



Image credit: "RED" by Maxence Marthouret
(CC BY-NC-ND 4.0)

Insights

Welcome to the November 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.

Editorial: Insights <i>Stoyan Tanev and Gregory Sandstrom</i>	3
Working with Startups? These are the Three Things You Ought to Know about Startup Teams <i>Anna Brattström</i>	5
A University Business School as an Entrepreneurial Ecosystem Hub <i>Haven Allahar and Ron Sookram</i>	15
The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: the Mediating Role of Marketing, Innovation and Learning Capabilities <i>Yan Yin Lee and Mohammad Falahat</i>	26
The Emergence of Deepfake Technology: A Review <i>Mika Westerlund</i>	39
Design Rules for 'Triple Helix' Organizations <i>Ben Dankbaar</i>	53
Uncovering Research Streams in the Data Economy Using Text Mining Algorithms <i>Can Azkan, Markus Spiekermann and Henry Goecke</i>	62
Author Guidelines	75

Publisher

The Technology Innovation Management Review is a monthly publication of the Talent First Network.

ISSN 1927-0321

Editor-in-Chief Stoyan Tanev

Managing Editor Gregory Sandstrom

International Advisory Board

Dana Brown, Chair, Carleton University, Canada

Alexander Brem, Friedrich-Alexander-Universität

Erlangen-Nürnberg, Germany

K.R.E. (Eelko) Huizingh, University of Groningen, the Netherlands

Joseph Lipuma, Boston University, USA

Danielle Logue, University of Technology Sydney, Australia

Associate Editors

Martin Bliemel, University of Technology, Australia

Kenneth Husted, University of Auckland, New Zealand

Mette Priest Knudsen, University of Southern Denmark, Denmark

Rajala Risto, Aalto University, Finland

Jian Wang, University of International Business and Economics, China

Review Board

Tony Bailetti, Carleton University, Canada

Peter Carbone, Ottawa, Canada

Mohammad Saud Khan, Victoria University of Wellington, New Zealand

Seppo Leminen, Pellervo Economic Research and Aalto University, Finland

Colin Mason, University of Glasgow, United Kingdom

Steven Muegge, Carleton University, Canada

Punit Saurabh, Nirma University, India

Sandra Schillo, University of Ottawa, Canada

Marina Solesvik, Nord University, Norway

Michael Weiss, Carleton University, Canada

Mika Westerlund, Carleton University, Canada

Blair Winsor, Memorial University, Canada

Mohammad Falahat, Universiti Tunku Abdul Rahman, Malaysia

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.

We welcome input from readers into upcoming themes. Please visit timreview.ca to suggest themes and nominate authors and guest editors.

Contribute

Contribute to the TIM Review in the following ways:

- Read and comment on articles.
- Review the upcoming themes and tell us what topics you would like to see covered.
- Write an article for a future issue; see the author guidelines and editorial process for details.
- Recommend colleagues as authors or guest editors.
- Give feedback on the website or any other aspect of this publication.
- Sponsor or advertise in the TIM Review.
- Tell a friend or colleague about the TIM Review.

Please contact the Editor if you have any questions or comments: timreview.ca/contact

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.

© 2007–2019

Talent First Network

www.timreview.ca



Except where otherwise noted, all content is licensed under a Creative Commons Attribution 3.0 License.



The PDF version is created with Scribus, an open source desktop publishing program.

Editorial: Insights

Stoyan Tanev, Chief Editor and Gregory Sandstrom, Managing Editor

Welcome to the November issue of the *Technology Innovation Management Review*. This edition brings together a mixed collection of Insights, covering a range of themes from entrepreneurship, university-business ecosystems, incubation practices, marketing, competitive advantage, and learning capabilities, to new themes such as “deepfakes” online and in the digital media, as well as a paper on “design rules” for inter-organisational collaboration.

The edition starts with **Anna Brattström**’s “Working with Startups? These are the Three Things You Ought to Know about Startup Teams”. Dr. Brattström provides a general introduction to startup teams, teamwork, and the people side that makes successful startups, based on a review of “state-of-the-art research about startups” (5). The aim is to provide “actionable insights about startup teams; who they are, how they work, and how they stay together” (5). The author conducted a study in the Web of Science research database focusing on new venture teams, startups, and entrepreneurship between 1997-2019. From this, she identifies “three stylized facts” that help keep startup teams together, which deal with team composition, structure and emotion. The focus on homogeneity, change, and emotion is likely to resonate with experienced startup teams, as well as assist new startups, or startups-in-formation to navigate the fast-moving new business relationship territory.

Haven Allahar and **Ron Sookram** follow up by presenting a use case paper on university-business incubation, collaboration, and scaleup in, “A University Business School as an Entrepreneurial Ecosystem Hub”. The authors raise important questions about what role is or can be played by a university business school in incubating startups, and thus also in producing entrepreneurs. The paper takes a constructive approach to building an “entrepreneurial ecosystem” based on the authors’ experiences and research conducted at the University of the West Indies (UWI). They start with a university-industry-government “triple helix” approach (see paper 5 by Dankbaar), then apply the lens of “the extended concept of the ‘quadruple helix’ of university-industry-government-civil society collaboration” (16). Their paper covers a range of topics that involve “entrepreneurship education”, drawing on examples as the authors participated in planning, designing, participating in, and overseeing the MBA entrepreneurship education program at UWI. In assessing the entrepreneurial ecosystem hub at UWI, the

paper’s conclusions resonate with existing literature in reporting that “collaboration between university and industry was the decisive factor in stimulating innovation” (22). It makes forward-looking suggestions in promoting “an investment facilitation platform to address the funding challenges” (21). The article will be of interest to a range of actors and stakeholders involved in entrepreneurship ecosystem hubs now being developed in business schools around the world.

In “The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities”, co-authors **Yan Yin Lee** and **Mohammad Falahat** aim to test “the direct and indirect effects of digitalization on enterprise, specifically focusing on price, product, and service advantages in digitalized international markets” (26). They base their research on a study of data collected from 143 exporting manufacturers in Malaysia. The paper considers the competitive advantages that can arise for SME’s through digitalization efforts to open up international markets. It concludes that while “digitalization has no direct effect on any of these competitive advantages ... [yet] the indirect effects of digitalization and resources on product and service advantages keep these two constructs important in any comprehensive model of determinants for competitive advantages in international markets” (33). The paper provides readers with an accessible way to approach the growing trend of emerging economies looking to internationalize with the help of digitalization.

Mika Westerlund’s “The Emergence of Deepfake Technology: A Review” opens a new theme in the TIM Review. The paper aims to present this currently growing topic in a balanced way by providing an overview of the current literature about deepfakes. It answers basic questions about what deepfakes are and who produces them, along with explaining possible potential benefits, as well as various misuses, and possible threats they may cause. It provides examples of deepfakes, as well as methods to combat deepfakes. The paper concludes that “deepfakes are a major threat to society, the political system and businesses because they put pressure on journalists struggling to filter real from fake news, threaten national security by disseminating propaganda that interferes in elections, hamper citizen trust toward information by authorities, and raise cybersecurity issues for people and organizations” (47).

Editorial: Insights

Stoyan Tanev & Gregory Sandstrom

It points out that technological solutions are currently in high demand in this field and encourages budding entrepreneurs and engineers that “there are numerous business opportunities for technology entrepreneurs, especially in the areas of cybersecurity and AI” (47).

Following the introduction to a “quadruple helix” framework in paper 2 above by Allahar and Sookram, in “Design Rules for ‘Triple Helix’ Organizations”, **Ben Dankbaar** focuses on how to improve triple helix collaboration between organizations. He starts by giving an example of a “successful failure” where a multinational company partnered with a university department and received partial government funding. While it may sound familiar for TIM Review readers, he also notes that “neither the university professors nor the PhD students were very motivated to spend a lot of time integrating their results with those of others” (55). The paper therefore looks at factors that contribute to failure or success among triple helix organizations. To do this it combines cybernetic thinking and organization design theory as a background for the proposed “design rules”, which constitute the main body and theme of the paper. It concludes, noting that “these [11 rules] or similar design rules may be codified into a general norm for the organization of triple helix and other collaborative projects” (60).

The final paper turns our attention to look at the data in **Can Azkan, Markus Spiekermann** and **Henry Goecke**’s “Uncovering Research Streams in the Data Economy Using Text Mining Algorithms”. Launching off the growth of data-driven business models, the paper delves into the new “data economy” as it relates to the innovation potential of companies. It shows the results of searching over 800 scientific publications and text mining them using a systematic literature review for its research design. It provides several visualisations, including both geographical and subject area specialities, a network graph of keywords, and a Gephi analysis of nodes involving fields of innovation potential. The paper concludes by suggesting it has come up with “an automatized way to derive areas for innovation in the field of data economy” (72).

The December issue of the TIM Review will be a special edition on Artificial Intelligence, based on a working group that met at the ISPIM Florence conference in 2019. 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 solving practical problems in emerging domains. Please contact us with potential article topics and submissions, or proposals for future special issues.

Stoyan Tanev
Chief Editor &
Gregory Sandstrom
Managing Editor

Citation: Tanev, S. & Sandstrom, G. 2019. Editorial: Insights. Technology Innovation Management Review, 9(11): 3–4.
<http://doi.org/10.22215/timreview/1278>



Keywords: entrepreneurship, new venture teams, teamwork, entrepreneurial ecosystems, entrepreneurial university, entrepreneurship education, university business incubation, triple helix, quadruple helix, international entrepreneurship, digitalization, competitive advantage, innovation, marketing, learning capabilities, SMEs, deepfake, fake news, artificial intelligence, deep learning, cybersecurity, design rules, motivation, sanctions, leadership

Working with Startups? These are the Three Things You Ought to Know about Startup Teams

Anna Brattström

“Talent wins games, but teamwork and intelligence win championships.”

Michael Jordan
Basketball player

While much has been written about how startups work to develop their product, this paper focuses instead on how to manage the startup team. Based on a systematic review of current research, I present actionable insights about startup team characteristics; who they are, how they work, and how they stay together. I explain how these characteristics imply both opportunities and threats for the viability of the team and discuss how startup teams can be managed to increase the likelihood of their survival and growth. Given that the majority of startup failures are attributed to the team, not to the product, these insights are valuable both to aspiring entrepreneurs and to their external stakeholders.

Introduction

In the past decade, we have witnessed a surge of interest in how to manage startup companies. Popular methods have had a fundamental impact on new ventures across the world (for example, Ries, 2011; Blank, 2013), describing how to develop minimum viable products, how to find product-market fit, and how to pivot a business. Interestingly, however, the core reason for why many startups fail is not because of problems in their business; it is rather because of problems in their team. Among venture capitalists, this is well known, and across different surveys (Gorman & Sahlman, 1989; Kaplan & Strömberg, 2004), venture capitalists attribute between 60-65% of failures to problems within the startup team. Yet, there is a noticeable lack of practical advice on how to successfully manage a startup team.

In academic research, scholars have recently begun to pay more attention to the startup team (Klotz et al., 2014; Lazar et al., 2019). Results, however, are mainly directed towards an academic audience. They are divided into fairly narrow subdisciplines, such as sociology (Ruef, 2010); strategy (Eisenhardt, 2013) or social psychology (Breugst & Shepherd, 2017), and as such, typically not accessible to practitioners. This leaves entrepreneurs, as well as the investors, partners and incubators that work with them, lacking research-based insights into startup teams and how they function. Given how much we already know about how to manage startups, it is time we also pay attention to

the fundamental issue of how to manage collaborations with and within the new venture team.

Addressing this need for knowledge, I present in this paper actionable insights about startup teams; who they are, how they work, and how they stay together. My model is based on a thorough review of state-of-the-art research about startups. I curate this research into stylized facts about startup teams, concluding with an actionable framework to help practical assessments of startup teams' viability. My core purpose is to offer practitioners research-based knowledge about how to organize and manage startup teams, with an aim of complementing the abundance of literature that focuses on how to organize and manage new ventures.

Literature Background

The majority of entrepreneurship research focuses on individual entrepreneurs, seeking to understand the personalities, abilities, and motivations that make them successful (Davidsson & Honig, 2003; Wiklund et al., 2003; McKelvie et al., 2018). Yet, most startups are founded and managed by teams, not by entrepreneurs who operate in solo (Ruef, 2010). Knowledge-intensive startups that pursue innovation and growth especially are more often founded by teams than by single entrepreneurs (Hellerstedt, 2009; Steffens et al., 2012). Understanding what makes these teams come together, work together and stay together is an important, but currently under evaluated, aspect of entrepreneurship.

Working with Startups? These are the Three Things You Ought to Know about Startup Teams *Anna Brattström*

For the purpose of this paper, I define a startup team broadly as “two or more individuals who commit to each other to create a new firm” (Brattström et al., 2019). Startups come in many forms. Most are small-scale businesses, never intended to become more than a source of income for the founding team. In this paper, however, my core focus is on innovative, knowledge-intensive startups formed with an intention to grow and perhaps scale, hereafter referred to as startup teams.

To date, systematic evidence on the operation of startup teams has been generated from scholars in three different academic sub-disciplines. The first is deeply rooted in sociology (Aldrich & Kim, 2007; Ruef et al., 2009; Kim et al., 2013). Research in this discipline provides important insights into how startup team members come together, such as how their relationships, status, or social networks influence how members team up with each other. This research is fundamental for understanding the composition of startup teams and how such composition influences team operations over time. The second tradition finds its roots in strategy research (Beckman & Burton, 2008; Eisenhardt, 2013; Eberhart et al., 2017). An important focus of scholars in this tradition has been to investigate the economic context in which a startup team operates. As a result, we have gained important insights into how teams deal with uncertainty and velocity, using limited resources. The third research tradition takes standpoint in social psychology (Breugst et al., 2015; Breugst & Shepherd, 2017; Cardon et al., 2017). Inspired by team research more broadly (Marks et al., 2001; Mathieu et al., 2017), this research has generated insights into how the dynamic interactions among team members influence startup team functioning over time.

In this paper, I integrate these academic insights into three stylized facts about startup teams and how they operate. Thus, I do not claim to provide a full account of all research in the field. For this, I refer to the excellent recent reviews of Klotz et al. (2014), Jin et al. (2017), and Lazar et al. (2019). Instead, my core purpose here is to provide curated insights, accessible to practitioners.

How I Identified Relevant Research

To ensure an accurate and comprehensive reading, I engaged in a structured review of research on startup teams. I began by searching the Web of Science database for articles published under the topic of new

venture teams in the last 22 years (from January 1st 1997 until June 3rd 2019). I searched for articles covering topics with the combinations of the words “team(s)” or “group(s)” in together with: start-up, entrepreneurial, new venture, founding, and nascent. This generated a list of 225 papers. From this list, I selected journals that had published two or more papers on the topic. This restricted my list to 166 papers. Thereafter, I read each abstract in order to identify papers which specifically addressed the role of teams for new venture performance. In addition, I also benefited from scholarly books in the field, in particular the works of Ruef (2010) and Wasserman (2008).

The scope of my review differs from Klotz et al. (2014) in two fundamental ways. First, I included conceptual papers, in addition to only empirical papers. Second, I included the term “group”, in addition to the term “team”. Third, instead of restricting my analysis to a particular set of journals prior to the search, I first conducted a broad search in Web of Science.

Three Stylized Facts about Startup Teams

In the following, I integrate current research into three stylized facts about startup teams; simplified generalizations that help to summarize what we currently know. As stylized facts, the insights presented in this paper are not necessarily true to all startup teams, in all places, and at all times. Moreover, it is also important to keep in mind that research on startup teams is an emergent field, and that much remains to be understood about this phenomenon.

Stylized fact no. 1: they are birds of similar feathers

Most startup teams are homogenous, meaning that team members share similar attributes, skills, and characteristics. This is well established across different samples of startups. In the US, for instance, researchers found that almost half of all startup teams that are formed are all-male or all-female teams (Ruef et al, 2003; Ruef et al., 2009). Moreover, ethnically homogenous teams are considerably more common than mixed teams (Ruef et al., 2009; Ruef, 2010). In a US study, it was even found that almost 30% of startup teams are composed of individuals who share the same occupational experiences (Ruef et al., 2009). We also see homophily being put to practice in several well-known startup teams. Snapchat, for example, was founded by three young men, all graduates of Stanford University, and Facebook was formed among a group of roommates at Harvard University.

Working with Startups? These are the Three Things You Ought to Know about Startup Teams *Anna Brattström*

Drivers of homogeneity: social networks and in-group bias

At first glance, such homogeneity might seem surprising. Given their ambitions to come up with new innovation, explore novel business opportunities and overturn existing markets (McKelvie et al., 2017; McKelvie et al., 2018), one might expect entrepreneurs to team up in heterogenous teams in order to spur creativity and innovation. Taking a closer look into how startup teams are formed, however, the homogeneity of teams becomes more understandable. After all, homophily, i.e. the tendency of human beings to seek similar others, is deeply rooted in human nature (McPherson et al., 2001).

Two strong forces drive this tendency for homogeneity. The first is homogeneity of the social network in which team members are recruited. When it is time to form a new venture, entrepreneurs look for team mates in their social networks. Studying US data, Ruef (2010) for instance found that 14-17% of all startup teams are founded among former co-workers, and 19-21% are formed among friends or acquaintances. The second force driving homogeneity is startup teams' in-group bias. As human beings, we simply seem to be more inclined to positively evaluate, trust, and collaborate with similar others (Tajfel, 1978; Tajfel & Turner, 1986). Such trust, in turn, is an important performance driver in teams (Brattström et al., 2012; Brattström & Richtnér, 2014). When forming a group, we therefore tend to flock with those that are similar to ourselves. This is well established across different types of relationships, from marriages to friendships (McPherson et al., 2001). Interestingly, teams in established organizations are important exceptions to this principle. Different from marriages or friendships, teams in established organizations are deliberately designed. For such teams, members are usually assigned rather than self-selected. Startup teams, however, emerge because team members chose to work together. When making that choice, it seems that the comfort of similarity exerts a larger influence than the potential advantage of seeking out someone different with the same or better skillset.

Implications of homogeneity: efficiency at the cost of blind spots

On the bright side, homogeneity often makes the startup team function smoothly. In general, homogenous teams tend to perform better than heterogenous ones (Murnighan & Conlon, 1991). For example, homogenous teams are better at solving complex problems (Woolley et al., 2010), have lower

turnover, and also a higher degree of cohesion (O'Reilly III et al., 1989), which in turn makes them better able to productively manage conflict (Ensley et al., 2002). By and large, homogenous teams are efficient and agile, which are important characteristics of successful startups.

On the darker side, homogenous teams can be subject to cognitive and social blind spots (Steffens et al., 2012). Cognitively, heterogenous teams bring together different skills, resources, competences, perspectives, and social network contacts. This allows team members to draw on a wider breadth of perspectives (Van Knippenberg et al., 2004; Van Knippenberg et al., 2015) and contacts (Milanov & Fernhaber, 2009). In the volatile and dynamic context that characterize startups, this gives heterogenous teams an important advantage over homogenous ones.

Socially, teams that are composed of friends may not have the type of formal authority that sometimes is required to establish leadership and work relationships (Reagans et al., 2004). This can make roles and relationships blurred within the team, ultimately hampering startup performance (Jung et al., 2017).

Dealing with homogeneity: towards more reflective decision making

An important thing to realize about social network constraints and in-group bias is that they unconsciously influence choice of startup team members. Therefore, when forming a team, it is important to explicitly reflect on what grounds team members are chosen. Is it because they are best suited or is it because they happen to be close and available? One might also consider explicit ways to mitigate the disadvantages with overly homogenous teams. For example, if a team is homogenous, it can be important to bring in external stakeholders, whether as board members, consultants or coaches, who bring a wider set of perspectives and network to the team (Vandenbroucke et al., 2016).

Stylized fact no. 2: Their only constant is change

Drivers of change: market, technological and financial uncertainty

Managing a startup is about managing change. The process, however, is rarely smooth. Instead, it is described as a process of "creative revision" (Grimes, 2018), meaning that the startup team needs to constantly revisit and revise taken-for granted assumptions about their product and their customer. In a study of high-tech firms, Shane (2008) found that almost half (49.6 %) of all startups change their initial

Working with Startups? These are the Three Things You Ought to Know about Startup Teams *Anna Brattström*

business idea. YouTube is a great example. Before YouTube pivoted into what it is known for today, this video-streaming service was launched as a dating-site, where users could upload videos in search for potential partners.

A strained financial situation further adds a need for change. Most startup teams, especially those that are engaged in costly innovations, face a constant shortage of cash. As a result, entrepreneurs may need to revise their ambitions and work practices over time: beggars can seldom be choosers. Sometimes, change is driven by the individual members of the team. Starting and growing a firm is often a long-term process, unfolding over several years. During this time, aspirations and motivations of individual entrepreneurs can change, as does family situation, health conditions or the availability of outside options. When this happens, it has implications for the aspirations and activities of other team members.

Finally, as the company develops and matures, new skills are needed. New members enter and old ones exit, leading to change in team composition, boundaries, and size. Even for those individuals who stay in the team, roles and relationships may change over time. In the beginning, team members may collectively take on a wide range of tasks, from product development to sales. Over time comes the need for role specialization, demanding some individuals to step up while others might need to take a step back.

Implications of change: need to adapt team structures

In short, startup teams deal more with change than stability. Surprisingly, however, many startups are rigid in the sense that members struggle to adapt to roles, relationships, and equity splits over time. Across several studies, researchers have found that the set of initial conditions, such as partnerships or resources, have a long-lasting impact on the future of the startup (Schoonhoven et al., 1990; Milanov & Fernhaber, 2009). For example, the set of values that represents the initial founding team typically has a strong imprinting effect on the new venture, guiding the future norms and values of the emergent organization (Baron et al., 1999). Along similar lines, studies have shown that the initial divisions of roles and relationships in a startup typically prevail over time. Even as conditions change for the startup, many startup teams find it difficult to adapt their organizational structure accordingly (Beckman & Burton, 2008).

One explanation is that change is challenging for

teams. Divisions of roles, responsibilities, and rewards are closely related to perceptions of fairness; thus changing them can easily provoke conflict (Breugst et al., 2015). In the early stage of a startup's life, it may seem fair to make an equal split: each founder gets the same amount of equity. Over time, however, the issue of equity splitting can be more complicated. One member might find herself working harder than the others; another member might realize that he contributes more; a third member might be added to the team, requiring original founders to renegotiate equity. Such renegotiations easily turn nasty (Breugst et al., 2015; Breugst & Shepherd, 2017; Jung et al., 2017; Brattström, 2018). In one study, for example, Breugst et al. (2015) followed eight startup teams over six months and found that perceived justice in how equity was split had profound implications for team outcomes. In teams where members thought that equity distribution was just, a positive spiral emerged, drawing team members closer to one another. However, when these teams faced external threats, such as being pressured by an investor or questioned by board members, they easily drifted from a positive spiral into a negative one. Even in those cases where the initial equity distribution was considered fair, external threats made team members doubt each other, leading to conflict and turnover within the team.

Dealing with change: incorporate dynamics into the structure of the venture

Whether working within or with a startup team, it is important nowadays to incorporate change into work practices. One example is to use dynamic equity splits (Wasserman, 2008). In such agreements, members of the startup team pre-define milestones, phases in the startup life, and the roles and relationships within each phase. These definitions are subsequently used to structure discussions and renegotiations about equity splits within the team. As Wasserman (2008) notes, an important implication of such dynamic agreements is that they make both the tangible and the intangible factors salient for the team.

Along similar lines, startup teams might benefit from scheduling regular reviews of roles and relationships within their team. One option, advocated by Beckman and Burton (2008), is to create "organizational placeholders" already at the inception of the firm. For example, to make explicit early on that at some point, someone in the team will need to assume the role of the CEO, CFO, or CTO, even though it can remain an open question about when, how, and to whom this happens. Another option is to involve external stakeholders,

Working with Startups? These are the Three Things You Ought to Know about Startup Teams *Anna Brattström*

mentors or board members, in regularly revisiting team members' (implicit) assumptions about roles and relationships in the team.

Independent on which option that is chosen, discussing roles, rewards and relationships over time is an important sensemaking exercise. As human beings, we tend to count what can be easily measured, even though we know that not all that can be measured counts (Brattström et al., 2018). To avoid falling apart in times of change, startup teams need to turn difficult though necessary discussions into qualitative and collective sensemaking exercises, rather than making them numbers-games where different individuals fight for a larger share of the pie.

Stylized fact no. 3: emotion is the glue that keeps them together

Entrepreneurship requires persistence (Markman et al., 2005; Wu et al., 2007). This is true for entrepreneurs in general; entrepreneurs who stubbornly pursue their goals (Timmons & Spinelli, 1994) believe in their own abilities (Shane et al., 2003), and have passion for their company (Cardon et al., 2017), have a higher likelihood of succeeding. FedEx, for example, is a company that was about to go bankrupt, but survived merely due to the founders' persistence. During the first years of operations, FedEx lost millions of dollars every year, leading several investors to suggest that its original founder, Frederick Smith, should step down from operations. Smith, however, remained persistent and eventually managed to turn FedEx into a great success. In a startup team, persistence is even more complicated than for a solo-operating entrepreneur such as Smith. In addition to being persistent about their new venture, entrepreneurs must also be persistent in terms of their team. When the going gets rough, it is easy to turn failures into a blame game among team members. For a team to work together, however, members must persistently keep together.

Factors that strain team commitment

There are many issues that strain commitment in new venture teams. One example is time. We know from team research that commitment is easier in the early stages of a team's development (Tuckman, 1965). Known as the "forming stage", members tend to be careful with each other as they test and develop norms around appropriate behavior. Over time, however, teams in general often undergo a "storming phase", when the challenges of task demands, and interpersonal differences start to surface (Tuckman,

1965). This can lead to conflicts, stress, and quarrels that challenge team members' persistence.

Another issue that can strain commitment is stress. Organizing a startup is a process fraught with challenges and setbacks. Product development timelines are often delayed, sales can be lower than expected, and investors pose difficult demands on the team. Such setbacks cause stress that challenges team commitment. Busenitz, Moesel, Fiet, and Barney (1997), for instance, found that new venture team members who felt unfairly treated by investors were more likely to leave their teams.

Implications of team exits: positive and negative

To some extent, team member turnover is necessary for startups. As the venture matures, the team requires novel competences, leading to new members entering the team, whereas other members leave (Ucbasaran et al., 2003). In many situations, however, team members exits can constitute nasty divorces. They are foregone by unproductive conflict and leave behind wounds that need to heal. This latter type of team divorce is one that needs to be prevented because it distracts the team from constructive problem solving, consumes attention and effort, and decreases the likelihood of a startup's success (Busenitz et al., 2004).

Preventing dysfunctional team exits: nurture the emotions that keeps the team together

In the context of established organizations, teams can be held together by strong managers who force persistence upon the team, by contracts that makes persistence legally binding, or by salaries that are paid out as compensation for loyalty. Among startup founders, however, there is no manager or contract to force members to stay together, and salaries are often both uncertain and distant. Instead, emotions, such as passion, attachment, joy, and energy constitute an important glue that keeps the team together (Cardon et al., 2017; Brattström, 2018). Shared positive emotions, for example, enable team members to learn from each other (Klimoski & Mohammed, 1994) and improve their abilities to work together (Rhee, 2006). In a similar vein, a feeling of shared identity is also important, as it tends to increase information exchange and promote cooperation in teams (Chatman & Flynn, 2001). By and large, building emotional attachment to and identification with an organization and team enhance the likelihood that startup team members persist (Mathieu & Zajac, 1990; Meyer et al., 2002).

Emotions play an important role also for how team members behave (Baron, 2008; Cardon et al., 2012).

Working with Startups? These are the Three Things You Ought to Know about Startup Teams *Anna Brattström*

Welpel et al., (2012), for instance, demonstrated that entrepreneurs who feel vigorous are more likely to engage in proactive behavior, whereas entrepreneurs who feel satisfied are more likely to engage in reactive behavior. In an experimental study Hahn et al., (2012) also concluded that fear tends to reduce entrepreneurs' tendencies to explore novel opportunities, whereas joy and anger tend to increase exploration. In all cases, this seems to make emotions a matter of priority.

A Framework to Guide Assessment of a Startup Team

In sum, there are three things one ought to know about startup teams. First, that they are often homogenous groups. This makes them agile but sometimes subject to cognitive and social blind spots. Second, that they work under conditions of constant change, although they often find it surprisingly difficult to adapt roles, relationships, and rewards over time. Third, that they are entirely dependent on members' voluntary commitment, but struggle to keep together in difficult times.

Knowing these things is important, because it helps to better understand how startup teams function. This is

important for entrepreneurs themselves, who look to form the best team possible and to develop that team into its full potential. It's equally important for external stakeholders, whether venture capitalists, potential alliance partners, or incubator coaches. If an investor is about to spend time and money in such an uncertain endeavor as a startup, he or she ought to be able to identify the strengths and weaknesses of the team that is supposed to make it happen.

In Figure 1, I present a guiding framework to help make such assessments. The framework is intended to be used both by aspiring entrepreneurs, by teams that are already in operation, as well as external stakeholders, such as investors. For an aspiring entrepreneur, the framework can help to develop a better understanding of what would be a potential "dream team". For an existing team, the framework can be used as a sensemaking device, to encourage discussions about strengths, weaknesses, and possible areas of improvement. For an investor, the framework provides guidance to enable a qualitative assessment of potential investments. After all, it is the team, just as much as the idea they pursue, that determines startup success (Gorman & Sahlman, 1989; Kaplan & Strömberg, 2004).

	Why is this an important dimension to assess?	What is the known "best practice"?	Key questions to guide reflection and assessment	Where can I read more about this?
1. Team composition	Even though managing a new venture typically requires a breadth of skills and experiences, most startup teams are homogenous: composed of members with similar competences and which are part of the same social networks.	<ul style="list-style-type: none"> In general, <i>homogenous</i> teams are better at solving complex problems and less prone to conflict. However, <i>heterogenous</i> teams may be less subjective to cognitive and social blind spots and they are often more creative. 	<p><i>Does the team have the right composition of people in place?</i></p> <ol style="list-style-type: none"> What are the problems to be solved in the short- and long term and what are the competences, characteristics and social network contacts required to solve these problems? Are these competences, characteristics and social network contacts represented among team members? If not, why is that and how can team composition be adapted? 	Ruef et al. (2003); Ruef (2010); Jin et al. (2017); Lazar et al. (2019)
2. Team structure	Even though startup teams deal more with change than stability, surprisingly many teams are rigid in the sense that they fail to adapt roles, relationships and equity splits over time.	<ul style="list-style-type: none"> Startup teams with clear task positions tend to create more valuable ventures. Dynamic agreements around roles, relationships and equity allows the team to readjust structures over time. 	<p><i>Does the team have a structure favors change?</i></p> <ol style="list-style-type: none"> Does the team have clear structures and are they accepted by all team members? If not, how will this influence the venture's chances to develop over time? Does the team have a process for regularly reviewing assumptions about division of roles, relationships and rewards? If not, consider implementing one since this might help to adjust structures over time. 	Burton and Beckman (2007); Beckman and Burton (2008); Wasserman (2008); Jung et al. (2017)
3. Team emotions	Startup team members need to be persistent, both with their venture and their team. Emotion is an important glue that keeps members together.	<ul style="list-style-type: none"> Entrepreneurs who are persistent are more likely to create valuable ventures. Positive emotions are important in keeping team members together. Negative emotions can be an important trigger of sensemaking, but also strain relationships among team members. 	<p><i>Are team members emotionally attached to their team and their venture?</i></p> <ol style="list-style-type: none"> How do members of the team feel about their team and their venture? Is there enough positivity for team members to keep together in difficult times? Are there negative feelings present among team members? Can these feelings be openly discussed without overwhelming the team? If not, consider how to help the teams preempt emotional conflict. 	Cardon et al. (2012); Breugst and Shepherd (2017); Cardon et al. (2017); Brattström (2018)

Figure 1. A framework to guide team assessment in three core dimensions

Working with Startups? These are the Three Things You Ought to Know about Startup Teams *Anna Brattström*

In line with the stylized facts I have presented above, the framework breaks down team assessments into three core dimensions represented in rows. 1. *Team composition*, to allow assessment about who the startup team is. 2. *Team structure*, to allow assessment of how the team works. 3. *Team emotion*, to allow insights about how members stay together. For each dimension, I first explain why this particular issue is an important area of reflection and assessment. In the second column, I briefly summarize the known “best practice”. In the third column, I provide questions to help guide assessment about a startup team. These questions are qualitative in nature and as such, they are designed to encourage reflection, rather than a quantitative “scoring” of a team. The final column provides some reference pointers about where to turn for further depth and insights about these important matters.

When assessing a startup team, it is important to keep in mind that team composition, team structure, and team emotions are not isolated but interrelated. Team composition, for instance, influences emotionality; a team of friends might have a surplus of positive emotions among them, while a team of strangers may be more emotionally detached to each other. In a similar way, team structure might influence how the team is composed: a team with specific place-holder positions (for example, CEO, CTO, and so forth) might be encouraged to search for team members that encompass the capabilities to uphold such positions, whereas a team that does not have designed placeholders might be less systematic in their search for new team members (Beckman & Burton, 2008). Because the three dimensions are interrelated, Figure 1 does not imply that assessment should be made in any particular order. For some teams, it can make sense to start with a reflection on emotionality, for others, it can make sense to start with an analysis of team composition.

Neither does Figure 1 give greater weight to one dimension over others. Instead, the three dimensions should be seen as complementary. There is no such thing as a “perfect team” and rather than striving for perfection, it can make sense to consider how strength in one dimension can compensate for weaknesses in others. For example, a team that is weak in its composition may compensate in persistence, commitment, and positivity. A team in which there is a lot of affective conflict might consider handling it by making changes in the team’s structure.

To conclude, it is extremely difficult to predict the performance of a startup (Shepherd et al., 2018). Similarly, it is impossible to single out any one particular factor that explains the performance of a team (Mathieu et al., 2017). In both startups and teams, success is dependent on a myriad of different factors, including luck, and there is more than one road leading to success and failure (Katz & Kahn, 1978). On the other hand, what can be done is to make an overall assessment of a startup team’s viability. This does not guarantee success, but rather decreases the likelihood of failure.

As illustrated in Figure 1, I suggest that such sensemaking should be informed about the issues that typically characterize startup teams. This involves insights for what viable teams need, and should be grounded in solid research. After all, given that the team is such an important aspect of successful entrepreneurship, it is time we pay teams their due attention.

Acknowledgements

The author gratefully acknowledges financial support from the Ragnar Söderberg Foundation

Working with Startups? These are the Three Things You Ought to Know about Startup Teams *Anna Brattström*

References

- Aldrich, H. E., & Kim, P. H. 2007. Small Worlds, Infinite Possibilities? How Social Networks Affect Entrepreneurial Team Formation and Search. *Strategic Entrepreneurship Journal*, 1(1-2): 147-165.
- Baron, J. N., Hannan, M. T., & Burton, M. D. 1999. Building the Iron Cage: Determinants of Managerial Intensity in the Early Years of Organizations. *American Sociological Review*: 527-547.
- Baron, R. A. 2008. The Role of Affect in the Entrepreneurial Process. *Academy of Management Review*, 33(2): 328-340.
- Beckman, C. M., & Burton, M. D. (2008). Founding the Future: Path Dependence in the Evolution of Top Management Teams from Founding to IPO. *Organization Science*, 19(1): 3-24.
- Blank, S. 2013. Why the Lean Start-up Changes Everything. *Harvard Business Review*, 91(5): 63-72.
- Brattström, A. 2018. Voice and Punctuation: A Process Model of Conflict Enactment in New Venture Teams. *Academy of Management Best Paper Proceedings*, 2018(1), 16935.
- Brattström, A., Delmar, F., Johnson, A., & Wennberg, K. 2019. A Longitudinal Project of New Venture Teamwork and Outcomes. In B. Gartner & B. Teague (Eds.), *Handbook on Entrepreneurial Behavior, Practice and Process*: Edward Elgar.
- Brattström, A., Frishammar, J., Richtnér, A., & Pflueger, D. 2018. Can Innovation Be Measured? A Framework of How Measurement of Innovation Engages Attention in Firms. *Journal of Engineering and Technology Management*.
- Brattström, A., Löfsten, H., & Richtnér, A. 2012. Creativity, Trust and Systematic Processes in Product Development. *Research Policy*, 41(4): 743-755.
- Brattström, A., & Richtnér, A. 2014. Good Cop - Bad Cop: Trust, Control and the Lure of Integration. *Journal of Product Innovation Management*, 31(3): 584-598.
- Breugst, N., Patzelt, H., & Rathgeber, P. 2015. How Should We Divide the Pie? Equity Distribution and Its Impact on Entrepreneurial Teams. *Journal of Business Venturing*, 30(1): 66-94.
- Breugst, N., & Shepherd, D. A. 2017. If You Fight with Me, I'll Get Mad! A Social Model of Entrepreneurial Affect. *Entrepreneurship Theory and Practice*, 41(3): 379-418.
- Busenitz, L. W., Fiet, J. O., & Moesel, D. D. 2004. Reconsidering the Venture Capitalists' "Value Added" Proposition: An Interorganizational Learning Perspective. *Journal of Business Venturing*, 19(6): 787-807.
- Busenitz, L. W., Moesel, D. D., Fiet, J. O., & Barney, J. B. 1997. The Framing of Perceptions of Fairness in the Relationship between Venture Capitalists and New Venture Teams. *Entrepreneurship Theory and Practice*, 21(3): 5-22.
- Cardon, M. S., Foo, M. D., Shepherd, D., & Wiklund, J. 2012. Exploring the Heart: Entrepreneurial Emotion Is a Hot Topic. *Entrepreneurship Theory and Practice*, 36(1): 1-10.
- Cardon, M. S., Post, C., & Forster, W. R. 2017. Team Entrepreneurial Passion: Its Emergence and Influence in New Venture Teams. *Academy of Management Review*, 42(2): 283-305.
- Chatman, J. A., & Flynn, F. J. 2001. The Influence of Demographic Heterogeneity on the Emergence and Consequences of Cooperative Norms in Work Teams. *Academy of Management Journal*, 44(5): 956-974.
- Davidsson, P., & Honig, B. 2003. The Role of Social and Human Capital among Nascent Entrepreneurs. *Journal of Business Venturing*, 18(3): 301-331.
- Eberhart, R. N., Eesley, C. E., & Eisenhardt, K. M. 2017. Failure Is an Option: Institutional Change, Entrepreneurial Risk, and New Firm Growth. *Organization Science*, 28(1): 93-112.
- Eisenhardt, K. M. 2013. Top Management Teams and the Performance of Entrepreneurial Firms. *Small Business Economics*, 40(4): 805-816.
- Ensley, M. D., Pearson, A. W., & Amason, A. C. 2002. Understanding the Dynamics of New Venture Top Management Teams: Cohesion, Conflict, and New Venture Performance. *Journal of Business Venturing*, 17(4): 365-386.
- Gorman, M., & Sahlman, W. A. 1989. What Do Venture Capitalists Do? *Journal of Business Venturing*, 4(4): 231-248.
- Grimes, M. G. 2018. The Pivot: How Founders Respond to Feedback through Idea and Identity Work. *Academy of Management Journal*, 61(5): 1692-1717.
- Hahn, V. C., Frese, M., Binnewies, C., & Schmitt, A. 2012. Happy and Proactive? The Role of Hedonic and Eudaimonic Well-Being in Business Owners' Personal Initiative. *Entrepreneurship Theory and Practice*, 36(1): 97-114.
- Hellerstedt, K. 2009. *The Composition of New Venture Teams: Its Dynamics and Consequences*. Jönköping International Business School.
- Jin, L. L., Madison, K., Kraiczy, N. D., Kellermanns, F. W., Crook, T. R., & Xi, J. 2017. Entrepreneurial Team Composition Characteristics and New Venture Performance: A Meta-Analysis. *Entrepreneurship Theory and Practice*, 41(5): 743-771.
- Jung, H. J., Vissa, B., & Pich, M. 2017. How Do Entrepreneurial Founding Teams Allocate Task Positions? *Academy of Management Journal*, 60(1): 264-294.
- Kaplan, S. N., & Strömberg, P. E. 2004. Characteristics, Contracts, and Actions: Evidence from Venture Capitalist Analyses. *The Journal of Finance*, 59(5): 2177-2210.
- Katz, D., & Kahn, R. L. 1978. *The Social Psychology of Organizations* (Vol. 2): Wiley New York.

Working with Startups? These are the Three Things You Ought to Know about Startup Teams *Anna Brattström*

- Kim, P. H., Longest, K. C., & Aldrich, H. E. 2013. Can You Lend Me a Hand? Task-Role Alignment of Social Support for Aspiring Business Owners. *Work and Occupations*, 40(3): 213-249.
- Klimoski, R., & Mohammed, S. 1994. Team Mental Model: Construct or Metaphor? *Journal of Management*, 20(2): 403-437.
- Klotz, A. C., Hmieleski, K. M., Bradley, B. H., & Busenitz, L. W. 2014. New Venture Teams a Review of the Literature and Roadmap for Future Research. *Journal of Management*, 40(1): 226-255.
- Lazar, M., Miron-Spektor, E., Agarwal, R., Erez, M., Goldfarb, B., & Chen, G. 2019. Entrepreneurial Team Formation. *Academy of Management Annals*(ja).
- Markman, G. D., Baron, R. A., & Balkin, D. B. 2005. Are Perseverance and Self Efficacy Costless? Assessing Entrepreneurs' Regretful Thinking. *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior*, 26(1): 1-19.
- Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. 2001. A Temporally Based Framework and Taxonomy of Team Processes. *Academy of Management Review*, 26(3): 356-376.
- Mathieu, J. E., Hollenbeck, J. R., van Knippenberg, D., & Ilgen, D. R. 2017. A Century of Work Teams in the Journal of Applied Psychology. *Journal of Applied Psychology*, 102(3): 452.
- Mathieu, J. E., & Zajac, D. M. 1990. A Review and Meta-Analysis of the Antecedents, Correlates, and Consequences of Organizational Commitment. *Psychological bulletin*, 108(2): 171.
- McKelvie, A., Brattström, A., & Wennberg, K. 2017. How Young Firms Achieve Growth: Reconciling the Roles of Growth Motivation and Innovative Activities. *Small Business Economics*, 49(2): 273-293.
- McKelvie, A., Wiklund, J., & Brattström, A. 2018. Externally Acquired or Internally Generated? Knowledge Development and Perceived Environmental Dynamism in New Venture Innovation. *Entrepreneurship Theory and Practice*, 42(1): 24-46.
- McPherson, M., Smith-Lovin, L., & Cook, J. M. 2001. Birds of a Feather: Homophily in Social Networks. *Annual Review of Sociology*, 27(1): 415-444.
- Meyer, J. P., Stanley, D. J., Herscovitch, L., & Topolnysky, L. 2002. Affective, Continuance, and Normative Commitment to the Organization: A Meta-Analysis of Antecedents, Correlates, and Consequences. *Journal of Vocational Behavior*, 61(1): 20-52.
- Milanov, H., & Fernhaber, S. A. 2009. The Impact of Early Imprinting on the Evolution of New Venture Networks. *Journal of Business Venturing*, 24(1): 46-61.
- Murnighan, J. K., & Conlon, D. E. 1991. The Dynamics of Intense Work Groups: A Study of British String Quartets. *Administrative Science Quarterly*: 165-186.
- O'Reilly III, C. A., Caldwell, D. F., & Barnett, W. P. 1989. Work Group Demography, Social Integration, and Turnover. *Administrative Science Quarterly*: 21-37.
- Reagans, R., Zuckerman, E., & McEvily, B. 2004. How to Make the Team: Social Networks vs. Demography as Criteria for Designing Effective Teams. *Administrative Science Quarterly*, 49(1): 101-133.
- Rhee, S.-Y. 2006. Shared Emotions and Group Effectiveness: The Role of Broadening-and-Building Interactions. Paper presented at the *Academy of Management Proceedings*.
- Ries, E. 2011. *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*. Crown Books.
- Ruef, M. 2010. *The Entrepreneurial Group: Social Identities, Relations, and Collective Action*. Princeton University Press.
- Ruef, M., Aldrich, H. E., & Carter, N. M. 2003. The Structure of Founding Teams: Homophily, Strong Ties, and Isolation among Us Entrepreneurs. *American Sociological Review*: 195-222.
- Ruef, M., Bonikowski, B., & Aldrich, H. E. 2009. Business Owner Demography, Human Capital, and Social Networks New Firm Creation in the United States, *Springer*: 95-114.
- Schoonhoven, C. B., Eisenhardt, K. M., & Lyman, K. 1990. Speeding Products to Market: Waiting Time to First Product Introduction in New Firms. *Administrative Science Quarterly*, 35(1): 177-207.
- Shane, S., Locke, E. A., & Collins, C. J. 2003. Entrepreneurial Motivation. *Human Resource Management Review*, 13(2): 257-279.
- Shane, S. A. 2008. *The Illusions of Entrepreneurship: The Costly Myths That Entrepreneurs, Investors, and Policy Makers Live By*. Yale University Press.
- Shepherd, D. A., Wennberg, K., Suddaby, R., & Wiklund, J. 2018. What Are We Explaining? A Review and Agenda on Initiating, Engaging, Performing, and Contextualizing Entrepreneurship. *Journal of Management*, 0149206318799443.
- Steffens, P., Terjesen, S., & Davidsson, P. 2012. Birds of a Feather Get Lost Together: New Venture Team Composition and Performance. *Small Business Economics*, 39(3): 727-743.
- Tajfel, H., & Turner, J. C. 1986. The Social Identity Theory of Intergroup Behavior. In S. Worchel & W. Austin (Eds.), *Psychology of Intergroup Relations*. Chicago: Nelson-Hall: 7-24.
- Tajfel, H. E. 1978. *Differentiation between Social Groups: Studies in the Social Psychology of Intergroup Relations*. Academic Press.
- Timmons, J. A., & Spinelli, S. 1994. *New Venture Creation: Entrepreneurship for the 21st Century* (Vol. 4): Irwin Burr Ridge, IL.
- Tuckman, B. W. 1965. Developmental Sequence in Small Groups. *Psychological bulletin*, 63(6): 384.

Working with Startups? These are the Three Things You Ought to Know about Startup Teams *Anna Brattström*

- Ucbasaran, D., Lockett, A., Wright, M., & Westhead, P. 2003. Entrepreneurial Founder Teams: Factors Associated with Member Entry and Exit. *Entrepreneurship Theory and Practice*, 28(2): 107-127.
- Van Knippenberg, D., Dahlander, L., Haas, M. R., & George, G. 2015. Information, Attention, and Decision Making. *Academy of Management Journal*, 58(3): 649-657.
- Van Knippenberg, D., De Dreu, C. K., & Homan, A. C. 2004. Work Group Diversity and Group Performance: An Integrative Model and Research Agenda. *Journal of Applied Psychology*, 89(6): 1008.
- Vandenbroucke, E., Knockaert, M., & Ucbasaran, D. 2016. Outside Board Human Capital and Early Stage High-Tech Firm Performance. *Entrepreneurship Theory and Practice*, 40(4): 759-779.
- Wasserman, N. 2008. The Founder's Dilemma. *Harvard Business Review*, 86(2): 102-109.
- Welpe, I. M., Spörrle, M., Grichnik, D., Michl, T., & Audretsch, D. B. 2012. Emotions and Opportunities: The Interplay of Opportunity Evaluation, Fear, Joy, and Anger as Antecedent of Entrepreneurial Exploitation. *Entrepreneurship Theory and Practice*, 36(1): 69-96.
- Wiklund, J., Davidsson, P., & Delmar, F. 2003. What Do They Think and Feel About Growth? An Expectancy-Value Approach to Small Business Managers' Attitudes toward Growth. *Entrepreneurship Theory and Practice*, 27(3): 247-270.
- Woolley, A. W., Chabris, C. F., Pentland, A., Hashmi, N., & Malone, T. W. 2010. Evidence for a Collective Intelligence Factor in the Performance of Human Groups. *Science*, 330(6004): 686-688.
- Wu, S., Matthews, & Dagher, G. K. 2007. Need for Achievement, Business Goals, and Entrepreneurial Persistence. *Management Research News*, 30(12): 928-941.

About the Author

Anna Brattström works at Lund University, Sweden. Her research focuses on how people come together and work together in contexts such as innovative start-ups or inter-organizational R&D alliances. Her work has been published in journals such as the *Academy of Management Journal*, *Organization Studies*, *Research Policy*, *Entrepreneurship Theory and Practice* and *Journal of Product Innovation Management*.

Citation: Brattström, A. 2019. Working with Startups? These are the Three Things You Ought to Know about Startup Teams. *Technology Innovation Management Review*, 9(11): 5-14. <http://doi.org/10.22215/timreview/1279>



Keywords: entrepreneurship, new venture teams; teamwork

A University Business School as an Entrepreneurial Ecosystem Hub

Haven Allahar and Ron Sookram

“What is increasingly recognized is that establishing a high-impact sustainable entrepreneurship ecosystem requires that all stakeholders need to collaborate and contribute.”

Mark Rice, Michael Feters, and Patricia Greene (2014)

Professors and researchers in entrepreneurship, and innovation

This article assesses the progress of a business school toward achieving the status of an entrepreneurial ecosystem hub with emphasis on the components related to entrepreneurial universities, entrepreneurship education, university business incubators, and university-enterprise-government-civil society collaboration. The objective of a business school serving as an entrepreneurial ecosystem hub, is to stimulate economic development, generate employment, and create innovative technology-based ventures or service businesses. These components are discussed from theoretical and practical viewpoints in order to provide greater understanding of the concepts. An insider action research assessment of the university-affiliated business school was conducted to gauge the progress made in building an embryonic entrepreneurial ecosystem centered upon a business school as a hub. Emphasis is placed on the need to develop strong collaboration among key stakeholders for achieving success in building an effective entrepreneurial ecosystem based on a quadruple helix system, consistent with the lead-in quotation to the article.

Introduction

The aim of this article is to present the key concepts and insights from literature related to the question of building a university entrepreneurial ecosystem centered upon the development of an aspiring university business school as the hub of the ecosystem. The article further examines empirically, the progress of business schools toward the achievement of an “entrepreneurial ideal”, which is described as embracing the triple helix model of university-industry-government collaboration, along with pursuing a third mission of regional/national economic development initiatives (Philpott et al., 2011). The term “entrepreneurial business school” is hereafter used as a proxy for the “entrepreneurial university” to suit the context of a university business school that is independently structured, managed, funded, and staffed, with teaching personnel mainly recruited from business as adjunct lecturers, and with a board of predominantly business sector members.

The concept of an “entrepreneurial ecosystem” is used in this article as an umbrella term to cover the related components of entrepreneurial universities, entrepreneurship education, university incubation, and stakeholder collaboration, with particular focus on university + industry + government + civil society

participation in a quadruple helix system (McAdam & Debackere, 2018). The relatively new notion of an entrepreneurial ecosystem can be viewed as, “the union of localized cultural networks, investment capital, universities, and active economic policies that create environments supportive of innovation-based ventures” (Spigel, 2017). Although research in this field is recent, it has been established that the components of entrepreneurship education, business incubation, and forming partnership arrangements among stakeholders within universities and with external players, are vital to building successful ecosystems (Rice et al., 2014; Guerrero et al., 2016).

The setting for our research is a small developing middle-income country in the Caribbean whose major university’s business school mission is to provide “a world-class, dynamic environment for continuous learning and action aimed at problem-solving and innovative management and business” (Arthur Lok Jack Global School of Business, 2018). The article targets an audience of university administrators that are contemplating the development of entrepreneurial ecosystems and how to establish entrepreneurial universities, incubator sponsors, managers, and graduates who are contemplating launching a technology or service business. As well, it targets potential academic entrepreneurs, especially those

A University Business School as an Entrepreneurial Ecosystem Hub

Haven Allahar and Ron Sookram

involved in business schools and technology departments, as well as the wider business and academic communities.

Many theories and definitions are cited in relation to entrepreneurial ecosystems (Isenberg, 2010), entrepreneurial universities, and their third mission of economic development through participation in triple helix collaboration (Zawdie, 2010; Etzkowitz, 2013; Kunttu, 2017), tertiary-level entrepreneurship education (Fayolle & Gailly, 2008), university-based incubation (von Zedtwitz, 2003), and key stakeholder collaboration (Etzkowitz & Leydesdorf, 2000). However, there is no generally agreed upon definition, nor coherent theory that integrates the various elements of an entrepreneurial ecosystem. Rather the tendency is to import policies and practices from successful ecosystems while disregarding the relevant cultural and economic features of the local setting (Mian et al., 2016; Spigel, 2017). Against this theoretical background, this article builds on the core concept of the triple helix of Etzkowitz and Leydesdorff (2000), by applying the extended concept of the 'quadruple helix' of university + industry + government + civil society collaboration (Carayannis & Campbell, 2009; Ranga & Etzkowitz, 2013). The latter brings the community element forward with a collaborative network as the essential role of universities (Breznitz & Feldman, 2012).

The paper's research approach involved: (1) an exploratory phase of identifying, collecting, and analyzing relevant themes from secondary literature on entrepreneurial ecosystems and its related components, in order to gain a deeper understanding of the concepts and their applications; and (2) an empirical phase of tracking the trajectory of our use case business school, on its path toward creating an entrepreneurial ecosystem hub. The published data were sourced from leading online journal databases and from Internet searches, while the empirical data were obtained from an "insider action research" approach, that produced contextual insights into the inner operations of the business school as a nascent entrepreneurial ecosystem hub (Coglan & Brannick, 2005) that were not available to outsiders because of privacy and sensitivity matters (Ollila & Williams-Middleton, 2011). The authors' insider status derives from their respective direct involvement in: the planning, design and conduct of the MBA entrepreneurship education program and business planning workshops, close interaction with MBA students through providing mentorship for project work and coaching practicum (capstone project) teams,

advising on the operations of the business incubator, and building quadruple helix collaboration through undertaking consulting exercises for the corporate and public sectors.

The rest of the article contains two major sections with the first examining the main requirements for building entrepreneurial ecosystems distilled from the research. The second section offers an empirical assessment that tracks the progress of the nascent business school toward serving as an entrepreneurial ecosystem hub. The article ends with a discussion of the main conclusions and implications for key stakeholders.

Building University-based Entrepreneurial Ecosystems

There appears to be a consensus that entrepreneurial ecosystems are built on eight specific pillars comprising: 1) access to markets, 2) adequate human resource capacity, 3) appropriate funding from various sources, 4) support mechanisms comprising advisors, 5) networking arrangements, professional services, and incubators or accelerators, 6) a business friendly environment, 7) university entrepreneurship education and training that promotes a culture of entrepreneurship, idea generation, and graduates with a venture orientation, and, 8) a culture that respects research, entrepreneurs, and innovation (World Economic Forum, 2014). Agreement on these ecosystem pillars points to a shift in business perspectives to a focus on people, networks, and institutions, based on the view that "entrepreneurs create new value, organized by a wide variety of governance modes, enabled and confined within a specific institutional context" (Stam, 2015). It is argued that there is no single path to creating an entrepreneurial ecosystem, and that rather the process involves multiple stages that are ill-defined as the university proceeds through them (Rice et al., 2014). It is likewise uncertain whether the concept is applicable to all regions, or more appropriate to regions where support systems already exist (Malecki, 2017). Against this background, the key components of a university-based entrepreneurial ecosystem that are relevant to a nascent entrepreneurial business school are highlighted below.

Entrepreneurial universities

The concept of the entrepreneurial university has three missions (Zawdie, 2010). Teaching was the original function of universities. To this was added research activity as a second mission, with an aim of generating and disseminating knowledge beyond the academy. In

A University Business School as an Entrepreneurial Ecosystem Hub

Haven Allahar and Ron Sookram

time, universities came under pressure to generate revenue, which led to the third mission of converting its efforts into economic development activities, such as “technology transfer that support[s] the modernization of low-tech and mid-tech firms” (Zawdie, 2010). The established entrepreneurial university model, which mirrors the business school case in this article, was seen as comprising close interaction with industry and government (triple helix). This meant relatively independent operations, a hybrid organization that deals effectively with the tensions between external interactions and independence for attaining objectives, as well as constant modification of the structure to sustain triple helix relations (Etzkowitz, 2013). Many definitions have been suggested for entrepreneurial universities. One perspective appropriate to this article is the notion that “an institution that creates an environment, within which the development of entrepreneurial mindsets and behaviors are embedded, encouraged, supported, incentivised, and rewarded” (Hannon, 2013). Thus, what is needed at entrepreneurial universities is entrepreneurship education.

Entrepreneurship education

The study of entrepreneurship has gained impetus over the past 20 years and is now common in many institutions of higher learning. The trend points to employing experiential learning techniques, involving experienced entrepreneurs, utilizing lessons from failure, adopting entrepreneurship as a practice, training in opportunity identification, and adapting content to cultural contexts (Blenker et al., 2012; Naia et al., 2014). The role of university-based entrepreneurship in the stimulation of economic activity and enterprise creation is acknowledged, but the role of universities in building entrepreneurial institutions, creating new ventures, and fostering effective triple helix relationships continues to be debated (Davey et al., 2016). In this context, it was emphasized that “entrepreneurship [i]s not only for the chosen few who can identify business opportunities in the market-place, produce a business plan, provide the necessary financial capital and build a new venture” (Blenker et al., 2012). In other words, more people at universities can be doing it and studying it than have tried so far.

Universities are considered as “entrepreneurial” when they adopt an entrepreneurial perspective in teaching and learning that incorporates a blended and interactive approach. Among the main causes is building a creative society as an imperative of the knowledge society (Ratten, 2017). Embedding entrepreneurship studies in

the curricula of universities and business schools is thus increasingly viewed as a means of fostering entrepreneurial behavior and mindsets in business and technology disciplines (Pittaway & Edwards, 2012; De Cleyn et al., 2013). In turn, the responsibilities of entrepreneurs include the need to adopt a problem-solving approach to wider social value creation, act responsibly with investors and key stakeholders, practice environmental sustainability and ethical behavior, recognize the community’s stake in the success of the venture, and provide appropriate rewards for responsible entrepreneurship (Rae, 2010).

University business incubation

The concept of business incubation as a university initiative, dates back to the late 1950s. In the 1980s, the initiative grew into for-profit incubators facilitated by the availability of venture capital, in response to prospects of profitability. The expansion was sustained in the early 2000s, even the economic downturn of 2008 notwithstanding. Several types of incubators emerged according to various categorizes independent commercial, regional, company-internal, university-affiliated, virtual incubators, mixed, technology, social, and basic research (von Zedtwitz, 2003; Aernoudt, 2004). The defining characteristics of early incubators were provision of workstations, office support, accessible funding, startup technical support, and introduction to business networks (von Zedtwitz, 2003). Currently, incubators are considered “a concerted, systematic effort to nurture new firms in the early-stage of their activity in a controlled environment”, and are viewed as a dynamic process which offers “a combination of infrastructure, development support processes and expertise needed to safeguard against failure and steer incubatee firms into a growth path” (Theodorakopoulos et al., 2014). This process has led to a shift in priority to incubator services with access broadband, Wi-Fi, and networked computers, meeting rooms, and even mentoring (Culkin, 2013).

There is a growing body of research on university-led incubators that are considered catalysts for the development of sustainable university-based entrepreneurial ecosystems, while cases of incubation initiatives in small developing countries universities are generally neglected (Dahms & Kingkaew, 2016). Therefore, this article represents a significant contribution in this area by updating and adding to previous work (Allahar & Brathwaite, 2016). Incubators are consistently viewed as entrepreneurial development services that seek to enlarge the pool of

A University Business School as an Entrepreneurial Ecosystem Hub

Haven Allahar and Ron Sookram

new business ventures and to address their vulnerability in the early stage of development (Isabelle, 2013). More specifically, the common purpose of university incubators operating within an entrepreneurial ecosystem was described as being “to promote entrepreneurship, innovation, the creation of new firms, and economic development” (Theodoraki & Messegem, 2018). New ventures often emerge as university spinoffs, which are somewhat rare, but still contribute to the commercialization of technology and engage the inventor in the development process (Pattnaik & Pandey, 2014).

Stakeholder collaboration: From triple to quadruple helix model

The success of innovation systems is based on strong linkages among academia/universities, industry, and state/government, whose interactions form the triple helix model of collaboration (Etzkowitz & Leydesdorff, 2000). With the emergence of “knowledge economies”, the effectiveness of triple helix collaboration in delivering the expected amount of innovation and economic development was questioned. This led to the addition of a fourth helix, comprising the media, creative industries, culture, values, life styles, and art, extending the concept to a quadruple helix system (Carayannis & Campbell, 2009; Leydesdorff, 2012). These actors constituted part of the wider community engaged in creating “new knowledge, technology and innovation meeting both economic and societal needs” (Kolehmainen et al., 2016). In this regard, the extension of the triple helix to the quadruple helix, was meant to acknowledge the critical role of the general public and community for achieving the knowledge objectives and innovation policies (McAdam & Debackere, 2018). This happens through a more intensive field of collaboration within a regional development network focused on knowledge-intensive development (Kolehmainen et al., 2016).

This article argues that strengthening the existing stakeholder collaborative efforts, is critical to the development of a nascent entrepreneurial ecosystem hub. The successful case of iMinds was described as an initiative to link university research to business needs, and to develop a climate conducive to progressive startups and new ventures (De Cleyn, 2013). This climate represents a new model of an entrepreneurial ecosystem that involves open collaboration with key stakeholders, “intensive cooperation and interaction, human and social capital development, spillover effects, and mutual reinforcement” (De Cleyn, 2013),

that is, one that mirrors the operation of quadruple helix interrelationships.

Assessment of an Embryonic Entrepreneurial Ecosystem Hub

Institutional context

The University of the West Indies (UWI) is part of the Caribbean regional multi-campus university system that emerged in 1948 as a traditional British-style institution. Initially, the university offered traditional degrees in the natural sciences, humanities, social sciences, medicine, engineering, and law. In the 1990s, a business school was established that focused on graduate business studies.

This section traces the progress of the UWI-Arthur Lok Jack Global School of Business (B-school) in its pursuit of creating an ideal entrepreneurial business school to serve as the case of an embryonic entrepreneurial ecosystem hub in Trinidad. While the B-school is part of the overall UWI system, it operates as a semi-autonomous school that offers standard MBA programs, a relatively wide range of specialized masters programs, and a recently introduced undergraduate program in International and Sustainable Business. Ostensibly, these programs provide a platform for developing management professionals and potential entrepreneurs in various fields. An empirical assessment of the entrepreneurial ecosystem hub’s development follows.

Developing an embryonic entrepreneurial ecosystem

It is a relatively long-term undertaking to build a university-based entrepreneurial ecosystem. Such an ecosystem undergoes a dynamic process that Rice (2014) estimates to require at least 20 years for full development. This position was supported by Brown and Mason (2017) who described entrepreneurial ecosystems as “highly variegated, multi-scalar phenomena”, which is reflected in the fact that every ecosystem is unique and displays distinct “idiosyncrasies and characteristics which are spatially, relationally and socially embedded”.

This article examines the case of an embryonic entrepreneurial ecosystem built on an aspiring entrepreneurial business school, and recognizes that there is no consensus on whether an entrepreneurial ecosystem is an aspiration or a status that is only attainable by some university business schools, thus implying degrees of ‘ecosystemness’ (Malecki, 2017). While there is no acknowledged template for building a

A University Business School as an Entrepreneurial Ecosystem Hub

Haven Allahar and Ron Sookram

successful entrepreneurial ecosystem, relevant guidelines were offered comprising of senior leadership vision and engagement, faculty and administrative leaders, commitment to teaching, research and building the ecosystem elements, creating or participating in wide global networks of partners, developing an effective organizational structure in support of entrepreneurial initiatives, curriculum development, networking, and business incubation, promoting continuous innovation as a cultural norm, unrelenting pursuit of financial resources, and attention to succession planning for long-term success (Rice et al., 2014).

Utilizing these guidelines to assess the stages of development of an entrepreneurial ecosystem hub, the authors, as ecosystem insiders, were able to engage key stakeholders, including managerial and administrative staff, adjunct lecturers, financial planning personnel, and corporate clients in discussions on the future of the business school as a hub. Engagement with key stakeholders provided specific insights that are highlighted below. The B-school's senior leadership, which includes one of this paper's co-authors, strongly supports the promotion of entrepreneurial training, and that the extension of training to the wider community needed to be intensified.

The lack of a critical mass of researchers together with reduced corporate funding support is witnessing a reduction of research publication incentives. However, an endowment fund has been created that requires more proactive fund-raising efforts. A curriculum development committee at UWI was established whose mandate is to build an entrepreneurial culture within the B-school. This includes the issue of positive leadership, which is often referred to in research on ecosystems development. Significant measures were taken in this case to introduce new leadership with an entrepreneurial orientation. Overall, the development of the ecosystem lacks momentum. This can be attributed to difficult local economic conditions, current management restructuring, inadequate commitment of key stakeholders, and a current ongoing review of operational processes of the business incubator.

Tracking the business school's transition toward an entrepreneurial ecosystem hub

The progress of an entrepreneurial business school can be measured from different perspectives. These

include development stage analysis (Guerrero & Urbano, 2012), the hard-soft mix in entrepreneurial teaching and learning (Philpott, et al., 2011), the existence of a unified culture for supporting stakeholder involvement and quadruple helix interactions, motivation incentives, as well as resources devoted to developing entrepreneurial leadership capabilities (Coyle, 2014), and a framework for entrepreneurial self-assessment (OECD, 2012). This latter framework was applied in recent assessments of entrepreneurial universities (Williams & Kluev, 2014; Sperrer et al., 2016), and the indicators itemized below, are applied in assessing the current case:

1. *Leadership*: Entrepreneurship is a major aspect of the business school strategy; high-level commitment exists, and the B-school is a driving force for entrepreneurship development in the university community.
2. *Organizational capacity*: A wide range of funding sources are tapped both to ensure a sustainable financial strategy, and to provide staff incentives and rewards in support of the entrepreneurial agenda.
3. *Entrepreneurship development*: The B-school's structure stimulates the development of entrepreneurial mindsets and innovative approaches to teaching.
4. *Pathways to entrepreneurial action*: Entrepreneurial activity is encouraged through support in moving from idea to action, providing mentors, and establishing incubators.
5. *Business school relationships*: The B-school links research, entrepreneurship education, industry, and community activities to improve the knowledge ecosystem.
6. *Internationalization*: The entrepreneurial strategy incorporates an international perspective in teaching, participating in networks, and global exchanges.
7. *Impact*: The business school assesses its impact on entrepreneurship teaching, learning, and startup support at regular intervals.

Applying these indicators to the current case resulted in

A University Business School as an Entrepreneurial Ecosystem Hub

Haven Allahar and Ron Sookram

the following assessment:

- Deficiencies exist in the leadership structure of the B-school, whereas top-level commitment was evidenced in pursuing entrepreneurship education, training, and research as strategic priorities. This is reflected in the increasing entrepreneurship content of its programs, the range of consultancy services provided to the public and private sectors, as well as developing and maintaining a web page for disseminating staff research publications.
- Funding for startups remains a major challenge, one exacerbated by economic strictures within the country that negatively impact the provision of staff rewards and incubator funding, and thus limit entrepreneurial action in some areas.
- Orienting the entrepreneurship curriculum to experiential teaching and learning approaches, emphasizing mentorship, building institutional alliances with local and external organizations, and researching MBA programs in the Caribbean helps in fostering entrepreneurial mindsets (Allahar & Sookram, 2018).
- Global thinking has been introduced to the curricula of all relevant programs, wherein an internationalization perspective is applicable that is reflected in its hosting of the annual *Distinguished Leadership and Innovation Conference*, which attracts international experts and leaders in entrepreneurship and innovation.
- Implementing tracer studies of graduates can assist in assessing the outputs and impacts of the ecosystem.

State of entrepreneurship education and training

Universities are considered entrepreneurial when they adopt an entrepreneurial perspective in teaching and learning that incorporates a blended and interactive approach, with an aim of building a creative society as an imperative of the knowledge society (Ratten, 2017). The B-school incorporated entrepreneurship education in its initial MBA elective on entrepreneurship and innovation (Allahar & Brathwaite, 2017). Specific components of the entrepreneurship curriculum were subsequently included in specialized masters programs. The teaching method followed the trend towards experiential learning and entrepreneurship as everyday practices. It also acknowledged a student audience comprising professionals and managers, and the

assertion that “entrepreneurship education that is not based on everyday practice ... is unlikely to generate the desired outcome, be it new venture creation, growth or social change” (Blenker et al., 2012). Increasingly, the need to embed entrepreneurship studies in the curricula of universities and business schools is emphasized as a means of fostering entrepreneurial behavior and mindsets in business and technology disciplines (Pittaway & Edwards, 2012; De Cleyn et al., 2013; van Weele, 2018). However, in projecting the future of entrepreneurship, Kuratko and Morris (2018) argue that entrepreneurship education will not be about the mechanics of starting up and growing new ventures, or opportunity identification and implementation techniques. Rather, it will be about empowering and transforming students through encouragement to dream big along with the tools to realize their dreams, while at the same time being “allowed to fail”.

The research results indicate that the experiential entrepreneurial program introduced its new undergraduate course by incorporating practical workshops about how to register a business, pitch and raise funds for the respective ventures. A student-team approach is standard to learning in B-school programs, with coaches assigned to each team developing sustainable ventures. Graduate students, working in teams of three persons to complete their capstone projects, have the option of preparing a comprehensive business plan based on an approved opportunity, or to work with a designated organization or company to undertake a diagnosis of key problems, and participate in the implementation of key solutions. However, the process of embedding entrepreneurship education in all university programs is lagging and our assessment shows that follow-up action is essential.

Business incubation as an ecosystem catalyst

In 2012, the B-school established a virtual incubator (BizBooster), as a non-profit subsidiary company designed to operate on the basis of networked online services targeting both university graduates internally, and startups or existing SMEs as external clients. The overriding objectives were economic development, job creation and social impact, which are consistent with international comparisons, and with a standard menu of business support services, including mentorship. The incubator operates under the guidance of an independent board of private businesspersons and dedicated management staff that orchestrate the processes. The incubator is linked to the national incubator system, which does not function effectively largely because the other incubators are all dependent

A University Business School as an Entrepreneurial Ecosystem Hub

Haven Allahar and Ron Sookram

on government funding, and thus subject to the vagaries of national income flows. A sample of businesses generated within BizBooster cover a range of activities, including a mix of services, manufacturing, and technological pursuits such as mobile applications, aquaponics ICT services, 3-D manufacturing, and developing an e-commerce facility for exporting artisanal products.

Traditionally, the success of incubators is judged by the number of firms that graduate and move to operations in the open business environment. Further, these types of businesses are assessed for meeting their main venture creation objectives in terms of the sectors targeted, while recognizing that incubators vary between service-type business and technology-based ventures. More recently, it was argued that the above success indicators were limiting and should also include: approved business plans prepared, business models developed, prototypes created, applications for patents or intellectual property protection, marketing surveys undertaken and analyzed, and proposals submitted to financial institutions, venture capitalists, or SME funds (Kuratko & Morris, 2018). University incubators are increasingly being considered as catalysts for creating sustainable university-entrepreneurial ecosystems. This highlights the role of incubators in the third mission of entrepreneurial universities (Theodoraki & Messeghem, 2018). A relevant observation by Dahms and Kingkaew (2016) is that university incubators need not focus exclusively on technology-related ventures because non-technology programs such as business schools can also deal with non-tangible services, as well as technology transfer activities.

Our investigation of BizBooster operations revealed moderate success in attracting innovative businesses. This situation is linked to challenges with securing business funds from grants, angels, and venture capital. As a result, the B-school is now pursuing the establishment of an investment facilitation platform to address the funding challenges. The platform intends to draw upon available concessionary financing for business development currently being offered by multilateral development agencies in the region, as well as participants in its network of support institutions. The B-school recognizes that this approach requires significant time, effort, networking capacity, feasibility analyses, and technical knowhow. Nevertheless, the viability of BizBooster depends on success in these areas.

In this context, the B-school is undertaking a restructuring of incubator management and operational processes, and will adopt the following best practices: formulate and adopt an 'incubation charter' that includes an investment portfolio and provides guidelines for client selection and investment practices, emphasize the importance of day-to-day management in dealing with residual risk by providing coaching and startup support services, optimize the benefits from industry experience and expertise, both internal and external networks, and incubator team's skills, and tap into the synergy created through coaching, interactions among startups, and internal value chain creation (von Zedtwitz, 2003). B-school acknowledges that BizBooster has not been meeting its objectives, hence a restructuring exercise is in progress. Focus is being placed on extended mentoring services, evidenced by the launch of the Alumni Mentoring Program 2019.

Quadruple helix stakeholder collaboration

With pressure to accelerate development in many economies, the triple helix actors were added to by a fourth 'helix' of civil society players, thus generating a quadruple helix system of collaboration (McAdam & Debackere, 2018). Strengthening the entrepreneurial ecosystem, ensuring survival of the entrepreneurial B-school, and sustainability of the incubation facility, ultimately depend on the value of quadruple helix collaboration, especially in a developing business environment.

Our assessment of the status of quadruple helix collaboration at UWI revealed that the B-school's link with the university as its main internal stakeholder remains firm. This is demonstrated by the University Principal's continuing service as chair of the school, as well as in the provision of administrative services for examinations, curricula development, and related academic requirements. The university-industry link is sustained by the fact that the majority of lecturers are adjunct staff from business and industry. This has facilitated the implementation of industry-based internships for students. Further, B-school is involved with industry and businesses through consulting work on organizational issues, executive training and customized courses, and research conducted on areas such as competitiveness, cluster development, and business strategy formulation. In this connection, B-school serves as the national-local partner for Global Entrepreneurship Monitor, and the World Economic Forum's Global Competitiveness Report.

A University Business School as an Entrepreneurial Ecosystem Hub

Haven Allahar and Ron Sookram

The overall conclusion is that the channels of collaboration are growing steadily. For future progress, greater efforts are required to strengthen interrelations and deepen collaboration among all participants in the quadruple helix system.

Conclusions and Implications

The article sought to provide insight into the concept of university-based entrepreneurial ecosystems. These are based on developing entrepreneurial universities, incorporating entrepreneurship education in the curricula, establishing university-led business incubators as new venture development tools, and extending stakeholder collaboration in the form of a “quadruple helix” system. The authors undertook an empirical assessment of a university-based business school aiming to serve as an entrepreneurial ecosystem hub as case study, based on insider action research to gauge progress towards the ecosystem goals.

The main conclusions reached are as follows:

- The building of an effective university entrepreneurial ecosystem is a long term undertaking that demands sustained attention because of how universities operate in silos counter to effective collaboration.
- The development of an entrepreneurial business school, especially in the context of a small developing country, represents a major challenge because of sparse funding, human resource capacity, fully committed leadership, and an underdeveloped entrepreneurial culture.
- The imperative of embedding entrepreneurship education in the curriculum of business schools has gained slow acceptance (within the UWI system).
- Support for incubation projects has been reluctant. This is exemplified by inadequate financial resources and quality management. A solution is to strengthen stakeholder interrelationships by extending them to a quadruple helix collaboration through the inclusion of civil society.
- Ecosystem weaknesses may lead to unacceptable levels of quality for graduating innovative ventures.

These conclusions point to a need for promoting greater collaboration among participants developing the B-school as an ecosystem hub. A systematic review of the research emphasized that collaboration between university and industry was the decisive factor in stimulating innovation (Sjöo & Hellström, 2019). Strengthening key stakeholder collaboration, particularly in the context of a quadruple helix arrangement, as proposed in the article, therefore suggests specific actions that should be pursued vigorously. Primary among these are:

1. Commencing a program for mobilizing resources to support the human resource capacity of the B-school, and to secure adequate funding for incubator operations,
2. Creating an incentive structure that favors collaboration rather than operating in silos, promotes the host university’s educational structure, and offers a scope that increases peoples’ propensity to collaborate with each other,
3. Strengthening the ecosystem infrastructure and contributing to building an appropriate regulatory framework for the constituent elements of the ecosystem,
4. Creating informal relationships that facilitate boundary-spanning activities that arise from joint projects among the actors in the quadruple helix system, and drawing on shared experiences from previous collaborative efforts,
5. Fostering a culture of collaboration that extends beyond the borders of academia, in a way that produces role models, start-ups, spinoffs, and innovative ventures, and thus strengthens universities’ entrepreneurial mission.

To sum up, we believe that the development of more intensive and extensive collaboration among partners and participants is achievable, and that pursuing the action items suggested above will go a long way to improving peoples’ collaborative results in building a university-based entrepreneurial ecosystem hub.

A University Business School as an Entrepreneurial Ecosystem Hub

Haven Allahar and Ron Sookram

About the Authors

Haven Allahar has served for over 25 years as an adjunct lecturer in entrepreneurship and innovation, and a coach of MBA teams' capstone projects at the Arthur Lok Jack Global School of Business of the University of the West Indies, Trinidad and Tobago. Haven has a wide academic and specialized training background in Economics (B.Sc., Jamaica), Entrepreneurship & Management (M.A. & DBA, US); Industrial Project Planning, Financing, & Management (UK & Poland). Haven served for over 40 years in senior management and CEO positions in companies involved in developing and managing an energy-based industrial park, SME development, urban development, and project planning and management. Haven, along with two partners, owned and operated for 15 years a consulting firm that provided project planning, design, and management services to a variety of clients in Trinidad and Tobago and the Caribbean. Haven's research interests are in broad areas of business, management, and economic development issues. His publications are available at Academia.edu and ResearchGate.

Ron Sookram is Director, Client Solutions and Director, Centre for Corporate Social Responsibility at the Arthur Lok Jack Global School of Business, The University of the West Indies (UWI-ALJGSB), Trinidad and Tobago. Ron serves also as the School's Resident Consultant on Corporate Governance-related projects and in this capacity leads governance interventions and designs customized governance training for boards of private and publicly-listed companies, state-owned enterprises, civil society organizations and credit unions. Ron has published peer-reviewed articles and book chapters on corporate governance, corporate responsibility and cultural history. Ron has collaborated with Haven on publishing journal articles on MBA studies, entrepreneurial universities, and management research. Ron is an alumnus of the University of the West Indies where he obtained a B.A., MPhil, and Ph.D.

Citation: Allahar, H. & Sookram, R. 2019. A University Business School as an Entrepreneurial Ecosystem Hub. *Technology Innovation Management Review*, 9(11): 16-25.
<http://doi.org/10.22215/timreview/1280>



Keywords: entrepreneurial ecosystems, entrepreneurial university, entrepreneurship education, university business incubation, triple helix, quadruple helix

References

- Allahar, H. & Brathwaite, C. 2016. Business Incubation as an Instrument of Innovation: The Experience of South America and the Caribbean. *International Journal of Innovation*, 4(2): 71-85.
<http://dx.doi.org/10.1177/0950422216118764>
- Allahar, H. & Brathwaite, C. 2017. Entrepreneurship Education for Executive MBAs: The Case of a Caribbean Business School. *Industry & Higher Education*, 31(5): 305-317.
<http://dx.doi.org/10.1177/0950422217718764>
- Allahar, H. & Sookram, R. 2018. Globalization of MBA Studies and Transnational Educational Institutions in the Caribbean. *Industry and Higher Education*, 32(5):290-301.
<http://dx.doi.org/10.1177/0950422218792156>
- Arthur Lok Jack Global School of Business. 2018. *About*. Accessed March 10, 2018: <http://www.lokjackgsb.edu.tt>
- Blenker, P., Frederiksen, S. H., Korsgaard, S., Müller, S., Neergaard, H. & Trane, C. 2012. Entrepreneurship as Everyday Practice: Towards a Personalized Pedagogy of Enterprise Education. *Industry and Higher Education*, 26(6): 417-430.
<http://dx.doi.org/10.5367/ihe.2012.0126>
- Breznitz, S. M. & Feldman, M. P. 2012. The engaged university. *Journal of Technology Transfer*, 37: 139-157. <http://dx.doi.org/10.1007/s10961-010-9183-6>
- Brown, R. & Mason, C. 2017. Looking Inside the Spiky Bits: A Critical Review and Conceptualisation of Entrepreneurial Ecosystems. *Small Business Economics*, 49:11-30.
<http://dx.doi.org/10.1007/s11187-017-9865-7>
- Carayannis, E. G. & Campbell, D. F. J. 2009. 'Mode 3' and 'Quadruple Helix': Toward a 21st Century Fractal Innovation System. *International Journal of Technology Management*, 46(3/4): 201-234.
- Coghlan, D. & Brannick, T. 2005. *Doing action research in your own organization*. London, UK: Sage.
- Coyle, P. 2014. How Entrepreneurial Leadership can Engage University Staff in the Development of an Entrepreneurial Culture. *Industry and Higher Education*, 28(4): 263-269.
<http://dx.doi.org/10.5367/ihe.2014.0215>
- Culkin, N. 2013. Beyond being a Student: An Exploration of Student and Graduate Startups (SGSUs) Operating from University Incubators. *Journal of Small Business and Enterprise Development*, 20(3): 634-649.
<http://dx.doi.org/10.1108/JSBED-05-2013-0072>
- Dahms, S. & Kingkaew, S. 2016. University Business Incubators: An Institutional Demand Side Perspective on Adding Features. *Entrepreneurial Business and Economic Review*, 4(3): 41-56.
<http://dx.doi.org/10.15678/EBER.2016.040304>

A University Business School as an Entrepreneurial Ecosystem Hub

Haven Allahar and Ron Sookram

- Davey, T., Hannon, P. & Penaluma, A. 2016. Entrepreneurship Education and the Role of Universities in Entrepreneurship: Introduction to the Special Issue. *Industry and Higher Education*, 30(3): 171-182.
<http://dx.doi.org/10.1177/0950422216656699>
- DeCleyne, S. H., Gielen, F. & Coppens, J. 2013. Incubation Programs from Public Research Organizations as Catalysts for Open Business Ecosystems. *Technology Innovation Management Review*, April 2013: 29-34.
- Etzkowitz, H. 2013. Anatomy of the Entrepreneurial University. *Social Science Information*, 52(3): 486-511.
<http://dx.doi.org/10.1177/0539018413485832>
- Etzkowitz, H. & Leydesdorff, L. 2000. The Dynamics of Innovation: From National Systems and "Mode 2" to a Triple Helix of University-Industry-Government Relations. *Research Policy*, 29:109-123.
- Fayolle, A. & Gailly, B. 2008. From Craft to Science Teaching Models and Learning Processes in Entrepreneurship Education. *Journal of European Industrial Training*, 32(7): 569-593.
- Gartner, W. B. 1985. A Conceptual Framework for Describing the Phenomenon of New Venture Creation. *Academy of Management Review*, 10(4): 696-706.
- Guerrero, M. & Urbano, D. 2012. The Development of an Entrepreneurial University. *Journal of Technology Transfer*, 37: 43-74.
<http://dx.doi.org/10.1007/s10961-010-9171-x>
- Guerrero, M. & Urbano, D. 2016. Entrepreneurial Universities: Emerging Models in the New Social and Economic Landscape. *Small Business Economics*, 47(3): 551-563.
<http://dx.doi.org/10.1007/s11187-016-97554>
- Hannon, P. D. 2013. Why is the Entrepreneurial University Important? *Journal of Innovation Management*, 1(2): 10-17.
- Isabelle, D. A. 2013. Key Factors Affecting a Technology Entrepreneur's Choice of Incubator or Accelerator. *Technology Innovation Management Review*, February 2013:16-22.
- Isenberg, D. J. 2010. The Big Idea: How to Start an Entrepreneurial Revolution. *Harvard Business Review*, June: 40-50.
- Kolehmainen, J., Irvine, J., Stewart, L. et al. 2016. Quadruple Helix, Innovation and the Knowledge-Based Development: Lessons from Remote Rural and Less Favoured Regions. *Journal of the Knowledge Economy*, 7:23-42.
<http://dx.doi.org/10.1007/s13132-015-0289-9>
- Kuntu, L. 2017. Educational Involvement in Innovative University-Industry Collaboration. *Technology Innovation Management Review*, 7(12): 14-22.
- Kuratko, D. F. & Morris, M. H. 2018. Examining the future trajectory of entrepreneurship. *Journal of Small Business Management*, 56(1): 11-23.
<http://dx.doi.org/10.1111/jsbm.12364>
- Lahikainen, K., Kolhinen, J., Ruskovaara, E. & Pihkala, T. 2019. Challenges to the Development of an Entrepreneurial University Ecosystem: The Case of a Finnish University Campus. *Industry and Higher Education*, 33(2): 96-107.
<http://dx.doi.org/10.1177/0950422218815806>
- Leydesdorff, L. 2012. The Triple Helix, Quadruple Helix ..., and an N-Tuple of Helices: Explanatory Models for Analyzing the Knowledge-Based Economy. *Journal of the Knowledge Economy*, 3: 25-35.
<http://dx.doi.org/10.1007/s13132-011-0049-4>
- Malecki EJ. 2017. Entrepreneurship and entrepreneurial ecosystems. *Geography Compass*, e12359, 1-21. Accessed 12 October 2018:
wileyonlinelibrary.com/journal/gec3.
- McAdam, M. & Debackere, K. 2018. Beyond Triple Helix Toward Quadruple Helix Models in Regional Innovation Systems: Implications for Theory and Practice. *R&D Management*, 48(1): 3-6.
- Mian, S., Lamine, W. & Fayolle, A. 2016. Technology Business Incubation: An Overview of the State of Knowledge. *Technovation*, 50-51: 1-12.
<http://dx.doi.org/10.1016/j.technovation.2016.02.005>
- Naia, A, Baptista, R., Januário, C. and Trigo, V. 2014. A Systematization of the Literature on Entrepreneurship Education. *Industry and Higher Education*, 28(2): 79-96.
<http://dx.doi.org/10.5367/ihe.2014.0196>
- Ollila, S. & Williams-Middleton, K. 2011. The Venture Creation Approach: Integrating Entrepreneurial Education and Incubation at the University. *International Journal of Entrepreneurship and Innovation Management*, 13(2): 161-178.
- Organization for Economic Cooperation and Development (OECD). 2012. *Guiding Framework for Entrepreneurial Universities*. European Commission. Accessed June 10, 2019:
<https://www.oecd.org/.../EC-OECD%20Entrepreneurial%20Universities%20Framework.pdf>
- Pattnaik, P. N. & Pandey, S. C. 2014. University Spinoffs: What, Why, and How? *Technology Innovation Management*, December 2014: 44-49.
- Philpott, K., Dooley, L., O'Reilly, C. & Lupton, G. 2011. The Entrepreneurial University: Examining the Underlying Academic Tensions. *Technovation*, 31: 161-170.
- Pittaway, L. & Edwards, C. 2012. Assessment: Examining Practice in Entrepreneurship Education. *Education + Training*, 54(8/9): 778-800.
<http://dx.doi.org/10.1108/00400911211274882>
- Rae, D. 2010. Universities and Enterprise Education: Responding to the Challenges of the New Era. *Journal of Small Business and Enterprise Development*, 17(4): 591-606.
<http://dx.doi.org/10.1108/14626001011088741>
- Ranga, M. & Etzkowitz, H. 2013. Triple Helix Systems: An Analytical Framework for Innovation Policy and Practice in the Knowledge Society. *Industry and*

A University Business School as an Entrepreneurial Ecosystem Hub

Haven Allahar and Ron Sookram

- Higher Education*, 27(3): 237-262.
<http://dx.doi.org/10.5367/ihe.2013.0165>
- Ratten, V. 2017. Entrepreneurial Universities: The Role of Communities, People, and Places. *Journal of Enterprising Communities: People and Places in the Global Economy*, 11(3): 310-315.
<http://dx.doi.org/10.1108/JEC-03-2017-0021>
- Rice, M. P., Fetters, M. L. & Greene, P. G. 2014. University-Based Entrepreneurship Ecosystems: A Global Study of Six Global Institutions. *International Journal of Entrepreneurship and Innovation Management*, 18(5/6): 481-501. Sperrer, M. Muller, C. & Soos, J. 2016. The Concept of the Entrepreneurial University Applied to Universities of Technology in Austria: Already Reality or Vision of the Future? *Technology Innovation Management Review*, 6(10): 37-44.
- Spigel, B. 2017. The Relational Organization of Entrepreneurial Ecosystems. *Entrepreneurship Theory and Practice*, 41(1): 49-72.
<http://dx.doi.org/10.1111/etap.12167>
- Stam, E. 2015. Entrepreneurial ecosystems and regional policy: a sympathetic critique. *European Planning Studies*, 23(9): 1759-1769.
- Sjöö, K. & Hellström, T. 2019. University-Industry Collaboration: A Literature Review and Synthesis. *Industry and Higher Education*, 33(4): 275-285.
<http://dx.doi.org/10.1177/0950422219829697>
- Theodoraki, C. & Messeghem, K. 2018. A Social Capital Approach to the Development of Sustainable Entrepreneurial Ecosystems: An Explorative Study. *Small Business Economics*, 51(1): 153-170.
<http://dx.doi.org/10.1007/s11187-017-9924-0>
- Theodorakopoulos, N., Kakabadse, N. K. & McGowan, C. 2014. What Matters in Business Incubation? A Literature Review and a Suggestion for Situated Theorising. *Journal of Small Business and Enterprise Development*, 21(4): 602-622.
<http://dx.doi.org/10.1108/JSBED-09-2014-0152>
- von Zedtwitz, M. 2003. Classification and Management of Incubators: Aligning Strategic Objectives and Competitive Scope for New Business Facilitation. *International Journal of Entrepreneurship and Innovation Management*, 13(2): 176-196.
- Williams, D. & Kluev, A. 2010. The Entrepreneurial University: Evidence of the Changing Role of Universities in Modern Russia. *Industry and Higher Education*, 28(4): 1-10.
<http://dx.doi.org/10.5367/ihe.2014.0212>
- World Economic Forum. 2014. *Entrepreneurship Ecosystems around the Globe and Early Stage Company Growth Dynamics*. Geneva, Switzerland: WEF. Accessed January 6, 2017: www.weforum.org
- Zawdie, G. 2010. Knowledge Exchange and the Third Mission of Universities. *Industry and Higher Education*, 24(3): 151-155.

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

“If all you're trying to do is essentially the same thing as your rivals, then it's unlikely that you'll be very successful.”

Michael Porter
Professor at Harvard Business School

International Entrepreneurship as a field of studies depends on digitalization as an essential factor that drives internationalization. Riding on the wave of digitalization, firms can produce and market their products and services globally through digital platforms with reduced costs and time savings. Yet, digitalization as a determinant of competitive advantages for small and medium enterprises in international markets is rarely examined. This study fills the gap by testing the direct and indirect effects of digitalization on enterprise, specifically focusing on price, product, and service advantages in digitalized international markets. Based on the data collected from 143 exporting SME manufacturers in Malaysia, results from our analysis revealed that digitalization has no direct effect on competitive advantage, but rather has strong indirect effects on product and service advantages. Managers and policymakers can thus leverage digitalization to improve their company's internationalization plans according to its intended competitive strategies.

Introduction

This study aims to contribute to an acceleration of small and medium enterprises (SME) internationalization by identifying key determinants of their competitive advantages for internationalization. Resource-based theory (Barney, 1991; Barney et al., 2011) is often used to explain the determinants of international performance (Cavusgil and Knight, 2015; Øyna and Alon, 2018). However, little is known about the resources and capabilities that lead to Malaysian SMEs' competitive advantages in international markets (Falahat et al., 2013; Falahat et al., 2018). In addition to resources and capabilities, international entrepreneurship scholars are also showing increased interest to explore the role of digitalization in SME internationalization through studies of digital platform firms (Ojala et al. 2018; Stallkamp & Schotter 2018), internet-based companies (Wittkop et al., 2018), ibusiness firms (Brouthers et al., 2018), and high-tech startups (Neubert 2017 & 2018). While resources and

capabilities are fundamental prerequisites for international research exploration, the concepts existed prior to the emergence of digital era (Coviello, Kano, and Liesch 2017; Wittkop et al. 2018). To date, the interaction between digitalization and these fundamental prerequisites has not been sufficiently validated with quantitative evidence (Coviello et al., 2017; Strange & Zucchella, 2017; Watson et al., 2018). Despite earlier studies that acknowledge the needs for integrating digitalization with a strategic internationalization model, most studies are still qualitative in nature. More quantitative evidence is therefore needed to demonstrate the role of digitalization in SME internationalization studies (Coviello et al., 2017; Knight & Liesch, 2016; Neubert, 2018; Ojala et al., 2018).

The impacts of digitalization on business models have been well described in case studies (Neubert, 2017 & 2018). Some businesses that embrace digitalization for internationalization have achieved early and rapid

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

internationalization (Stallkamp & Schotter, 2018; Wittkop et al., 2018). Consistent with this understanding, digitalization's role in determining a SME's competitive advantages and its interaction with other factors are crucial for business owners in their planning and decision-making strategies (Dana, 2017; Knight & Liesch, 2016; Romanello & Chiarvesio, 2019). It is important to understand the relationships between digitalization, various resources and capabilities that give a firm competitive advantages, in order for SMEs to accelerate their internationalization (Coviello et al., 2017; Neubert, 2018; Wittkop et al., 2018).

The main objective of this study is to examine the impact of digitalization on SMEs, and to develop a model for the determinants of SMEs' competitive advantages in international markets, with specific consideration to digitalization, resources, and capabilities. The study also tests various capabilities as a mediator in the relationship of digitalization, resources, and competitive advantages. Based on the findings, researchers may further explore the role of digitalization and other determinants of competitive advantages in the context of international entrepreneurship. Managers and policymakers should gain a better understanding of how to incorporate digitalization together with other determinants of competitive advantages that enable the company to enter international markets. This will reduce the risk, time, and cost for a company's internationalization process (Neubert, 2017; 2018; Ojala et al., 2018).

Literature Review

Underlying theories

Since the 1990s, "born global" theory has often been used to explain the process of SME internationalization (Rennie, 1993). In this study, we refer to both born global and international new venture studies (Oviatt & McDougall, 1994 & 1999) through the lens of a resource-based view (RBV) (Barney, 1991; Grant, 1991) combined with a dynamic capability view (Teece et al., 1997). In these approaches, empirical studies conducted to relate the resources and capabilities for SME internationalization are used as input to develop the research model.

Competitive advantages in international markets

In this study, competitive advantages refer to whether a firm performs better in price, product, or service advantages, in comparison with its competitors in international markets (Kaleka & Morgan, 2017). Specifically, price advantage means a firm is at a better

position in terms of pricing when it comes to competing with other industry players in their international venture. Product advantage in contrast means that a firm is at a better position in terms of their product design, customization, adaptation, and/or overall quality in comparison with other industry players in their international venture. Additionally, a service advantage refers to a firm that is at a better position in terms of their reliability of service, timeliness of delivery, product accessibility, and/or overall service quality, and customer satisfaction. These three performance measurements are analogous to the concepts of lower cost strategy and differentiation strategy (Porter, 1980), in which differentiation can be studied either as product differentiation or service differentiation.

Among empirical studies in the field of international entrepreneurship, focus has generally been skewed to international performance, while little investigation has been done on competitive advantages in international markets. This study posits that understanding digitalization, resources, capabilities, and competitive advantages provides additional insights for more systematic planning of resource allocation (Grant, 1991). Hence, we were motivated for the present study to operationalize competitive advantages in international markets that reflect the price, product, and service advantage.

Digitalization for competitive advantages in international markets

As defined by Autio (2017: 2), digitalization refers to "the application of digital technologies and infrastructures in business, economy, and society". Firms thus apply different types of digital technologies, such as e-commerce, big data analytics, internet of things, machine learning, additive manufacturing, and others for value creation (Autio et al., 2018; Nambisan, 2017; Strange & Zucchella, 2018). SME adopts digital technologies such as informmediation (Ordanini & Pol 2001), e-Commerce (Gregory et al., 2007; Gregory et al., 2019), social media (Eggers et al., 2017), and others in their business (Foroudi et al., 2017; Neubert, 2018; Pagani & Pardo, 2017). Adopting digital technology can directly or indirectly create competitive advantages in the digital economy.

This study posits that fragmented digitalization studies are in line with Grant's RBV(1991), in which digitalization is a specific resource that contributes to a company's competitive advantage. Thus, the following hypotheses are developed:

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

H1: Digitalization positively affects competitive advantage (price, product, service) for SMEs in international markets.

Resources for competitive advantages in international markets

Guided by new venture internationalization studies, we compile key resources (Laanti et al., 2007; Oviatt & McDougall, 2005; Ruzzier et al., 2006) that are essential for competitive advantages, and conceptualize them as an international resource. We often see three concepts of management characteristics (Madsen & Servais, 1997; Weerawardena et al., 2007; Zor et al., 2019), international knowledge (Johanson & Valne, 1977; Rodríguez-Serrano & Martín-Armario, 2019), and network (Che Senik et al., 2011; Falahat et al., 2015; Freeman & Cavusgil, 2007) in SME internationalization studies. Based on the empirical studies, resources may directly be related to capability (Fernández-Mesa & Alegre, 2015; Lu et al., 2010; Monteiro et al., 2017; Weerawardena, 2003), or to international performance (Cao & Ma, 2009; Kaleka, 2002; Krammer et al., 2018).

Despite the fact that most studies have directly tested international performance based on financial and strategic performance, this study instead intended to provide more insights on competitive advantages in international markets. The discussion in the earlier section leads to the following hypothesis development:

H2: Resources positively affect competitive advantage (price, product, service) for SMEs in international markets.

Capabilities for competitive advantages in international markets

Grounded on a resource-based view, we see a likely a bundle of capabilities that contributes to international performance (Kaleka, 2002; Leonidou et al., 2011). A bundle's complexity prevents other firms from imitating or transferring the capabilities easily, thus assisting the firm to outperform its competitors. This study compiles key capabilities from SME internationalization studies that are deemed essential nowadays for competitive advantages.

We posit that a firm with strong international capabilities should exhibit advanced innovation capacities in terms of product and innovation process, which they have control over in terms of product specification, quality, and customization. At the same time, the firm should be able to control productivity and production costs in order to meet price flexibility. In addition, a firm with strong capabilities should exhibit

strong marketing capacities (Morgan et al., 2004; Morgan et al., 2012) so that they can effectively introduce their product to new markets. In light of the dynamic capability view, firms with strong capabilities should exhibit strong learning capacities (Gassmann & Keupp, 2007; Grant, 1991; Johanson & Vahlne, 2009; Teece et al., 1997), where they can always respond to changes in international markets in terms of regulatory, customer, or market requirements. Firms with learning capabilities know how to apply new technology to support product and innovation process (Fernández-Mesa & Alegre, 2015; Oura et al., 2016; Raymond et al., 2013).

Based on empirical studies, capabilities are directly related to competitive advantages (Ahmadi et al., 2014; Kamboj et al., 2015; Weerawardena, 2003). Nevertheless, most studies have directly tested resources and capabilities on international performance without explicitly investigating competitive advantages (Evangelista & Mac, 2016; Pham et al., 2017; Raymond et al., 2013; Takahashi et al., 2016). This study instead intended to provide more insights on competitive advantages.

Discussion in the earlier sections leads to the following hypothesis development:

H3: International capabilities positively affect competitive advantage (price, product, service) for SMEs in international markets.

Capabilities as mediator for competitive advantages in international markets

The study of interactions between resources and capabilities is scarce in comparison to study of the direct relationship between resources, capabilities, and competitive advantages (Kaleka, 2002). Nevertheless, there are exceptions. Some scholars have proposed that capabilities often act as a mediator between resources and performance (Lu et al., 2010). Extending from the direct relationship reported in H2, this study posits that capabilities are a mediator between resources and competitive advantages in international markets.

Although digitalization may be considered separately from resources, it is conjectured to have similar attributes as a resource. Firms utilize digital tools as input to enhance their international capabilities (Neubert, 2018), and subsequently lead to improved international performance (Lee et al., 2019). This assumption is in line with Grant (1991) and other research models (Fernández-Mesa & Alegre, 2015; Lu et al., 2010; Monteiro et al., 2017; Weerawardena, 2003).

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

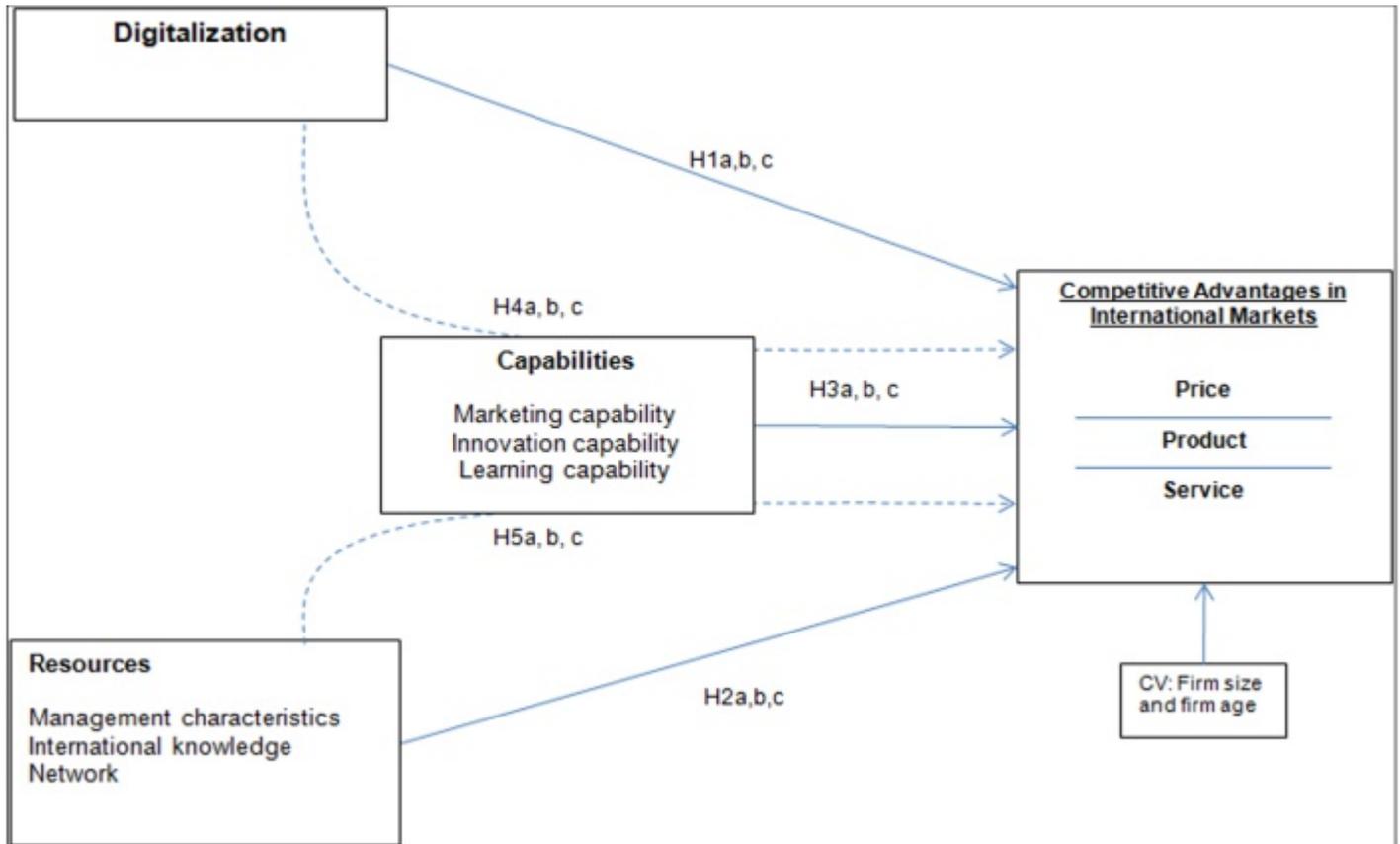


Figure 1. Research model

(Note: Dotted line denotes the indirect relationship, capabilities construct as a mediator)

Thus, the following hypotheses are developed:

H4: International Capabilities mediate the relationship between digitalization and competitive advantage (price, product, service) for SMEs in international markets.

H5: International Capabilities mediate the relationship between resources and competitive advantage (price, product, service) for SMEs in international markets.

The research model is presented in Figure 1.

Research Methods

Malaysia is considered as a good representative of emerging countries in the world (Bloomberg 2018). Based on key determinants of competitive advantages compiled from SME internationalization literature, this study adopts a quantitative research approach to examine the role of these determinants in the Malaysian context. In addition to a literature review, advice from experts was used as input to further advance a questionnaire related to the main objectives of the research. This gave us extensive information about key

determinants associated with competitive advantages for Malaysian firms in international markets.

Manufacturers were selected as the study's sample, due to the fact that their international export business mostly involved manufactured goods. Owing to the type of business, this excluded service providers to ensure homogeneity of the samples, especially in term of resources and capabilities involved in the business process. Thus, the questionnaire was distributed to exporting SMEs from manufacturing sectors.

The MATRADE (Malaysia External Trade Development Corporation) directory was used as the sampling frame. This directory is the most complete and updated directory to reach exporting SME manufacturers, compared with other directories that are not export-focus. Company selection was derived by using a quota sampling technique. First, a total of 8,869 unique contacts in the directory was categorized according to industry sectors, and a ratio of each sector was calculated. For instance, 2,643 out of 8,869 firms (30% of

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

the firms) were from the food and beverage industry. Next, a total of 1,000 SMEs were randomly selected from the directory, according to the calculated ratio. The chosen firms were contacted through email, or called to verify their ongoing activity in an export business, prior to sending the questionnaire.

The survey received 143 usable responses. All responses were screened to ensure they are exporting manufacturers. 41.3% of the respondents had business operations under 10 years, and 49% had below 25 employees. Respondents came from multiple industries, the top three being food and beverages (32%), household and consumer products (15%), and electrical, electronic, medical, and telecommunications (14%).

The measurements were adapted from existing literature and all measures used were previously validated in the literature. Sources for measured items are outlined in Appendix 1. All items were measured in a five-point Likert scale. The analysis was carried out using SmartPLS v.3.2.8 software (Ringle et al., 2015).

Results

A total of 143 responses were received and used for data analysis. Prior to assessing the measurement model, the data was checked for non-response bias and common method bias. Next, the composite reliability and average variance extracted were confirmed within the recommended threshold (Hair et al., 2017). Then, the Heterotrait-monotrait ratio approach (HTMT) was used to assess discriminant validity. All HTMT values are below 0.85, thus all constructs are distinctive (Henseler et al., 2015).

Resource and capability constructs were developed using repeated indicators approach (Hair et al., 2017). Prior to hypotheses testing, a collinearity test was carried out. VIF values recorded below five, thus there is no critical concern of collinearity (Hair et al., 2017).

Hypotheses testing

Based on 5,000 samples using a bootstrapping procedure, the significance of the path coefficients of hypothesized relationships was assessed based on p-values. The beta values and p-values were reported in Table 1. In a PLS-SEM context, bootstrapping is the most recommended approach to test mediating effects (Hair et al., 2017). Table 1 shows the mediator test results, including two control variables and their relationships with competitive advantages. Most of the relationships

are not significant, except firm age, which is positively related to service advantage.

The coefficient of determination (R^2) represents the amount of variance in the endogenous construct explained by all predictors in the model. Table 2 indicates that exogenous constructs explain 59.6% variance in price advantage, 42.6% variance in service advantage, and 33.9% variance in product advantage. As well, the Stone-Geisser's Q^2 values were greater than zero, which indicates the predictive relevance of the model (Hair et al., 2017).

Discussion

The research objective was to better understand the role of digitalization in achieving competitive advantages for SMEs internationalization. A firm can utilize different types of digital technologies (Pagani & Pardo, 2017; Strange & Zucchella, 2017) to enhance their competitive advantages. This study measures digitalization based on the use of digital technologies for learning, sales and marketing, process improvement, and product development, thus covering a wider scope of digitalization instead of focusing on a specific type of digital application (Gregory et al., 2019; Ordanini & Pol, 2001).

We find that capabilities can be used to mediate digitalization for better product and service advantages. The study also provides an important insight that digitalization has no direct influence on either price, product, or service advantage. A firm should not automatically expect a positive outcome on its international competitive advantages through digitalization, without at the same time considering the roles of other interrelated factors (Neubert, 2018; Ojala et al., 2018). Instead, a firm should aim to develop international capabilities through digitalization, which eventually will lead it to better product and service advantages. The study shows no effect of digitalization on price advantage, in line with other studies that have commented that digitalization is costly, and often unable to yield short term financial gain (Choshin & Ghaffari, 2017). Overall, the impact of digitalization may not be directly reflected through competitive advantages in international markets. Yet, firms should not ignore the indirect effect of digitalization as an antecedent to ramping up international capabilities.

The study also examined resources associated with competitive advantages for SMEs aiming to internationalize. While resources themselves appear

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

Table 1. Hypotheses testing

#	Hypotheses	Path Coefficient	p Value	VIF	Result
H1a	Digital -> Price Adv	0.057	0.569	2.155	Not supported
H1b	Digital -> Prod Adv	-0.003	0.983	2.155	Not supported
H1c	Digital -> Service Adv	0.063	0.530	2.155	Not supported
H2a	Resource -> Price Adv	0.714	0.000* **	2.149	Supported
H2b	Resource -> Prod Adv	0.115	0.233	2.149	Not supported
H2c	Resource -> Service Adv	0.031	0.741	2.149	Not supported
H3a	Capability -> Price Adv	0.031	0.744	2.351	Not supported
H3b	Capability -> Prod Adv	0.503	0.000* **	2.351	Supported
H3c	Capability -> Service Adv	0.587	0.000* **	2.351	Supported
H4a	Digital -> Capability -> Price Adv	0.014	0.746		Not supported
H4b	Digital -> Capability -> Prod Adv	0.218	0.002* **		Supported
H4c	Digital -> Capability ->Service Adv	0.255	0.000* **		Supported
H5a	Resource -> Capability -> Price Adv	0.012	0.751		Not supported
H5b	Resource -> Capability -> Prod Adv	0.201	0.000* **		Supported
H5c	Resource -> Capability ->Service Adv	0.234	0.000* **		Supported
CV	Firm size--> PriceAdv	-0.015	0.748		Insignificant
CV	Firm size--> ProdAdv	0.007	0.911		Insignificant
CV	Firm size--> ServiceAdv	0.014	0.829		Insignificant
CV	Firm age--> PriceAdv	0.032	0.473		Insignificant
CV	Firm age--> ProdAdv	0.075	0.231		Insignificant
CV	Firm age--> ServiceAdv	0.148	0.009* **		Significant

Note: CV: Control variable

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities *Yan Yin Lee and Mohammad Falahat*

insufficient to yield product and service advantages, they may assist exporting SME manufacturers to gain a better position in international markets with a price advantage. Hypothesis 2 showed that there is a direct relationship between resources and price advantage. This implies that SMEs without strong capabilities can explore international markets if they are able to offer a price advantage compared with their competitors. These SMEs strive to compete with lower costs, and sell with a better price in order to gain market attention. Generally, resources are a strong predictor of price advantage, as shown with a path coefficient in the study of 0.714 and effect size of 0.587.

The study also examines marketing, innovation and learning capabilities as associated with competitive advantages for SMEs internationalization. Hypothesis 3 reveals that capabilities are not a predictor for price advantage. Firms with strong capabilities may not be competitive in term of their pricing. Nevertheless, they can still compete in international markets through better products or service advantages. This is consistent with prior studies that suggest resource-scarce SMEs mostly compete with niche strategies, instead of cost leadership strategies (Knight & Liesch, 2016).

	R Square	Q Square
Price Advantage	0.596	0.491
Prod Advantage	0.339	0.174
Service Advantage	0.426	0.266

Table 2. The value of R square and Q square

Apart from having a direct relationship, capabilities also act as a mediator in 'digitalization-competitive advantages' and 'resources-competitive advantages' relationships. Hypotheses 4 and 5 validate the resource-capability-competitive advantage relationship, consistent with other studies (Lu et al., 2010). In brief, our findings demonstrate the important roles of capabilities, particularly in achieving product and service advantages. Firms are likely to accelerate their internationalization through product and service advantages by developing strong capabilities.

This study empirically tested a model that was developed on the ground of a few well recognized theories for SME internationalization. It thus extends our understanding of network theory, resource-based theory, organisational learning theory, and new venture internationalisation theory. Before this, there were only limited quantitative studies for drivers of SME internationalisation (Gerschewski et al., 2015), particularly empirical studies related to Malaysian SMEs (Falahat et al., 2018). Additionally, the study discussed the role of digitalization for SME internationalisation. Although researchers always highlight the importance of digitalization in the current digital economy, the digitalization construct has rarely been tested in SME internationalisation research model especially in emerging market. This research therefore provides important insights about the role of digitalization, and extends our understanding of the resource-based view in digital economics. It also connects resources and capabilities to three different types of competitive

advantages in international markets. In the field of international entrepreneurship, our research helps to close the gap between digitalization, resources, capabilities, and international performance through a better understanding of the outcomes of these variables on price, product, and service advantages. This complements earlier work on international performance, which were consulted and cited throughout our analysis.

Generally, this study discusses the success factors for Malaysian exporting manufacturers who use digital tools. SMEs who wish to explore international markets can evaluate their readiness to internationalize or transnationalize through examining the extent of their resources and capabilities. Subsequently, they can focus their investment by developing resources and capabilities that best suit their business strategy. Apart from resources, firms may also consider digitalization as a mean of enhancing their international capabilities.

The research findings contribute to justifications for the need to adopt digitalization, together with other resources and capabilities for internationalisation. In the real business world, a firm may need to achieve a price advantage, product or service advantage, depending on their operating context. Based on their research findings, managers are aware of the relationships between resources and the capabilities that give different types of competitive advantages. Managers can assess their company resources for potential to achieve price advantages. Similarly,

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

managers who plan to pursue product and service advantages should enhance their international capabilities. They may in this pursuit cultivate suitable management characteristics, build up network orientation, acquire more international knowledge, and adopt digitalization to achieve greater international capabilities. The ready and suitable use of digital tools is going to accelerate this process.

We recommend that SMEs with comparatively limited resources to sustain in a price war should consider more effective use of digital tools to enhance their marketing, learning, and innovation capabilities. This will enable them to outperform otherwise more resourceful competitors, through uniqueness of service or product.

This study has a few limitations. First, the collected data does not realistically demonstrate the dynamic pattern of the relationships due to it is cross-sectional character. Second, the model intends to focus on firms' internal factors only; thus, the influence of external factors on the model has not been considered. Third, the findings are restricted to manufacturing firms from a single country, which limits the generalizability of the findings.

In the future, researchers may extend the research model to exporters from other industries, such as the service industry, and examine the dynamic pattern of relationships there by employing longitudinal data. It is also essential that future research demonstrate how robust this model is when interacting with important external factors, such as market conditions and government intervention (Knight & Liesch, 2016).

Conclusion

This study demonstrates the distinctive roles of digitalization, resources, and capabilities with different types of competitive advantages in international markets. Resources contribute to price advantage, capabilities contribute to product and service advantages, while digitalization has no direct effect on any of these competitive advantages.

Yet, the indirect effects of digitalization and resources on product and service advantages keep these two constructs important in any comprehensive model of determinants for competitive advantages in international markets. These findings shed light on unique mechanisms and antecedents for managers who aim to focus on specific aspects of competitive strategies.

Acknowledgements

This work was supported by the Malaysia Ministry of Education (MOE) under FRGS scheme (FRGS/1/2017/SS01/UTAR/02/3).

References

- Ahmadi, H., Cass, A. O., and Miles, M. P. 2014. Product Resource - Capability Complementarity, Integration mechanisms, and First Product Advantage. *Journal of Business Research*, 67(5): 704-709.
- Autio, E. 2017. Digitalisation, Ecosystems, Entrepreneurship and Policy. Perspectives into Topical Issues Is Society and Ways to Support Political Decision Making. *Government's Analysis, Research and Assessment Activities Policy Brief*, 20: 1-12.
- Autio, E., Nambisan, S., Thomas, L. D., and Wright, M. 2018. Digital Affordances, Spatial Affordances, and the Genesis of Entrepreneurial Ecosystems. *Strategic Entrepreneurship Journal*, 12(1): 72-95.
- Barney, J. B. 1991. Firm Resources and Sustained Competitive Advantage. *Journal of Management*.
- Barney, J. B., Ketchen Jr, D. J., and Wright, M. 2011. The Future of Resource-based Theory: Revitalization or Decline? *Journal of Management*, 37(5): 1299-1315.
- Bloomberg 2018. *Malaysia Beats Emerging Market Peers as Asia Outshines*. <https://www.bloomberg.com/news/articles/2018-11-27/turkey-sinks-to-last-on-emerging-market-scorecard-malaysia-tops>. Accessed on February. 22, 2019.
- Brouthers, K. D., Geisser, K. D., and Rothlauf, F. 2016. Explaining the Internationalization of ibusiness Firms. *Journal of International Business Studies*, 47(5): 513-534.
- Cao, C. X., and Ma, H. Y. 2009. Business, Network, and Entrepreneur: The Drivers of Rapid Internationalization of the Born Global Firms. *Proceedings - International Conference on Management and Service Science*, MASS 2009.
- Cavusgil, S. T., and Knight, G. 2009. *Born Global Firms: A New International Enterprise*. New York: Business Expert Press.
- Cavusgil, S. T., and Knight, G. 2015. The Born Global Firm: An Entrepreneurial and Capabilities Perspective on Early and Rapid Internationalization. *Journal of International Business Studies*, 46(1): 3-16.
- Che Senik, Z., Scott-Ladd, B, Entekin, I and Adham KA. 2011. Networking and Internationalization of SMEs in Emerging Economies. *Journal of International Entrepreneurship*, 9(4): 259-281.

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

- Choshin, M., and Ghaffari, A. 2017. An Investigation of the Impact of Effective Factors on the Success of E-commerce in Small- and Medium-sized Companies. *Computers in Human Behavior*, 66: 67-74.
- Coviello, N., Kano, L., and Liesch, P. W. (2017). Adapting the Uppsala Model to a Modern World: Macro-context and Microfoundations. *Journal of International Business Studies*, 48(9): 1151-1164.
- Dana, L. P. 2017. International entrepreneurship research: how it evolved and directions for the future. *International Journal of Entrepreneurship and Small Business*, 30(4): 477-489.
- Eggers, F., Hatak, I., Kraus, S., and Niemand, T. 2017. Technologies that Support Marketing and Market Development in SMEs: Evidence from Social Networks. *Journal of Small Business Management*, 55(2): 270-302.
- Eriksson, K., Johanson, J., Majkgård, A., & Sharma, D. D. 1997. Experiential Knowledge and Cost in the Internationalization Process. *Journal of International Business Studies*, 28(2): 337-360.
- Evangelista, F. and Mac, L. 2016. The Influence of Experience and Deliberate Learning on SME Export Performance. *International Journal of Entrepreneurial Behavior and Research*, 22(6): 860-879.
- Falahat, M., Knight, G. and Alon, I. 2018. Orientations and Capabilities of Born Global Firms from Emerging Markets. *International Marketing Review*, (35)6: 936-957.
- Falahat, M., Migin, M.W., Chong, S.C. and Phang, F.K. 2015. Conceptualising the Early and Rapid Internationalising Firms. *2nd Global Conference on Business and Social Science: Procedia-Social and Behavioral Sciences*, 211, Bali, Indonesia: 612-618.
- Falahat, M., Mohamad, O. and Migin, M.W. 2013. Born Global Firms in Developing Economies: The Case of Malaysia. *Australian Journal of Basic and Applied Sciences*, 7(4): 586-594.
- Fernández-Mesa, A., and Alegre, J. 2015. Entrepreneurial Orientation and Export Intensity: Examining the Interplay of Organizational Learning and Innovation. *International Business Review*, 24(1): 148-156.
- Foroudi, P., Gupta, S., Nazarian, A. and Duda, M. 2017. Digital Technology and Marketing Management Capability: Achieving Growth in SMEs. *Qualitative Market Research: An International Journal*, 20(2): 230-246.
- Freeman, S., and Cavusgil, S. T. 2007. Toward a Typology of Commitment States among Managers of Born-Global Firms: A Study of Accelerated Internationalization. *Journal of International Marketing*, 15(4): 1-40.
- Gassmann, O., and Keupp, M. M. 2007. The Competitive Advantage of Early and Rapidly Internationalising SMEs in the Biotechnology Industry: A Knowledge-based View. *Journal of World Business*, 42(3): 350-366.
- Gerschewski, S., Rose, E. L., & Lindsay, V. J. 2015. Understanding the Drivers of International Performance for Born Global Firms: An Integrated Perspective. *Journal of World Business*, 50(3): 558-575.
- Grant, R. M. 1991. The Resource-based Theory of Competitive Advantage: Implications for Strategy Formulation. *California Management Review*, 33(3): 114-135.
- Gregory, G., Karavdic, M., and Zou, S. 2007. The Effects of E-commerce Drivers on Export Marketing Strategy. *Journal of International Marketing*, 15(2): 30-57.
- Gregory, G. D., Ngo, L. V., and Karavdic, M. 2019. Developing E-commerce Marketing Capabilities and Efficiencies for Enhanced Performance in Business-to-Business Export Ventures. *Industrial Marketing Management*, 78: 146-157.
- Hair, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. 2017. *A Primer on Partial Least Squares Q6 Structural Equation Modeling (PLS-SEM)*. Sage Publications.
- Hao, S., & Song, M. 2016. Technology-driven Strategy and Firm Performance: Are Strategic Capabilities Missing Links? *Journal of Business Research*, 69(2): 751-759.
- Henseler, J., Ringle, C. M., and Sarstedt, M. 2015. A New Criterion for Assessing Discriminant Validity in Variance-based Structural Equation Modeling. *Journal of the Academy of Marketing Science*, 43(1): 115-135.
- Johanson, J. and Vahlne, J.E. 1977. The Internationalization Process of the Firm - A Model of Knowledge Development and Increasing Foreign Market Commitments. *Journal of International Business Studies*, 8 (1): 23-32.
- Johanson, J., and Vahlne, J. E. 2009. The Uppsala Internationalization Process Model Revisited: From Liability of Foreignness to Liability of Outsidership. *Journal of International Business Studies*: 1-22.
- Kaleka, A. 2002. Resources and Capabilities Driving Competitive Advantage in Export Markets: Guidelines for Industrial Exporters. *Industrial Marketing Management*, 31(3): 273-283.
- Kaleka, A. and Morgan, N.A. 2017. Which Competitive Advantage(s)? Competitive Advantage-Market Performance Relationships in International Markets. *Journal of International Marketing*, 25(4): 25-49.
- Kamboj, S., Goyal, P., and Rahman, Z. 2015. A Resource-based View on Marketing Capability, Operations Capability and Financial Performance: An Empirical Examination of Mediating Role. *Procedia-Social and Behavioral Sciences*, 189: 406-415.
- Knight, G. A., and Cavusgil, S. T. 2004. Innovation, Organizational Capabilities, and the Born-Global Firm. *Journal of International Business Studies*, 35(2): 124-141.
- Knight, G. A., and Liesch, P. W. 2016. Internationalization: From Incremental to Born Global. *Journal of World Business*, 51(1): 93-102.

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

- Krammer, S. M. S., Strange, R., and Lashitew, A. 2018. The Export Performance of Emerging Economy Firms: The Influence of Firm Capabilities and Institutional Environments. *International Business Review*, 27(1): 218-230.
- Laanti, R., Gabrielsson, M., and Gabrielsson, P. 2007. The Globalization Strategies of Business-to-Business Born Global Firms in the Wireless Technology Industry. *Industrial Marketing Management*, 36(8): 1104-1117.
- Lee, Y. Y., Falahat, M., and Sia, B. K. 2019. Impact of Digitalization on the Speed of Internationalization. *International Business Research*, 12(4): 1-11.
- Leonidou, L. C., Paliawadana, D., and Theodosiou, M. 2011. National Export-Promotion Programs as Drivers of Organizational Resources and Capabilities: Effects on Strategy, Competitive Advantage, and Performance. *Journal of International Marketing*, 19(2): 1-29.
- Lu, Y., Zhou, L., Bruton, G., and Li, W. 2010. Capabilities as a Mediator Linking Resources and the International Performance of Entrepreneurial Firms in an Emerging Economy. *Journal of International Business Studies*, 41(3): 419-436.
- Madsen, T. K., and Servais, P. 1997. The Internationalization of Born Globals: An Evolutionary Process? *International Business Review*, 6(6): 561-583.
- Monteiro, A. P., Soares, A. M., and Rua, O. L. 2017. Linking Intangible Resources and Export Performance. *Baltic Journal of Management*, 12(3): 329-347.
- Morgan, N. A, Kaleka, A., and Katsikeas, C. S. 2004. Antecedents of Export Venture Performance: A Theoretical Model and Empirical Assessment. *Journal of Marketing*, 68(1): 90-108.
- Morgan, N. A., Katsikeas, C. S., and Vorhies, D. W. 2012. Export Marketing Strategy Implementation, Export Marketing Capabilities, and Export Venture Performance. *Journal of the Academy of Marketing Science*, 40(2): 271-289.
- Morgan-Thomas, A. and Bridgewater, S. 2004. Internet and Exporting: Determinants of Success in Virtual Export Channels. *International Marketing Review*, 21(4/5): 393-408.
- Nambisan, S. 2017. Digital Entrepreneurship: Toward a Digital Technology Perspective of Entrepreneurship. *Entrepreneurship Theory and Practice*, 41(6): 1029-1055.
- Neubert, M. 2017. Lean Internationalization: How to Globalize Early and Fast in a Small Economy. *Technology Innovation Management Review*, 7(5).
- Neubert, M. 2018. The Impact of Digitalization on the Speed of Internationalization of Lean Global Startups. *Technology Innovation Management Review*, 8(5): 44-54.
- Ojala, A., Evers, N., and Rialp, A. 2018. Extending the International New Venture Phenomenon to Digital Platform Providers: A Longitudinal Case Study. *Journal of World Business*, 53(5): 725-739.
- Ordanini, A., and Pol, A. 2001. Infomediation and Competitive Advantage in B2B Digital Marketplaces. *European Management Journal*, 19(3): 276-285.
- Oura, M. M., Zilber, S. N., and Lopes, E. L. 2016. Innovation Capacity, International Experience and Export Performance of SMEs in Brazil. *International Business Review*, 25(4): 921-932.
- Oviatt, B. M., and McDougall, P. P. 1994. Toward a Theory of International New ventures. *Journal of International Business Studies*, 25(1): 45-64.
- Oviatt, B. M., and McDougall, P. P. 1999. A Framework for Understanding Accelerated International Entrepreneurship. *Research in Global Strategic Management*, 7: 23-40.
- Oviatt, B. M., and McDougall, P. P. 2005. Defining International Entrepreneurship and Modeling the Speed of Internationalization. *Entrepreneurship Theory and Practice*, 29(5): 537-553.
- Øyna, S. and Alon, I. 2018. A Review of Born globals. *International Studies of Management and Organization*, 48(2): 157-180.
- Pagani, M., and Pardo, C. 2017. The Impact of Digital Technology on Relationships in a Business Network. *Industrial Marketing Management*, 67 (May): 185-192.
- Pham, T. S. H., Monkhouse, L. Le, and Barnes, B. R. 2017. The Influence of Relational Capability and Marketing Capabilities on the Export Performance of Emerging Market Firms. *International Marketing Review*, 34(5): 606-628.
- Porter, M. E. 1980. *Competitive Strategy: Techniques for Analyzing Industries and Companies*. (1st ed). Free Press, New York.
- Raymond, L., Bergeron, F., and Croteau, A.M. 2013. Innovation Capability and Performance of Manufacturing SMEs: The Paradoxical Effect of IT Integration. *Journal of Organizational Computing and Electronic Commerce*, 23(3): 249-272.
- Rennie, M. W. 1993. Born global. *The McKinsey Quarterly*, 4: 45-53.
- Ringle, C. M., Wende, S., and Becker, J.M. 2015. *SmartPLS 3*. Boenningstedt: SmartPLS GmbH. <http://www.smartpls.com>
- Rodríguez-Serrano, M. Á., and Martín-Armario, E. 2019. Born Global SMEs, Performance, and Dynamic Absorptive Capacity: Evidence from Spanish Firms. *Journal of Small Business Management*, 57(2): 298-326.
- Romanello, R., and Chiarvesio, M. 2019. Early internationalizing firms: 2004-2018. *Journal of International Entrepreneurship*: 1-48.
- Ruzzier, M., Hisrich, R. D., and Antoncic, B. 2006. SME Internationalization Research: Past, Present, and Future. *Journal of Small Business and Enterprise Development*, 13(4): 476-497.

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

- Song, M., Nason, R. W., and Di Benedetto, C. A. 2008. Distinctive Marketing and Information Technology Capabilities and Strategic Types: A Cross-national Investigation. *Journal of International Marketing*, 16(1): 4-38.
- Stallkamp, M., and Schotter, A. P. 2018. Platforms Without Borders? The International Strategies of Digital Platform Firms. *Global Strategy Journal*: 1-23.
- Strange, R., and Zucchella, A. 2017. Industry 4.0, Global Value Chains and International Business. *Multinational Business Review*, 25(3): 174-184.
- Takahashi, A., Bulgacov, S., Semprebon, E., and Giacomini, M. 2016. Dynamic Capabilities, Marketing Capability and Organizational Performance. *Brazilian Business Review*, 14(5): 466-478.
- Teece, D., Pisano, G., and Shuen, A. 1997. Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, 18(7): 509-533.
- Watson, G., Weaven, S., Perkins, H., Sardana, D., and Palmatier, R. 2018. International Market Entry Strategies: Relational, Digital, and Hybrid Approaches. *Journal of International Marketing*, 26(1): 30-60.
- Weerawardena, J. 2003. The Role of Marketing Capability in Innovation-based Competitive Strategy. *Journal of Strategic Marketing*, 11(1).
- Weerawardena, J., Mort, G. S., Liesch, P. W., and Knight, G. 2007. Conceptualizing Accelerated Internationalization in the Born Global Firm: A Dynamic Capabilities Perspective. *Journal of World Business*, 42(3): 294-306.
- Wittkop, A., Zulauf, K., and Wagner, R. 2018. How Digitalization Changes the Internationalization of Entrepreneurial Firms: Theoretical Considerations and Empirical Evidence. *Management Dynamics in the Knowledge Economy*, 6(2): 193-207.
- Yiu, D. W., Lau, C., & Bruton, G. D. 2007. International Venturing by Emerging Economy Firms: The Effects of Firm Capabilities, Home Country Networks, and Corporate Entrepreneurship. *Journal of International Business Studies*, 38(4): 519-540.
- Yu, W., Jacobs, M. A., Chavez, R., & Feng, M. 2017. The Impacts of IT Capability and Marketing Capability on Supply Chain Integration: A Resource-based Perspective. *International Journal of Production Research*, 55(14): 4196-4211.
- Zhang, M., Sarker, S. and Sarker, S. 2013. Drivers and Export Performance Impacts of IT Capability in 'Born Global' Firms: A cross National Study. *Information Systems Journal*, 23(5): 419-443.
- Zor, U., Linder, S., and Endenich, C. 2019. CEO Characteristics and Budgeting Practices in Emerging Market SMEs. *Journal of Small Business Management*, 57(2): 658-678.

About the Authors

Yan Yin Lee is a scholarship recipient funded by Malaysia's Ministry of Education (MoE) under FRGS scheme (FRGS/1/2017/SS01/UTAR/02/3) at the Faculty of Accountancy and Management (FAM), Universiti Tunku Abdul Rahman (UTAR), Sungai Long campus, Malaysia. She received the Best Graduate Award in the School of Applied Physics from the Universiti Sains Malaysia (USM), majoring in Applied Physics and minoring in Management Studies. She has been a Senior Management Consultant and trainer in Quality and Environmental Management Systems for over ten years and has consulted more than 100 companies from various industries. She is currently pursuing her Masters of Philosophy. Her research interests include SME internationalisation, SME digitalization, and government support programs.

Mohammad Falahat is currently at the Faculty of Accountancy and Management (FAM), Universiti Tunku Abdul Rahman (UTAR), Sungai Long campus, Malaysia. He is the Chairperson for the Centre for Sustainable Development and Corporate Social Responsibility (CSDCSR) in Business at UTAR. He was awarded a grant to conduct research in the field of International Entrepreneurship by Malaysia's Ministry of Education (MoE) under FRGS scheme (FRGS/1/2017/SS01/UTAR/02/3). He holds a Doctorate of Business Administration from Universiti Sains Malaysia (USM) where he received a Gold Medal Award for the Best Doctor of Business Administration. His interests cover SMEs internationalisation, International Entrepreneurship, business strategies, and born global. His academic work has been presented at international conferences as well as published in reviewed journals and books.

Citation: Lee, Y.Y. and Falahat, M. 2019. The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: Mediating Role of Marketing, Innovation and Learning Capabilities. *Technology Innovation Management Review*, 9(11): 26-38. <http://doi.org/10.22215/timreview/1281>



Keywords: International Entrepreneurship, Digitalization, Competitive advantage, Innovation, Marketing, Learning Capabilities, SMEs

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

Appendix: Descriptive Statistics

Constructs		Outer Loading	CR	AVE
Resources (Reflective second order construct)			0.826	0.615
Management characteristics	Mgmt1	0.640	0.922	0.573
Source: Adapted from Knight and Cavusgil (2004); Zhang, Sarker and Sarker (2013); Pre-test	Mgmt2	0.779		
	Mgmt3	0.805		
	Mgmt4	0.547		
	Mgmt5	0.838		
	Mgmt6	0.831		
	Mgmt7	0.777		
	Mgmt8	0.760		
	Mgmt9	0.785		
International Knowledge	IK1	0.843	0.920	0.794
Source: Adapted from Eriksson, Johanson, Majkgard, and Sharma (1997); Monteiro, Soares, and Rua (2017)	IK2	0.903		
	IK3	0.925		
Network	Netw1	0.778	0.881	0.553
Source: Adapted from Falahat et al.(2018); Yiu, Lau, and Bruton (2007); Pre-test	Netw2	0.758		
	Netw3	0.778		
	Netw4	0.679		
	Netw5	0.795		
	Netw6	0.664		
Digitalization	Digital 1	0.864	0.938	0.716
Source: Adapted from Hao and Song (2016); Song, Nason, and Di Benedetto (2008); Yu, Jacobs, Chavez, and Feng (2017)	Digital 2	0.896		
	Digital 3	0.841		
	Digital 4	0.873		
	Digital 5	0.776		
	Digital 6	0.824		

The Impact of Digitalization and Resources on Gaining Competitive Advantage in International Markets: The Mediating Role of Marketing, Innovation and Learning Capabilities

Yan Yin Lee and Mohammad Falahat

Constructs		Outer Loading	CR	AVE
Capabilities (Reflective second order construct)			0.942	0.843
Learning capability Source: Adapted from Pham et al. (2017)	LearnCap1	0.882	0.959	0.826
	LearnCap2	0.927		
	LearnCap3	0.910		
	LearnCap4	0.921		
	LearnCap5	0.901		
Marketing capability Source: Adapted from Pham et al. (2017)	MktCap1	0.960	0.947	0.914
	MktCap2	0.959		
	MktCap3	0.959		
	MktCap4	0.946		
Innovation capability Source: Adapted from Pham et al. (2017)	InvCap1	0.827	0.977	0.719
	InvCap2	0.837		
	InvCap3	0.857		
	InvCap4	0.859		
	InvCap5	0.834		
	InvCap6	0.864		
	InvCap7	0.854		
Price advantage	PriceAdv1	0.927	0.938	0.883
	PriceAdv2	0.952		
Product advantage	ProdAdv1	0.794	0.834	0.626
	ProdAdv2	0.788		
	ProdAdv3	0.792		
Service advantage Source: Adapted from Kaleka and Morgan (2017)	ServiceAdv1	0.774	0.918	0.691
	ServiceAdv2	0.847		
	ServiceAdv3	0.807		
	ServiceAdv4	0.846		
	ServiceAdv5	0.879		

The Emergence of Deepfake Technology: A Review

Mika Westerlund

“*This is developing more rapidly than I thought. Soon, it's going to get to the point where there is no way that we can actually detect [deepfakes] anymore, so we have to look at other types of solutions.*”

Hao Li

Deepfake Pioneer & Associate Professor

Novel digital technologies make it increasingly difficult to distinguish between real and fake media. One of the most recent developments contributing to the problem is the emergence of deepfakes which are hyper-realistic videos that apply artificial intelligence (AI) to depict someone say and do things that never happened. Coupled with the reach and speed of social media, convincing deepfakes can quickly reach millions of people and have negative impacts on our society. While scholarly research on the topic is sparse, this study analyzes 84 publicly available online news articles to examine what deepfakes are and who produces them, what the benefits and threats of deepfake technology are, what examples of deepfakes there are, and how to combat deepfakes. The results suggest that while deepfakes are a significant threat to our society, political system and business, they can be combatted via legislation and regulation, corporate policies and voluntary action, education and training, as well as the development of technology for deepfake detection, content authentication, and deepfake prevention. The study provides a comprehensive review of deepfakes and provides cybersecurity and AI entrepreneurs with business opportunities in fighting against media forgeries and fake news.

Introduction

In recent years, fake news has become an issue that is a threat to public discourse, human society, and democracy (Borges et al., 2018; Qayyum et al., 2019). Fake news refers to fictitious news style content that is fabricated to deceive the public (Aldwairi & Alwahedi, 2018; Jang & Kim, 2018). False information spreads quickly through social media, where it can impact millions of users (Figueira & Oliveira, 2017). Presently, one out of five Internet users get their news via YouTube, second only to Facebook (Anderson, 2018). This rise in popularity of video highlights the need for tools to confirm media and news content authenticity, as novel technologies allow convincing manipulation of video (Anderson, 2018). Given the ease in obtaining and spreading misinformation through social media platforms, it is increasingly hard to know what to trust, which results in harmful consequences for informed decision making, among other things (Borges et al., 2018; Britt et al., 2019). Indeed, today we live in what some have called a “post-truth” era, which is characterized by digital disinformation and information warfare led by malevolent actors running false information campaigns to manipulate public opinion (Anderson, 2018; Qayyum et al., 2019; Zannettou et al., 2019).

Recent technological advancements have made it easy to create what are now called “deepfakes”, hyper-realistic videos using face swaps that leave little trace of manipulation (Chawla, 2019). Deepfakes are the product of artificial intelligence (AI) applications that merge, combine, replace, and superimpose images and video clips to create fake videos that appear authentic (Maras & Alexandrou, 2018). Deepfake technology can generate, for example, a humorous, pornographic, or political video of a person saying anything, without the consent of the person whose image and voice is involved (Day, 2018; Fletcher, 2018). The game-changing factor of deepfakes is the scope, scale, and sophistication of the technology involved, as almost anyone with a computer can fabricate fake videos that are practically indistinguishable from authentic media (Fletcher, 2018). While early examples of deepfakes focused on political leaders, actresses, comedians, and entertainers having their faces weaved into porn videos (Hasan & Salah, 2019), deepfakes in the future will likely be more and more used for revenge porn, bullying, fake video evidence in courts, political sabotage, terrorist propaganda, blackmail, market manipulation, and fake news (Maras & Alexandrou, 2019).

While spreading false information is easy, correcting the record and combating deepfakes are harder (De

The Emergence of Deepfake Technology: A Review

Mika Westerlund

keersmaecker & Roets, 2017). In order to fight against deepfakes, we need to understand deepfakes, the reasons for their existence, and the technology behind them. However, scholarly research has only recently begun to address digital disinformation in social media (Anderson, 2018). As deepfakes only surfaced on the Internet in 2017, scholarly literature on the topic is sparse. Hence, this study aims to discuss what deepfakes are and who produces them, what the benefits and threats of deepfake technology are, some examples of current deepfakes, and how to combat them. In so doing, the study analyzes a number of news articles on deepfakes drawn from news media websites. The study contributes to the nascent literatures of fake news and deepfakes both by providing a comprehensive review of deepfakes, as well as rooting the emerging topic into an academic debate that also identifies options for politicians, journalists, entrepreneurs, and others to combat deepfakes.

The article is organized as follows. After the introduction, the study explains data collection and news article analysis. The study then puts forward four sections that review deepfakes, what the potential benefits of deepfake technology are, who the actors involved in producing deepfakes are, and the threats of deepfakes to our societies, political systems, and businesses. Thereafter, two sections provide examples of deepfakes and discuss four feasible mechanisms to combat deepfakes. Finally, the study concludes with implications, limitations, and suggestions for future research.

Method

This study relies on the emerging scholarly literature and publicly available news articles on deepfakes. A total of 84 articles from 11 news companies' websites were collected in August 2019 for the purpose of conducting empirical analysis on how the news media has discussed deepfakes. All articles focused on deepfakes, were written in English and were published in 2018-2019. They were found through Google News search, using keywords "deepfake", "deep fake", and the corresponding plural forms. Once an article was found, a similar search was performed using the news website's own search option to find more articles by that particular media source. The focus of the selected news media ranged from general daily news to concentration on business or technology news. The dataset includes 2 to 16 news articles on deepfakes from each news company. The articles were coded with a short identifier for citing purposes, then analyzed via content analysis with focus on what deepfakes are, who produces them,

what the benefits and threats of deepfake technology are, some current examples of deepfakes, and how to combat them. Table 1 in the appendix shows the news articles, their authors, news companies, and publication dates; the article titles are shortened due to space limitations.

What are Deepfakes?

A combination of "deep learning" and "fake", deepfakes are hyper-realistic videos digitally manipulated to depict people saying and doing things that never actually happened (CNN03; FRB04). Deepfakes rely on neural networks that analyze large sets of data samples to learn to mimic a person's facial expressions, mannerisms, voice, and inflections (CBS02; PCM10). The process involves feeding footage of two people into a deep learning algorithm to train it to swap faces (PCM01). In other words, deepfakes use facial mapping technology and AI that swaps the face of a person on a video into the face of another person (FOX09; PCM03). Deepfakes surfaced to publicity in 2017 when a Reddit user posted videos showing celebrities in compromising sexual situations (FRB01; FRB08; USAT03). Deepfakes are difficult to detect, as they use real footage, can have authentic-sounding audio, and are optimized to spread on social media quickly (FRB05; WP01). Thus, many viewers assume that the video they are looking at is genuine (CNET01; CNN10).

Deepfakes target social media platforms, where conspiracies, rumors, and misinformation spread easily, as users tend to go with the crowd (CNET05; FOX06). At the same time, an ongoing 'infocalypse' pushes people to think they cannot trust any information unless it comes from their social networks, including family members, close friends or relatives, and supports the opinions they already hold (CNN06). In fact, many people are open to anything that confirms their existing views even if they suspect it may be fake (GRD09). Cheap fakes, that is, low-quality videos with slightly doctored real content, are already everywhere because low-priced hardware such as efficient graphical processing units are widely available (CBS01; CNN08). Software for crafting high-quality, realistic deepfakes for disinformation is increasingly available as open source (FOX05; FT02; PCM04). This enables users with little technical skills and without any artistic expertise to near-perfectly edit videos, swap faces, alter expressions, and synthesize speech (CNET08; GRD10).

As for technology, deepfakes are the product of Generative Adversarial Networks (GANs), namely two artificial neural networks working together to create

The Emergence of Deepfake Technology: A Review

Mika Westerlund

real-looking media (CNN03). These two networks called ‘the generator’ and ‘the discriminator’ are trained on the same dataset of images, videos, or sounds (GRD03). The first then tries to create new samples that are good enough to trick the second network, which works to determine whether the new media it sees is real (FBR07). That way, they drive each other to improve (PCM05). A GAN can look at thousands of photos of a person, and produce a new portrait that approximates those photos without being an exact copy of any one of them (GRD07). In the near future, GANs will be trained on less information and be able to swap heads, whole bodies, and voices (GRD08; USAT01). Although deepfakes usually require a large number of images to create a realistic forgery, researchers have already developed a technique to generate a fake video by feeding it only one photo such as a selfie (CBS03; CNET07).

The Benefits of Deepfake Technology

Deepfake technology also has positive uses in many industries, including movies, educational media and digital communications, games and entertainment, social media and healthcare, material science, and various business fields, such as fashion and e-commerce (FRB04).

The film industry can benefit from deepfake technology in multiple ways. For example, it can help in making digital voices for actors who lost theirs due to disease, or for updating film footage instead of reshooting it (FRB01; PCM10). Movie makers will be able to recreate classic scenes in movies, create new movies starring long-dead actors, make use of special effects and advanced face editing in post-production, and improve amateur videos to professional quality (FOX05; GRD07). Deepfake technology also allows for automatic and realistic voice dubbing for movies in any language (PCM09; USAT04), thus allowing diverse audiences to better enjoy films and educational media. A 2019 global malaria awareness campaign featuring David Beckham broke down language barriers through an educational ad that used visual and voice-altering technology to make him appear multilingual (USAT03). Similarly, deepfake technology can break the language barrier on video conference calls by translating speech and simultaneously altering facial and mouth movements to improve eye-contact and make everyone appear to be speaking the same language (CNET05; FRB03; FT03).

The technology behind deepfakes enables multiplayer games and virtual chat worlds with increased telepresence (CNET07), natural-sounding and -looking

smart assistants (PCM09) and digital doubles of people. This helps to develop better human relationships and interaction online (CBS03; FRB02). Similarly, the technology can have positive uses in the social and medical fields. Deepfakes can help people deal with the loss of loved ones by digitally bringing a deceased friend “back to life”, and thereby potentially aiding a grieving loved one to say goodbye to her (FOX05; PCM10). Further, it can digitally recreate an amputee’s limb or allow transgender people to better see themselves as a preferred gender (USAT04). Deepfake technology can even help people with Alzheimer’s interact with a younger face they may remember (FOX05). Scientists are also exploring the use of GANs to detect abnormalities in X-rays (CNET04) and their potential in creating virtual chemical molecules to speed up materials science and medical discoveries (GRD03).

Businesses are interested in the potential of brand-applicable deepfake technology, as it can transform e-commerce and advertising in significant ways (FRB02). For example, brands can contract supermodels who are not really supermodels, and show fashion outfits on a variety of models with different skin tones, heights, and weights (FRB07). Further, deepfakes allow for superpersonal content that turns consumers themselves into models; the technology enables virtual fitting to preview how an outfit would look on them before purchasing and can generate targeted fashion ads that vary depending on time, weather, and viewer (FRB02; FRB07). An obvious potential use is being able to quickly try on clothes online; the technology not only allows people to create digital clones of themselves and have these personal avatars travel with them across e-stores, but also to try on a bridal gown or suit in digital form and then virtually experience a wedding venue (FRB02). Also, AI can provide unique artificial voices that differentiate companies and products to make branding distinction easier (PCM10).

Who Produces Deepfakes?

There are at least four major types of deepfake producers: 1) communities of deepfake hobbyists, 2) political players such as foreign governments, and various activists, 3) other malevolent actors such as fraudsters, and 4) legitimate actors, such as television companies.

Individuals in deepfake hobby communities are difficult to track down (FRB06). After the introduction of celebrity porn deepfakes to Reddit by one user in late 2017, it only took a few months for a newly founded deepfake hobbyist community to reach 90,000 members

The Emergence of Deepfake Technology: A Review

Mika Westerlund

(CBS01; GRD08). Many hobbyists focus on porn-related deepfakes (USAT01), while others place famous actors in films in which they never appeared to produce comic effects (GRD05). Overall, hobbyists tend to see AI-crafted videos as a new form of online humor, and contribution to the development of such technology as solving an intellectual puzzle, rather than as a way to trick or threaten people (CNN07; GRD05). Their deepfakes are meant to be entertaining, funny, or politically satirical, and can help with gaining followers on social media (FOX01). Some hobbyists may be looking for more concrete personal benefits, such as raising awareness about the potential of deepfake technology in order to get deepfake-related paid work, for example, with music videos or television shows (GRD02). Thus, hobbyists and legitimate actors such as television companies may collaborate with each other.

While meme-like deepfakes by hobbyists can entertain online users, more malicious actors are also involved. Various political players, including political agitators, hacktivists, terrorists, and foreign states can use deepfakes in disinformation campaigns to manipulate public opinion and undermine confidence in a given country's institutions (CBS01; CBS02). In these times of hybrid warfare, deepfakes are weaponized disinformation aimed at interfering with elections and sowing civil unrest (CNET12). We may anticipate more and more domestic and foreign state-funded Internet "troll farms" that use AI to create and deliver political fake videos tailored to social media users' specific biases (CNN06). Deepfakes are also increasingly being deployed by fraudsters for the purpose of conducting market and stock manipulation, and various other financial crimes (USAT03). Criminals have already used AI-generated fake audios to impersonate an executive on the phone asking for an urgent cash transfer (CNN01; FT01). In the future, video calls will also be able to be faked in real-time. Visual materials required to produce impersonations of executives are often available on the Internet. Deepfake technology can make use of visual and audio impersonations of executives from, for example, TED Talk videos available on YouTube (WP01).

The Possible Threats of Deepfakes

Deepfakes are a major threat to our society, political system, and business because they 1) put pressure on journalists struggling to filter real from fake news, 2) threaten national security by disseminating propaganda and interfering in elections, 3) hamper citizen trust toward information by authorities, and, 4) raise cybersecurity issues for people and organizations.

It is highly probably that the journalism industry is going to have to face a massive consumer trust issue due to deepfakes (USAT01). Deepfakes pose a greater threat than "traditional" fake news because they are harder to spot and people are inclined to believe the fake is real (CNN06). The technology allows the production of seemingly legitimate news videos that place the reputation of journalists and the media at risk (USAT01). Also, winning the race to access video footage shot by the witness of an incident can provide competitive advantage to a news media outlet, while danger rises if the offered footage is fake. During the spike in tensions between India and Pakistan in 2019, Reuters found 30 fake videos on the incident; mostly old videos from other events posted with new captions (DD02). Misattributed video footage such as a real protest march or violent skirmish captioned to suggest it happened somewhere else is a growing problem, and will be augmented by the rise of deepfakes (WP01). While looking for eyewitness videos about the mass shooting in Christchurch, New Zealand, Reuters came across a video which claimed to show the moment a suspect was shot dead by police. However, they quickly discovered it was from a different incident in the U.S.A., and the suspect in the Christchurch shooting was not killed (DD02).

The intelligence community is concerned that deepfakes will be used to threaten national security by disseminating political propaganda and disrupting election campaigns (CNET07; CNN10). U.S. intelligence officials have repeatedly warned about the threat of foreign meddling in American politics, especially in the lead-up to elections (CNN02; CNET04). Putting words in someone's mouth on a video that goes viral is a powerful weapon in today's disinformation wars, as such altered videos can easily skew voter opinion (USAT02; WP02). A foreign intelligence agency could produce a deepfake a video of a politician using a racial epithet or taking a bribe, a presidential candidate confessing complicity in a crime, or warning another country of an upcoming war, a government official in a seemingly compromising situation, or admitting a secret plan to carry out a conspiracy, or U.S. soldiers committing war crimes such as killing civilians overseas (CBS02; CNN06; FOX06). While such faked videos would likely cause domestic unrest, riots, and disruptions in elections, other nation states could even choose to act out their foreign policies based on unreality, leading to international conflicts (CBS03).

Deepfakes are likely to hamper digital literacy and citizens' trust toward authority-provided information, as fake videos showing government officials saying

The Emergence of Deepfake Technology: A Review

Mika Westerlund

things that never happened make people doubt authorities (CNET11; FOX10). Indeed, people nowadays are increasingly affected by AI-generated spam, and by fake news that builds on bigoted text, faked videos, and a plethora of conspiracy theories (GRD06). Nonetheless, the most damaging aspect of deepfakes may not be disinformation per se, but rather how constant contact with misinformation leads people to feel that much information, including video, simply cannot be trusted, thereby resulting in a phenomenon termed as "information apocalypse" or "reality apathy" (CNN01; GRD07). Further, people may even dismiss genuine footage as fake (CBS02), simply because they have become entrenched in the notion that anything they do not want to believe must be fake (CNET05). In other words, the greatest threat is not that people will be deceived, but that they will come to regard everything as deception (GRD07).

Cybersecurity issues constitute another threat imposed by deepfakes. The corporate world has already expressed interest in protecting themselves against viral frauds, as deepfakes could be used for market and stock manipulation, for example, by showing a chief executive saying racist or misogynistic slurs, announcing a fake merger, making false statements of financial losses or bankruptcy, or portraying them as if committing a crime (CNN02; FRB04; WP01). Further, deepfaked porn or product announcements could be used for brand sabotage, blackmail, or to embarrass management (FRB06; PCM03). In addition, deepfake technology enables real-time digital impersonation of an executive, for example, to ask an employee to perform an urgent cash transfer or provide confidential information (CNN01; FT01; PCM03). Further, deepfake technology can create a fraudulent identity and, in live-stream videos, convert an adult face into a child's or younger person's face, raising concerns about the use of the technology by child predators (FOX06). Lastly, deepfakes can contribute to the spread of malicious scripts. Recently, researchers found that a website devoted to deepfakes used its visitors' computers to mine cryptocurrencies. Deepfake hobbyists may in this way become targets of 'cryptojacking' because they are likely to have powerful computers (CNET16).

Current Examples of Deepfakes

Most deepfakes today on social platforms like YouTube or Facebook can be seen as harmless fun or artistic works using dead or alive public figures. But there are also examples from the dark side of deepfakes, namely celebrity and revenge porn, as well as attempts at political and non-political influencing.

Many deepfakes focus on celebrities, politicians, and corporate leaders because the internet is packed with source photos and videos of them from which to build the large image stockpiles required to train an AI deepfake system (CNET08; PCM03). The majority of such deepfakes are goofs, pranks, and funny memes with comedic or satirical effect (CNET07; DD01). A deepfake might show, for example, Nicolas Cage acting in movies in which he has never starred in, such as Indiana Jones or Terminator 2 (CNET05; PCM10). Some intriguing examples of deepfakes include a video that replaces Alden Ehrenreich with young Harrison Ford in clips taken from Solo: A Star Wars Story, and a video of actor Bill Hader appearing on Late Night with David Letterman. While Hader talks about Tom Cruise, his face morphs into Cruise's (CNET01; FRB06). Some deepfakes show dead celebrities such as the band Queen's ex-vocalist Freddie Mercury's face imposed on that of actor Rami Malek's, along with the Russian mystic Grigori Rasputin singing Beyonce's powerful ballad "Halo" (FOX02). An art museum in the U.S. has used the technology to bring Salvador Dali back to life to greet visitors (DD01), and another AI system makes anyone dance like a prima ballerina by imposing a real dancer's moves onto a target person's body, thereby generating a video that shows the target as a professional dancer (CNET14; PCM05).

Examples of harmful deepfakes, however, are also popping up increasingly (FOX04). Deepfake technology enables celebrity and revenge porn, that is, involuntary pornography using images of celebrities and non-celebrities, which are shared on social networks without their consent (CNET07; CNET15). Thus, celebrities such as Scarlett Johansson have been featured on deepfaked adult movies, in which their faces have been superimposed over porn stars' faces (CNET08; PCM03). In the political scene, a 2018 deepfake created by Hollywood filmmaker Jordan Peele featured former US President Obama discussing the dangers of fake news and mocking the current president Trump (CBS01; CNN06). In 2019, an altered video of American politician Nancy Pelosi went viral and had massive outreach; the video was slowed down to make her sound intoxicated (CNET01; FRB06). In a 2018 deepfake video, Donald Trump offered advice to the people of Belgium about climate change. The video was created by a Belgian political party "sp.a" in order to attract people to sign an online petition calling on the Belgian government to take more urgent climate action. The video provoked outrage about the American president meddling in a foreign country with Belgium's climate policy (GRD07). In 2019, the U.S. Democratic Party deepfaked its own chairman Tom Perez to highlight the

The Emergence of Deepfake Technology: A Review

Mika Westerlund

potential threat of deepfakes to the 2020 election (CNN01).

While these are examples of limited political influencing, other deepfakes may have more lasting impact. In Central Africa in 2018, a deepfake of Gabon's long-unseen president Ali Bongo, who was believed in poor health or dead, was cited as the trigger for an unsuccessful coup by the Gabonese military. And in Malaysia, a viral clip deepfake of a man's confession to having sex with a local cabinet minister caused political controversy (WP01). Also non-political individuals have been used for creating deepfakes. In June 2019, a high-quality deepfake by two British artists featuring Facebook CEO Mark Zuckerberg racked up millions of views (CBS01). The video falsely portrays Zuckerberg giving respect to Spectre, a fictional evil organization from the James Bond series that teaches him how to take total control of billions of peoples' confidential data, and thus own their future (CNN04; FOX03; FRB05). Using news footage, deepfake technology, and a voice actor, the video was meant to show how technology can be used to manipulate data (CNN05).

Methods to Combat Deepfakes

The reviewed news articles suggest that there are four ways to combat deepfakes: 1) legislation and regulation, 2) corporate policies and voluntary action, 3) education and training, and 4) anti-deepfake technology that includes deepfake detection, content authentication, and deepfake prevention.

Legislation and regulation are both obvious means against deepfakes. At present, deepfakes are not specifically addressed by civil or criminal laws, although legal experts have suggested adapting current laws to cover libel, defamation, identity fraud, or impersonating a government official using deepfakes (FT02; WP01). Virginia state law against revenge porn recently made distributing "falsely created" images and videos a misdemeanor, and thus expanded the law to include deepfakes (CNET03). That said, the increasing sophistication of AI technologies calls for new types of laws and regulatory frameworks (GRD03). For example, deepfakes raise concerns about privacy and copyright, as the visual depictions of people on deepfake videos are not exact copies of any existing material, but rather new representations generated by AI (CNET03; GRD07). Thus, regulators must navigate a difficult legal landscape around free-speech and ownership laws to properly regulate the use of deepfake technology (FRB06).

On the other hand, an appropriate legal solution to the proliferation of harmful deepfakes would not be a complete ban on the technology, which would be unethical (USAT04). While new laws can be introduced to prevent deepfakes, they also need mechanisms of enforcement (FRB09). Today's social media firms enjoy broad immunity for the content that users post on their platforms (WP02). One legislative option could be to walk back social media firms' legal immunity from the content their users post, thus making not only users but also the platforms more responsible for posted material (CNET09). Nonetheless, legislation has had little effect on malevolent actors such as foreign states and terrorists, that may run massive disinformation campaigns against other states on social media platforms.

Corporate policies and voluntary action may provide more effective tools against deepfakes. For example, politicians can commit not to use illicit digital campaign tactics or spread disinformation such as deepfakes in their election campaigns (WP04). Social media companies need to enforce ethics and turn away from the fact that divisive content getting pushed to the top of the feed is financially a win because it maximizes engagement time for advertisements (GRD01). While few social media firms have policies yet about deepfakes, they should collaborate to prevent their platforms from being weaponized for disinformation, and thus proactively enforce transparent, shared policies to block and remove deepfakes (CNET10; FOX06; GRD04). Presently, many companies do not remove disputed content, rather they downrank it to make it more difficult to find, by being less prominent in users' news feeds (CNN04; FOX02; FOX03). On the other hand, the increase in hate speech, fake news, and disinformation polluting digital platforms has led some firms to take more action, such as suspending user accounts and investing in quicker detection technology (CNET03; CNN05; CNN06). Reddit and Pornhub have banned deepfake porn and other non-consensual pornography, and act upon users' flagging of such material (CNET15; FRB10; PCM07). Facebook cuts off any content identified as false or misleading by third-party fact-checkers from running ads and making money; the company works with over 50 fact-checking organizations, academics, experts, and policymakers to find new solutions (CNET06; CNET09; CNET11). Instagram's algorithms will not recommend people view content that is marked as "false" by fact checkers (CNN04). Among news media companies, Wall Street Journal and Reuters have formed corporate teams to help and train their reporters to identify fake content,

The Emergence of Deepfake Technology: A Review

Mika Westerlund

and to adopt detection techniques and tools such as cross-referencing location on Google maps and reverse image searching (DD01; DD02; CNN01).

Education and training are crucial for combatting deepfakes. Despite considerable news coverage and concerns presented by authorities, the threat of deep fakes has not yet been reckoned with by the public (FRB08). In general, there is a need to raise public awareness about AI's potential for misuse (FOX01). Whereas deepfakes provide cyber criminals new tools for social engineering, companies and organisations need to be on high alert and to establish cyber resilience plans (FT01). Governments, regulators, and individuals need to comprehend that video, contrary to appearances, may not provide an accurate representation of what happened, and know which perceptual cues can help to identify deepfakes (USAT01; WP01). It is recommended that critical thinking and digital literacy be taught in schools as these traits contribute to children's ability to spot fake news and interact more respectfully with each other online.

These skills likewise should also be promoted among the older, less technology-savvy population (GRD02; FOX06). The reason for this is that people need to be able to critically assess the authenticity and social context of a video they may wish to consume, as well as the trustworthiness of its source (that is, who shared the video and what does that say), in order to understand the video's real intent. It is also important to remember that quality is not an indicator of a video's authenticity (FOX04; FRB01). Also, people need to understand that as the technology develops, fewer photographs of real faces will be required to create deepfakes and that nobody is immune (FRB06). Anyone who posts a single selfie or a video capturing 30 frames per second on a social networking site is at risk of being deepfaked (USAT03). While the best method is keeping photos and videos off the internet, having obstructions such as waving hand in front of a face in a photo or on a video can provide some protection (CNET08). Companies, governments, and authorities using facial recognition technology and storing vast amounts of facial data for security and verification purposes, need to address the threat of identity theft if such data were to be leaked (FRB06).

Anti-deepfake technology provides perhaps the most varied set of tools to 1) detect deepfakes, 2) authenticate content, and 3) prevent content from being used to produce deepfakes. Overall, the problems of technology to authenticate content and identify fakes is doing it at scale, and the fact that there are far more available

research resources and people working on developing technology to create deepfakes than on technology to detect them (CBS02; WP02). For instance, users upload 500 hours of content per minute on YouTube. Twitter struggles with 8 million accounts a week that attempt to spread content through manipulative tactics (PCM02; WP01). This creates massive challenges for technologies to go through all of the posted material in a short time. Further, deepfake developers tend to use results from published deepfake research to improve their technology and get around new detection systems (CNN06). For example, researchers found that early deepfake methods failed to mimic the rate at which a person blinks; whereas recent programs have fixed the lack of blinking or unnatural blinking after the findings were published (CNN03; GRD05). While funding for deepfake detection development mainly comes from national security agencies such as The Defense Advanced Research Projects Agency (DARPA), there are significant business opportunities for private cybersecurity companies to produce solutions for deepfake detection, build trusted platforms, weed out illicit bots, and fight against fraud and digital pollution (CBS03; FT01; FT02). However, the development of anti-deepfake technology alone is not enough. Organizations must also adopt these technologies; for example, the government in any given country can be modernized to face and help protect its citizens against deepfakes (WP03).

Media forensic experts have suggested subtle indicators to detect deepfakes, including a range of imperfections such as face wobble, shimmer and distortion; waviness in a person's movements; inconsistencies with speech and mouth movements; abnormal movements of fixed objects such as a microphone stand; inconsistencies in lighting, reflections and shadows; blurred edges; angles and blurring of facial features; lack of breathing; unnatural eye direction; missing facial features such as a known mole on a cheek; softness and weight of clothing and hair; overly smooth skin; missing hair and teeth details; misalignment in face symmetry; inconsistencies in pixel levels; and strange behavior of an individual doing something implausible (CNET08; CNET14; CNN09; GRD05; USAT03; USAT04; WP01). While it is getting more and more difficult for people to distinguish between a real video and a fake, AI can be instrumental in detecting deepfakes (CBS02; FRB01). For example, AI algorithms can analyze Photo Response Non-Uniformity (PRNU) patterns in footage, that is, imperfections unique to the light sensor of specific camera models, or biometric data such as blood flow indicated by subtle changes that occur on a person's face in a video (CNN06; GRD07; USAT01). New fake-

The Emergence of Deepfake Technology: A Review

Mika Westerlund

detection algorithms are based on mammalian auditory systems, for example, the ways mice detect inconsistencies and subtle mistakes in audio, which are often ignored by humans (CNET02). AI can either look at videos on a frame-by-frame basis to track signs of forgery, or review the entire video at once to examine soft biometric signatures, including inconsistencies in the authenticated relationships between head movements, speech patterns, and facial expressions such as smiling, to determine if the video has been manipulated (CNN03; FOX07). The latter method can be tailored for individuals, such as high-profile politicians who are likely to be deepfaked (PCM01).

The problem with deepfakes is not only about proving something is false, but also about proving that an object is authentic (FT02). Authentication of video is especially important to news media companies who have to determine authenticity of a video spreading in a trustless environment, in which details of the video's creator, origin, and distribution may be hard to trace (WP01). Proposed solutions to authenticate content range from digital watermarks to digital forensic techniques (FOX06; GRD01). It would be ideal to create a "truth layer", an automated system across the internet to provide a fake vs. authentic measure of videos; that way, every video posted to a social media site would go through an authentication process (CBS03; USAT04). For example, software embedded in smartphone cameras can create a digital fingerprint at the moment of a film's recording. Upon footage playback, its watermark can be compared with the original fingerprint to check for a match, and provide the viewer with a score that indicates the likelihood of tampering (GRD05). Indeed, digital watermarking such as hashing can provide a video file with a short string of numbers that is lost if the video is manipulated (FOX04; FRB04). It can also provide an authenticated alibi for public figures, given that they constantly record where they are and what they are doing (GRD03). Support for video authenticity is also provided by mapping its provenance, that is, whether the video came from a reputable source originally, and how it has since travelled online (FT01). Blockchain technology can help in verifying the origins and distribution of videos by creating and storing digital signatures in a ledger that is almost impossible to manipulate (CNN06). Social media platforms, news media companies and other online actors should then promote the videos that are verified as authentic over non-verified videos (USAT01). Nonetheless, there will always be people who choose not to believe a verification tool, and rather still have a desire to consume and endorse fake media (USAT01).

Finally, technology can prevent the creation of deepfakes by inserting "noise" into photos or videos. This noise is imperceptible to the human eye, but prevents the visual material from being used in automated deepfake software (USAT04). One could also wear specifically designed 3D-printed glasses to evade facial recognition by tricking deepfake software into misclassifying the wearer. This technology could help likely targets such as politicians, celebrities and executives to prevent deepfakes being made of them (FT01). Also, researchers who are developing GAN technologies can design and put proper safeguards in place so that their technologies become more difficult to misuse for disinformation purposes (FOX06). Similar to the cybersecurity domain in general, the first step towards a solution is understanding the problem and its ability to affect us. Only then does it become possible to develop and implement technical solutions that can solve the challenges (FRB04). That said, none of the technological solutions can entirely remove the risk of deepfakes, and technological solutionism (that every problem has a technological solution) may even disorientate the discussion away from more existential questions of why deepfakes exist and what other threats AI can impose (GRD01; GRD03; GRD04). The most efficient ways to combat deepfakes from spreading therefore involve a mixture of legal, educational, and sociotechnical advances (USAT01).

Discussion and Conclusion

This study reviewed and analyzed 84 recent public news articles on deepfakes in order to enable a better understanding of what deepfakes are and who produces them, the benefits and threats of deepfake technology, examples of current deepfakes, and how to combat them. In so doing, the study found that deepfakes are hyper-realistic videos digitally manipulated to depict people saying and doing things that never happened. Deepfakes are created using AI, that is, Generative Adversarial Networks (GANs) that pit discriminative and generative algorithms against one another to fine-tune performance with every repetition, and thereby produce a convincing fake (Fletcher, 2018; Spivak, 2019). These fakes of real people are often highly viral and tend to spread quickly through social media platforms, thus making them an efficient tool for disinformation.

The findings of this study offer several contributions to the emerging body of scholarly literature on deepfakes (see Anderson, 2018; Qayyum et al., 2019; Zannettou et al., 2019). Previous research (Fletcher, 2018) argues that

The Emergence of Deepfake Technology: A Review

Mika Westerlund

deepfakes benefit from, 1) a citizenry increasingly reliant upon commercial media platforms to absorb, process, and communicate information, 2) a heated political context where false narratives are easily spread and easily believed online, and 3) the appearance of powerful AI algorithms capable of manufacturing seemingly real videos. Our findings support these arguments by specifying that such commercial platforms consist of both news media platforms and a range of social media platforms, and that deepfakes are not only fed by a heated political context, but also the current social context due to the so-called information apocalypse, which makes people cease trusting information that does not come from their personal social networks and is inconsistent with their prior beliefs, a phenomenon addressed in previous literature (Britt et al., 2019; Hamborg et al., 2018; Zannettou et al., 2019). The increase in fake news business models that generate web traffic to fake news pages to earn profit through advertising, which has been discussed in previous research (e.g., Figueira & Oliveira, 2017), did not come up in the present study. A likely reason is that the study analyzed news articles from journalists who wish to avoid being associated with actors in the field of journalism that rely on unethical methods such as clickbaiting (cf. Aldwairi & Alwahedi, 2018).

Zannettou et al. (2019) list a number of actors associated with deepfakes, ranging from governments, political activists, criminals, and malevolent individuals creating fake content to paid and unpaid trolls, conspiracy theorists, useful idiots, and automated bots disseminating it through social media platforms. According to Zannettou et al. (2019), the motivation behind these actors' actions may include malicious intent to hurt others in various ways, manipulate public opinion with respect to specific topics, sow confusion or discord to the public, monetary profit, passion about a specific idea or organization or, as MacKenzie and Bhatt (2018) note, plain fun and amusement. Our findings highlight that there are also individuals and organizations such as television companies that generate and support deepfakes in order to develop and apply deepfake technology for legit use such as paid work for music videos. These are considered as early examples of the benefits anticipated from applying GANs.

In regard to legitimate uses for deep learning technology, previous research has addressed movie studios, personalized advertisement companies, and media broadcasters as potential beneficiaries. For example, Netflix could enable watchers to pick on-screen actors before hitting play or even enable

watchers themselves to star in the movie (Chawle, 2019). The present study identified a number of additional areas for legitimate uses of the technology, including educational media and digital communications, games and entertainment, social and healthcare, material science, and various business fields such as fashion and personalized e-commerce.

According to our study, deepfakes are a major threat to society, the political system and businesses because they put pressure on journalists struggling to filter real from fake news, threaten national security by disseminating propaganda that interferes in elections, hamper citizen trust toward information by authorities, and raise cybersecurity issues for people and organizations. In this vein, the study largely supports the findings from previous research (Aldwairi & Alwahedi, 2018; Bates, 2018; Chawla, 2019; Hamborg et al., 2018; Lin, 2019; Wagner & Blewer, 2019) and, at the same time, details these threats through examples of existing and potential uses of deepfakes.

On the other hand, there are at least four known ways to combat deepfakes, namely 1) legislation and regulation, 2) corporate policies and voluntary action, 3) education and training, and 4) anti-deepfake technology. While legislative action can be taken against some deepfake producers, it is not effective against foreign states. Rather, corporate policies and voluntary action such as deepfake-addressing content moderation policies, and quick removal of user-flagged content on social media platforms, as well as education and training that aims at improving digital media literacy, better online behavior and critical thinking, which create cognitive and concrete safeguards toward digital content consumption and misuse, are likely to be more efficient. Government authorities, companies, educators, and journalists need to increase citizens' awareness of the threats posed by AI to media trust, and prohibit fraudulent usage of such technologies for commercial, political, or anti-social purposes. In this vein, our results support and complement those presented by previous studies (Anderson, 2018; Atodiresei et al., 2018; Britt et al., 2019; Cybenko & Cybenko, 2018; Figueira & Oliveira, 2017; Floridi, 2018; Spivak, 2019).

Technological solutions, including automated tools for deepfake detection, content authentication, and deepfake prevention constitute a dynamic field of security methods. Consequently, there are numerous business opportunities for technology entrepreneurs, especially in the areas of cybersecurity and AI. The study highlights that deepfake technology is progressing at an increasing pace. It is quickly becoming impossible

The Emergence of Deepfake Technology: A Review

Mika Westerlund

for human beings to distinguish between real and fake videos. Hence, our results list numerous cues for detecting deepfakes, and suggest harnessing AI in order to detect AI-generated fakes as an efficient combat strategy. At the same time, the study reckons that there are growing needs for online source verification and content authentication, and that ubiquitous truth layers based on digital watermarks should be used. Further, another emerging technology, namely blockchain can be of help. Blockchain technology is not only highly resistant to forgeries and can store data in an accruable, safe, transparent, and traceable way, but it can also track and certify the origins and history of the data (Floridi, 2018). Again, these results are in line with previous research (Anwar et al., 2019; Atanasova et al., 2019; Bates, 2018; Chawla, 2019; Floridi, 2018; Hasan & Salah, 2019; Qayyum et al., 2018; Spivak, 2019). In the spirit of a review study, our results contribute to the emerging field of deepfakes by pulling together dispersed findings from the sparse academic research on fake news and deepfakes, and by fine-tuning those findings with examples and discussion on deepfakes taking place in public news articles.

All said, there are certainly limitations in the study. First, although the empirical research covered 84 online news articles on deepfakes, there are many more articles available and, given the speed of development of this technology, those articles could also provide additional information on deepfakes and suggest more methods to fight them. Second, our empirical material was collected from public sources, namely online news media sites. Using other types of data, such as deepfake-focused online community discussions and interviews with GAN developers and deepfake artists, some of whom are known to the public due to their work not only as deepfake technology developers but also as anti-deepfake technology developers, could give additional insight on strategies to combat deepfakes. Also, commentary sections in some of the analyzed news articles had extensive amount of opinions and ideas from readers; analysis of those comments might give additional insights on how deepfakes are perceived by a larger audience, and thus what education-oriented combat methods should emphasize. These limitations provide ample opportunities for future research on deepfakes.

References

- Aldwairi, M., & Alwahedi, A. 2018. Detecting Fake News in Social Media Networks. *Procedia Computer Science*, 141: 215–222.
<https://doi.org/10.1016/j.procs.2018.10.171>
- Anderson, K. E. 2018. Getting acquainted with social networks and apps: combating fake news on social media. *Library HiTech News*, 35(3): 1–6.
- Anwar, S., Milanova, M., Anwer, M., & Banihirwe, A. 2019. Perceptual Judgments to Detect Computer Generated Forged Faces in Social Media. In F. Schwenker, & S. Scherer (Eds.), *Multimodal Pattern Recognition of Social Signals in Human-Computer-Interaction*. MPRSS 2018. Lecture Notes in Computer Science, vol. 11377. Springer, Cham.
https://doi.org/10.1007/978-3-030-20984-1_4
- Atanasova, P., Nakov, P., Márquez, L., Barrón-Cedeño, A., Karadzhov, G., Mihaylova, T., Mohtarami, M., & Glass, J. 2019. Automatic Fact-Checking Using Context and Discourse Information. *Journal of Data and Information Quality*, 11(3): Article 12.
<https://doi.org/10.1145/3297722>
- Atodiresei, C.-S., Tănăselea, A., & Iftene, A. 2018. Identifying Fake News and Fake Users on Twitter. *Procedia Computer Science*, 126: 451–461.
<https://doi.org/10.1016/j.procs.2018.07.279>
- Bates, M. E. 2018. Say What? 'Deepfakes' Are Deeply Concerning. *Online Searcher*, 42(4): 64.
- Borges, L., Martins, B., & Calado, P. 2019. Combining Similarity Features and Deep Representation Learning for Stance Detection in the Context of Checking Fake News. *Journal of Data and Information Quality*, 11(3): Article No. 14.
<https://doi.org/10.1145/3287763>
- Britt, M. A., Rouet, J.-F., Blaum, D., & Millis, K. 2019. A Reasoned Approach to Dealing With Fake News. *Policy Insights from the Behavioral and Brain Sciences*, 6(1): 94–101.
<https://doi.org/10.1177/2372732218814855>
- Chawla, R. 2019. Deepfakes: How a pervert shook the world. *International Journal of Advance Research and Development*, 4(6): 4–8.
- Cybenko, A. K., & Cybenko, G. 2018. AI and Fake News. *IEEE Intelligent Systems*, 33(5): 3–7.
<https://doi.ieeecomputersociety.org/10.1109/MIS.2018.2877280>
- Day, C. 2019. The Future of Misinformation. *Computing in Science & Engineering*, 21(1): 108–108.
<https://doi.org/10.1109/MCSE.2018.2874117>
- De keersmaecker, J., & Roets, A. 2017. 'Fake news': Incorrect, but hard to correct. The role of cognitive ability on the impact of false information on social impressions. *Intelligence*, 65: 107–110.
<https://doi.org/10.1016/j.intell.2017.10.005>
- Figueira, A., & Oliveira, L. 2017. The current state of fake news: challenges and opportunities. *Procedia Computer Science*, 121: 817–825.
<https://doi.org/10.1016/j.procs.2017.11.106>

The Emergence of Deepfake Technology: A Review

Mika Westerlund

- Fletcher, J. 2018. Deepfakes, Artificial Intelligence, and Some Kind of Dystopia: The New Faces of Online Post-Fact Performance. *Theatre Journal*, 70(4): 455–471. Project MUSE, <https://doi.org/10.1353/tj.2018.0097>
- Florida, L. 2018. Artificial Intelligence, Deepfakes and a Future of Ectypes. *Philosophy & Technology*, 31(3): 317–321.
- Hamborg, F., Donnay, K., & Gipp, B. 2018. Automated identification of media bias in news articles: an interdisciplinary literature review. *International Journal on Digital Libraries*. <https://doi.org/10.1007/s00799-018-0261-y>
- Hasan, H. R., & Salah, K. 2019. Combating Deepfake Videos Using Blockchain and Smart Contracts. *IEEE Access*, 7: 41596–41606. <https://doi.org/10.1109/ACCESS.2019.2905689>
- Jang, S. M., & Kim, J. K. 2018. Third person effects of fake news: Fake news regulation and media literacy interventions. *Computers in Human Behavior*, 80: 295–302. <https://doi.org/10.1016/j.chb.2017.11.034>
- Lin, H. 2019. The existential threat from cyber-enabled information warfare. *Bulletin of the Atomic Scientists*, 75(4): 187–196. <https://doi.org/10.1080/00963402.2019.1629574>
- MacKenzie, A., & Bhatt, I. 2018. Lies, Bullshit and Fake News: Some Epistemological Concerns. *Postdigital Science and Education*. <https://doi.org/10.1007/s42438-018-0025-4>
- Maras, M. H., & Alexandrou, A. 2019. Determining authenticity of video evidence in the age of artificial intelligence and in the wake of Deepfake videos. *International Journal of Evidence & Proof*, 23(3): 255–262. <https://doi.org/10.1177/1365712718807226>
- Qayyum, A., Qadir, J., Janjua, M. U. & Sher, F. 2019. Using Blockchain to Rein in the New Post-Truth World and Check the Spread of Fake News. *IT Professional*, 21(4): 16–24. <https://doi.org/10.1109/MITP.2019.2910503>
- Spivak, R. 2019. “Deepfakes”: The newest way to commit one of the oldest crimes. *The Georgetown Law Technology Review*, 3(2): 339–400.
- Wagner, T.L., & Blewer, A. 2019. “The Word Real Is No Longer Real”: Deepfakes, Gender, and the Challenges of AI-Altered Video. *Open Information Science*, 3(1): 32–46. <https://doi.org/10.1515/opis-2019-0003>
- Zannettou, S., Sirivianos, M., Blackburn, J., & Kourtellis, N. 2019. The Web of False Information: Rumors, Fake News, Hoaxes, Clickbait, and Various Other Shenanigans. *Journal of Data and Information Quality*, 1(3): Article No. 10. <https://doi.org/10.1145/3309699>

About the Author

Mika Westerlund, DSc (Econ), is an Associate Professor at Carleton University in Ottawa, Canada. He previously held positions as a Postdoctoral Scholar in the Haas School of Business at the University of California Berkeley and in the School of Economics at Aalto University in Helsinki, Finland. Mika earned his doctoral degree in Marketing from the Helsinki School of Economics in Finland. His research interests include open and user innovation, the Internet of Things, business strategy, and management models in high-tech and service-intensive industries.

Citation: Westerlund, M. 2019. The Emergence of Deepfake Technology: A Review. *Technology Innovation Management Review*, 9(11): 39-52. <http://doi.org/10.22215/timreview/1282>



Keywords: Deepfake, fake news, artificial intelligence, deep learning, cybersecurity.

The Emergence of Deepfake Technology: A Review

Mika Westerlund

Appendix: Studied news articles on deepfakes

#ID	Author(s)	Title (shortened)	Date
<i>CBS News</i>			
CBS01	Patterson, D.	From deepfake to "cheap fake"...	June 13, 2019
CBS02	N/A	I never said that! High-tech deception ...	July 2, 2018
CBS03	Evans, C.	Spotting fake news in a world with ...	April 17, 2018
<i>CNET</i>			
CNET01	Van Boom, D.	These deepfakes of Bill Hader are ...	August 12, 2019
CNET02	Mack, E.	Researchers propose detecting deepfakes ...	August 12, 2019
CNET03	Al-Heeti, A.	Sharing deepfake revenge porn is now ...	July 1, 2019
CNET04	Singh, D.	Google, Facebook, Twitter put on notice ...	July 17, 2019
CNET05	Solsman, J.E.	Deepfakes freak YouTubers out ...	July 12, 2019
CNET06	Solsman, J.E.	Google, Facebook, Twitter aren't ...	August 6, 2019
CNET07	Solsman, J.E.	Samsung deepfake AI could fabricate ...	May 24, 2019
CNET08	Solsman, J.E.	Deepfakes may ruin the world ...	April 4, 2019
CNET09	Solsman, J.E.	Facebook, YouTube, Twitter must team ...	June 13, 2019
CNET10	Gonzalez, O.	Instagram chief Adam Mosseri: We don't ...	June 25, 2019
CNET11	Keane, S.	Congress wrestles with 'deepfake' threat ...	September 5, 2018
CNET12	Ng, A.	Deepfakes, disinformation among global ...	January 29, 2019
CNET13	Ng, A.	Deepfakes are a threat to national ...	September 13, 2018
CNET14	Kooser, A.	Deepfake your dance moves with an AI ...	August 27, 2018
CNET15	Carson, E.	Reddit cracks down on 'deepfake' ...	February 7, 2018
CNET16	Hautala, L.	If you like deepfakes, you might be ...	February 11, 2018
<i>CNN</i>			
CNN01	O'Sullivan, D.	The Democratic Party deepfaked its own ...	August 10, 2019
CNN02	O'Sullivan, D.	House Intel chair sounds alarm in ...	June 13, 2019
CNN03	Metz, R.	The fight to stay ahead of deepfake ...	June 12, 2019
CNN04	Metz, R., O'Sullivan, D.	A deepfake video of Mark Zuckerberg ...	June 11, 2019
CNN05	Yurieff, K.	Instagram head says company is ...	June 25, 2019
CNN06	O'Brien, S.A.	Deepfakes are coming. Is Big Tech ready?	August 8, 2018
CNN07	Metz, R.	Baby Elon Musk, rapping Kim Kardashian: ...	June 23, 2019
CNN08	O'Sullivan, D.	Congress to investigate deepfakes as ...	June 4, 2019
CNN09	Metz, R.	Researchers can now use AI and a photo ...	May 24, 2019
CNN10	O'Sullivan, D.	Lawmakers warn of 'deepfake' videos...	January 28, 2019

The Emergence of Deepfake Technology: A Review

Mika Westerlund

<i>Digiday</i>			
DD01	Southern, L.	'A perfect storm': The Wall Street Journal ...	July 1, 2019
DD02	Southern, L.	How Reuters is training reporters to spot ...	March 26, 2019
<i>Forbes</i>			
FRB01	Marr, B.	The Best (And Scariest) Examples Of ...	July 22, 2019
FRB02	Baron, K.	Digital Doubles: The Deepfake Tech ...	July 29, 2019
FRB03	Ballantine, M.	Are Deepfakes Invading The Office?	July 3, 2019
FRB04	Taulli, T.	Deepfake: What You Need To Know	June 15, 2019
FRB05	Sandler, R.	Instagram Won't Take Down Mark ...	June 11, 2019
FRB06	Towers-Clark, C.	Mona Lisa And Nancy Pelosi: The ...	May 31, 2019
FRB07	Dietmar, J.	GANs And Deepfakes Could Revolutionize ...	May 21, 2019
FRB08	Leetaru, K.	DeepFakes: The Media Talks Politics While...	Mar 16, 2019
FRB09	Morris, I.	Revenge 'Porn' Gets Even More Horrifying ...	Feb 5, 2018
FRB10	Morris, I.	Deepfake Porn Banned By Reddit And ...	Feb 7, 2018
<i>Fox News</i>			
FOX01	Carbone, C.	Scary deepfake video shows Bill Hader ...	August 13, 2019
FOX02	Carbone, C.	New deepfake technology makes Rasputin...	June 20, 2019
FOX03	Mikelionis, L.	'Deepfake' clip of Mark Zuckerberg ...	June 12, 2019
FOX04	Carbone, C.	Creepy deepfake AI lets you put words ...	June 11, 2019
FOX05	Brandon, J.	Terrifying high-tech porn: Creepy ...	February 16, 2018
FOX06	Farid, H.	Deepfakes give new meaning to the ...	June 18, 2019
FOX07	Carbone, C.	New tool detects deepfakes with 96 ...	June 24, 2019
FOX08	Brandon, J.	How AI-generated videos could be the ...	March 12, 2018
FOX09	Wallace, D.	'Deepfake' videos, other tech could ...	June 14, 2019
FOX10	Carbone, C.	Creepy AI generates endless fake faces ...	February 18, 2019
<i>Financial Times</i>			
FT01	Murphy, H.	Cyber security companies race to combat ...	August 16, 2019
FT02	Waters, R.	Rising tide of online deepfakes bring ...	June 13, 2019
FT03	Kuper, S.	The age of scepticism: from distrust to ...	October 18, 2018
FT04	Khalaf, R.	If you thought fake news was a problem ...	July 25, 2018
FT05	Murgia, M.	Why some AI research may be too ...	June 19, 2019
<i>The Guardian</i>			
GRD01	Schwartz, O.	Deepfakes aren't a tech problem. They're ...	June 24, 2019
GRD02	Hunt, E.	Deepfake danger: what a viral clip of Bill ...	August 13, 2019

The Emergence of Deepfake Technology: A Review

Mika Westerlund

GRD03	Chivers, T.	What do we do about deepfake video?	June 23, 2019
GRD04	Beard, M.	To fix the problem of deepfakes we must ...	July 23, 2019
GRD05	Parkin, S.	The rise of the deepfake and the threat to ...	June 22, 2019
GRD06	Hern, A.	New AI fake text generator may be too ...	February 14, 2019
GRD07	Schwartz, O.	You thought fake news was bad? Deep ...	November 12, 2018
GRD08	Hern, A.	My May-Thatcher deepfake won't fool ...	March 12, 2018
GRD09	Chadwick, P.	The liar's dividend, and other challenges ...	July 22, 2018
GRD10	Hern, A.	I thought online fakes would cause an ...	January 2, 2019
<i>PC Magazine</i>			
PCM01	Eddy, M., Rubenking, N.	Detecting Deepfakes May Mean Reading ...	August, 9, 2019
PCM02	Albanesius, C.	Deepfake Videos Are Here, and We're Not...	June 13, 2019
PCM03	Horowitz, B.T.	AI and Machine Learning Exploit...	May 13, 2019
PCM04	Rubenking, N.	How Lab Mice Are Helping Detect ...	August 8, 2019
PCM05	Kan, M.	Latest Deepfake Tech Will Have You ...	August 24, 2018
PCM06	Kan, M.	US Lawmakers: AI-Generated Fake Videos ...	September 13, 2018
PCM07	Moscaritolo, A.	PornHub, Twitter Ban 'Deepfake' ...	February 7, 2018
PCM08	Kan, M.	Facebook Declines to Delete Fake ...	June 11, 2019
PCM09	Kan, M.	This AI Can Recreate Podcast Host Joe ...	May 17, 2019
PCM10	Dickson, B.	When AI Blurs the Line Between Reality ...	June 7, 2018
<i>USA Today</i>			
USAT01	Andrews, J.	Fake news is real – A.I. is going to make ...	July 12, 2019
USAT02	Molina, B.	'Deepfake' videos can be generated with ...	May 24, 2019
USAT03	Brown, D.	Wait, is that video real? The race against ...	May 13, 2019
USAT04	Walsh, C.	What is a deepfake? This video technology...	March 15, 2019
<i>Washington Post</i>			
WP01	Harwell, D.	Top AI researchers race to detect ...	June 12, 2019
WP02	Zakrzewski, C.	The Technology 202: It's time for ...	June 13, 2019
WP03	Sasse, B.	This new technology could send American ...	October 19, 2018
WP04	Wang, A.B.	Biden says he won't use bots...	June 14, 2019

Design Rules for ‘Triple Helix’ Organizations

Ben Dankbaar

“I think we need much greater connective tissue” among all of the players – government, industry, academia and philanthropy. “We need more efficiency, more interaction, more collaboration.”

Kelvin Droegemeier,
Director of the White House Office of Science and Technology Policy

The image of the triple helix with three forces spiraling around each other has proven to be a powerful and inspiring image of the collaboration between government, business, and academia. The partners in such collaborative arrangements no doubt share an interest in making the collaboration successful. However, they also have specific interests and goals of their own. Too many triple helix arrangements have failed, because they did not consider this basic fact. Achieving their own goals is not necessarily the intention with which partners enter the collaborative effort, but they may well end up following this strategy. We start this paper with a brief description of what can be considered a typical case of ‘successful failure’ in a triple helix organization. We then review the literature regarding reasons for success or failure of triple helix organizations. We find that transparency and credible sanctions for self-interested behaviour are important requirements for successful triple helix arrangements. We then use notions from cybernetics and organizational design to develop basic rules for the design of triple helix arrangements. Basically, these rules and arrangements aim to ensure that self-interest and common purpose will concur.

Introduction

Collaborative arrangements in research, development, or innovation between universities and other public research institutions, private companies and government, or government agencies (so-called ‘triple helix’ arrangements) are of key importance for technological and economic progress. While these arrangements were more or less accidental in the past and/or guided by specific interests like national security (armaments) or international prestige (outer space), they are now increasingly seen as ‘systems of innovation’ that can be subject to conscious management, regulation, and organization (Cavallini et al. 2016; Mazzucato 2013).

The expression ‘triple helix’ was coined by Etzkowitz and Leydesdorff (1998, 2000) to refer to the complex interactions between the three types of actors involved. It obviously refers to the famous ‘double helix’ structure of DNA, discovered in the early 1950s. A DNA molecule consists of two strands that wind around each other and are connected in various places, so that the structure looks like a twisted ladder. The image of the triple helix emphasizes the relative independence of the three

actors spiralling around each other over time. Government and/or business are usually the sources of funding, while research takes place at universities and/or business; and innovation takes place in business. There is usually only one government (or government agency) involved, but there may be more than one company or university participating. The arrangement can refer to a single project, to a program consisting of many projects, or to an organization or agency in which the three parties collaborate, for instance, through representatives in a steering board as part of a regional development effort. In the following, we will mainly speak of ‘projects’, but the argument basically refers to all forms of triple helix organizations.

Some authors have introduced civil society as a fourth type of actor and consequently speak of a ‘quadruple helix’ (Arnkil et al., 2010). Philanthropy, mentioned by U.S. President Donald Trump’s science adviser in the introductory quotation, can be considered as one possible representative of civil society. The argument of this paper does not depend on the number of actors involved. We limit ourselves to ‘triple helix’ because it is the most commonly used expression. Carayannis and Campbell (2010, 2012) have gone even further and

Design Rules for ‘Triple Helix’ Organizations

Ben Dankbaar

included the natural environment as a fifth element in a ‘quintuple helix’. We don’t think this is very helpful. Although the importance of the natural environment for innovation cannot be denied, it is somewhat confusing to consider the natural environment as an ‘actor’ in the same way that the other four actors are. One could indeed argue that climate change and other environmental problems have been caused by the fact that the natural environment cannot (re)act in the way that human beings and their organizations do.

The three types of actors in the triple helix are very different in history, culture, and purpose. They enter into collaboration with very different interests: companies hope to achieve competitive advantage, universities are interested in scientific publications, government hopes for improved performance of the economy, more employment, more progress in the development and implementation of specific technologies, or the achievement of other public goals, for instance, with regard to climate change. The participating actors may agree on the need to investigate specific problems or to develop specific technologies, but once the money has been allocated, researchers want to be left alone, companies sit on their intellectual property rights, and governments can only guess if public goals have been achieved efficiently, if at all. Efforts to gain more control often result in cost-increasing bureaucratic rules. More often than not, projects or programs are proclaimed to be successful, because none of the parties involved is interested in saying that targets have not been met.

In this paper we develop some design rules for triple helix arrangements that have the specific aim of keeping all parties involved, focused on an agreed common goal. As a further introduction to the issue at hand, we sketch the problems of a recent project in which we were involved ourselves (section 1). In section 2, we briefly review the literature on the causes of success and failure of triple helix arrangements. We find considerable attention to issues of management and leadership, but relatively little to the conditions that allow management and leadership to be effective.

The paper provides insights into the necessary conditions for effective leadership. These conditions constitute the substance of the design rules presented in section 3. Building on insights acquired in the first two sections, we use notions from cybernetics and organizational design to develop design rules for triple helix organizations. These rules aim to create an environment that influences the behaviour of all participating parties in such a way that they see it as

being in their best interest to act in the way they had promised in the first place, that is, to serve the common purpose. Before concluding, we briefly react to two objections frequently made to our approach.

1. A Case of Successful Failure of a Triple Helix Organization

A couple of years ago, our department was involved in a large research program funded by a multinational company. It involved a technical university, the research department of the multinational in question, and a partially government-funded independent research organization. On top of staff contributions from the three participating organizations, 40 PhD projects were initiated. The purpose of the program was to develop an integrated approach to the application of a wide range of technologies needed to improve the production operations of the multinational in question. The underlying problem was that many of these technologies had been developed, or at least been identified, but so far, the different pieces of the puzzle had not fit together so that implementation in actual production was slow in spite of the fact that considerable investment had already been made in these technologies. The involvement of our department in the program was relatively limited. We were approached to help think about technological implications for how work is organized in the various production locations of the multinational, and also about organizing the research program itself.

After the program had run its course (after about five years), two further activities were initiated: one involving the multinational and the technical university, and the other involving the independent research organization, the technical university and several companies from the same industry as the original partner. These two programs have meanwhile also been completed. Was the original program a success or a failure? The fact that similar follow-up activities were initiated does suggest that it was considered successful. One of the difficulties in answering this question is that it is not so easy to (re)construct a measure of success. Obviously, the true measure of success would be the achievement of an integrated technology solution as envisaged at the start of the program. However, that didn’t happen; or at least, far less than hoped for. Nevertheless, all participating partners were quite satisfied with the program results. The technical university received funding for a large number of PhDs. The professors supervising the PhD projects generated new publications in their areas of expertise. The independent research organization was happy to have access to a considerable flow of new

Design Rules for ‘Triple Helix’ Organizations

Ben Dankbaar

knowledge, with which it could hope to acquire new industry research contracts. The multinational company was happy to have direct access to university research and especially to be able to recruit candidates among the 40 PhD students. Clearly, apart from the official goal of the program, all partners had their own goals or at least an understanding of the minimum that they would be able to get out of the program.

One of the reasons that the integration effort did not get as far as expected was that staff at the multinational’s research lab suffered from the not-invented-here syndrome, that is, they were more interested in developing their own solutions internally than adopting solutions coming from outside. Another reason was that neither the researchers from the partner organizations nor the 40 PhD students were located in one place. Face-to-face contacts in different locations were limited and specialists tended to cluster with their own kind. Moreover, neither the university professors nor the PhD students were very motivated to spend a lot of time integrating their results with those of others. The main goal of the PhD students was to complete their dissertation within the time available, and they therefore were reluctant to spend time communicating about things not immediately relevant to their own project. The 40 projects had been defined to form a more or less coherent program, but once started the projects tended to develop their own logic and it was difficult to keep them on the originally planned track.

Program management was present to organize program meetings for participants, but was not very strong. It’s not that they were incompetent or bad managers; they simply didn’t have the power to take corrective action, to keep projects on track, or to force people to spend more time on integration. And even if they would have had such power, they seldom had enough information to find out if projects were proceeding as planned and if enough attention was paid to integration efforts.

In the following section, we take a look at the literature on success and failure of triple helix organizations to find out recommendations that would help avoid the kind of problems encountered in this case.

2. Literature Insights on Factors Contributing to Triple Helix Success and Failure

The literature on triple helix collaboration provides a considerable number of factors that contribute to the success of a project or program. One of them frequently mentioned is ‘trust’, but this begs the question how trust

becomes established and how it remains alive over the course of a project.

Scheirer (2005) reviews 19 empirical studies of the sustainability (in the sense of long-run survival) of American and Canadian health-related programs. On the basis of her cross-study analysis, she argues that five important factors influence the extent of sustainability: (a) the possibility to modify the program over time, (b) the presence of a “champion”, (c) a clear “fit” between the program and the mission and procedures of the organization that is mainly responsible, (d) the presence of readily perceived benefits to staff members and/or clients, and (e) support from stakeholders in other participating organizations.

Gray et al. (2011) study five cases of industry–university cooperative research centres in order to identify possible causes of success and failure. Their findings largely confirm Scheirer’s observations, but they argue that the deeper single cause of success or failure is leadership or lack thereof. In their analysis, all failure cases involved leadership shortcomings. Directors did not devote enough time or were marginalized in their organization (for example, because they were not tenured). Some directors departed without a successor picking up where they left off. Even if there was continuity in leadership, there was failure in adapting the centre to changing environmental requirements. In contrast, the only successful centre studied exhibited both continuity in leadership and effective coping with environmental turbulence.

Gray et al. (2011) also point to some “fatal flaws” that will quickly lead to failure in research centres. These flaws are less organizational, and have more to do with the capabilities and motivations of the participating organizations. Companies may have insufficient absorptive capacity to make knowledge transfer possible. Or they may have the capacity, but be unwilling to share knowledge with others and/or value IPR (Intellectual Property Rights) such that they do not want to run the risk of scientists claiming some of their findings. Moreover, although university staff may be motivated, institutional support from the university may not be forthcoming. The university board may in the end be more interested in scientific publications than in collaboration with companies, especially if this involves focusing on problems in the region instead of global science problems.

In an assessment of a mobility-related program in the Netherlands, Bressers (2012) found that researchers and

Design Rules for ‘Triple Helix’ Organizations

Ben Dankbaar

consultants so much dominated the program that the “demand side”, that is, the government that paid for the whole program, was not really heard. However, because research fulfilled all formal requirements, government representatives saw no possibility to modify the program according to their interests. Instead, they more or less withdrew. In a similar vein, Amaral (2015) found that lack of government involvement is an important explanation for lack of growth and “maturation” of triple helix projects. At the same time, he finds that local governments lack the expertise to actively intervene in innovation processes. This problem is exacerbated when the project’s management lacks experience in dealing with a large diversity of participants.

Ranga and Etzkowitz (2013) argue that triadic entities (like triple helix programs) have a higher potential than dyadic entities for turning tension and conflict of interest into convergence and confluence of interest. They see an important role for “conflict moderation” (in which government agencies can play a role) and “collaborative leadership”. In their concluding section, however, they emphasize the importance of the “motivation” of triple helix actors, “to engage in joint projects and set common goals”. It remains unclear, however, under what circumstances the actors’ “motivation” will be sustained over time.

A “practical guide” for connecting universities to regional growth, published by the European Commission (Goddard, 2011), does indicate that collaboration between universities, companies, and public authorities is not a matter of course. It provides a detailed discussion of the ways in which regional demand and knowledge supply can be brought together, and emphasizes the need for public authorities to clearly specify the needs of the region. Several case studies in the guide point to “enablers” of success, but there is no discussion of the organization and management of collaborative projects beyond the general observation that “leadership” is important and should be formally organized at the regional level with high-ranking representatives of participating parties.

Having looked over the literature, we find that program evaluations as well as case studies focus on the proclaimed goal of a triple helix project, but pay little attention to the particular and possibly diverging interests of participating parties. The main exception is constituted by conflicts of interest with regard to IPR that frequently arise in collaborations between companies and universities, especially when companies are not paying 100% of the bill, or when potentially

competing companies are involved (Perkmann et al. 2013). However, here too, it is usually argued that “moderation” and “leadership” will help sort things out. It remains unclear under what conditions leadership and moderation can be effective.

Trust is an important issue in any collaborative scheme. Partners in a triple helix project promise each other to contribute to a joint effort. It can be safely assumed that at the start of the project, all partners in a triple helix project are prepared to collaborate. However, collaboration takes time and many things can happen that have an impact on the willingness to collaborate: managers, professors, politicians and civil servants come and go; research goes into an academically interesting direction, but the interest of the companies involved goes into another direction; political priorities change; each partner has a different time horizon regarding success. So once the project is underway, there are many reasons why partners may start to lower their expectations. If any partner expects that (some of) the other partners will not contribute as promised, this partner will start to focus on the things he wanted to do anyway and before long all the others will follow.

In the studies on success and failure of triple helix organizations, the possibility of sanctioning lack of cooperation and selfish behaviour is seldom mentioned. The emphasis on leadership and the need to involve ‘high ranking’ people in supervisory functions does seem to suggest that such people have the power to sanction in one way or another. Of course, leadership does not only consist of punishing people; leadership can also be inspiring and supportive. However, leadership without the ability to show its teeth is likely to be ineffective. This insight also provides us with a different perspective on the need for mutual trust that is so frequently mentioned in the literature. Trust in the behavior of others arises from the conviction that they will be punished if they do not behave as promised.

Sanctions are only possible if leadership is informed about what is going on. Conversely, reporting obligations in triple helix projects don’t make much sense, if there are no sanctions in the background. Reporting obligations can be bureaucratic and burdensome. Moreover, the reporting is often self-reporting and therefore not necessarily very reliable. We conclude that the presence of reliable information about the behaviour of partners and empowerment of management to sanction unwanted behaviour are important requirements for the design of triple helix organizations.

Design Rules for ‘Triple Helix’ Organizations

Ben Dankbaar

3. Design Rules for Triple Helix Organizations

Collaboration is a central theme of organization theory and design. Organizations are usually defined in terms of people collaborating for a common goal. Yet it is also generally recognized that people in organizations also have goals of their own. In fact, they may not be interested at all in the goals of the organization, only contributing to it because they get paid for it. That is why motivation is an important aspect in organization design (Wiley, 1997). Motivation can be intrinsic, if the individual has “internalized” the goals of the organization and largely considers them to be identical with his or her own goals. It can also be extrinsic, guided by a system of rewards and punishments. Although modern organizations prefer to emphasize intrinsic motivation, if only because knowledge-intensive work is difficult to subject to objective measurement and control (Adler & Chen, 2011), they usually also evaluate individual performance and eventually dismiss people who do not perform well.

In the previous sections we saw that transparent behaviour and empowered leadership are important organizational requirements for successful collaboration. The following design rules aim to fulfil these requirements. For this purpose, we make use of basic tools from cybernetics and organization design. From cybernetics we draw on the feedback cycle (Ashby, 1956; De Sitter et al., 1996), which with regard to a process consists of the activities measurement or registration (of results), evaluation (against a target), and intervention (if the target has not been reached). An important issue in cybernetics is the possibility of assigning some or all of these three activities to separate actors, which differ from the persons carrying out the process in question. If the persons in the process take care of their own feedback cycle, one can speak of self-regulation (self-reporting, self-evaluation, and self-correction). From theories of organization design, we take the following notions: the centrality of the external demands made on the organization for the organization design (Nadler & Tushman, 1997; Galbraith, 2002), the distinction and separation between performance and control (Hackman, 1990; De Sitter et al., 1996; Burton & Obel, 2018), and the view of organizations as information processing systems (Galbraith, 1974; Simon, 1996).

Design Rule 1. The purpose of the collaborative triple helix effort should be clearly stated.

Organization design starts with demands made upon an organization. Although this may seem self-evident, lack

of clarity or imprecision with regard to purpose is the first step toward failure.

Design Rule 2. Contributions of each partner should be specified in detail.

It should be specified as clearly as possible what each partner is expected to contribute to the project. These contributions should not just be specified in number of hours or for instance “two PhD theses”, but also spelled out what is supposed to be done in these hours, and how the work (for instance, a PhD thesis) will contribute to the purpose of the project. Primary contributions like money and time should naturally be specified, but also secondary contributions like the obligation of a participating company to provide data, or to engage in serious discussions about the results of a researcher’s work.

Design Rule 3. It should be specified as clearly as possible what each partner hopes to get out of the project.

Note that we are not speaking of the project’s purpose here, but rather about the benefits participants hope to receive from the project. Sometimes, a party’s contribution and the possible benefits seem almost identical. For the participating university, and certainly for the PhD student, having a PhD thesis completed is already valuable, regardless of whether it contributes to the project’s goal. For the project, however, it is important that the thesis produces useful knowledge that can be implemented by the participating companies. In that case, somebody’s contribution becomes somebody else’s benefit. The expectations of government, which is often only a financial contributor, should also be clearly specified. As we have seen (Bressers, 2012), lack of specified government expectations may lead to spending money on activities the government isn’t really interested in. Successful triple helix projects instead are projects in which government is not just a source of finance, but also an active partner with interests of its own (Amaral, 2015).

Design Rule 4. Contributions and expected benefits should be laid down in a document and discussed at kick-off.

The common purpose, contributions, and expected benefits of each party, should be specified in such a way that they are measurable, preferably quantifiable, so that progress can be measured over time. This information should be laid down in a document that should be available for discussion at the kick-off meeting. A deep understanding of each other’s possible contributions and expectations will be helpful throughout the duration of the project. Specifying the expectations of all partners

Design Rules for ‘Triple Helix’ Organizations

Ben Dankbaar

at the start may also lead to a reformulation or further clarification of project goals.

Design Rule 5. An independent evaluator should be part of the project from the beginning.

It is desirable to have an evaluator or evaluating party participating in the project. The evaluator should be independent from all other participating parties, so that there is no reason to consider him biased. The evaluator will collect management information. Moreover, such concurrent project evaluation is usually cheaper and more informed than ex-post evaluation.

Design Rule 6. The evaluator’s task is to regularly collect information on the activities of all partners.

The evaluator is charged with drawing up the kick-off document and with regularly collecting data on project activities, producing progress reports, and comparing progress with the promises and expectations laid down at the start of the project, that is, producing (interim) evaluation reports.

Design Rule 7. Evaluator reports are made available to all participants.

Transparency requires that information concerning the project’s progress with regard to contributions and targets should be made available regularly to everyone involved.

The evaluator carries out most of the work collecting and reporting on data. This way, some of the drawbacks of self-reporting can be avoided. Nevertheless, participants are required to provide data to the evaluator at their request. In that sense, there will still be self-reporting, but a third party (the evaluator) now critically reviews the data provided by each partner.

Design Rule 8. Project management is tasked with ensuring collaboration by all parties.

Project management is specifically charged with promoting the overall purpose of the collaborative exercise. It must see to it that all partners effectively collaborate as promised. Informed by evaluation reports, and by its own experienced estimation of the situation, project management makes ready action if necessary.

Design Rule 9. Project management is empowered to sanction undesirable behaviour.

Management has the power to withhold rewards or in other ways punish partners who do not fulfil their obligations as specified in the project’s kick-off document and underlying contracts. Real leadership,

however, means that there is no automatic sanctioning, if someone does not fulfil their obligations.

Design Rule 10. Project management decides if action is necessary on the basis of evaluator reports and other available information.

Leadership is also about understanding and forgiving. There may be good reasons for undesirable behaviour that became visible in an evaluation report. Project management may decide not to intervene, but it will have to explain its actions to the partners, because evaluation reports are visible to all. Note that intervention by project management and evaluation are separate activities. Evaluation reports should be as much as possible factual reports, simply comparing what happened with what was supposed to happen, and providing evidence as collected in data and other documentation. If a party does not agree with an evaluation in a report, the discussion should not be with the evaluator, but rather with project management.

Design Rule 11. Project management is ideally independent of the participating parties.

In smaller, one-off projects, project management often comes from one of the participating parties, usually the leading party in the project. The project manager will thus be seen by the others primarily as a representative of his or her own company or institution. And in such a case, if their own organization fails to deliver as promised, it will be difficult if not impossible to start sanctioning partners. In larger programs, it is often possible to have the far better organizational device of an independent party, consultancy or agency taking the role of project management. Independent project management may also have interests of its own, but these will seldom concur entirely with any of the other parties. After all, an independent project manager has an interest in getting more similar jobs in the future, and would like to be known as someone who keeps programs and projects on course.

4. Discussion

These design rules aim to create a working environment in which it is difficult for project actors to deviate from their promises. What is proposed here is to assign the different elements of a cybernetic feedback cycle to different actors. Registration (or measurement) is done by the participants themselves and by the evaluator. evaluation is assigned to the evaluator, while interventions are the task of project management. By assigning these tasks to separate actors, we create a greater level of transparency than would be possible if

Design Rules for ‘Triple Helix’ Organizations

Ben Dankbaar

they were assigned to a single actor. First of all, there is transparency created by evaluation reports. All participants are aware of the evaluator’s task of getting as much valid information as possible, and also that the evaluator will make it publicly known if a participant is not forthcoming with necessary project information. Secondly, because the evaluation reports are accessible to all participants, the project manager cannot sweep them under the carpet. They will instead be under pressure to react to deviant behaviour or to explain to all participants why no action has been taken. Thirdly, as a result of this transparency, trust can easily develop among actors. Trust arises from the knowledge that project management has the right and the power to intervene. Since everyone is aware of this, actual intervention will seldom be necessary.

Providing project management with enforcement power to punish individual partners is a necessary element of these design rules, but also the most difficult part. Especially when a project or program has been funded by government, neither the advocating politicians nor the civil servants involved are keen to admit that public money has not been well spent. It is easier to say that the effects of the project cannot be measured, or will only become visible in the future, rather than when the project ends (which may be true). That’s why it is important to identify measurable targets and contributions at the project’s outset. Even if the targets are clear, however, it still may not be easy to prove that a participant has not contributed as promised.

Forcing participants to pay back money they have received (and since then spent) may become a time-consuming affair that involves lawyers. Withholding payment of (the last instalment of) the budget after the completion of the project may be easier. However, there are other, non-financial ways to sanction undesirable behaviour. Naming and shaming is important in this respect. In most triple helix projects, the participating companies and universities are interested to participate in follow-up activities or in other programs. This becomes difficult if it is known from earlier projects that a participant has acted in an untrustworthy way. The prospect of participating in other and/or follow-up projects should have a positive impact on participant behaviour in a project. Here too, transparency is of key importance.

A possible objection to the above design rules could be that they display an unwarranted lack of trust in the sincerity of the participants and their motivation to turn the project into a success. Some people argue that “motivation” is a critical success factor in a project. It is

obviously difficult to deny that projects are likely to fail if participants are not motivated. Our reply to such objections would be that structural preconditions have to be created for motivation to stay alive. Projects usually take many years to set up and a lot can happen that undermines the original motivation of the partners, not necessarily because anyone consciously or willingly refuses to deliver. Delays may arise, for example, because of changes in personnel. If there is no transparency, a lack of confidence in the contributions of one partner can easily arise and may create reluctance to go all out for the project by other partners. Project management needs to pick up signals of this kind (possibly generated by the evaluator’s activities) as early as possible, and visibly undertake action to either correct false impressions or to ensure that the partner in question gets back on track.

Another objection to these design rules could be that triple helix projects are very often research projects, and it is often impossible to predict what will come out of research. If the participating parties knew that, then research wouldn’t be needed. Therefore, the idea of specifying clearly at the beginning what, for instance, a university will contribute to the project should be rejected. Although this argument contains a grain of truth, it can also be an excuse for the university researchers to simply “do their own thing” as soon as funding has been secured. If they do that, other partners may quickly lose motivation.

It is obviously impossible to specify in detail what will come out of a research project, but it is very well possible to describe general aims and expectations. Likewise, this can be done for how each of the partners will be involved, and indeed empowered, to ensure that the project at least tries to come close to these aims and expectations, or pivots and departs from them with the agreement of all partners.

Conclusion

Triple helix organizations, projects and programs suffer from a tendency to lose track of their original aim and to degenerate to the point where participating parties mainly focus on things they would have done anyway. We found that the literature on success and failure of triple helix organizations points to many factors of success, but does not provide us with many useful instruments showing project participants how to organize for success. In response to this gap in the literature, we presented 11 rules for designing triple helix organizations, based on fundamentals found in cybernetics and organization design.

Design Rules for ‘Triple Helix’ Organizations

Ben Dankbaar

Organizations built according to these design rules are characterized by transparency, and the ability of managers to sanction non-collaborative behaviour. This is achieved, among other things, by early identification and clarification of the goals and interests of all participants, by the continuous registration and evaluation of all activities by an independent evaluator, and by the separation of evaluation from intervention by management. The possibility of sanctions for partners that do not keep their promises to the initial agreement is an integral part of triple helix project design. Our analysis makes it clear that while transparency will usually make sanctions unnecessary, the threat of sanctions is nevertheless important. This feature is often considered problematic in triple helix arrangements because there is no clear hierarchical relationship between the participants.

The question remains why partners in a project would agree to design their project along the lines proposed here. Roughly speaking, there are two main reasons. First, organizations funding a project may make it a precondition for funding. Second, these or similar design rules may be codified into a general norm for the organization of triple helix and other collaborative projects. If so, conforming to this norm will become an indication of quality and not conforming to it a signal that the project should not be taken too seriously.

Acknowledgements

The ideas underlying this paper were first presented at the Triple Helix Conference in Manchester, September 5-8, 2018. The author wishes to acknowledge inspiring conversations on public organization with Harry van de Loo. He is also grateful for comments made by the reviewers of this journal.

References

- Adler, P.S. & C. Xiaoling Chen. 2011. Combining creativity and control: Understanding individual motivation in large-scale collaborative creativity. *Accounting, Organizations and Society*, 36(2): 63–85.
- Amaral, M. 2015. Management and assessment of innovation environments, Triple Helix. *A Journal of University-Industry-Government Innovation and Entrepreneurship*, 2(19).
doi: 10.1186/s40604-015-0030-5
- Arnkil R., A. Järvensivu, P. Koski & T. Piirainen. 2010. Exploring Quadruple Helix. Outlining user-oriented innovation models. *Final Report on Quadruple Helix Research for the CLIQ project*, under the Interreg IVC Programme, Tampere: University of Tampere, Work Research Center.
- Ashby, W.R. 1956. *An introduction to cybernetics*. Chapman & Hall, London.
- Bressers, N. 2012. The triple helix organization in practice: Assessment of the triple helix in a Dutch sustainable mobility program. *Science and Public Policy*, 39(5): 669-679.
- Burton, R.M. & B. Obel. 2018. The science of organizational design: fit between structure and coordination. *Journal of Organization Design*, 7(5): 1-13.
- Carayannis, E.G. & D.F.J. Campbell. 2010. Triple helix, Quadruple helix and Quintuple helix and how do Knowledge, Innovation and the Environment relate To Each other? a Proposed Framework for a Trans-disciplinary analysis of Sustainable development and Social Ecology. *International Journal of Social Ecology and Sustainable Development*, 1(1), 41-69.
- Carayannis, E.G., T.D. Barth & D.F.J Campbell. 2012. The Quintuple Helix innovation model: global warming as a challenge and driver for innovation. *Journal of Innovation and Entrepreneurship*, 1:2.
DOI: 10.1186/2192-5372-1-2
- Cavallini, Simona, Rossella Soldi, Julia Friedl & Margherita Volpe. 2016. Using the Quadruple Helix Approach to Accelerate the Transfer of Research and Innovation Results to Regional Growth. *Technical Report, Committee of the Regions*, EU, Brussels.
DOI: 10.2863/408040
- De Sitter, L.U. et al. 1997. From Complex Organizations with Simple Jobs to Simple Organizations with Complex Jobs. *Human Relations*, 50(5): 497-534.
- Droegemeier, Kelvin. 2019. Director of the White House Office of Science and Technology Policy
<https://www.sciencemag.org/news/2019/02/exclusive-first-interview-trump-s-new-science-adviser>
- Etzkowitz, H. & Leydesdorff, L. 1998. The Endless Transition: A “Triple Helix” of University-Industry-Government Relations. *Minerva*, 36: 203-208.
- Etzkowitz, H. & Leydesdorff, L. 2000. The Dynamics of Innovation: From National Systems and “Mode 2” to a Triple Helix of University-Industry-Government

Design Rules for ‘Triple Helix’ Organizations

Ben Dankbaar

- Relations. *Research Policy*, 29(2): 109-123.
- Galbraith, J.R. 1974. *Designing complex organizations*. Addison-Wesley, London.
- Galbraith, J.R. 2002. *Designing Organizations: An Executive Guide to Strategy, Structure and Process*. JosseyBass, San Francisco.
- Goddard, J. 2011. Connecting universities to regional growth — A practical guide, Smart Specialization Platform. *EU Regional Policy*, Brussels.
- Gray, D., E. Sundstrom, L.G. Tornatzky and L. McGowen, 2011. When Triple Helix unravels. A multi-case analysis of failures in industry–university cooperative research centres. *Industry and Higher Education*, 25(5): 333-345.
- Hackman, J.R. 1990. *Groups that work (and those that don't): creating conditions for effective teamwork*. Jossey Bass, San Francisco.
- Mazzucato, M. 2013. *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*. London: Anthem Press.
- Nadler, D.A. & M.L. Tushman. 1997. *Competing by Design. The Power of Organizational Architecture*. Oxford University Press, New York/Oxford.
- Perkmann et al. 2013. Academic engagement and commercialisation: A review of the literature on university–industry relations. *Research Policy*, 42(2): 423-442.
- Ranga, M. & H. Etzkowitz. 2013. Triple Helix systems: an analytical framework for innovation policy and practice in the Knowledge Society. *Industry and Higher Education*, 27(3): 237-262.
- Scheirer, M.A. 2005. Is Sustainability Possible? A Review and Commentary on Empirical Studies of Program Sustainability. *American Journal of Evaluation*, 26(3): 320-347.
- Simon, H.A. 1996. *The Sciences of the Artificial*. MIT Press, Cambridge, Mass.
- Wiley, C. 1997. What motivates employees according to over 40 years of motivation surveys. *International Journal of Manpower*, 18(3): 263-280.

About the Author

Ben Dankbaar is emeritus professor of innovation management and organization design, Nijmegen School of Management, Radboud University Nijmegen, The Netherlands. He also held a chair on management and technology at the Science Faculty of the same university. Before coming to Nijmegen, he worked as an assistant professor at the University of Amsterdam and as a researcher at the Berlin Social Science Center (Germany) and the Maastricht Economic Research Center on Innovation and Technology (MERIT) in Maastricht, The Netherlands. Ben has been guest professor at Hitotsubashi University in Tokyo and guest researcher at Macquarie University in Sydney and the Max Planck Institute for Social Studies in Cologne. He has published widely on technology and work organization, organization design, innovation management, innovation policy, industrial policy and sustainability. He has a special interest in the automobile industry, which he has been following for over 35 years.

Citation: Dankbaar, B. 2019. Design Rules for ‘Triple Helix’ Organizations. *Technology Innovation Management Review*, 9(11): 53-61. <http://doi.org/10.22215/timreview/1283>

Keywords: triple helix, design rules, motivation, sanctions, lea 

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

“Data is only as valuable as the decision it enables.”

Ion Stoica
Computer scientist

Data-driven business models arise in different social and industrial sectors, while new sensors and devices are breaking down the barriers for disruptive ideas and digitally transforming established solutions. This paper aims at providing insights about emerging topics in the data economy that are related to companies' innovation potential. The paper uses text mining supported by systematic literature review to automatize the extraction and analysis of beneficial insights for both scientists and practitioners that would not be possible by a manual literature review. By doing so, we were able to analyze 860 scientific publications resulting in an overview of the research field of data economy and innovation. Nine clusters and their key topics are identified, analyzed as well as visualized, as we uncover research streams in the paper.

Introduction

Due to rapid technological and organizational progress in digitalization, a diverse ecosystem of innovative technologies, platforms, and digital market players has emerged, leading to what we now call the “data economy”. One characteristic of this data economy is the huge amount of available data, which is often referred to as the “big data” paradigm. There are many sources available in scientific and practitioner communities, which need to be analyzed in order to stay informed, and thus capable of acting. The volume of sources means that a complete manual analysis is time consuming. Information overload leads to challenges for scientists as well as practitioners to identify and track the main topics in which innovation might take place. The challenge, however, is a prerequisite for achieving sustainable competitive advantage, due to volatile market changes and disruptive innovation approaches.

This paper aims at facing this challenge and enables an automatized, repeatable way to identify topics of interest and track the fields of innovation as discussed in published research literature. By systematically reviewing scientific publications, major research streams and their (sub-)topics are revealed. This will help scientists and practitioners to identify potentials for innovation and give guidance regarding which topics

could be of future interest for scientists on the one side as well as practitioners on the other side. Given the volume of publications, this paper uses a literature review and text mining approach to analyze keywords and abstracts of scientific publications in the context of the data economy in terms of their relevance, relation, and potential for automated innovation. In this paper, we provide the following results: on the one hand, we show what a text mining supported systematic literature review could look like. This approach can be easily adapted to analyze other research fields and topics. On the other hand, we provide content-related insights in the field of data economy and innovation.

Background Information

Data Economy

Organizations invest a lot in digitalization programs and projects aiming to benefit from data economics. The discussion around digital business as “a business model whose underlying business logic deliberately acknowledges one or more characteristics of digitalization and aims to take advantage of them” (Otto et al., 2015), shows the growing importance of data within enterprises business (Moody & Walsh, 1999). Digitalization and advancing an organization's business model in this direction requires considering the opportunities and challenges that data and information

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

bring to value creation. Business models in the digital economy (Otto, 2015; Zimmerman, 2000) are characterized by developing products into hybrid or purely digital services. The close integration of digital and physical products in combination with a vast amount of internally and externally available data enables data-driven service offerings for traditional products, as well as innovations to add more value to tangible products (Yoo et al., 2010). However, what does the term “data economy” mean exactly? Despite, or perhaps even because of the high attention given to it, a common understanding of the term “data economy” is still missing.

Nevertheless, a number of definitions have formed in practice, which are presented as follows:

According to the German Association for the Digital Economy (BVDW), data economy deals with the monetization of information based on acquired data, which is transformed into valuable information using an algorithm, and then made accessible on the basis of business management functions. A data economy can be operated as its own business model or it can support, modify, or replace existing value creation models by increasing digitalization (German Association for the Digital Economy, 2018).

By the European Commission’s definition, data economy measures the overall impacts of the data market on the economy as a whole. It involves the generation, collection, storage, processing, distribution, analysis elaboration, delivery, and exploitation of data enabled by digital technologies (European Commission, 2019).

A study by Digital Reality, a worldwide leader in building data centers, defines data economy as the financial and economic value created by the storage, retrieval and analysis—using sophisticated software and other tools—of large volumes of business and organizational data at very high speeds (so-called ‘big data’). This can involve, for example, realizing improved operational efficiency or implementing improved strategic decisions (Digital Reality, 2018).

This paper therefore defines “data economy” as an umbrella term, which includes digital business models independent of a particular industry, for example, data products and services, digital technologies, data value chains, and their technical implications for data creation, processing, provision, and use to gain benefits for an organization.

Innovation

Schumpeter's (1912) work on economic development theory, in which he describes an innovation as a "new combination" that asserts itself on the market and establishes a "creative redesign", is regarded as fundamental for introducing the concept of innovation. Numerous authors and scientists have taken up and interpreted innovation differently (Schumpeter, 1912). The following definitions reveal diverse understandings of the concept of innovation.

Barnett argues that innovation is a qualitative differentiation from existing ideas or objects. The distance or the extent of novelty is the decisive factor to distinguish between "non-innovation" and innovation (Barnett, 1953).

Many authors take up the characteristic of novelty in their definition of innovation, while nevertheless interpreting novelty in decisively different ways. Thus, Vedin sees innovation in the first application of the new idea, method, or use of a novel object (Vedin, 1980).

In his work on innovation diffusion theory, Rogers also takes up this approach, but adds a perspective that defines the concept more clearly. He thus interprets that something new only leads to an innovation if the adapting user perceives it in the same way (Rogers, 1983). This definition implies that (early) users adapt an innovation, which is to be understood as a first step in the later diffusion process. In addition to novelty, the concept of innovation is here linked with adaptation, that is, the application of a novel idea, method, or use of a new product by users. Following this definition, an innovation can be understood as a novel idea or invention that eventually finds commercial application. Zawislak et al. also define innovation as the application of knowledge to generate technical or organizational changes capable of offering advantages to the firm that accomplishes them (Zawislak et al., 2008).

Francis and Bessant view innovation from the perspective of the change that comes with innovation (Francis & Bessant, 2005). Regarding this view, Bessant and Tidd distinguish four categories of innovation. “Product innovation” refers to changes in the things (product/services) an organization offers. “Process innovation” implies changes in the way in which things are created and delivered. “Position innovation” refers to changes in the context in which things are introduced, while “paradigm innovation” describes changes in the underlying mental models that frame what the

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

organization does. These changes always lead to something new that creates some kind of value (Bessant & Tidd, 2007). Van der Kooij finds a generic definition for innovation and highlights the aspect of change as well. Here, an innovation is a change in the function of a system (product, process, organization, or society) that has a stepwise character. In short, it is the result of a process of human activity. The steps could be small, incremental, or large, and hence result in discontinuities (Van der Kooij, 2017).

An innovation is thus created by combining the two characteristics of novelty and use, as defined by Ahmed and Shepherd (2010). This paper follows the Ahmed and Shepherd's definition and consider innovation as a combination of something new that using or applying brings a change to the status quo.

Research Design

This paper adopts the methodology of systematic literature review (SLR) (Kitchenham, 2004, Figure 1). The SLR consists of three phases: planning, conducting, and reporting. Within the first phase, "planning the review", the goal is to create a basic framework and design the content arrangement. This involves identifying the need for a review, specifying the addressed research questions, and developing a review protocol for controlling the review. "Conducting the review" in the second phase means executing the review protocol designed in the planning phase, which includes the creation of a dataset. This begins with the selection of suitable publications as a first step, quality assessment

and cleaning as a second step, and data extraction as a final step. The third and last phase, "Reporting the review", concludes with results that answer the predefined research questions (Kitchenham & Charters, 2007).

To obtain valid results it is important to follow a systematic search strategy while doing a literature review. This can be done by defining the objectives and formulating specific research questions to be answered by carrying out the review. The research questions addressed by this article are derived from the objectives mentioned in the introduction. Our research answers the following research question (RQ):

Which subject areas are relevant in the context of data economy innovation and what are the major research streams and (sub-) topics?

The first step to conduct a phase of the SLR is the study selection. As a first step, we focused on Elsevier's Scopus database as a source for exploring peer-reviewed publications. Scopus offers easy access for meta-data on publications and has one of the largest databases for scientific publications with over 70 million publications (<https://www.elsevier.com/solutions/scopus>). For the second step, we defined suitable keywords to meet the objectives of our review and to answer the above research questions. We used the keywords "digital economy", "data economy", "digital business model", "data driven business model", "digital business", "digital platforms", "data technologies", "digital disruption", and "digital transformation". These keywords, chained

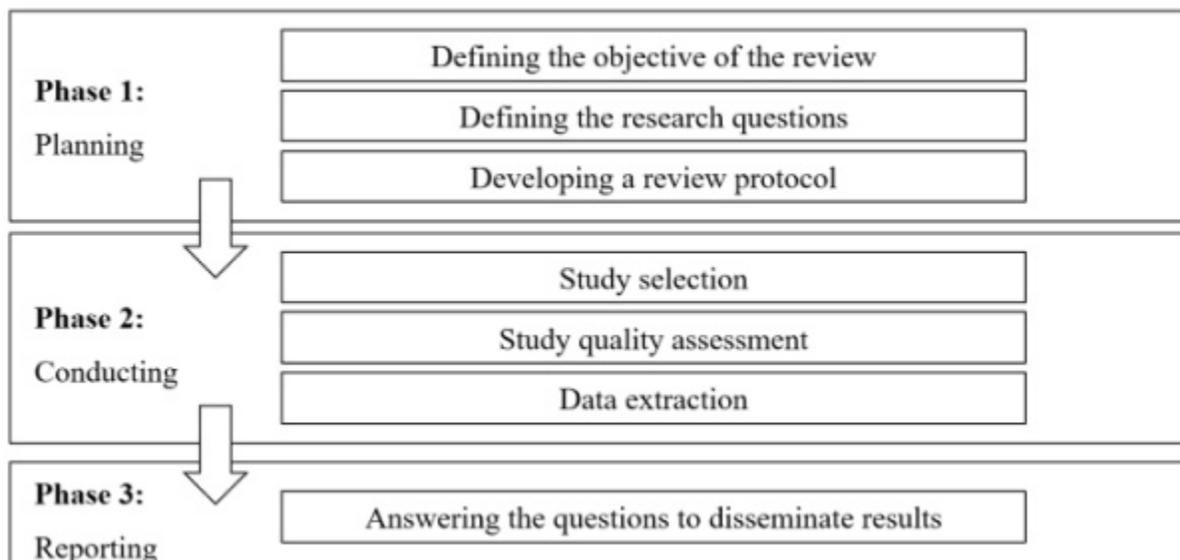


Figure 1. SLR process phases according to Kitchenham and Charters (2007)

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

```
TITLE-ABS-KEY ("digital economy" OR "data economy" OR "digital business model" OR
"data driven business model" OR "digital business" OR "digital platforms" OR "data
technologies" OR "digital disruption" OR "digital transformation") AND TITLE-ABS-KEY
("Innovation") AND (LIMIT-TO (DOCTYPE, "cp") OR LIMIT-TO (DOCTYPE, "ar"))
AND (LIMIT-TO (LANGUAGE, "English" ))
```

Figure 2. Search Query from Scopus

as or-conditions, set the basis for retrieving appropriate publications for our review. Furthermore, we needed to ensure a connection to innovation. For this reason, we added the keyword “innovation” as a mandatory condition in the title, abstract, or keyword of the publication, and chained this as a prerequisite regardless of all the other keywords, that is, where that particular term has to be matched. With this combination of keywords, we ensured a focus on publications in the area of data economy and innovation. Following this approach, we were able to retrieve 1,163 publications as the foundational data set.

For the second step, we had to ensure the quality of our data set, and therefore combined the results with different filters and inclusion criteria, in order to gain a higher level of quality. In the second stage, 908 publications were returned, after limiting the result set to journal articles and conference papers. The third stage included only articles published in English, which returned 863 articles. Stage four excluded another three articles due to missing author names. We also consciously decided not to exclude subject areas in Scopus in order to cover a wide range of research. The final search string, as the result of combining our keyword search together with the limitation criteria, is depicted in Figure 2.

The final limitation on stage five was performed outside the Scopus search engine. We used Scopus’ export functionality to export a BibTeX formatted file of the search results, including the fields: Author (a), Document title (b), Year (c), Source title (d), volume, issue, pages (e), Citation count (f), Source & document type (g), DOI (h), Affiliations (i), Language (j), Abstract (k), Author keywords (l), and Index keywords (m). A python script was implemented to extract the information, which was exported in BibTeX format within a relational database system in order to have a better structure for further analyses of relations. The script systematically loops through the BibTeX file and stores article information, as listed above, for each entry.

In order to focus our analysis on innovation topics within the data economy, we limited our dataset by searching for specific words within the articles’ abstracts, and excluded all articles that did not include these terms. For filtering, we choose the words (a) problem, (b) challenge, (c) demand, (d) requirement, (e) obstacle, (f) limit, (g) barrier, and (h) necessity. We argue that these terms, related to challenges and obstacles, within the abstracts enables through filtering the identification of novel approaches and applications to a specific problem. It was deliberately decided not to do a full-text analysis of the publications for two reasons:

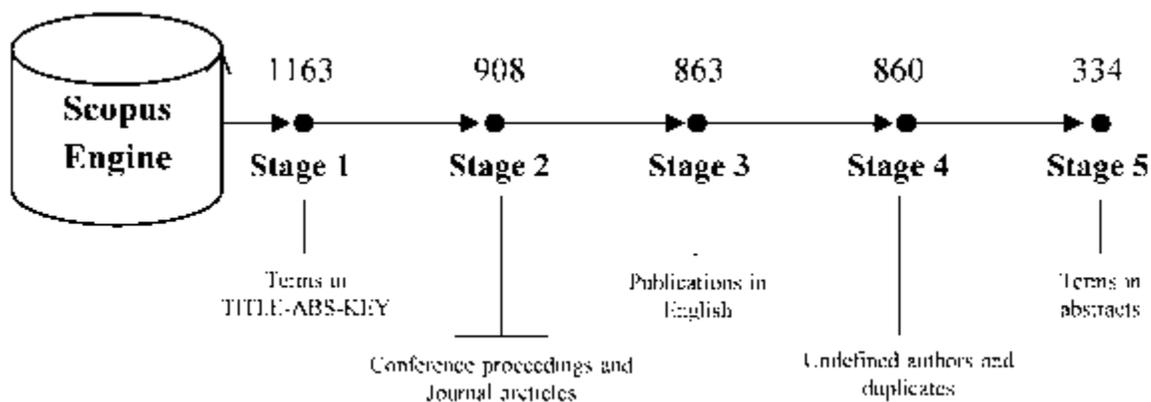


Figure 3. Study selection on the Scopus Engine

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

First, information density is highest in the abstract (Scheumie et al., 2004). Second, access to scientific full-text content for text mining is difficult due copyright and licensing reasons (O'Mara-Eves et al., 2015). Based on our approach, the final number of articles, as result of stage five, returned 334 documents. The full study selection and cleaning process is depicted in Figure 3.

In order to answer the specified research questions, we analyzed the abstracts and topic for data extraction. To get first insights into the data set, we used available general meta information. For example, we considered the year of publication in the area of data economy and innovation. In addition, in co-authored papers, author affiliations were analyzed, as well as country of work, in order to depict where research on the focus topic is done. From a content perspective, we took subject areas from different sources within our data set to get a distribution overview. For our main research, we focused on annotated keywords, since they can serve to help articulate a highly concise summary of a document (Siddiqi and Sharan, 2015). Within the available datasets, the keywords exported from Scopus database differed between indexed and author keywords. While author keywords are exempt from semantics rules and annotated directly by the authors, indexed keywords are assigned by Scopus using a taxonomy to form a semantic system and organize the platforms entries. Using this system enables a more consistent analysis through better comparability between different keywords. For further analyses, we used indexed keywords only.

To answer the specified research questions, we analyzed the relations between different keywords and formed clusters of different topics and sub-topics. The assigned relations between keywords were done by creating a correlation matrix. We looped through different keywords and selected all publications containing a specific keyword. After that we mapped all other keywords assigned to these publications and linked these relations within our database.

Findings

Summary and analysis of results

It should be noted as a general result that the number of scientific publications in this field has increased more than 2,800% over the last 10 years (Figure 4). Although the publication date was not considered as a filter criterion in the search process, the following graph starts at 1998, because before 1998 only one article (in 1985) was published.

From a geographical point of view, most of the publications we studied where published within the United States of America, Germany, United Kingdom, China, and the Russian Federation, as seen in the following Figure 5.

Figure 6 shows the main subject areas: computer science (28%), business, management & accounting (16%), and engineering (14%). Surprisingly, the social science sector is also strongly represented with 11% of all scientific



Figure 4. Number of scientific publications by year

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

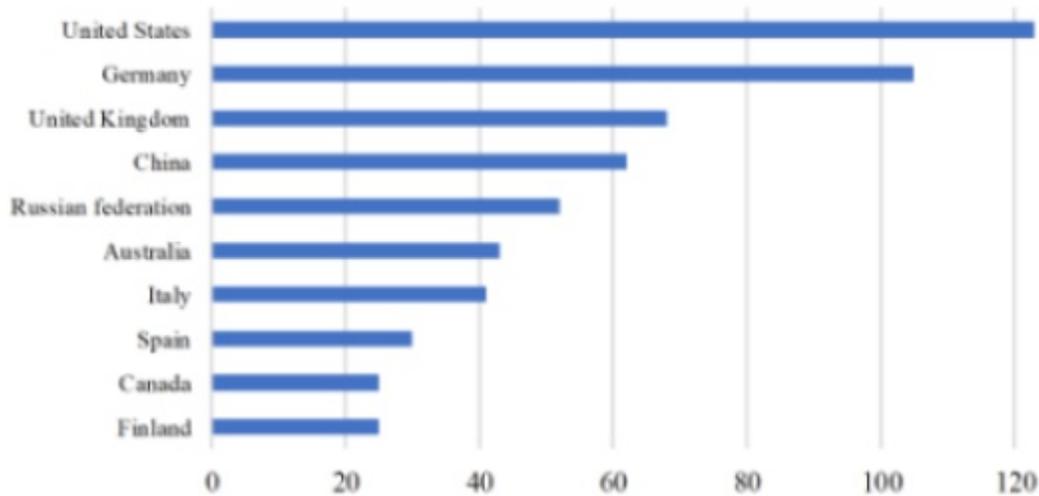


Figure 5. Number of scientific publications by country

publications on our topic. Figure 7 shows the leading research institutions in this field.

Keyword relations in a network graph

Gephi (<http://gephi.org>) software was used in order to identify and visualize subject areas and relations between keywords from the scientific literature. This software enabled the creation of a network graph, which illustrates the relations between keywords, as shown in Figure 8. In this graph, one can see so-called keyword nodes, as well as the edges that establish connections between nodes. The unfiltered graph includes 5,231

nodes and 114,414 edges. By using force-directed algorithms, where nodes repulse and edges attract each other, we identified nine relevant clusters.

By using filter techniques, such as a giant component (see Fulton et al., 2001) as used in the network theory, and a degree range setting of 65, only 658 nodes and 23,706 edges were left. In order to spatialize the network graph, the Forceatlas2 algorithm was used. Forceatlas2 is a force-directed layout where nodes repulse and edges attract (Jacomy et al., 2014). Furthermore, a modularity class filter was applied to examine the resulting

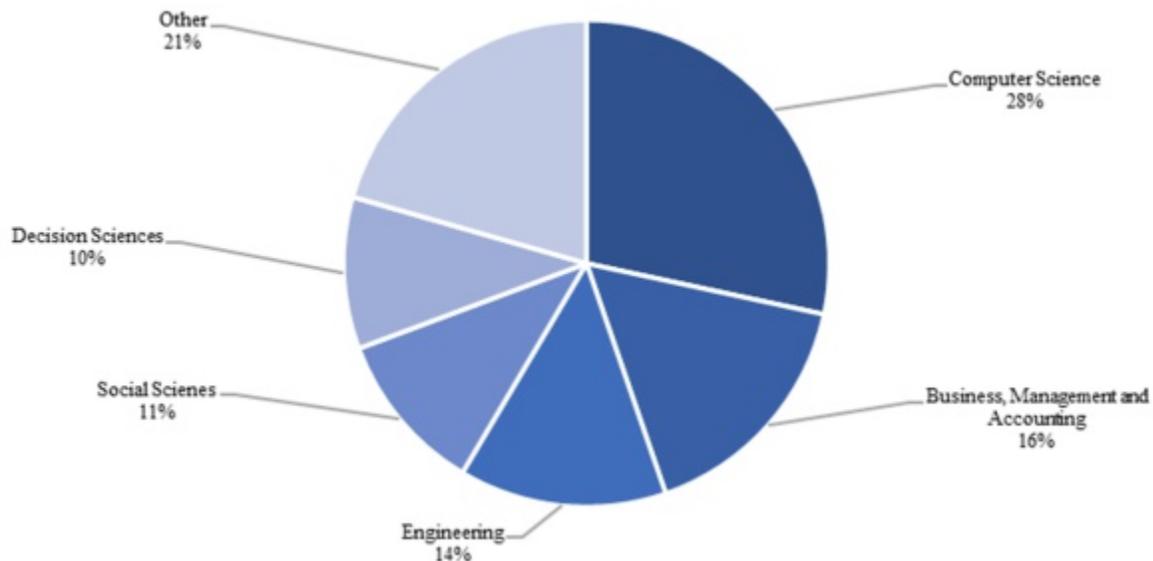


Figure 6. Portion of scientific publications by subject area

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

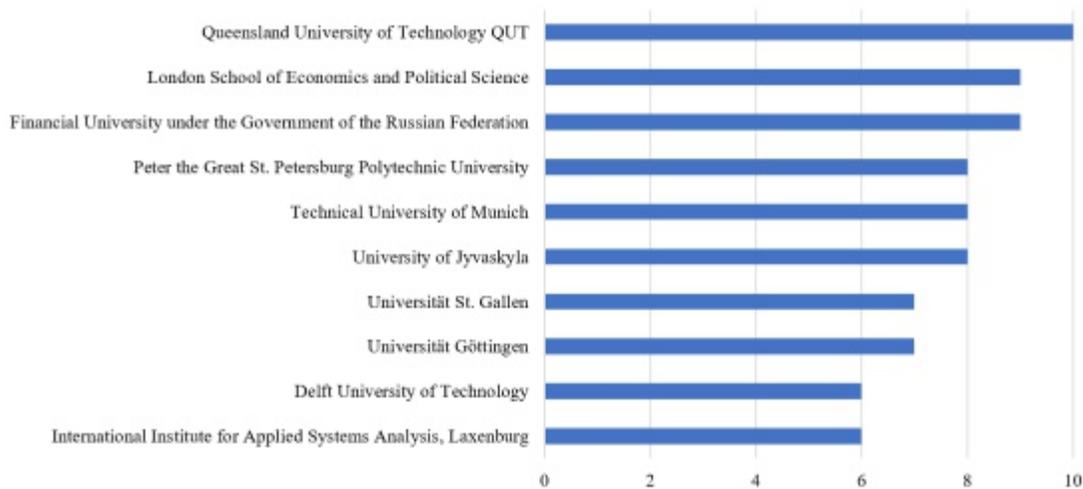


Figure 7. Number of scientific publications by affiliation

communities in the network (Blondel et al., 2014). As shown in Figure 8, the network graph has nine clusters. These were resized according to their degree of their interconnectedness to give a better presentation of the most relevant nodes.

Table 1 sums up the identified clusters, including the top keywords from each cluster. The name of the cluster is based on the node with the most incoming and outgoing edges. The number of all edges in total are given according to the keyword within the table. Based on the keywords related to the presented clusters, we derived a proposal for interpretation. This explanation was used to form a common understanding of the clusters in communicating preliminary results.

Fields of innovation potential

We argue that the nine clusters are to be regarded as categories for potential innovation within the overall data transformation towards a data economy. Organizations should pay attention to these topics, while transforming their business and developing digital services and business models. As well, they should track ongoing research to identify novel approaches and applications to different areas and topics.

In order to obtain more precise evaluation, we carried out a keyword comparison. For this purpose, we compared the number of keywords between the articles reviewed in stages 4 and 5. This was done to identify the ratio of keywords within all articles in order to discover possible articles for innovation topics.

Figure 9 shows a comparison between the top four article subject areas in data economy, as well as two selected subject areas (knowledge management and

artificial intelligence), which are based on article abstracts. As can be clearly seen, many scientific publications address challenges within their abstracts, and therefore are rated as likely to provide insights about innovation potential. The topics of innovation management (76%), machine learning (71%), decision making (63%), and knowledge management (31%) are overrepresented in the publications dealing with challenges compared to all publications. However, contrary to expectations, we also found artificial intelligence having only a small increase (20%) in the number of mentions by comparison. While the ratio of artificial intelligence (AI) is relatively similar, the subclass of machine learning reveals a considerable difference. This dominance of ML shows that authors prefer ML vs. AI terminology.

Node analysis

Analysis of the results shows that authors on this topic seem to assume that challenges are associated with data handling, innovation management, decision-making, and machine learning. We assume that more research in specific areas will lead also to higher innovation potential, especially in combination with other topics and technologies.

The following graph is presented in more detail for two concrete examples, first, for "Big Data" (Figure 10). The clearly visible connection to "Digital Transformation" and "Technological innovation" supports our argumentation about automatic identification of innovation potential.

Secondly, the node "machine learning" shows a very strong connection with the 5th cluster "Decision making" (Figure 11). Along with machine learning, one

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

Name	Terms	Interpretation
Digital transformation	Digital transformation (474) information systems (324), digital platforms (294), commerce (216), digital technologies (190), digital business (172), information services (148), ecosystems (136), open innovation (128), digital innovations (122), industry 4.0 (114)	The first cluster is the biggest cluster within the network graphic, and contains related terms with digital transformation.
Big data	Big data (362), data technologies (158), internet of things (142), data handling (142), learning systems (122), artificial intelligence (120), cloud computing (114), data mining (98), technological innovation (98), data privacy (88), Hadoop (68)	The cluster big data stands in close coloration with data ecosystems. This includes topics such as the handling of data, data processing, or big data technologies, such as Hadoop.
Digital Economy	Digital Economy (410), knowledge management (232), knowledge-based systems (230) business models (198), innovation management (148), international trade (124), competitive advantage (102), innovation network (102), High tech industry (78), Chinese companies (72)	Within the third cluster, the keyword digital economy has the most connections by far. This keyword is related, for example, to the development of new innovative business models in order to gain an advantage over competitors.
Economics	Economics (436), competition (246), information and communication technologies (160), productivity (102), regional planning (100), industrial management (92), economic growths (64), enabling technologies (52), industrial economics (42)	The topics of the Economics cluster are about general management topics, and processes as well as their adaption through digital components. This can be derived from strong relations to various keywords of topics within digital economy and innovation.
Decision making	Decision making (240), machine learning (136), information science (134), standardization (132), algorithms (110), image processing (110), image analysis (90), Prognosis (90)	The Gephi graphic shows that the use of decision-making algorithms, machine learning, Pattern recognition in the 5th cluster is very important for innovation and data.
Human	Human (536), information technology (210), internet (176), education (146), social media (86), united states (86), organization (70), efficiency (70), entrepreneurship (62), organizational innovation (60), international cooperation (46), leadership (44)	The cluster shows that roles and actors play an important role within data ecosystems. This is illustrated by keywords such as human, organization, and leadership.
Environmental Protection	Environmental protection (140), ecosystem (110), female (104), male (104), stakeholder (102), cooperation (98), conceptual framework (88), mass communication (88), natural resource (80), resource management (72)	This cluster shows close connections to environment & nature. Participants in natural ecosystems, as well as with resources seem to play a role here.
Information management	Information management (320), life cycle (162), information use (140), ontology (130), standards (128), semantic web (114), product design & development (112), software applications (94), design method (78), data quality (76), life cycle assessment (72)	The core of "information management" includes the handling and use of information. This is where the entire lifecycle of data plays a role: from data collection to the use of information for product development.
Healthcare	Exercise (78), preventive medicine (78), sports medicine (78), Patient-Centered Care (78), arthritis (72), behavior change (72), cardiovascular disease (72), cognitive defect (72), consensus (72), depression (72), diabetes mellitus (72), hypertension (72)	The ninth cluster is the only one with an industry focus. On the one hand, this cluster shows how important the use of data and information is in healthcare. On the other hand, it could be deduced that research and development in this sector is comparatively high.

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

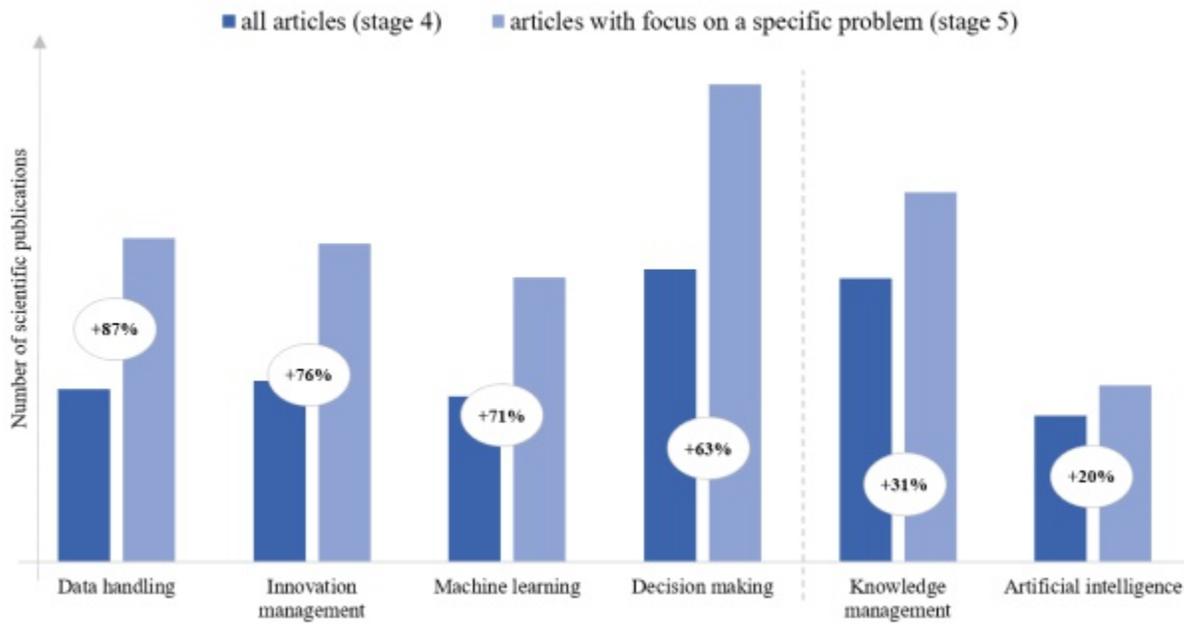


Figure 9. Keywords vs. keywords in context of challenges

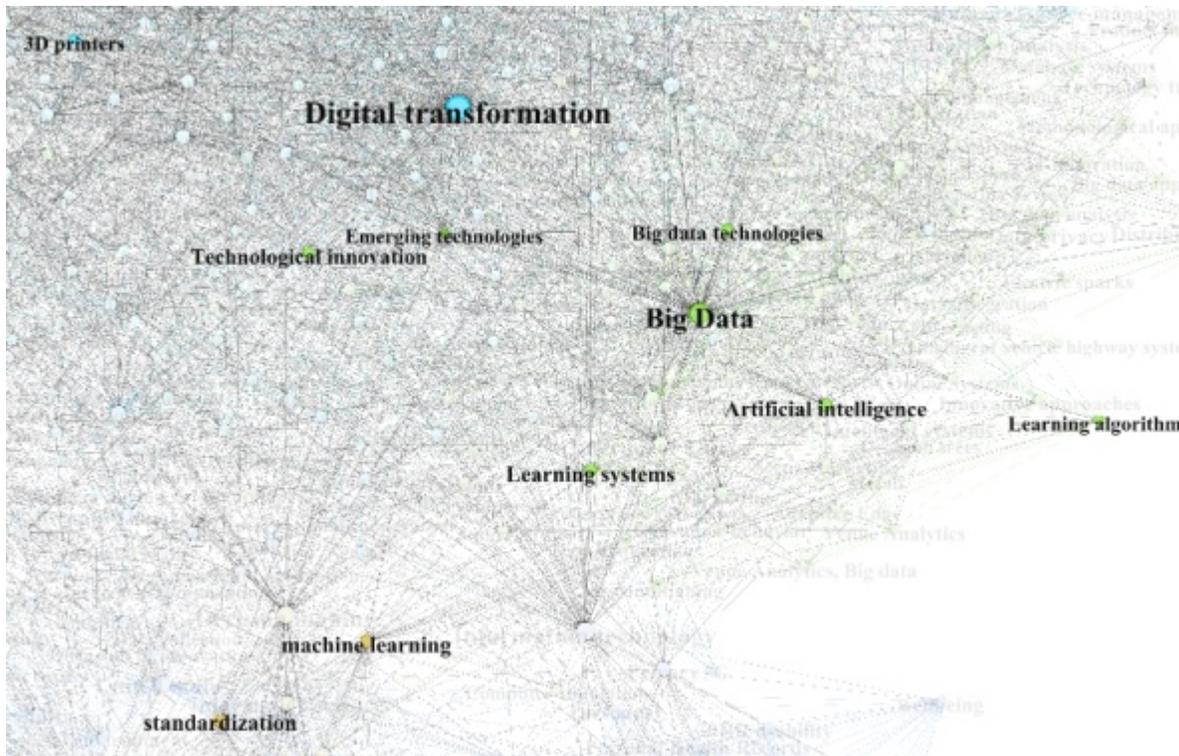


Figure 10. Gephi analysis of the node "Big Data"

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

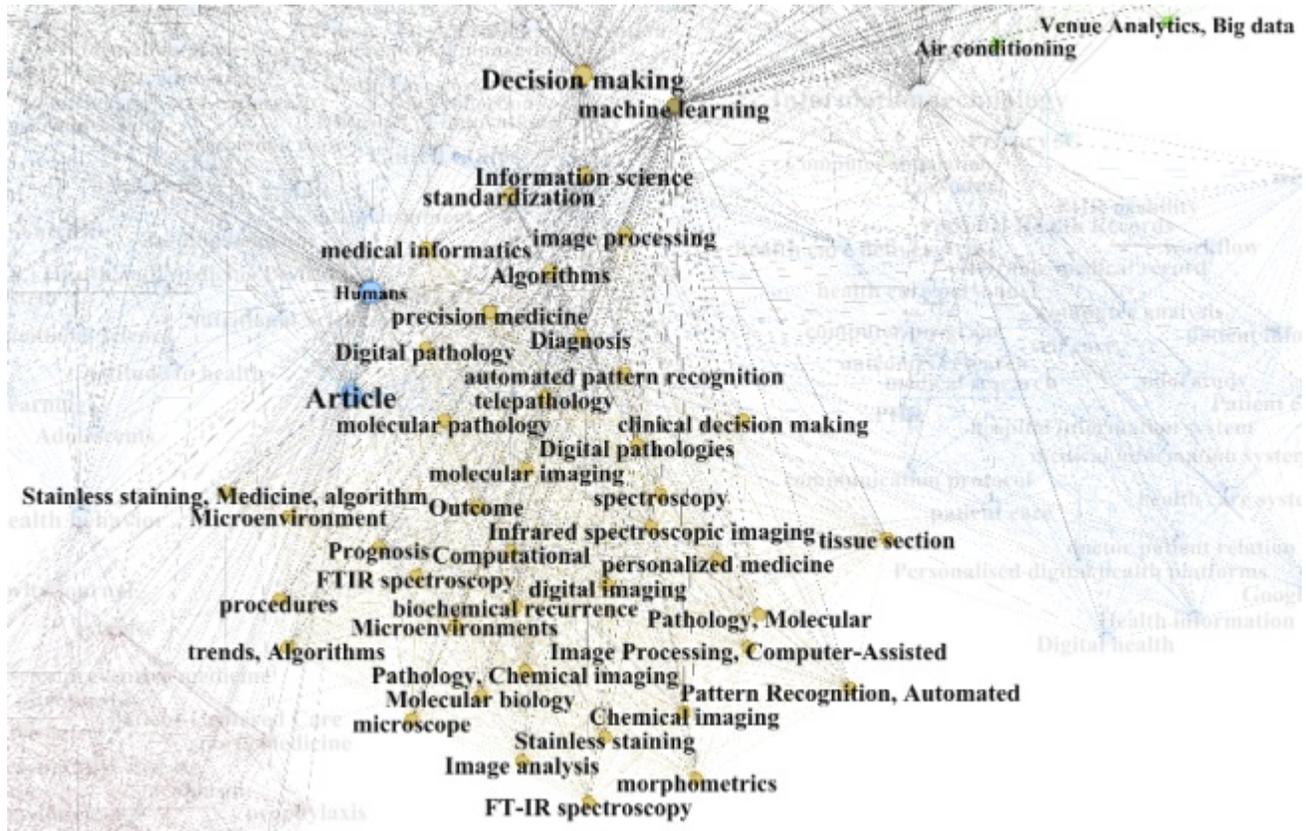


Figure 11. Gephi analysis of the node "machine learning"

can identify also strong connections to applications within the medical sector, shown by the nodes "medical informatics", "digital pathology", and "clinical decision making".

Conclusion

This paper presents an automatized way to derive areas for innovation in the field of data economy. By conducting a systematic literature review in combination with basic text-mining methods, we identified 1,163 publications in the Scopus database. We analyzed them to identify a suitable dataset of publications containing terms related to challenges and requirements, as a way to answer our predefined research questions. We focused on these publications because abstracts dealing with challenges and related terms also refer to innovation topics. With pattern recognition based on text mining, we identified 334 articles based on abstracts that included specified terms for our analysis.

We then illustrated the development of topics and sub-topics related to data economy and innovation over the time, and depicted the main contributors in this area

according to geography as well as affiliation. In addition, we identified major research streams by performing a network analysis and forming clusters based on the number of interconnections between different topics and their sub-topics. This provided an overview about relevant topics within the data economy that can help researchers derive topics where future research will probably emerge.

Researchers and practitioners are welcome to test the usefulness and applicability of our approach, especially evaluating our argumentation that derives innovation potential from challenges and requirement-related publications. Further research in the field of data economy may challenge our results with a more detailed view of specific clusters to gain even more insights.

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

Reference

- Ahmed, Pervaiz K., Shepherd, Charlie. 2010. Innovation Management. *Context, strategies, systems and processes* (1st ed.). Harlow: Financial Times Prentice Hall.
- Barnett, Homer G. 1953. *Innovation: The basis of cultural change*. New York: McGraw- Hill.
- Blondel, Vincent D., Guillaume, Jean-Loup, Lambiotte, Renaud, and Lefebvre, Etienne. 2008. Fast unfolding of communities in large networks. *J. Stat. Mech. Theory Exp.*
- Federal Association of the Digital Economy. 2018. Data Economy. *Datenwertschöpfung und Qualität von Daten*.
- Coupland, Rob. 2018. Digital Realty. *Data Economy Report*.
- Ding, Ying, Chowdhury, Gobinda, Foo, Schubert. 2001. Bibliometric cartography of information retrieval research by using co-words analysis. *Inf. Process.*
- European Commission 2019. *Building a European data economy*. www.ec.europa.eu/digital-single-market/en/policies/building-european-data-economy.
- Francis, Dave L. and Bessant, John. 2005. Targeting Innovation and Implications for Capability Development. *Technovation*, 25, (3): 171-183.
- Bollobas, Bela. 2001. Random Graphs. *Cambridge Studies in Advanced Mathematics*, 73.
- Jacomy, Mathieu, Venturini, Tommaso, Heymann, Sebastien, Bastian, Mathieu. 2014. ForceAtlas2, a continuous graph layout algorithm for handy network visualization designed for the Gephi software. *PLoS One*. 9: 1–12.
- Kitchenham, Barbara. 2004. Procedures for Undertaking Systematic Reviews. *Joint Technical Report*, Computer Science Department, Keele University (TR/SE-0401) and National ICT Australia Ltd.
- Kitchenham, Barbara, and Charters, Stuart. 2007. Guidelines for performing Systematic Literature reviews in Software Engineering Version 2.3. *Engineering*, 45.
- Moody, Daniel, and Walsh, Peter. 1999. Measuring the Value Of Information: An Asset Valuation Approach. *Seventh Eur. Conf. Inf. Syst.*: 1–17.
- O'Mara-Eves, Alison, Thomas, James, McNaught, John, Miwa, Makoto, and Ananiadou, Sophia. 2015. Using text mining for study identification in systematic reviews: A systematic review of current approaches. *Syst. Rev.* 4: 1–22.
- Otto, Boris. 2015. Quality and Value of the Data Resource in Large Enterprises. *Inf. Syst. Manag.* 32: 234–235.
- Otto, Boris, Bärenfänger, Rieke, Steinbuß, Sebastian. 2015. Digital Business Engineering: Methodological Foundations and First Experiences from the Field. *Proc. 28th Bled eConference*: 58–76.
- Rogers, Everett M. 1983. *Diffusion of Innovations* (3rd ed.). New York: Free Press.
- Schuemie, Martijn J., Weeber, Marc, Schijvenaars, Bob JA, Mulligen, Rik M. Van, van der Eijk, C. Cristiaan, Jelier, C. Cristiaan, Mons, Barend, and Kors, Jan A. 2004. Distribution of information in biomedical abstracts and full-text publications. *Bioinformatics*, 20: 2597–2604.
- Schumpeter, Joseph. 1912. *Theorie der wirtschaftlichen Entwicklung. Eine Untersuchung über Unternehmerrgewinn, Kapital, Kredit, Zins und Konjunkturzyklus* (9. Aufl.). Berlin: Duncker und Humboldt.
- Siddiqi, Sifatullah, and Sharan, Aditi. 2015. Keyword and Keyphrase Extraction Techniques: A Literature Review. *Int. J. Comput. Appl.* 109: 18–23.
- Tidd, Jie, and Bessant, John R. 2015. *Innovation and Entrepreneurship* (3rd ed.). Wiley.
- van der Kooij, Bouke. 2017. Search for a Common Ground in the Fogs of Innovation Definitions. *SSRN Electronic Journal*.
- Vedin, Bengt-Arne. 1980. *Management and organization for innovation: radical product renewal in large corporations*. Göteborg: Chalmers TH.
- Yoo, Youngjin, Henfridsson, Ola, and Lyytinen, Ola. 2010. The new organizing logic of digital innovation: An agenda for information systems research. *Information Systems Research*. Vol. 21, No. 4, December: 724–735.
- Zimmerman, Hans-Dieter. 2000. Understanding the Digital Economy: Challenges for New Business Models. *AMCIS 2000 Proceedings*.
- Zawislak, Paulo Antônio, Borges, Mauro, Wegner, Douglas, Santos, Andre and Cristina, Castro-Lucas. 2008. Towards the Innovation Function. *Journal of Technology Management & Innovation*.

Uncovering Research Streams in the Data Economy Using Text Mining Algorithms

Can Azkan, Markus Spiekermann, Henry Goecke

About the Authors

Can Azkan is a scientist and PhD candidate at the Fraunhofer Institute for Software and Systems Engineering ISST in Germany. He studied Mechanical Engineering at the Technical University of Dortmund and the San Diego State University, while he gained practical experience in the field of industrial engineering and digital business models in machine and plant engineering. His research at Fraunhofer ISST focuses on value co-creation in emerging data ecosystems and the management of data as a corporate asset.

Markus Spiekermann currently works as Head of Department "Data Business" at the Fraunhofer Institute for Software and Systems Engineering in Dortmund, Germany. He leads research projects and is active in several related advisory boards. His main research focuses on the topics of data engineering and data management, alongside on the valuation of data assets especially within data ecosystems. Before his time at Fraunhofer, he worked as IT-Professional and Software Engineer from 2008 to 2016. He obtained his Bachelor and Master of Science degree in the field of information systems with a focus on IT Management at the FOM University of Applied Sciences in Essen.

Since 2017 Dr. Henry Goecke has been head of the Research Group "Big Data Analytics" at the German Economic Institute. Previously he worked at the German Economic Institute as scientific assistant of the Director, at the IW Consult as Senior Economist, at the TU Dortmund University as research and teaching assistant as well as lecturer at the University of Cologne and the Hochschule Fresenius. He studied Economics at the TU Dortmund University, Strathclyde University of Glasgow, and the Leuphana University of Lüneburg. His research interests are on the impact of social media, artificial intelligence, big data, and data economy.

Citation: Azkan, C., Spiekermann, M., Goecke, H.. 2019. Uncovering Research Streams in the Data Economy Using Text Mining Algorithms. *Technology Innovation Management Review*, 9(10): 62-74.
<http://doi.org/10.22215/timreview/1283>



Keywords: Data Ecosystem, Data Economy, Digital Economy, Data Ecosystem, Digital Transformation, Data Market, Big Data, Literature Review, Network Graph, Text Mining.

Author Guidelines

These guidelines should assist in the process of translating your expertise into a focused article that adds to the knowledge resources available through the Technology Innovation Management Review. Prior to writing an article, we recommend that you contact the Editor to discuss your article topic, the author guidelines, upcoming editorial themes, and the submission process: timreview.ca/contact

Topic

Start by asking yourself:

- Does my research or experience provide any new insights or perspectives?
- Do I often find myself having to explain this topic when I meet people as they are unaware of its relevance?
- Do I believe that I could have saved myself time, money, and frustration if someone had explained to me the issues surrounding this topic?
- Am I constantly correcting misconceptions regarding this topic?
- Am I considered to be an expert in this field? For example, do I present my research or experience at conferences?

If your answer is "yes" to any of these questions, your topic is likely of interest to readers of the TIM Review.

When writing your article, keep the following points in mind:

- Emphasize the practical application of your insights or research.
- Thoroughly examine the topic; don't leave the reader wishing for more.
- Know your central theme and stick to it.
- Demonstrate your depth of understanding for the topic, and that you have considered its benefits, possible outcomes, and applicability.
- Write in a formal, analytical style. Third-person voice is recommended; first-person voice may also be acceptable depending on the perspective of your article.

Format

1. Use an article template: **.doc .odt**
2. Indicate if your submission has been previously published elsewhere. This is to ensure that we don't infringe upon another publisher's copyright policy.
3. Do not send articles shorter than 2000 words or longer than 5000 words.
4. Begin with a thought-provoking quotation that matches the spirit of the article. Research the source of your quotation in order to provide proper attribution.
5. Include an abstract that provides the key messages you will be presenting in the article.
6. Provide a 2-3 paragraph conclusion that summarizes the article's main points and leaves the reader with the most important messages.
7. Include a 75-150 word biography.
8. List the references at the end of the article.
9. If there are any texts that would be of particular interest to readers, include their full title and URL in a "Recommended Reading" section.
10. Include 5 keywords for the article's metadata to assist search engines in finding your article.
11. Include any figures at the appropriate locations in the article, but also send separate graphic files at maximum resolution available for each figure.

Issue Sponsor

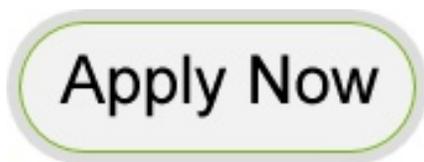


Do you want to start a new business? Do you want to grow your existing business?

Lead To Win is a free business-development program to help establish and grow businesses in Canada's Capital Region.

Benefits to company founders:

- Knowledge to establish and grow a successful businesses
- Confidence, encouragement, and motivation to succeed
- Stronger business opportunity quickly
- Foundation to sell to first customers, raise funds, and attract talent
- Access to large and diverse business network



leadtowin.ca



Academic Affiliations and Funding Acknowledgements



Technology Innovation Management (TIM; timprogram.ca) is an international master's level program at Carleton University in Ottawa, Canada. It leads to a Master of Applied Science (M.A.Sc.) degree, a Master of Engineering (M.Eng.) degree, or a Master of Entrepreneurship (M.Ent.) degree. The objective of this program is to train aspiring entrepreneurs on creating wealth at the early stages of company or opportunity lifecycles.

The TIM Review is published in association with and receives partial funding from the TIM program.

S SCALE EARLY RAPIDLY AND SECURELY (SERS)

The TIM Review team is a key partner and contributor to the Scale Early, Rapidly and Securely (SERS) Project: <https://globalgers.org/>. Scale Early, Rapidly and Securely (SERS) is a global community actively collaborating to advance and disseminate high-quality educational resources to scale companies.

The SERS community contributes to, and leverages the resources of, the TIM Review (timreview.ca). The authors, readers and reviewers of the TIM Review worldwide contribute to the SERS project. Carleton University's Technology Innovation Management (TIM) launched the SERS Project in 2019.

We are currently engaged in a project focusing on identifying research and knowledge gaps related to how to scale companies. We are inviting international scholars to join the team and work on shaping Calls for Papers in the TIM Review addressing research and knowledge gaps that highly relevant to both academics and practitioners. Please contact the Editor-in-Chief, Dr. Stoyan Tanev (stoyan.tanev@carleton.ca) if you want to become part of this international open source knowledge development project.