statistic	0.347	3.054**	3.287**	3.373**	0.767	7.709***	4.981***	2.261*
df	2; 43	3; 42	5; 22	5; 17	2; 43	3; 42	5; 22	5; 17

*p<0.1; **p<0.05; ***p<0.01

on the type of cooperation partners. Specifically, companies that coupled higher digital transformation and greater collaboration with their SC partners showed a significant increase in their SC adaptability compared to firms with low levels of either digital transformation or SC collaboration. This result confirms that collaborative innovation with SC members can augment and reinforce the positive impacts of digital transformation on SC adaptability.

Nevertheless, no evidence was found to support the hypothesis that combining digital transformation and SC cooperation can improve SC efficiency. This result can be explained in light of the resource-based view. According to this view, collaboration agreements that target cost reduction and economies of scale, or efficiency, must be based on pooling similar resources rather than complementary ones. Since the types of resources usually exchanged in SC cooperation are complementary in nature, an insignificant impact on SC efficiency is expected.

The combined effect of using digital technologies and collaborating with non-SC members, such as consultants and competitors, positively impacted SC efficiency in the companies we studied, with no effect on adaptability. As discussed above, this is due to the economies of scale resulting from pooling similar resources. Because rivals have similar problems and resources, however, it is unlikely that cooperative agreements between them will provide the required knowledge and insights needed to improve adaptability.

Conclusions

Collaborative innovation transforms business competition and cooperation (Lichtenthaler, 2008) by emphasizing the idea of widespread involvement and interdependence between actors at all levels (Lamming, 1993). According to the above discussion, firms can achieve SC ambidexterity through widening the scope of collaborative innovation by including different types of partners. In this way, firms would reap the benefits

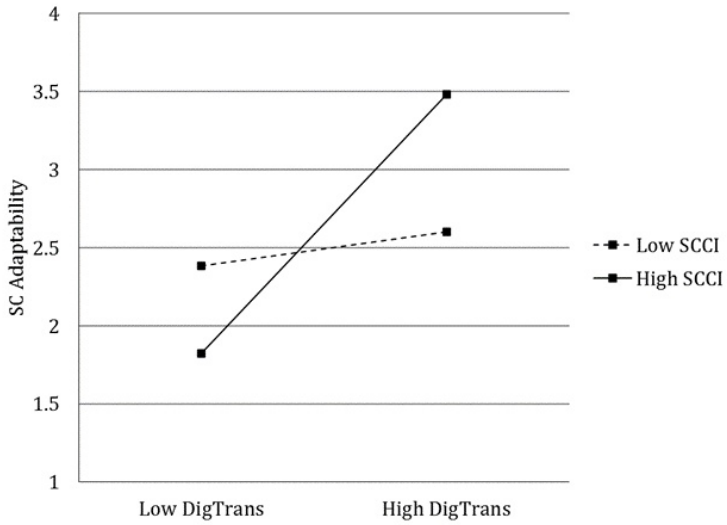

Figure 2. The effects of digital transformation and supply chain collaborative innovation on supply chain's adaptability.

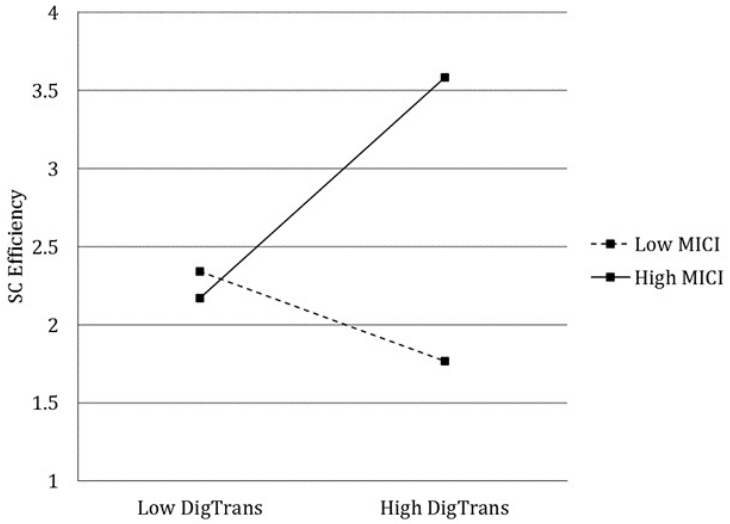

Figure 3. The effects of digital transformation and market/industry collaborative innovation on supply chain's efficiency.

associated with the inclusion of each type of partner. Although the management of several external cooperation projects with varying types of partners carries considerable challenges (Heide & John, 1990), the expected outcomes represented in achieving SC ambidexterity would certainly remunerate. In instances where a company's resources are strictly limited in a way that complex coordination of projects is not possible, firms are advised to build cooperative networks with partners in alignment with the desired objective, using either complementary resources to facilitate adaptability or similar resources to boost efficiency.

Suggestions for Future Research

The findings of this study, as well as its limitations, can guide some future directions for research on this topic. Due to the bias inherent in self-reported perceptual data, we believe a longitudinal study would be necessary to provide a more in-depth and balanced investigation. Longitudinal studies are especially encouraged given the fact that the outcomes of collaborative innovation

activities may be assessed more accurately over the long term.

The Japanese business environment is known around the world for its uniqueness, thus testing the model used for this study in different contexts would be expected to yield valuable insights. Moreover, the findings of this study have been discussed in light of resource-based theory, attributing the differences in moderation outcomes to the type of collaboration partner, which is usually determined by the kind of targeted resources sought from collaboration. Future researchers are encouraged to re-assess this justification and view the outcomes from other theoretical perspectives.

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