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Insights

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

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Overview

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

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

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

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About TIM

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

Editorial: Insights

Chris McPhee, Editor-in-Chief

Welcome to the March 2018 issue of the *Technology Innovation Management Review*. The authors in this issue share insights on creating value in the Internet of Things, using big data and analytics to develop value propositions, transitioning from closed to open innovation in an emerging economy, and deciding on the right timing and conditions for internationalization.

In the first article, **Heini Ikävalko**, **Petra Turkama**, and **Anssi Smedlund** from the Center for Knowledge and Innovation Research at Aalto University in Finland examine the co-creative nature of business opportunities in the Internet of Things (IoT). Taking an ecosystem perspective on three use cases within a larger European IoT initiative, they discover how different actors may take the roles of "ideator", "designer", or "intermediary" as they co-create business models in different design layers. Their mapping of value creation in IoT ecosystems has implications for both researchers and managers.

Next, **Victoria Kayser**, **Bastian Nehrke**, and **Damir Zubovic** from Ernst and Young in Germany ask: what can the practical discourse on big data and analytics learn from innovation management? Using a framework based on data, infrastructure, and analytics – and driven by business need – they have developed a process for taking analytics projects from the first ideas to the realization of a functional application. In their article, they outline the phases of this process and discuss how it can be transferred to organizations that wish to build analytics capabilities, regardless of size or level of experience.

Then, **Elisa Thomas** from the Centre for Innovation Research at the University of Stavanger in Norway examines the extent to which open innovation is undertaken by firms in an emerging economy as they engage in R&D activities. Despite finding some evidence of increasing openness in the flow of knowledge through the internal and external relationships in two chemical firms in Brazil, the study shows that these firms are not fully exploiting the potential benefits of open innovation, even when complete opening is not the main goal. The author highlights the scholarly contribution of the study and provides general recommendations for innovation managers.

Finally, **Flavia Luciane Scherer**, **Italo Fernando Minello**, **Cristiane Krüger**, and **Andréa Bach Rizzatti** from the Federal University of Santa Maria in Brazil describe a technology startup's failed early attempt at internationalization and the lessons its founders are applying as they contemplate a second attempt to grow beyond the Brazilian market. Drawing on the literature on internationalization (especially the Uppsala model), export barriers, and the origin and concept of startups, the authors share insights from the case and derive recommendations to help technology startups in emerging economies successfully internationalize.

In April, we will examine the theme of **Frugal Innovation** with Guest Editors **Deepak S. Gupta**, Executive Director of Applied Research, Innovation and Entrepreneurship Services (ARIES) at Centennial College in Toronto, Canada, and **Mokter Hossain**, Assistant Professor in the Center for Industrial Production at Aalborg University, Denmark.

We have also recently issued a call for papers (tinyurl.com/y76k3kkb) for a special issue on **Transdisciplinary Innovation** with Guest Editors **Martin Bliemel** and **Mieke van der Bijl-Brouwer** from the Faculty of Transdisciplinary Innovation at the University of Technology Sydney, Australia.

For future issues, we are accepting general submissions of articles on technology entrepreneurship, innovation management, and other topics relevant to launching and growing technology companies and solving practical problems in emerging domains. Please contact us (timreview.ca/contact) with potential article topics and submissions, and proposals for future special issues.

Chris McPhee
Editor-in-Chief

Editorial: Insights

Chris McPhee

About the Editor

Chris McPhee is Editor-in-Chief of the *Technology Innovation Management Review*. Chris holds an MASc degree in Technology Innovation Management from Carleton University in Ottawa, Canada, and BScH and MSc degrees in Biology from Queen's University in Kingston, Canada. He has nearly 20 years of management, design, and content-development experience in Canada and Scotland, primarily in the science, health, and education sectors. As an advisor and editor, he helps entrepreneurs, executives, and researchers develop and express their ideas.

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Value Creation in the Internet of Things: Mapping Business Models and Ecosystem Roles

Heini Ikävalko, Petra Turkama, and Anssi Smedlund

> *He had brought a large map representing the sea,*
> *Without the least vestige of land:*
> *And the crew were much pleased when they found it to be*
> *A map they could all understand.*
>
> Lewis Carroll (1832–1898)
> Writer, mathematician, cleric, and artist
> In *The Hunting of the Snark* (1876)

The increasing connectivity provided by the Internet of Things (IoT) supports novel business opportunities for actors in overlapping service systems. Therefore, the co-creative nature of IoT business needs to be further studied. This article reports an empirical study on a European IoT initiative. It contributes to the understudied area of IoT ecosystem dynamics by describing different actor roles and activities in the IoT use cases, and their implications for value creation in IoT ecosystems. Our findings show how IoT ecosystem actors may take the roles of ideator, designer, or intermediary in different IoT design layers, and we recommend this perspective to better understand and describe ecosystem business models. We also discuss the theoretical and managerial implications of our findings.

Introduction

The Internet of Things (IoT) has spawned emerging business opportunities as digital technology is embedded in previously unconnected objects (Turber et al., 2014). The IoT means physical or virtual devices capable of communicating in real time (ITU-T, 2012). The data is used in creating a virtual counterpart of reality for optimization, prediction, and control of systems (Främling et al., 2003). The IoT offers new business opportunities in domains such as transportation and logistics, healthcare, smart environments, and personal data (Atzori et al., 2010).

Business models, defined as "a simplified and aggregated representation of the relevant activities of a company" (Wirtz et al., 2016), provide structured tools for management and planning, and are increasingly being studied by academics (Magretta, 2002; Wirtz et al., 2016). Nonetheless, research on IoT business models remains limited. Earlier research proposes an increased relevance of customer and partner relationships (Magretta, 2002; Wirtz et al., 2016). Further, there is a shift towards an ecosystem perspective that differs from the firm-level perspective on business models (Turber et al., 2014; Westerlund et al., 2014; Iivari et al., 2016).

The IoT is characterized by complexity. In IoT ecosystems, the data and analytics not known in advance, satisfying the general definition of complexity (Johnson, 2001), where the actors have independent control logics, and the interactions are not pre-defined. Opportunities in the IoT include creating synergy and efficiency with connectivity of several service systems. In the resulting system of systems, service systems overlap and create new technical configurations, inviting actors to service creation with differing roles of providers and users. Identification and exploitation of the business opportunities in IoT ecosystems face challenges, such as the variety of objects, innovation immaturity, and structural ambiguity (Westerlund et al., 2014).

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This article is motivated by the aforementioned challenges and opportunities of IoT ecosystems, and the limited empirical research in this area. Recent work on IoT ecosystem business models notes the transition from providing products to services (Iivari et al., 2016; Westerlund et al., 2014) and the relevance of service-dominant logic (Turber et al., 2014), yet leaves the role of collaborators in value creation unexplored or remaining at a conceptual level. Here, we argue for the mapping of the relevant actors, relationships, and activities to realize the potential business opportunities in IoT ecosystems. With the aim of understanding IoT ecosystem business models, we ask: How do different actors contribute to co-creation in IoT ecosystems? We extend the earlier literature by differentiating the IoT ecosystem partners' service co-creation roles and by showing how the different roles relate to ecosystem value creation. This article deepens the business model discussion by suggesting the archetype roles of ideator, designer, and intermediary in the ecosystem business model mapping. By providing an empirical illustration of the variety of actor roles and the reasons those actors choose to participate in IoT ecosystem value creation, we contribute to the discussion of IoT ecosystem management and business models.

The article is structured as follows. We review the relevant literature concerning IoT ecosystem business models and value co-creation. Next, we describe the methodology of the study. In the results section, we describe the activities and roles through which the different actors contribute to value co-creation in IoT ecosystems. Finally, we discuss the results and their theoretical and managerial implications.

Literature Review

Business models in IoT ecosystems

The business model concept provides a suitable base for mapping the activities of IoT ecosystems. The extant literature on business models has developed towards a broader view, with an increasing interest in strategic and industry-level orientation (Wirtz et al., 2016). Along with digitalization, the focus shifts even more to the level of ecosystems, affecting the conceptualization of business models (Iivari et al., 2016; Westerlund et al., 2014). The ecosystem view answers questions such as: who are the collaborators, why do they participate, and where are the sources of value creation? (Turber et al., 2014).

The IoT business model literature includes both practical (Hui, 2014) and conceptual interests (Iivari et al., 2016; Westerlund et al., 2014). The role of the value proposition appears essential in empirical (Dijkman et al., 2015; Ju et al., 2016) and theoretical (Turber et al., 2014) approaches. One of the major shifts is the changing role of data in the IoT (Hui, 2014). The four layers of the digital architecture provide sources for value creation in the IoT, suggesting that value is created on: i) device layers (physical layers such as hardware and logical capability layers such as operating system); ii) network layers (physical transport layers such as cables and logical transmission layers such as network standards); iii) the service layer; and iv) the content layer (Yoo et al., 2010). In this article, we follow the suggestion by Turber and colleagues (2014) by analyzing value creation in an IoT ecosystem across these four layers of digital architecture.

Value co-creation in IoT ecosystems

IoT firms rely heavily on outsourcing activities to external partners, such as app developers, hardware providers, and analysis providers (Dijkman et al., 2015), which increases the complexity of the ecosystem. This tendency calls for an understanding of partner revenue streams (Dijkman et al., 2015; Hui, 2014). The trend to transform firm-centric activities towards network-centric activities also suggests a change to service-dominant logic in the IoT (Turber et al., 2014). This shift further highlights the need to consider business models at the level of ecosystems instead of single firms.

In this article, an ecosystem refers to "the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize" (Adner, 2017). This definition focuses on the configurations of activity around a value proposition (Adner, 2017) and fits with IoT ecosystems, in which building ecosystems around a focal actor is no longer the only solution.

As customers become collaborators through co-creation, the scope of a value proposition broadens to take into account collaborators' motives in addition to the traditional customer-specific value creation (Turber et al., 2014). This approach leads to inclusion of both monetary and non-monetary benefits, thus increasing the complexity of the ecosystem business model. Customer relationships in the IoT build on co-creation and communities thanks to the quick and personalized customer contact enabled by access to the customer data (Dijkman et al., 2015; Hui, 2014).

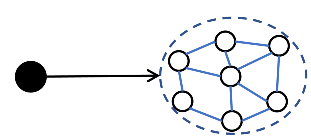
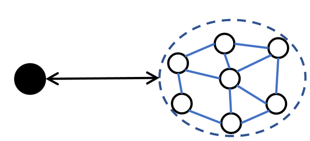
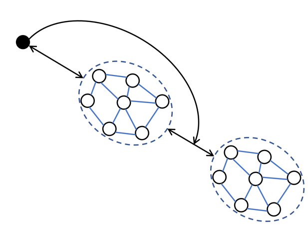
Despite acknowledging the relevance of value co-creation of IoT ecosystems (Iivari et al., 2016), the current literature lacks further conceptualization and empirical studies on the variety of actor roles in value co-creation within IoT ecosystems. Instead of simply describing who the collaborators are, we apply the differentiation of roles in service co-creation, as discussed by Lusch and Nambisan (2015) in their conceptual paper of digitally enabled service innovation.

Value co-creation in essence is the interactions between a firm and its customers (Prahalad & Ramaswamy, 2004), but can also include third parties, such as suppliers, business partners, or competitors (Kohlbacher, 2008). In light of service-dominant logic, value is co-created each time when capabilities, or specialized human knowledge and skills, are being applied for the benefit of the recipient (Vargo & Lusch, 2004; Vargo & Lusch, 2008). Service-dominant logic assumes that service is exchanged for service, and even a seemingly passive recipient provides input for the value co-creation relationship.

The recipient is the beneficiary of the value co-creation and can play many different roles (Lusch & Nambisan, 2015). Classification of the roles provides understanding of how value co-creation differs depending on the actors' orientation towards service innovation (Lusch & Nambisan, 2015) and the flow of knowledge (Smedlund & Toivonen, 2007). Defining the company's ecosystem role lays the foundation and defines the options for the company's business model design. The assumed role further expresses the service-exchange logic between the ecosystem partners.

The three identified role archetypes – ideators, designers, and intermediaries – have distinctly separate operating logic and activities in the ecosystems. First, ideators integrate current market offerings with their unique contexts and needs, and they provide input for service innovation by explicating these needs to the ecosystem with one-way communication. Second, designers mix and match existing knowledge components to develop new services with the ecosystem with reciprocal communication. Third, intermediaries cross-pollinate knowledge across many ecosystems and orchestrate service innovation with multi-way communication, affecting both the flow of knowledge and relationships. The intermediary role is especially important, because the intermediaries act as orchestrators by designing and facilitating the processes that allow ecosystem actors to collaborate with each other (Dhanaraj & Parkhe, 2006). Table 1 further illustrates the three roles.

Table 1. The three service exchange roles in IoT ecosystems (Adapted from Lusch & Nambisan, 2015; Smedlund & Toivonen, 2007)

Role	Definition	Illustration
Ideator	• Brings knowledge about their own needs to the ecosystem. • One-way knowledge flows. • Providing input for service innovation.	
Designer	• Mix and match existing knowledge components in the ecosystem. • Reciprocal knowledge flows. • Developing service innovation.	
Intermediary	• Intermediate flow of knowledge and relationships in the ecosystem. • Multi-way knowledge flow, orchestrating service innovation.	

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To summarize our perspective, we build on previous literature and define an IoT ecosystem business model as internet-mediated activities among the service co-creation actors and connected smart objects, aligned for creating and capturing value both for each role in service exchange and for a shared purpose. Figure 1 captures the key elements for mapping roles in an IoT ecosystem business model.

Methodology

Our study employs a multiple-case study design, which supports the goal of illuminating and extending the ecosystem relationships with an accurate approach (Eisenhardt & Graebner, 2007). The cases represent evolving IoT ecosystems in a Horizon 2020 initiative funded by the European Commission (Kubler et al., 2017). The case context for this study is a project called bIoTope (Building IoT Open Innovation Ecosystems; biotope-project.eu), which aims to accelerate innovation capacities for companies and public agencies with experimental large-scale pilots. The project builds on open standards and distributed value-creation models. Each pilot features use cases representing cross-sectorial IoT-enabled services.

The three selected use cases represent IoT ecosystems in a smart city context in Lyon, Brussels, and Helsinki. Qualitative data was collected mainly by participatory observation, co-working, and document reviews. The data consists of company and project documentation, meetings with project partners, project meetings, and presentations and informal discussions during the meetings.

We started mapping the IoT ecosystem business models based on use-case illustrations. We mapped the cases according to the dimensions described in the literature review (role, motivation, digital layer). After this within-case analysis, we proceeded to cross-case analysis. We summarized our findings concerning the service co-creation roles and reflected back to their relation to the corresponding business models.

Results

Case 1. Brussels / Safe school journey
The bIoTope Brussels IoT ecosystem use case ensures the safety of children commuting to school in Brussels, Belgium. The commute affects and is affected by traffic management, including extent of traffic, traffic lights, speed limits, and routing of delivery and emergency vehicles. The IoT ecosystem connects different sources of information and enables a smooth and safe commute by traffic optimization, for example, through using dynamic traffic lights, informing drivers of school hours, and organizing the co-mobility of children with the assistance of a mobile application. The platform builds on open standards allowing scalability to future services. The main actors in the case are the children and their parents, schools, the regional information technology (IT) agency, the Brussels Regional Informatics Centre (a public interest IT agency), Orange (a telecommunications company), the traffic administration for the region, Brussels Mobility (a regional administrative body responsible for infrastructure, public works, and transport), and companies offering mobile application and website development as well as big data analytics (e.g., Waze, BeMobile, Cityzendata, Holonix).

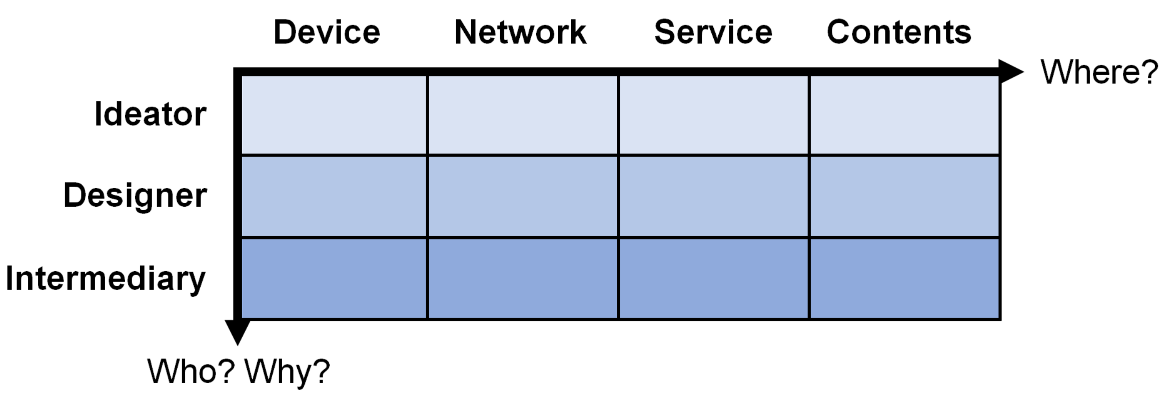

Figure 1. Key elements for mapping roles in IoT ecosystem business models

Ideators in this case are schoolchildren using a mobile application and volunteering their location data in exchange for the service. They operate in the content layer, bringing their context-specific request for service to the other actors in the ecosystem. They are motivated by non-monetary reasons such as increased safety and fun through the gamification of the app, as well as social motivators of treating the school journey as a collective activity. Their parents participate in the ecosystem by buying the application for their children and thus facilitating boundary crossing and acting as intermediary. Since their action is directly related to the end device, action takes place on the device layer.

The participating schools have a dual role as ideators and intermediaries. As ideators, the schools orchestrate the activities and communicate needs to developers. As intermediaries, they facilitate the exporting and importing of knowledge across boundaries. Their level of contribution to the ecosystem is at the service and contents levels, as they operate with data and knowledge. Their value proposition comes in a non-monetary form, as increased safety around their school and improved safety awareness.

A telecommunications operator (Orange) and data operators (Waze, BeMobile) as well as the company providing data analytics (Cityzen Data) act as ideators in the content layer. Orange provides information about the global flow of people in the Brussels Capital region around the schools, thus making it possible to address the needs of the application users. Consequently, Waze and BeMobile provide information about data flows concerning, for example, the current local traffic situation. Cityzen Data provides the analysis of the data provided by the mobile application and other sources (e.g., traffic information), thus making the knowledge embedded in data explicit for service providers. They all share a monetary motivation and are financially compensated for their work.

Another company (Holonix) develops the application for school kids to use during their school commute. Acting as designer, it develops the graphical user interface as a commercial service at the device layer, and mixes and matches existing knowledge components to develop new services. The University of Luxembourg acts in the role of designer on the network and content layers. The university enables the data flow in the network by enabling system interoperability through an O/MI-O/DF (an open messaging interface standard) wrapper connection to the application programming interface (API).

The regional IT agency (BRIC) collects and sends all the information to a central database in order to create a historical database in the IoT ecosystem. Acting on the network layer, it acts in an intermediary role as it exports and imports knowledge across ecosystem actors with the open API. Brussels Mobility acts as an intermediary in the ecosystem, providing the sensors and traffic data on both the network and content layers. Table 2 summarizes the actors' roles and layers of their contribution.

Case 2. Lyon / Sustainable bottle bank management

The bIoTope Lyon IoT ecosystem provides a sustainable waste management service in the Lyon region of France. It concerns bottle bank recycling and optimization of the collection truck routes. Previously, the collection frequency and routes were managed by the collection companies themselves. Now, the IoT ecosystem aims to use sensor data from the bottle banks to optimize the routes and collection schedule, thereby providing savings and environmental benefits. The system can be scaled to include additional information on weather, events, and traffic. The main actors are: citizens as users of the bottle banks, the regional mobility actor in the metropolitan area of Lyon (Métropole de Lyon), the municipal IT operator Data Grand Lyon, and the bottle bank collection company.

Table 2. Roles and layers in Brussels use case

	Device	Network	Service	Contents
Ideator			School, children	Schools, children, Orange, Waze, eMobile, CityzenData
Designer	Holonix	University of Luxembourg	Holonix	University of Luxembourg
Intermediary	Parents	BRIC, Brussels Mobility		Schools, Brussels Mobility

The value proposition for the citizens demonstrates itself in the form of better quality of life resulting from a cleaner, less polluted, and less noisy city. The citizen activities lay on the content level as they, by using the bottle banks, create data in the IoT ecosystem, thus acting in the role of ideator in service co-creation.

The city actor, Métropole de Lyon, has multiple motivations for participating. Monetary motivation arises from the logistics cost savings and application of additional services for the created platform. Non-monetary reasons include improving quality of life for citizens. The city actor has a dual role as an ideator and intermediary. It provides both the sensors in the bottle banks, as well as a metropolitan data platform for sharing information about, for example, bottle bank location and traffic, thus acting as intermediary. It also orchestrates collaboration among parties as the case owner. The ideator role is demonstrated through contribution to knowledge conversion both in the network and content layers.

Data Grand Lyon is the city-owned IT provider for the internet infrastructure. It develops the O/MI-O/DF wrapper connection to the API provided by the route optimizer. Thus, it acts as intermediary in the network layer, enabling data traffic.

The designers in this case are the truck company providing collection services and the company providing route-optimization services for them as subcontractor. They both contribute to the ecosystem by developing services by mixing and matching knowledge components. Their motivations to participate in the ecosystem are monetary-driven as they are financially compensated for their tasks. Their activities contribute to the service level. Table 3 summarizes the actors' roles and layers of their contribution.

Case 3: Helsinki / Promoting the use of electric vehicles

The bIoTope Helsinki IoT ecosystem promotes the use of electric vehicles. The use case focuses on charging electric vehicles, because the lack of related infrastructure is one of the major use barriers. The few existing charging service providers have proprietary systems (authentication, payment, booking, etc.), which are not connected with car manufacturers or city systems and platforms. In Finland, the existing electrical infrastructure for pre-heating cars in winter provides an underutilized opportunity for a slow charging service. To advance the use of electric vehicles, the aim of the project is to create a systems of systems (SoS) connecting information from different sources and providing interoperability for service suppliers through a common standard. The system is labeled IoTBnB, because the vision for the system is to ultimately grow into an Airbnb-type service system with independent providers posting their services, including additional ancillary services. The main actors in the case are the city, represented by the municipal innovation agency Forum Virium, the IT operator Helsinki Region Infoshare, users of electric vehicles, charging stations, Aalto University, and a company providing data analytics (ControlThings).

The city actor Forum Virium acts as an ideator in the case. Forum Virium initiated the case and articulated the user need in the conceptual and content layers. The users of electric vehicles act as user–developers, providing service providers with their personal data in the content layer. The charging providers broadcast their data to the IoTBnB in the content and service layers.

ControlThings is a company providing an IoT service catalogue (IoTBnB) for the IoT ecosystem, acting as designer in the service and device layers. Aalto University acts as designer, developing the interface standard API and the O/MI-O/DF wrapper for connecting all the in-

Table 3. Roles and layers in Lyon use case

	Device	Network	Service	Contents
Ideator			Métropole de Lyon	Citizens, Métropole de Lyon
Designer	Truck company	Data Grand Lyon	Truck company, route optimizer	Data Grand Lyon
Intermediary		Data Grand Lyon		Métropole de Lyon

formation within the ecosystem. The municipal digital services provider Helsinki Region Infoshare acts as intermediary in the network level by offering a dashboard and sharing the information concerning the charging stations. Table 4 summarizes the actor roles and layers of their contribution.

Ideators, designers and intermediaries for value creation in IoT ecosystems

The ideators in every use case represented the end users: the actors for whom the system-level service (SsS) was developed. These actors volunteer their data, thus providing one-way knowledge flow from them to the IoT ecosystem in exchange for added value that can be monetary or non-monetary. Individual users (i.e., citizens) benefit from improved service and, later, additional services that the platform can scale up to provide. The ideators mainly operate in the content and service layers, where the concrete service is consumed and where less technical expertise is required for its delivery. The ideators must perceive enough value in the exchange to be willing to pay for the developed service. Business model implications for commercial parties include new opportunities in terms of channel, value proposition, and partnership innovations.

Cities as ideators and intermediaries benefit from increased capability to perform their mandate as public service providers, and thus promote greater citizen satisfaction, cost efficiency, and public profile. They further improve citizen perceptions of the city through citizen engagement and participatory development. Cities can also concretely benefit from the accumulated data for future planning purposes and development of additional service on top of the platform by commercial parties. Cities can collect commission for transactions and thus sustain the services as well as facilitate the further use of the data for commercial parties for a fee.

Other intermediaries in the cases included the IT departments of public agencies and organizations. The public agencies enabled and orchestrated collaboration in the ecosystem in both providing knowledge to the ecosystems and establishing knowledge sharing between separate ecosystems. The IT departments of technology companies and cities enabled collaboration in technical terms, as in the case of the Lyon bottle banks, where they enabled the data flow from the banks and trucks to the city traffic management system to make decisions to optimize the operation. The major role for these commercially motivated companies was the data integration through a standard API to enable interoperability on the one hand and, on the other hand, data analysis for knowledge contextualization for the services. Typical layers were the network, device, and service layers. Their motivation for the ecosystem participation is the collected data and analytic tools, which enable enormous opportunities for scaling up the innovations and designing additional services. Direct impacts on business models can be achieved in terms of reaching out to new customer segments, channels, and value propositions.

Designers in each IoT ecosystem were represented by commercial actors developing user interfaces and apps for accessing the data. They were compensated for their activities, as in the case of Control Things deriving revenue from the electric vehicle charging app. Both actors provided knowledge and received it in reciprocal collaborative relationships with the ecosystems. The added value for the designers in the bIoTope-type ecosystems, building on open source standards, is that they bypass the dominant commercial technology platforms, and thus provide new opportunities and freedom in service creation. This also opens up new opportunities for niche providers, especially in the network and device layers, where entry barriers are currently high due to the required investments.

Table 4. Roles and layers in Helsinki use case

	Device	Network	Service	Contents
Ideator			City of Helsinki, charging service providers	City of Helsinki, users of electric vehicles, charging service providers
Designer	Control Things	Aalto University	Control Things	Aalto University
Intermediary		Helsinki Region Infoshare		City of Helsinki

These companies also benefited from free access to data, which enabled them to develop commercial applications with reduced cost and created opportunities to access a broader customer base. The open standard enabled several paths for scalability and increased profitability through network externalities and access to new partners and customers, as in the case of Brussels traffic safety, where additional traffic management services could be added. Table 5 summarizes the three roles and their main activities.

Discussion and Conclusion

Our research question was: How do different actors contribute to co-creation in IoT ecosystems? We have answered the question by exploring and describing the activities and roles of different IoT ecosystem actors in digital layers. We identified the activities of ideators, designers, and intermediaries in three cases and suggested patterns in their activities.

Our study makes several contributions to the understanding of the IoT ecosystem business model components and actor dynamics. Overall, we provide empirical evidence of the variety of activities that may take place in value creation in IoT ecosystems. We contribute to the so-far mainly conceptual IoT ecosystem business model discussion with an empirical case.

By defining different roles for the ecosystem actors in service co-creation, we extend the discussion on ecosystem business model mapping, which so far has not made explicit the role variation in service co-creation. Service-dominant logic is essentially about the application of capabilities, knowledge, and skills for the benefit of the recipient (Vargo & Lusch, 2004, 2008), and making sense of the roles provides a better understanding of value co-creation and specific business model options for each role archetypes in business ecosystems.

The finding that ideators are the beneficiaries of the developed services supports the user-driven development paradigm and earlier findings on the emphasized role of user data in service creation. Thus, the IoT ecosystem can be considered an ad hoc alignment structure for the approximation of designer resources and ideator needs for new value creation.

By adding the role variation to the previous contributions with digital layers and motivations of different actors (Turber et al., 2014), we expanded and advanced the existing discussion on IoT ecosystem business models. A better understanding of actor drivers clarifies the diversified and unstructured nature of IoT ecosystems and addresses the challenges identified by earlier literature (Westerlund et al., 2014). The structuring of activities around role archetypes may further the understanding about how ecosystems appear and evolve.

Table 5. Summary of roles and activities in IoT ecosystems

Role	Main Activities
Ideator *(Contents and Service layers)*	• Articulate need • Volunteer data • Consume commercial service
Designer *(Device, Network, and Service layers)*	• Analyze data • Develop commercial service • Deliver commercial service
Intermediary *(Network and Contents layers)*	• Coordinate activities • Enable access • Control platform

Our study supports earlier notions of the relevance of the ecosystem-level value proposition discussion (Dijkman et al., 2015; Hui, 2014; Ju et al., 2016; Turber et al., 2014). Our empirical cases demonstrate how value creation in these IoT ecosystems was constructed around a shared purpose, which expressed the values the actors wished to promote by their activities. This finding is in line with the recent “ecosystems as structure” perspective (Adner, 2017), which argues for the relevance of activities aligned according to a value proposition.

Our findings also suggest that cost reduction may not be the explicit shared purpose at the IoT ecosystem level, although it is sought for at the level of organizations (Dijkman et al., 2015). Our findings support earlier theorizing (Turber et al., 2014) that different ecosystem actors may have monetary or non-monetary drivers for their contribution to value creation in IoT ecosystems. Excluding non-monetary drivers and contributing activities might overlook relevant parts of the IoT ecosystem.

Our study provides empirical evidence for the earlier argument that value in the IoT context can be created in four layers (Turber et al., 2014). In addition, it adds to the earlier argument that one of the major changes in IoT business models is the change in the role of data (Hui, 2014; Ju et al., 2016). Our study adds to these notions and shows how sensors and analytical capabilities contribute strongly to value creation in IoT ecosystems.

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We extend the previous conceptualizations of the IoT ecosystem business model (Turber et al., 2014). The combining of the digital layers and service co-creation roles captures the key elements of IoT ecosystem business models, and it brings a new definition into the discussion of IoT ecosystem business models.

Managerial contribution

Our study offers insights for the planners and managers of IoT ecosystems. The detailed descriptions of the activities related to roles of ideators, designers, and intermediaries also make explicit the exact points of managerial intervention.

Increased awareness of the different roles supports strategy planning and visualization of business opportunities for firms participating in IoT ecosystems. The illustration of the ecosystem business model creates an opportunity for shared sensemaking, thus acting as a cognitive tool for business model design. Thus, it can provide firms a conceptual tool (Magretta, 2002; Osterwalder et al., 2005; Wirtz et al., 2016) for orchestrating the activities among the different actors (Pikkarainen et al., 2017) and for addressing complexity and integration in the ecosystem (Phillips et al., 2017).

Application of service-dominant logic to IoT ecosystems can provide highly relevant avenues for practitioners in the IoT. Lusch and Nambisan (2015) argue that, in service co-creation, it is necessary not only to define the roles but also to create supportive environments for the integration of resources. According to them, this can be done by "focusing on (1) mechanisms that facilitate interactions among diverse actors, (2) adapting internal processes to accommodate different actors (roles), and (3) enhancing the transparency of resource integration activities in the service ecosystem" (Lusch & Nambisan, 2015). This kind of ecosystem mapping can be a valuable tool for ecosystem actors as an architecture or strategy of participation (Lusch & Nambisan, 2015), as well as for the design of future IoT ecosystems and interfaces.

Limitations and further research

As with any research, this study has its limitations. Regarding the identified roles and their activities, other cases in different contexts could further the generalizability of the results. The increasing interest in the IoT in a smart city context lays opportunities for future research in this area. Other avenues for further research can be found in IoT ecosystems operating in different contexts, such as smart agriculture.

Further, the study is limited by the fact that the studied IoT ecosystems are in their early phases where the focus is predominantly on products rather than processes and business models. Therefore, a longitudinal analysis of the evolution of the IoT ecosystem business models would be beneficial for furthering the discussion.

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Data Science as an Innovation Challenge: From Big Data to Value Proposition

Victoria Kayser, Bastian Nehrke, and Damir Zubovic

> *Listening to the data is important… but so is experience and intuition. After all, what is intuition at its best but large amounts of data of all kinds filtered through a human brain rather than a math model?*
>
> Steve Lohr
> Technology and economics journalist

Analyzing "big data" holds huge potential for generating business value. The ongoing advancement of tools and technology over recent years has created a new ecosystem full of opportunities for data-driven innovation. However, as the amount of available data rises to new heights, so too does complexity. Organizations are challenged to create the right contexts, by shaping interfaces and processes, and by asking the right questions to guide the data analysis. Lifting the innovation potential requires teaming and focus to efficiently assign available resources to the most promising initiatives. With reference to the innovation process, this article will concentrate on establishing a process for analytics projects from first ideas to realization (in most cases: a running application). The question we tackle is: what can the practical discourse on big data and analytics learn from innovation management? The insights presented in this article are built on our practical experiences in working with various clients. We will classify analytics projects as well as discuss common innovation barriers along this process.

Introduction

Understandably, much effort is being expended into analyzing "big data" to unleash its potentially enormous business value (McAfee et al., 2012; Wamba et al., 2017). New data sources evolve, and new techniques for storing and analyzing large data sets are enabling many new applications, but the exact business value of any one big data application is often unclear. From a practical viewpoint, organizations still struggle to use data meaningfully or they lack the right competencies. Different types of analytics problems arise in an organizational context, depending on whether the starting point is a precise request from a department that only lacks required skills or capabilities (e.g., machine learning) or rather it stems from a principal interest in working with big data (e.g., no own infrastructure, no methodical experience). So far, clear strategies and process for value generation from data are often missing.

Much literature addresses the technical and methodical implementation, the transformative strength of big data (Wamba et al., 2015), the enhancement of firm performance by building analytics capability (Akter et al., 2016; Wamba et al., 2015), or other managerial issues (Davenport & Harris, 2007; McAfee et al., 2012). Little work covers the transformation process from first ideas to ready analytics applications or in building analytics competence. This article seeks to address this gap.

Analytics initiatives have several unique features. First, they require an explorative approach – the analysis does not start with specific requirements as in other projects but rather with an idea or data set. To assess the contribution, ideation techniques and rapid prototyping are applied. This exploration plays a key role in developing a shared understanding and giving a big data initiative a strategic direction. Second, analytics projects in their early phase are bound to a complex interplay between

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different stakeholder interests, competencies, and viewpoints. Learning is an integral part of these projects to build experience and competence with analytics. Third, analytics projects run in parallel to the existing information technology (IT) infrastructure and deliver short scripts or strategic insights, which are then installed in larger IT projects. Due to a missing end-to-end target, data is not only to be extracted, transformed, and loaded, but also needs to be identified, classified, and partly structured. So, a general process for value generation needs to be established to guide analytics projects and address these issues.

Here, we propose an exact configuration and series of steps to guide a big data analytics project. The lack of specified requirements and defined project goals in a big data analytics project (compared to a classic analytics project) make it challenging to structure the analytics process. Therefore, the linear innovation process serves as reference and orientation (Cooper, 1990). As Braganza and colleagues (2017) describe, for big data to be successfully integrated and implemented in an organization, clear and repeatable processes are required. Nevertheless, each analytics initiative is different and the process needs to flexible. Unfortunately, the literature rarely combines challenges in the analytics process with concepts from innovation management. Nevertheless, an integration of the concepts from innovation management could guide the analytics work of formulating digital strategies, organizational anchoring of the analytics units and their functions, designing the analytics portfolio, as well as the underlying working principles (e.g., rapid prototyping, ideation techniques).

Thus, in this article, we will concentrate on the question of what the practical discourse and work on analytics respectively implementing big data in organizations can learn from innovation management. A process for analytics innovation is introduced to guide the process from ideation to value generation. Emphasis is put on challenges during this process as well as different entry points. Thereby, we build on experience and insights from a number of analytics projects for different sectors and domains to derive recommendations for successfully implementing analytics solutions.

We begin with a definition of big data and analytics. Next, we propose a process for a structured approach to retrieving value from data. Finally, we discuss the results and outline directions for future research.

Big Data and Analytics

In this section, we address the elementary angles from which the analytics value chain should be looked at (Figure 1): data, infrastructure, and analytics – and the business need as the driver. According to our understanding, value is generated by analyzing data within a certain context, with a problem statement related to a business requirement driving the need for innovation. Besides expertise in conducting data and analytics projects, this process requires a working infrastructure, especially when volume, velocity, or variety of data to be analyzed exceeds certain limits. Below, we describe the three technical angles in more detail.

Data

Big data is often defined with volume (how much data), velocity (speed of data generation), and variety as the diversity of data types (Chen & Zhang, 2014; Gandomi & Haider, 2015). Big data describes data collections of a size difficult to process with traditional data management techniques. While many definitions of big data concentrate on the aspect of volume referring to the

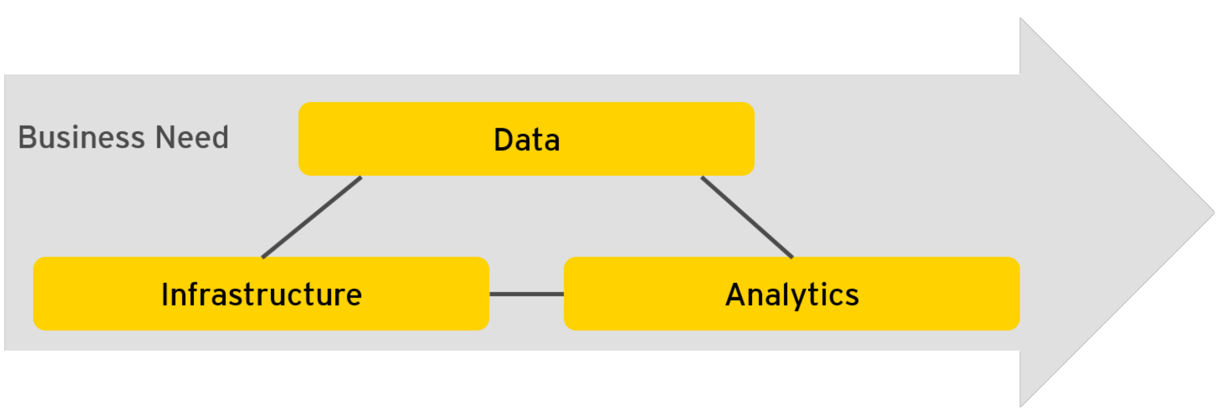

Figure 1. Framework of data, infrastructure, analytics and business need

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scale of data available, big data brings in particular heterogeneous formats and a broad spectrum of possible data sources. Examples are structured numeric data or unstructured data such as text, images, or videos. This variety and broad landscape of data sources offers many opportunities for generating insights. Moreover, the speed of data creation enables rapid insights in ongoing developments.

Recent technical improvements (e.g., cloud computing, big data architectures) enable data to be analyzed and stored on a large scale. For many (new) types of data, their exact business value is unclear so far and requires systematic exploration. Available data is often messy, and even when cleaned up can be overwhelming and too complex to be easily understood, even by professional data scientists. The contribution of data is, of course, context specific and varies among business cases and applications. One key challenge is to identify data that best meets the business requirement.

Analytics

Data science is concerned with knowledge generation from data. Analytics or data science addresses the exploration of data sets with different quantitative methods motivated from statistical modelling (James et al., 2015) or machine learning (Mitchell, 1997). Methods from different disciplines such as statistics, economics, or computer science find application to identify patterns, influence factors, or dependencies. In contrast to business intelligence, analytics reaches further than descriptive analytics (based on SQL) and often has a predictive component. Which method to apply depends on the exact business case. Analyzing data is restricted, for example, by a company's internal policies as well as legal restrictions and guidelines that vary among countries. Data quality and reliability are further issues. Data understanding and domain knowledge are key prerequisites in the analysis process (e.g., Waller & Fawcett, 2013), especially when model assumptions are made.

Concerning data analysis, there are primarily the following opportunities for organizations:

- Improved analysis of internal data: One example is forecasting methods that enhance expert-based planning approaches by additional figures. These methods build on existing databases such as business intelligence systems, and they contribute new or further insights to internal firm processes.

- New combinations of data sets offer new insights, for example, through the combination of sensor data and user profiles.

- Opening up to new or (so far) unused data sources (e.g., websites, open data) to identify potential for generating new insights. However, a context or application is necessary to use the data. One example is social media data used for market observation.

However, the core problem of analytics is to work out the guiding question and achieve a match between business need, data source, and analysis as discussed later in the article.

IT infrastructure

Relevant for the successful implementation of analytics is the adaption of the IT infrastructure to embed analytics solutions and integrate different data sources. The core layers of an IT infrastructure are the following:

1. **Data ingestion layer:** This layer covers the data transfer from a source system to an analytics environment. Therefore, a toolset and a corresponding process need to be defined. Traditional extract, transform, load (ETL) tools and relational databases are combined with Hadoop/big data setups covering, in particular, scenarios caused by less structured, high volume, or streamed data. Analytics use cases build on data from data warehouses to fully unstructured data. This breadth challenges classic architectures and requires adaptable schemes. Which data sources to integrate depends on the specific application.

2. **Data value exploration layer:** Based on the business need and corresponding use case, data is investigated, tested, and sampled in this layer. Depending on the complexity and business question, an appropriate analytics scheme is developed. Business and explorative analysis based on online analytical processing (OLAP) models in memory technologies are supplemented or expanded by using advanced analytics methods and integrating (e.g., R or Python plugins).

3. **Data consumption layer:** Here, the results are used for visualization, for example. The end user can consume the data or service without deep technical understanding (e.g., for self-service business intelligence).

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Modern approaches require structures that are adaptable and scalable to different requirements and data sources. Factors such as system performance, cost efficiency, and overall enterprise infrastructure strategy must be taken into consideration.

From Data to Value: Turning Ideas into Applications

Organizations still struggle to use data meaningfully or lack the right competencies. One of the key challenges in analytics projects is identifying the business need and the guiding questions. Principally, different types of analytics problems arise in an organizational context ranging from precise requests that only lack specific capabilities to a principal interest in working with big data (e.g., no own infrastructure, expert-based approaches). This approach implies different starting points for the analytics process and different innovation pathways, both of which are described later in this article.

What is the starting point?

The starting point for each analytics initiative varies. According to the four points mentioned above, the "state of the art" for each one needs to be assessed individually to estimate the analytics maturity:

1. **Business need:** From case to case, the precision of the problem description and scope varies. For some cases, the leading question and scope guiding the analysis phase are formulated very precisely and for other cases it needs to be worked out and refined during the process.

2. **Data:** The data to be used in the project can be defined or an appropriate source is not yet clear. The size and quality of the data essentially determine the progress of the further process. Parameters are, for example, structure (i.e., pre-processing effort) or the size of the data set (e.g., one CSV file or a large database).

3. **Analytics:** Which methods to apply differs from case to case and must be tested and explored.

4. **Infrastructure:** The current (technical) state of the business unit (e.g., own data warehouse, reporting system) or own (human) resources and competencies is a further important aspect in classifying requests.

These four angles can be rated differently with reference to the maturity level of the analytics request. Based on our experience, three scenarios, representing different maturity levels, can be distinguished (Figure 2):

1. In scenario 1, the data analysis is motivated by a defined requirement such as market observation during the rollout of a new product. The appropriate data source needs to be identified. The data missing so far implies that the precise analysis cannot be defined and also that there is no existing infrastructure. Ideas need to be developed as to which data sources could be relevant and which issues can be resolved on this basis. Then, different methods from data analysis are applied to generate new insights.

2. In scenario 2, the data source and infrastructure are clearly defined, and the specific questions need to be

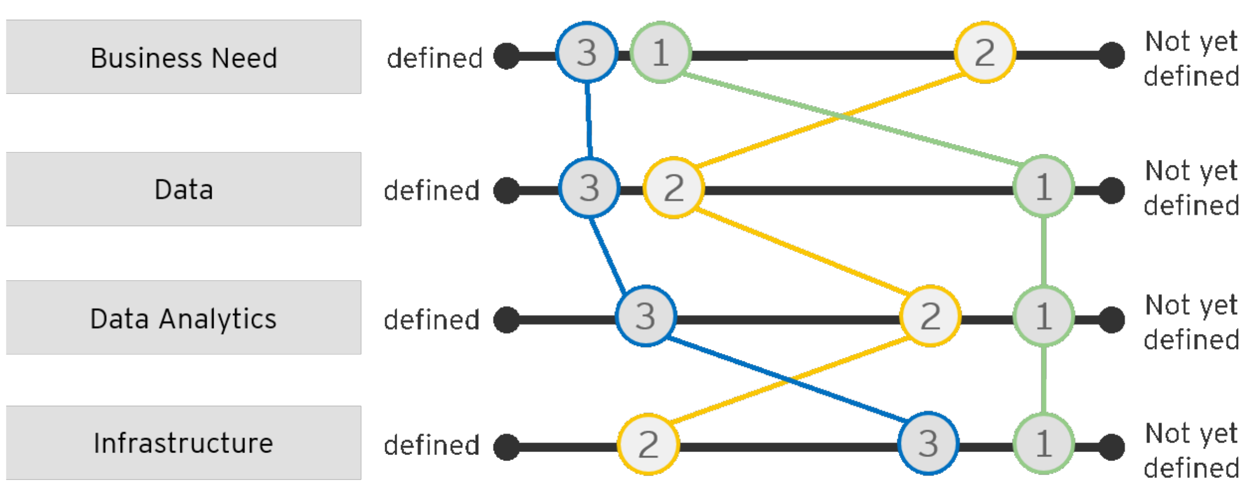

Figure 2. Classifying analytics requests: Three maturity levels

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identified. One application is assessing the contribution of a specific data source that has not been professionally analyzed so far, for example, by means of machine learning. For instance, the business unit has an internal database, considers new methods, and wants to further develop a business intelligence system by adding a forecasting component. In this case, the scope is clearer than in the first scenario and straight away an explorative data analysis can be started.

3. In scenario 3, there is a precise analytical problem that needs to be professionalized. A first draft shows promising results and the solution can, as a next step, be upscaled. Guidance in making architectural decisions is needed.

These three scenarios are exemplary starting points for analytics projects. The following section describes the implications for the innovation process and outlines different challenges and barriers.

The analytics process

To succeed with analytics, the process from data to value must be structured to be integrated in the existing organization. For example, Braganza and colleagues (2017) examine the management of organizational resources in big data initiatives. They stress the importance of systematic approaches and processes to operationalize big data.

Related work on analytics processes has a focus on service design (Meierhofer & Meier, 2017) or concentrates on the methodical part of analyzing data (e.g., Cielen & Meysman, 2016). The process, as introduced by Braganza and colleagues (2017), is too linear and does not address the systemic complexity of data analysis and necessary stakeholder discourse. To cover these issues, structuring the analytics process can be linked to the classic linear innovation process (Cooper, 1990; Salerno et al., 2015).

In our work, to guide the analytics process from ideation, scoping, and identifying a data set to value generation, a process with four phases is introduced. Taking the classic innovation funnel as starting point, this concept is transferred to the context of analytics. The process is divided in four parts: i) idea generation, ii) proof of concepts (PoCs) are conducted to test these ideas, iii) the successful PoCs are implemented and tested, and, finally, iv) they become available as a product or service. Based on a first idea or requirement, the process is initialized, while the number of ideas or projects is reduced within each phase. Each phase has tasks as well as barriers or filters that need to be passed to continue in the process chain.

The three scenarios described above are assessed differently concerning their maturity as illustrated in the process in Figure 3. Scenario 1 is in a very early stage of

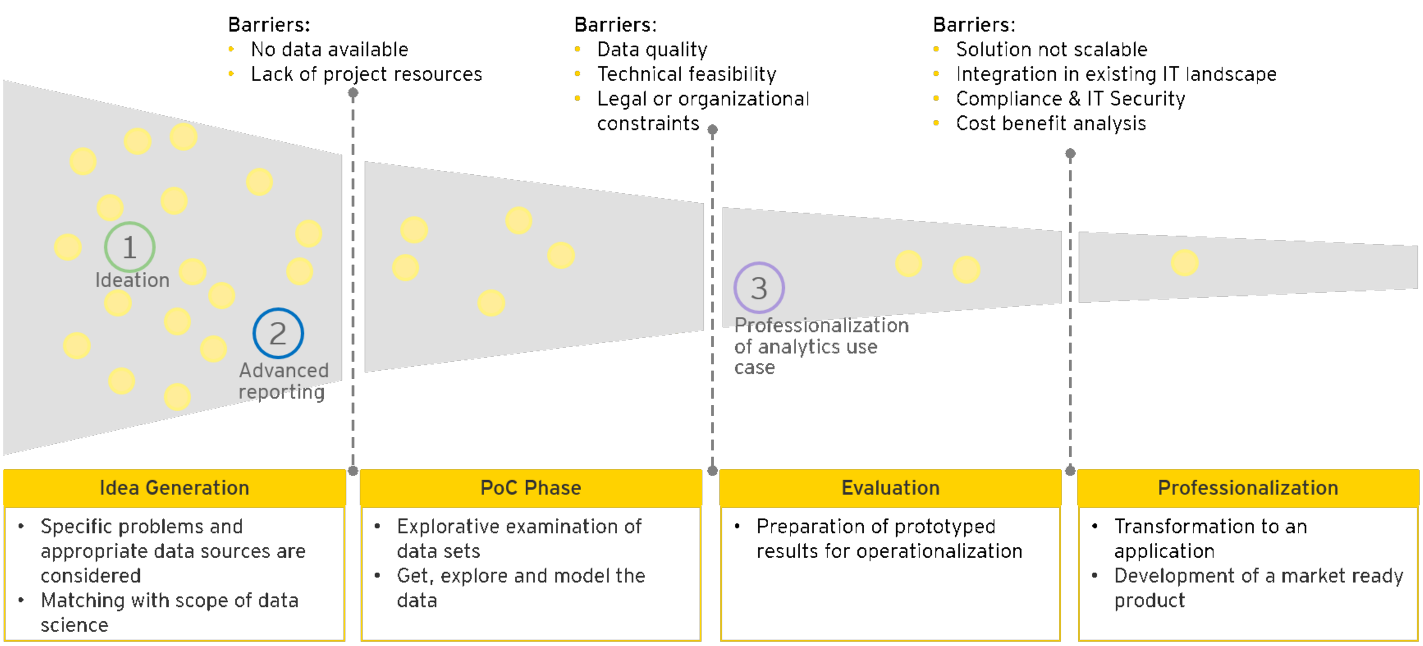

Figure 3. Phases of the analytics process

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idea generation and many open questions need to be addressed. Scenario 2 is more concrete and many more issues are resolved than in scenario 1. However, initiating questions need to be developed before a PoC can be conducted. Scenario 3 builds on a running system, so it is located in the phase of testing and operationalization (phase 3).

For each phase, different challenges arise. While related work emphasizes data-related challenges such as data acquisition, cleansing or aggregation (Sivarajah et al., 2017), this work focuses on process challenges.

Phase 1: Idea generation

Orientating analytics projects begins with an ideation phase. Here, the key challenge is to gather ideas and discuss relevant business problems (see also Provost & Fawcett, 2013). Idea generation plays a key role in developing a shared understanding, challenging existing assumptions, orientating big data initiatives, and identifying aspects that can be solved with analytics. For example, design thinking is applied as a systematic approach to problem solving (Liedtka & Ogilvie, 2011) and supports a structured ideation process. Problems of the business unit are collected and matched with the scope of analytics (e.g., technical feasibility, input parameters, and methodical requirements). The ideation phase is iterative. Initially, the general project objectives guide the first ideation round, which aims at getting an overview of present challenges and needs of the business unit. This is in line with identifying appropriate data sets. Then, the feasibility of the ideas must be checked by experts and the ideas are then selected for prototyping.

From an organizational perspective, involvement of decision makers from all hierarchy levels is a must. Top management is required to resolve conflicts of interest and to create a sense of urgency, middle management is required to free experts from daily work and onboard stakeholders into their particular roles, whereas the expert knowledge of operative specialists is key to detailing the guiding question and checking the feasibility.

A portfolio is drawn to select the ideas that are considered in the PoC phase. Innovation portfolios provide a coherent basis for judging the possible impact of ideas (Tidd & Bessant, 2013). They separate ideas into areas and indicate which ideas to prioritize. For the exemplary case as illustrated in Figure 4, the ideas are rated and assessed according to three categories: feasibility (x-axis), value creation (y-axis), and overall relevance (size of the node). *Feasibility* contains aspects such as data availability, time to access data, or the expected complexity of the task. *Value creation* addresses the expected business value and underlines ideas with

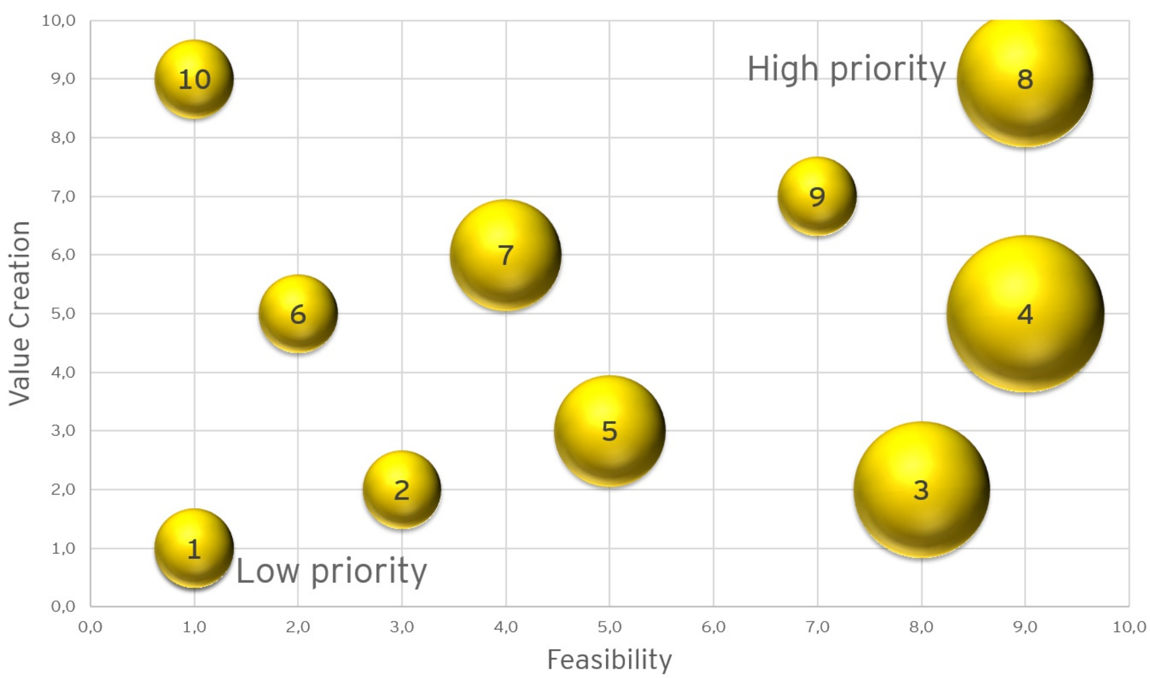

Figure 4. Portfolio for selecting ideas

a high expected contribution. The *overall relevance* is used to emphasize which ideas are expected to have greater impact on the problem at hand. So, for example, idea 3 has a high expected feasibility, but the created value is expected to be low. By contrast, idea 4 and idea 8 are bound to a higher expectation concerning value creation and should therefore be prioritized in the next phase.

Besides the portfolio-based selection process, ideas are filtered during the first phase, for example, because there is no data available to address the problem, the data must be raised first (e.g., implementation of additional sensors), or access is denied (e.g., internal policies, legal restrictions). So, appropriate data sources need to be identified and access needs to be granted for a reliable yet efficient assessment of business needs and data applicability.

As an organizational barrier, the right experts need to be identified and freed of their daily work such that they are available for analytics projects. During the ideation process, the right balance between creativity and focus is important as well as bridging the gaps between diverse knowledge areas to ask the right questions.

The outcome of this first phase are ideas plus the data sources on which basis the problems can be examined; a mapping of problems or ideas and data sources is required. In the first phase, strong facilitators are needed to guide through the process. In addition, someone with methodical expertise to check the technical feasibility of the ideas considered as well as business understanding are important. The ideas and data are only discussed; no examination takes place. This is done in the next step.

Another issue that needs to be clarified in this early phase are data security and data protection. Each country has individual regulations that limit the analysis.

Phase 2: Proof of concept

To test the ideas, prototypes are built and PoCs are conducted. PoCs are a first examination of the data set to see if a raised question can be answered based on the available data or not.

This phase is described in Figure 5: based on the defined scope from the previous phase, access to the data must be granted, the data is explored and analyzed, and finally the results are communicated.

As described above, this phase begins with a project goal or problem description (business need). Whereas classic IT development starts with requirements, analytics often starts in an explorative way with a dataset and a hypothesis. Specific requirements are generated during the analysis process. So, the PoC phase can only start with data or when data is available. Getting the data or retrieving it from existing systems is among the first steps in a PoC. Here, access barriers such as legal issues or organizational constraints need to be checked.

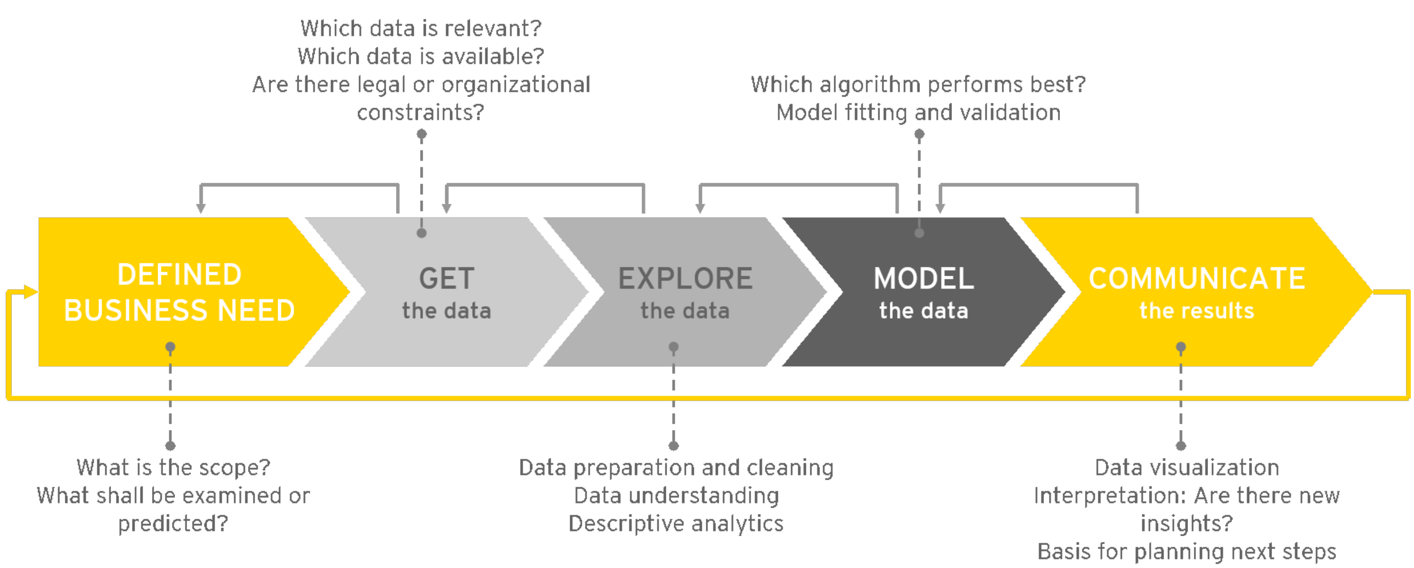

Figure 5. The analytics process

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So, for example, depending on the type of data (e.g., personal data, machine data, market figures), the analysis should be in line with these restrictions.

Next, the data is explored for a deeper understanding. Here, the data is transformed to a suitable format for further analysis. This step contains data preparation and cleaning, and the first descriptive analysis is conducted.

The data is then analyzed for patterns and dependencies during the modelling phase to answer the questions raised. Different methods and algorithms are tested and the results are validated in an iterative process of variable selection, model selection, model adaption, and validation.

Finally, the results are communicated. A PoC gives a first orientation on the potential in the data with an emphasis on strengths and weaknesses. Possible results are that different modelling techniques do not deliver a valid result, the data quality does not allow modelling, or there is not enough data for a significant statement. This is finally the basis for planning and communicating next steps and coordinating further actions.

Concerning the presentation of the results, different visualization techniques can be applied working with tools like such as Tableau, QlikView or different open source platforms. Especially to develop an understanding of the data, descriptive data analysis is helpful. Nevertheless, many models and techniques from advanced analytics deliver figures that cannot be captured by intuitive visualizations.

PoCs have a short duration of maybe 6–8 weeks. Besides getting access to the necessary data or extracting data from relevant sources, among the key challenges in this phase are data quality, data ownership, and data understanding. Further barriers are cleansing and munging of the data to a format that can be processed and to apply the right models. Furthermore, business understanding is key to retrieving valuable insights from the data and achieving outcomes that are not only plausible but relevant for the business. Another issue is the lack of experience with analytics and the required agility in implementing the results.

Phase 3 & 4: Operationalization

Then, the PoC results are integrated into a professional IT infrastructure. Prototyped results need to be prepared for operationalization and transformed to an application. The main question to answer is: Is the model scalable and can results achieved so far be applied to a larger data set? Adjustments have to be made so that a resulting application can be maintained by an IT service organization without continued support from data scientists. Event or time-based data flows have to be established and, together with the final application, need to be aligned with compliance, security, and data privacy requirements. Test management and service-level agreements for incident handling and application changes need to be agreed on as well as product and portfolio management functions in case the tool or application is meant to assume a strategic, long-term role.

Barriers include, for example, the required budget, overly complex tests, standards, and compliance. Together, the integration in IT management and allocation of tasks to the IT department represent another issue. This relates to switching from an agile, iterative working model to stable operations and scaling the analytical model and transferring it to maintainable code.

Generally, great effort is required in transforming the PoC prototype into a professional infrastructure. Further barriers during operationalization are, for example, establishing support and service management functions, achieving acceptance among the user base, developing adequate training concepts, and transferring knowledge required to maintain, test, and develop the application.

Discussion and Conclusion

Generally, the challenge for organizations lies in defining strategies for value generation from the large amount of available data sets. In this article, we discussed how to retrieve value from data and introduced a systematic process that analytics projects follow. First, we described the fundamental building blocks for value creation: business need, data, infrastructure, and analytics. Then, we described the process from ideation to market ready applications. According to the maturity state of the project, the process can be entered at different stages. The four phases of this process were described with emphasis on the specific barriers. This model is oriented towards a stage-gate model (Cooper, 1990) for analytics processes and aims to structure and systematize explorative analytics approaches.

Analytics and big data are not only a technical challenge but impact the whole organization and its processes. For being successful with analytics, less effort should be spent on building complex and sophisticated models but instead on integrating the results into the existing (technical) infrastructure and processes. For the prototype being professionalized, the results must be accepted and understood, and the business unit should be continuously involved in the process. Moreover, the right set of people and skills is necessary: not only are data scientists with competencies in machine learning and statistical modelling required (Mikalef et al., 2017), but also IT specialists and business understanding in general. In addition, value is only generated from data if the analysis is integrated into an overall framework of skills and competencies and the analytics initiative is embedded in a business application.

The results of this article can be transferred to organizations of different sizes and levels of experience when building analytics capabilities. The process as described in this work guides through analytics projects and illustrates the differences to known IT management approaches. By principally discussing the meaning of innovation for analytics, this work contributes to the evolving literature on digital innovation management (Nambisan et al., 2017). In our work, we have outlined an approach for data-driven innovation.

Future work should examine the decisions in organizing analytics. This covers aspects as roles and responsibilities, team structures, leading analytics teams, or the organizational embedding of analytics units in the organization. The results of this work should be linked to the extensive research on analytics capability, which are often classified along the dimensions of management, technology, and human capability (Akter et al., 2016; Mikalef et al., 2017). Throughout the process, as introduced in this work, the understanding of analytics becomes clearer. So, its contribution to organizational learning, skill development, developing a shared understanding, and building analytics capability should be examined. For example, according to Davenport and Harris (2007), this analytics learning process needs around 18–36 months. From a technical point of view, in particular the integration of analytics solution into the overall IT landscape, the professionalization of prototypes and change of established processes remain challenging.

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Elisa Thomas

> *I know we would have much more benefits if we shared our problems. But, in general, we do not explore partnerships as much as we should.*
>
> Purchasing Manager
> (Interviewed for this study)

In this article, we examine how firms in an emerging economy perform research and development (R&D) activities in regards to the concept of open innovation. Most literature on open innovation shows multinational knowledge-intensive firms with well-established R&D processes mainly in developed countries. Searching for management contributions for firms in emerging economies, we qualitatively analyzed two chemical firms in Southern Brazil that have different profiles and are representative samples of typical firms in the region. Our results show that firms did not fully exploit the potential benefits brought by open innovation, even when complete opening was not the main goal. The firms were similar concerning interactions with partners and stages where relationships occur. The generation of ideas was an open activity performed both by firms and by clients, and interactions with universities were getting stronger. On the other hand, intellectual property has not been used as means of profiting from innovation activities. Our main finding refers to the internal mediation of relationships with partners. R&D teams rarely contact external organizations directly; instead, they leave such interactions to other departments within their firms. Relationships with clients are mediated through technical and commercial departments, and interactions with suppliers are intermediated by the supply staff.

Introduction

As competitive dynamics compel organizations to seek alternatives for survival and growth, the innovation process is constantly changing, and new ways of developing products, processes, services, and businesses are pursued (OECD/Eurostat, 2005). Theoretical models have been developed in the search for ways to understand how factors such as policy (Khan et al., 2016), culture (Hogan & Coote, 2014), and leadership (Norbom & Lopez, 2016), for example, shape the innovation process. Also, the locus of innovation is no longer studied as restricted to internal activities. Recent literature has been focusing on how firms carry out new product development by accessing and absorbing ideas and knowledge from outside the organization, as well as outsourcing to the market some internal discoveries and achievements (Bogers et al., 2017). It includes external relationships with other organizations such as competitors, customers, suppliers, universities, or research institutes (Nooteboom, 2008; Pittaway et al., 2004).

The open innovation approach has already been analyzed in many large multinational knowledge-intensive companies, such as Intel (Chesbrough, 2003), Procter & Gamble (Huston & Sakkab, 2006), Fiat (Ciravegna & Maielli, 2011), Sony Mobile (Munir et al., 2017), and IBM (Dittrich et al., 2007) just to name a few. Most research on open innovation still approaches organizations and institutions in developed economies (e.g., Chesbrough, 2017; Lopez-Vega et al., 2016; Ullrich & Vladova, 2016). However, even large firms practicing some elements of open innovation reported that they were not satisfied with their processes for managing open innovation (Chesbrough & Brunswicker, 2014). Regarding innovation activities from emerging economies, such as China and India, open innovation has been studied in terms of patents in co-authorship with inventors from different countries (Pai et al., 2012). In Brazil, open innovation has been studied in the aerospace industry (Dewes et al., 2010) and in a few large firms trying to structure their open innovation strategies as in the cases of Natura, the Brazilian subsidiary of IBM, and Siemens/Chemtech (Ades et al., 2013). Given that the open innovation model was initially adopted by multinational companies – and as a consequence, most of the literature concentrates on large firms located in developed economies – and given the increasing importance of partnerships for firms in emerging economies as ways to overcome barriers to innovation as the limitation of resources, it is a valuable exercise to explore how open innovation is being performed by firms located in emerging countries. We also take into consideration the suggestion of Bogers and colleagues (2017) regarding the emerging theme of “formal and informal organisational structures and managerial tools that support different forms of openness” when we research Brazilian firms from an intra-organizational perspective on open innovation. Therefore, the aim of this article is to analyze *how local firms in an emerging economy such as Brazil are conducting R&D in regards to the open innovation concept.*

In this article, we draw on empirical data from case studies in two chemical firms with different profiles located in Southern Brazil. The chemical industry was chosen for being one of the most import economic sectors in that regional innovation system, and in which competitive forces are highly relevant. Globally, the chemical industry has traditionally been dependent on R&D activities to achieve competitive advantage. In fact, chemical firms were pioneers in establishing R&D departments and in performing internal research activities in the end of the 19th century (Walsh, 1984).

The article is organized as follows. We first lay out the theoretical foundations drawing on extant work from the broadly defined “open innovation” body of literature. The literature review discusses the concepts of closed and open innovation, and three main groups of differences were selected to be used as the analytical framework for the analysis of empirical cases. Second, we present a description of the research method and the profile of the firms. Finally, the cases are cross-analyzed to discuss some contributions for studies on innovation and implications for practice.

Closed and Open Innovation

Innovation processes have been studied for a long time and many methods have been described or prescribed in the literature (Christensen, 2006; Cooper, 1994; Utterback, 1994). Over the years, the organization of innovation activities has received extensive attention concerning how to transform an idea into a profitable product. The closed innovation model was the standard for firms in all industrial sectors until it started being challenged by a series of factors that caused the emergence of a more open manner of carrying out innovation activities (Chesbrough, 2003; Chesbrough et al., 2006). The classical perspective, in which R&D activities are described mainly as internal processes of generating technology and products, can still be appropriated for firms that face stable environments with products of long technological cycles. However, in knowledge-intensive sectors, as in the chemical industry, for example, there are large gains from innovation and steep losses from obsolescence, and competition is best regarded as a learning race (Powell, 1998).

Relationships with external partners are powerful for innovation because R&D is, by nature, intensive in knowledge and benefits from the interaction of many actors internal and external to the organization (Nonaka et al., 2006). Suppliers are recognized as the best partners to know the products and processes of their clients (Brem, 2011; Hoegl & Wagner, 2005; Klioutch & Leker, 2011; Soosay et al., 2008), and clients are considered efficient creativity resources (Gassmann et al., 2005). Also, extensive work has been published about users (Baldwin & von Hippel, 2011; Stockstrom et al., 2016; von Hippel, 2001) and universities (Bruneel et al., 2010; Freitas et al., 2013; Ramos-Vielba et al., 2010) as sources of complementary knowledge for innovation.

Overall, it is possible to identify a series of differences between open and closed innovation that goes beyond the discussion of where activities occur or the origins of the knowledge required to innovate. Chesbrough and colleagues (2006) consider several differences that we can organize into three groups: knowledge flow; changes in internal practices and intellectual property; and evaluation of innovation. Although the classification and the discussion of these differences yields a comprehensive and useful set of characteristics, they are also open to criticism. Table 1 summarizes the main aspects described by Chesbrough (2003), and several authors who follow the same line, with our own critical view about these characteristics.

Table 1. Differences between closed and open models of innovation

Group of Practices	Characteristics of Closed Innovation	Characteristics of Open Innovation	Author's Reflections
1. Knowledge flow	• External knowledge is scarce, hard to find, and hazardous to rely upon. • External knowledge plays a useful but supplemental role in innovation. • Purposive outbound flows of knowledge and technology are nonexistent (Chesbrough et al., 2006).	• Useful knowledge is believed to be widely distributed and of generally high quality. • External knowledge plays an equal role to internal knowledge (Chesbrough et al., 2006). • Enabling outward flows of technologies allows firms to let technologies that internally lack a clear path to the market seek such a path externally.	• Advanced knowledge is not an exclusive attribute of firms adopting the open innovation model. Evidently, different sources of information decrease bounded rationality, but *per se* do not guarantee useful knowledge. • Outbound flow of knowledge is conditioned by partner's absorptive capacities and previous knowledge.
2. Changes of internal practices	• Intermediary markets are rare. • The business model limits choices of projects. • Innovation processes are managed to reduce the chance of a Type 1, or "false positive" evaluation errors.	• Parties can transact through an intermediary agent for activities that were previously conducted within firms (Kock & Gözübüyük, 2011). • Inventive output from within the firm should not be restricted to the current business model, but instead have the opportunity to go to market through a variety of channels (Chesbrough et al., 2006). • The firm must incorporate processes to manage Type 2, or "false negative" evaluation errors.	• Core competences developed internally may also induce new businesses (Prahalad & Hamel, 1990). • False positives may also be present in open innovation decisions.
3. Intellectual property and evaluation of innovation activities	• Intellectual property is a by-product of innovation and is used defensively. • Performance of the innovation process is measured by percentage of sales spent on (internal) R&D; number of new products developed in the previous year, percentage of sales from new products; and the number of patents (West & Bogers, 2017).	• The management of intellectual property plays a proactive role for innovation. • Innovation performance is measured by R&D outsourcing; time it takes for ideas to get to the market; rate of utilization of patents owned by the firm; and investments in outside firms.	• Intellectual property rights among partners increases transaction costs (Williamson, 1979). • Actually, several open innovation practices may induce increasing transaction costs.

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The first group of differences relates to the knowledge flow. In the closed innovation model, useful knowledge for R&D is considered to be rare in the market because firms try to keep it within their own walls. In open innovation, useful knowledge can be broadly distributed; that is why external knowledge plays an equal role to that afforded to internal knowledge in innovation activities. Prior to the spreading of the idea of open innovation, Cohen and Levinthal (1990) affirmed that the success in the introduction of new technologies depends on the marriage between the offer of knowledge and the competence of firms to efficiently absorb new equipment, systems, and productive processes. Also, in this group of characteristics, there is the intentional flow for externalizing knowledge that found no place internally in the organization. In open innovation, internal interests of different departments of the firm compete with foreign commercial channels to negotiate a new technology. These outward channels to market must be managed as real options for the use of new technologies because they allow the firm to obtain higher profits from innovation activities. Bounded rationality, of course, is diminished when different actors participate, but it does not necessarily guarantee success in new product development. Also, the presence of asymmetry of information and previous knowledge are related to different absorptive capacities among partners (Franco et al., 2014).

A second group of differences includes changes of internal practices in regards to the choice of projects and the use of intermediaries. Open innovation points to the emergence of intermediaries of relationships that are non-existent in closed innovation or have irrelevant roles (De Silva et al., 2017; Howells, 2006; Thomas et al., 2017). Innovation brokers allow firms to transact, at stages previously conducted within the firm, by connecting those seeking solutions with a rather large number of potential knowledge suppliers (Kock & Gözübüyük, 2011).

In closed innovation, the centrality of the business model acts like a filter to limit the choice of projects and investments. Projects fitting the business model are accepted, and projects that do not fit the business model are not chosen to be developed (Chesbrough et al., 2006). This may lead to Type 1 or "false positive" errors when projects from R&D go to commercialization but end up being a failure in the market. However, when it comes to research activities, there may appear discoveries outside the business model that escape the attention of the firm. Open innovation considers that such projects should not be abandoned "on the shelf" or cancelled. The organization must search for ways to exploit them, whether that means launching them into a new market or selling the technology to another firm. These cases are called Type 2 or "false negative" errors because the idea could turn into a success for its novelty, but a firm in closed innovation does not invest in developments outside the business model. In open innovation, firms should incorporate additional processes to manage "false negatives" with the goal of exploiting their value and should identify new potential markets for these projects. A closer look at Chesbrough's arguments reveals that, previous to his work, Prahalad and Hamel (1990) presented the concept of core competences and already considered that, in a closed innovation situation, the firm is able to develop knowledge that may induce new business and new markets.

The third difference refers to intellectual property and the evaluation of innovation activities. In open innovation, intellectual property represents a new class of assets that can deliver additional revenues, and also point the way towards entry into new businesses (Chesbrough et al., 2006). Open innovation states that the firm owning a technology and its patent may sell or license the intellectual property, thereby profiting from it.

Without protection, an innovation developed in cooperation with other organizations can present higher risks. In his studies, Chesbrough analyzes mainly the North American environment, where the intellectual property system is fully institutionalized. However, reality is different in other countries (Cassiman & Valentini, 2016). Luoma, Paasi, and Valkokari (2010) found that a patent was an important protection method for only 30% of the 40 interviewed firms in Finland and in the Netherlands. In Brazil, the host country of our study, the culture of registering new developments is not common to most industrial sectors (Dewes et al., 2010; Etzkowitz et al., 2008). Therefore, we believe that, in countries where there is limited practice of protecting and negotiating intellectual property, this issue may be a limitation for the complete adoption of open innovation. The evaluation of innovation activities of a firm in an open innovation environment may also consider other activities with external partners besides the use of intellectual property, such as R&D outsourcing, time for ideas to get to the market, investment in spin-offs, etc. (West & Bogers, 2017). It is important to note that Chesbrough's arguments give little attention to transaction costs inherent to joint projects. Opportunistic behaviour, bounded rationality, and information asymmetry (Remneland-Wikhamn & Knights, 2012; Williamson, 1979) may generate additional costs to open innovation.

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As noted, open innovation activities offer different perspectives compared to a closed model; these differences will be analyzed in our case studies.

Research Method

This is a qualitative research study that uses multiple descriptive case studies (Eisenhardt, 1989; Eisenhardt & Graebner, 2007). The research analyzes Brazil's Rio dos Sinos Valley, which includes around 20 cities and almost one million people. The region experienced fast economic development due to European immigrants who settled there in the 19th century and led the industrial development. Its most prosperous period was the 1970s when it became an important cluster of production and export of leather and footwear (Santos et al., 2017). However, since the mid-1990s, competitive pressures from other parts of the world and changes in foreign exchange rates have intensified competition based on prices. We look upon this change in the economy of the region, where chemical firms – previously supplying footwear firms – had to find new paths for their survival, and innovation became crucial.

The selection of cases started considering all the chemical firms in the region – a total of 25 firms. The first criterion for narrowing the focus was to identify firms with R&D activities *in* the region, no matter the size of the firm. Among the remaining sample, the definition of cases considered the information provided by firms identifying open innovation activities. We followed what Seawright and Gerring (2008) call purposive selection of a representative sample. Two firms were chosen because they have distinct characteristics that enable analysis of different practices of relationships and a number of unique features particular to each firm. Companies A and B, both chemical firms, generally do not compete against one another because their product portfolios are different. The distinct features of the two case firms are described below, and their differences are summarized in Table 2:

- *A branch of a foreign firm in Brazil and a Brazilian firm:* Company A is a multinational organization focused on the production of chemical components. Headquartered in the Netherlands with subsidiaries in several countries, this case allows the study of the relationships among the headquarters and its international subsidiaries. Company A develops products for its local clients in Brazil and South America. Company B is a Brazilian firm, owned by a group of organizations in which each firm has a different business model and covers different stages in the value chain of the leather and footwear industry.

- *A firm created from opportunity and a firm created from need:* Company A opportunistically settled in Southern Brazil in 1993 to exploit the still strong manufacturing cluster of leather and footwear. Company B was established in 1969 to produce components for two footwear firms located in the Valley as a vertical integration strategy. At that time, the production of footwear in the region was strongly growing, driven by North American importers. But, there was a lack of available components for manufacturing due to the recent growth in the industry. Thus, Company B was established to fill this need for components, thereby enabling the broader vertical integration strategy.

Table 2. Main differences between the two case studies

Characteristic	Company A	Company B
Ownership	Branch of a multinational firm based in the Netherlands with subsidiaries in several countries	Headquarter of a Brazilian firm with two manufacturing branches
Foundation	Established in 1993 in Brazil to exploit the strong production cluster	Established in 1969 to produce components for two other firms
Market for innovation at the time of research	Product innovation for its current clients and process innovation	Product innovation for a new market
Interviewees	R&D manager; most senior researcher at the firm; technical manager of an innovative business unit; supply manager and coordinator of contracts with suppliers.	General manager; main researcher; another researcher; laboratory and test manager; consultant of ISO/TS 16949.

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- *A firm innovating to suit its current market and a firm innovating to suit a new market:* Company A was investing in product and process innovation for its current clients, especially the segment in which the firm is a market leader: synthetic laminates. Company B was investing in product innovation for a new market: the automotive industry.

We conducted semi-structured interviews with managers and employees directly involved in innovation activities, typically across two interview sessions. We analyzed the cases based on recordings and transcripts of the interviews, which were supplemented by observations of internal meetings and documents such as internal reports, news and press releases on the firms' websites (Flick, 2002; Simons, 2009). The combination of different sources of data aimed at improving the research validity. When analyzing the data, we used our categories of analysis organized from the literature about relationships between organizations and other concepts of open innovation (Bansal & Corley, 2011; Corley, 2012), as summarized in Table 1. We related the empirical data to the theoretical literature to help interpret the findings.

We began the analysis of the cases by assessing the innovation process of each firm through two intra-cases studies. The categories of analysis from Table 1 were used to identify which activities were conducted internally or externally (for the "Knowledge flow" category) to understand how each firm chooses projects to develop, if and how the firms use intermediaries during innovation activities (for the "Changes of internal practices" category), how each firm deals with intellectual property and other protection methods and how each firm assesses its R&D activities considering external partners (for the "Intellectual property and evaluation of innovation activities" category). We identified relationships with external organizations and the stages of R&D where such knowledge is sought and incorporated. Afterwards, the cross-analysis searched for complementary knowledge between the cases to open the possibility for a broad spectrum of conclusions.

Cross-Case Analysis and Discussion

First, a description of the flow of new product development considered stages of the innovation process and the internal and external relations in each step, as summarized schematically in Figures 1 and 2. In activities with more than one partner, the stronger relationships are highlighted in bold. In some activities, internal departments are the only partners. The arrows linking Companies A and B to external partners indicate the flow of knowledge with each partner: arrows pointing to one direction indicate the origin of the knowledge used for that R&D process (knowledge from the external partner into internal R&D of the case study) while arrows pointing both ways mean that there was a knowledge exchange that would benefit both partners.

As it can be seen from Figure 1, the amount of interactions at Company A decreases through the timeline of new product development. At the final part, the number of partners in each activity is smaller than at the beginning. Also, there are no new partners in the final stages – all relationships occur with organizations with whom the Company A has been previously connected. Figure 2 illustrates the flow of new product development activities at Company B and its internal and external relationships. New product development in the automotive industry is ruled by ISO/TS 16949 Advanced Product Quality Planning (APQP). Therefore, some activities of the flow would be equivalent to APQP steps.

The inter-case analysis showed similar and divergent aspects of the opening (or not) of R&D in both firms, as described in the sub-sections that follow.

1. Knowledge flow

We start by presenting the analysis of the first category from Table 1 regarding the knowledge flow with external partners:

- *Relationship with clients:* the firms interact with clients at the same stages, which are idea generation and final tests for the approval of new formulas. Both firms have the traditional process in which developments of new products are influenced by specific requests of customers, as described by Gassmann and colleagues (2005). Besides, there are some differences. Company A induces the opening of the innovation process of clients by suggesting how they can prepare their future collections. To be able to do so, Company A has a team of stylists who research fashion trends in many countries. The seasonality of products for winter and summer as well as the frequent changes in fashion goods produced by clients demand that developments of components are chronologically ahead of clients' launchings. In Company B, products for the automotive industry are ruled by the international certification ISO/TS 16949. There is a formal systematic registration for relationships with clients regarding new product development.

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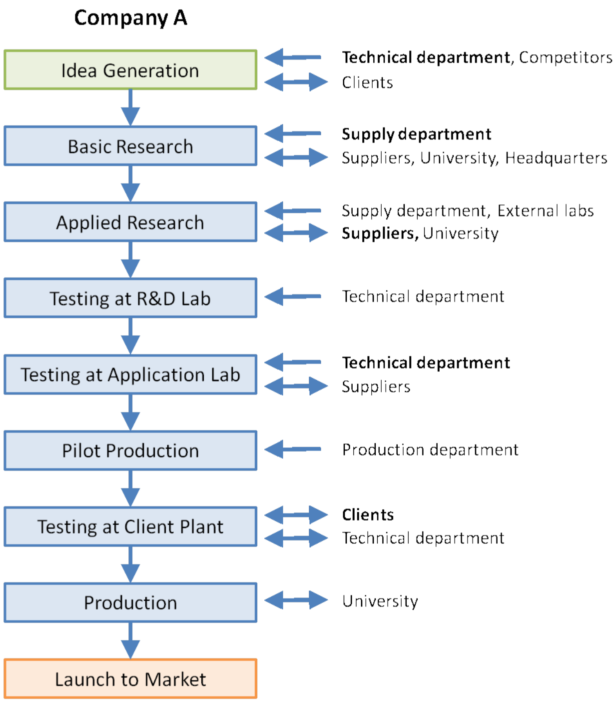

Figure 1. Internal and external relationships in Company A's innovation process

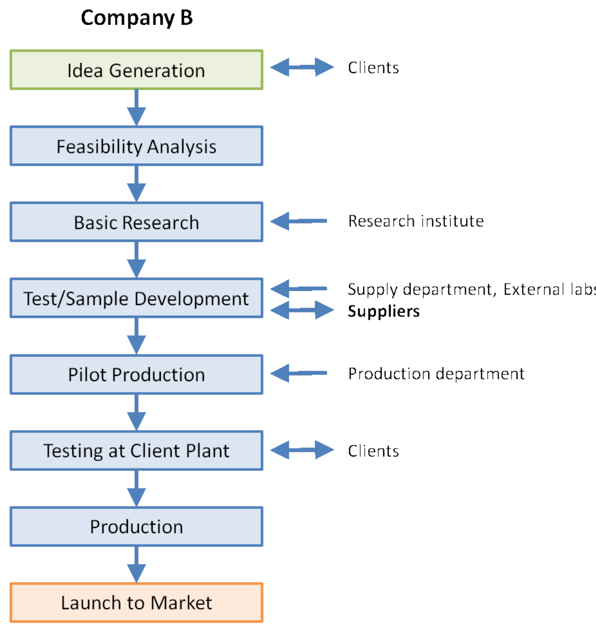

Figure 2. Internal and external relationships in Company B's innovation process

- *Relationship with suppliers:* the firms are related to their suppliers at the same stage of the innovation process, which is when new formulas are developed and tested. Also, the way of contact is similar, referring to the search for raw materials for new product development. In both firms, new product development provided inputs to suppliers in regards to new needs from clients. When Company B started the development of automotive products, it had a collaborative development with suppliers who helped to develop new formulas. The firm had parallel results from those mentioned by Hoegl and Wagner (2005), who found that strong buyer–supplier collaborations were "positively related with efficiency (development schedule and development cost) and effectiveness (product cost and product quality) of product development projects".

- *Relationship with universities and research institutes:* both firms have recently begun relationships with universities and research institutes. Company A invests in the academic development of staff by sponsoring a portion of their tuition fees for master's degrees, by encouraging informal relations with university members, and by organizing staff visits to laboratories located on campus as well as visits of professors to the firm. Company A is moving closer to findings by Bruneel and colleagues (2010), who stated that good university–industry collaboration is fostered by trust between partners, informal reciprocity and exchange, face-to-face contacts, repeated interactions, and the involvement of a wide range of interaction channels. However, Company B has a different approach. Open innovation occurs when the firm hires an external laboratory to develop part of an innovation project. Company B had tried a joint development project with a Brazilian university, but it did not achieve the expected result. Afterwards, this project was transferred to a German research institute of applied sciences. The new contract outsourced the development of a new product , thereby replacing internal R&D. Given that this development of a new product was directed toward the automotive industry, it relates to Chesbrough (2003), who pointed to the automotive industry as one of the industries in transition between closed and open innovation. However, we can see that the transition is happening in Brazil later than in developed countries studied by the author.

- *Relationship with other units of the corporation:* Company A maintains low-intensity relationships with its Dutch headquarters and with other organizations from the group. Company B does not interact with its branches for innovation. The other units of Company B's group are just production sites, located in other states of Brazil and abroad, where they are located to be closer to their clients.

- *Relationship with other partners:* the firms are related to external laboratories on the same stage of new product development, which is during applied research for the development of new formulations. Only Company A engaged in a relationship with competitors for the outward flow of knowledge, and it happened only once when a competitor approached Company A to negotiate a technology process. This may be a slight beginning of externalization flow of knowledge. Even so, considering the purposive outflow of knowledge to expand the markets for external use of innovation as one of the main concepts of open innovation (Chesbrough et al., 2006), both firms do not appropriate this practice as a way of profiting from their innovation.

2. Changes of internal practices

The analysis of the second category from Table 1 includes the choice of new R&D projects and the use of intermediaries:

- *The choice of project to be developed:* at Company A, the New Product Committee is responsible for the decision about starting a new product development project or interrupting an ongoing project. It includes managers from the departments of R&D, supply, and sales of each business unit. According to the supply manager, the firm is not interested in investing in new product development in unknown fields. It operates in line with the closed innovation approach because the firm's current business model acts as a filter to choose new R&D projects (Chesbrough et al., 2006). At Company B, the meetings involve only the researcher and the director of the business unit. The first filter to evaluate an idea for a new product development checks whether the suggestion fits the firm's business technology line. This practice complies with the closed innovation approach and fits the concept of core competences (Prahalad & Hamel, 1990). There is no concern from both firms to manage "false negative" errors in idea evaluation.

- *Intermediation:* in contrast to findings in recent literature (De Silva et al., 2017; Thomas et al., 2017), where intermediaries are external agents providing services for inter-organizational R&D projects, our research showed relationships intermediated by other departments of the firms. Relationships with external partners were not directly connected to R&D staff: relationships with suppliers occur through supply/purchasing departments in both firms. When the R&D team needs new raw materials or different components, the supply department searches for the best option among suppliers connected to the firm or with different suppliers. Problems can happen in both firms when the supply department does not find a suitable component to incorporate in R&D, because the R&D team might consider using another material if they were in charge of this search. Staff from the supply department do not have enough knowledge about new product development to choose different options for new raw materials. At the same time, interactions with clients happen mainly through technical and commercial departments. When the client requests a new product, the technical or the commercial team registers the demand and its features. Afterwards, the request is passed to the R&D department. Given that the technical staff is on the client's side, it sees needs and opportunities for new product development.

3. Intellectual property and evaluation of innovation activities

Finally, the third category from Table 1 analyzes intellectual property and the evaluation of innovation activities:

- *The policy of the firms concerning intellectual property:* Company A does not have the practice of registering the intellectual property of innovations, thus it fails to profit from any potential negotiation that might arise from it. Company B demonstrates concern about protecting innovation, as evidenced by its registration of intellectual property and publication of technical articles. Moreover, it sometimes intentionally does not register the intellectual property to maintain industrial secrecy. Patents are considered a by-product of innovation for Company B – as a way to establish ownership of the innovative products to be sold to clients. In our findings, both firms relate to the subject of intellectual property according to the closed innovation model (Chesbrough et al., 2006), and we confirm findings by Dewes and colleagues (2010), who point to the need for well-defined patenting policies in Brazilian firms.

- *Evaluation of innovation activities:* both firms assess their innovation activities in line with a closed innovation approach (Chesbrough et al., 2006), because innovation is not measured with consideration given to open innovation practices such as external contributions to the R&D of the firm, investments in spin-offs, licensing of intellectual property, R&D outsourcing, external paths to market for internal projects, or other practices.

Conclusion

The analysis of our cases contributes several insights to our understanding of how open innovation happens in firms in an emerging economy:

1. It is important to consider that open and closed models of innovation share complementary spaces in organizations and may even be simultaneous (as mentioned by Leminen et al., 2015).

2. Firms engage in relationships with other organizations in a variety of intensities and with different forms of interactions. The openness of the innovation process depends on the stage and activity of the flow of new product development. As seen in our cases, the early stages favour open innovation with a variety of partners more than stages nearer to commercialization. One of the reasons for this shift could be that uncertainty and risk are higher in the beginning of the process and, therefore, different knowledge sources are necessary to achieve innovation.

3. Openness also depends on the type of partner. It was found that openness is higher when firms establish partnerships for innovation with clients and universities.

4. Relationships for R&D could be both tacit and explicit (Nonaka et al., 2006) through formal and informal means. Interviewees reported informal visits of university researchers to the firm's sites, as well as visits by the firm's researchers to university laboratories. Informal relationships also occur when technical staff visits clients. Formal relations can be exemplified by hiring external applied research.

5. Another contribution of the research refers to strong internal intermediation of relationships with external partners. Howells (2006) and Chesbrough's concepts do not mention *mediated or indirect open innovation* considering *internal* departments as intermediaries. At the same time, literature on internal brokers focus on "individuals or teams who manipulate market knowledge to facilitate the process of *internal* transfer" (Cillo, 2005), which is a different role compared to the one found in our cases. The literature on innovation relates to the importance of gatekeepers and boundary spanners, but these *internal mediators* play a key role in helping firms to find the right partner with the right knowledge. In this sense, attention should be concentrated on the important role of *internal agents linking internal departments to external sources of knowledge.*

Although this research has focused on two chemical firms, it is possible to highlight some general recommendations for innovation managers based on our findings:

1. Open innovation should be part of the innovation strategy of the firm, as opposed to our cases, where relationships with external partners only occurred when the firm could not perform some R&D activity by itself. Inflows and outflows of knowledge and technology should be considered as regular activities in the innovation process.

2. Firms belonging to conglomerates can better exploit other organizations within the same group to open R&D activities, given that secrecy is not considered an obstacle to open innovation in this environment. Considering open innovation strategies as a continuum, firms belonging to conglomerates collaborate with other firms from the same group but keep the core of their innovation processes in house, being characterized as semi-open innovation (Barge-Gil, 2010).

3. To better exploit the benefits of open innovation, firms should develop structured ways to interact with partners. For example: software used for internal R&D management could have some fields accessible by external partners; events where suppliers could present new materials related to the firm's products; or frequent interactions with universities' research groups in areas that could generate innovation for firms.

4. Firms should establishing mechanisms to exploit the results of innovation, allowing outward flows of technology in order to generate profits for the innovator. These mechanisms include protecting the intellectual property and, afterwards, licensing and commercializing it.

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Despite presenting valuable insights on the process of open innovation in firms in emerging economies, this study does have its limitations. First, the findings are based on a limited set of case studies from the chemical industry. Second, we looked at practices from the firms' point of view, not by collecting data from external partners, which may have limited our understanding of certain situations related to partnerships.

In conclusion, the process of innovation is slowly shifting from a closed to an open model in firms from emerging economies. Some characteristics of the innovation process are common to firms, regardless of whether they are in developed or emerging economies, such as the diversity of knowledge needed to innovate, the impossibility of complete control of the state of art, the increasing investment demanded by R&D activities, and the high risks involved. However, our findings show that some characteristics of the innovation process are particular to emerging countries, such as the lack of culture regarding the protection of intellectual property, which can limit some practices of open innovation.

About the Author

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Keywords: open innovation, collaboration, R&D, intermediary, emerging economy

To Internationalize or Not to Internationalize? A Descriptive Study of a Brazilian Startup

Flavia Luciane Scherer, Italo Fernando Minello, Cristiane Krüger, and Andréa Bach Rizzatti

> *It's how you deal with failure that determines how you achieve success.*
>
> David Feherty
> Professional golfer

This study examines the failed internationalization experience of a Brazilian high-tech startup. The research methodology of the study is descriptive and aims to explore whether this startup should re-internationalize, despite an unsuccessful first experience. Based on interviews with the founders, it was found that the initial internationalization took place in an incipient way, in the heat of the moment. The lack of success with the initial internationalization did not shake the directors of the startup, who aim to return to internationalization, now in a consolidated way and counting on the advice of an investor. Despite its bitter first experience, should the startup try again? Through an analysis of the lessons learned from the startup's initial failure and insights from its consideration of a possible second attempt, this study contributes to the literature on competitiveness, internationalization, and international entrepreneurship.

Introduction

Technology-based startups have been growing exponentially in Brazil (ABStartups, 2018). Faced with a limited market with global potential, a technology startup aims to internationalize early and fast. These high-tech companies provide innovative products and services and operate as pioneers in a small global niche market (Neubert, 2015).

A company born of a small, open economy is often forced to internationalize early and fast to become profitable (Neubert, 2016a). However, early and rapid internationalization is very challenging for entrepreneurs because it requires specific skills and excellent preparation, including, for example, product adaptations (Neubert, 2016b).

This study stems from the authors' research on the themes of entrepreneurship and internationalization, and it focuses on the Brazilian scenario regarding the exponential growth of startups and the need for global technology startups to grow beyond national boundaries. The startup under study unsuccessfully attempted to internationalize shortly after its foundation. For the founders, it was a bitter result. However, years later, with the experience they have acquired and the injection of investment, the founders are considering a second attempt. To internationalize or not to internationalize? That is the question that is again facing the founders, and that is the focus of the present study.

In order to answer this question, the initial experience with the failed internationalization, the current startup context, the economic scenario, and the justification for potential expansion are described in this article. First, we review the literature on internationalization, export barriers, the origin and concept of startups, and related areas. Next, we summarize our descriptive research methodology. Then, we describe the results and discuss the history and current situation of the case. Finally, we conclude the article with a list of key findings and recommendations.

Literature Review

Internationalization

As the globalization of markets progressively develops, our understanding of cultural and social aspects emerges as a fundamental challenge in the process of internationalization of companies, in the search for global markets, and in the attraction and mainly maintenance of these new consumers (Honorato, 2007). Therefore, internationalization, according to Fleury and Fleury (2012) can be defined as a phenomenon that is related to the social actors that participate in the process of globalization, which they are public or private companies, or governmental or non-governmental institutions. Thus, internationalization is considered as the largest dimension of the continuous process of strategy and can be defined as a process involving a company in its operations with other countries (Melin, 1992; Reid, 1981). In this sense, companies can broaden the scope of their operations by insertion in international markets offering multiple products to different nations (De Moraes et al., 2015).

In this way, internationalization allows a company to become more competitive inside and outside its home country (Da Silva et al., 2016). In the process of internationalization, changes in coordination mechanisms associated with institutions and the market end up reflecting cultural exchanges and power disputes between nations and organizations (Lopes et al., 2007). However, for companies that want to expand their products or services to international markets, it becomes essential to gain legitimacy in foreign markets (Da Rocha et al., 2015).

Regarding the classification of internationalization theories, Carneiro and Dib (2007) address two main lines of research: the internationalization approaches based on economic criteria and the internationalization approaches based on behavioural evolution. According to the authors, the economic approach favours rational (pseudo-) solutions to questions arising from the internationalization process that would be oriented toward a decision-making path that would maximize economic returns. The second approach, based on behavioural evolution, assumes that the process of internationalization depends on the attitudes, perceptions, and behaviour of the decision makers, who would be guided by the search for risk reduction in decisions about where and how to expand.

According to Carneiro and Dib (2007), the internationalization process progressively answers six basic questions, as shown in Figure 1 and elaborated in Table 1 according to the theories that help firms find answers to these questions. In the present study, the Uppsala internationalization process model was used, considering that the Uppsala School studies internationalization from a behavioural perspective in which the process of internationalization would depend on the attitudes, perceptions, and behaviour of decision makers, who would be guided by the search for risk reduction in decisions on where and how to expand (Carneiro & Dib, 2007).

Table 1. Answers to the basic questions of the internationalization process according to the Uppsala stages model (Adapted from Carneiro & Dib, 2007)

	The Uppsala Stages Model
Why?	Market research.
What?	No restrictions in terms of products, services, technologies, or activities (implicit).
When?	Initial moment: saturation of the domestic market. Expansion: as knowledge is gradually gained through international experience.
Where?	For countries with "psychic distance" relative to the smaller domestic market at first, and then gradually increasing.
How?	In stages of gradual commitment of resources (first export, then sales office until production in the new market).

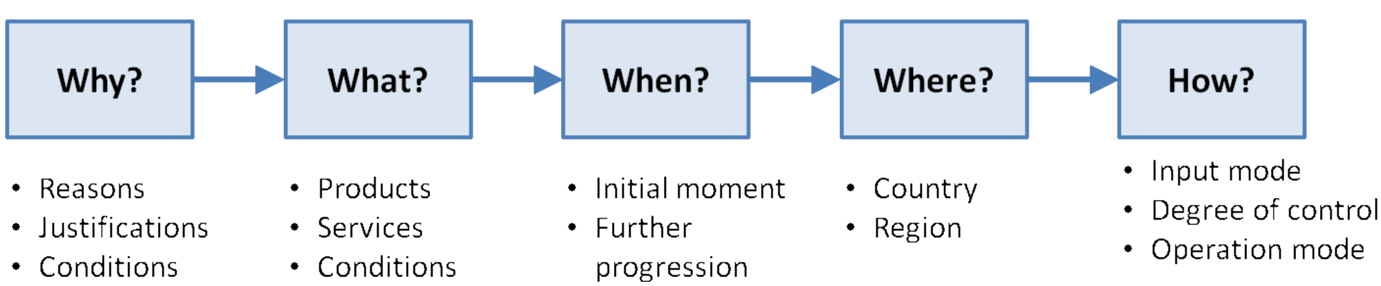

Figure 1. Basic questions addressed during the internationalization process (Adapted from Carneiro & Dib, 2007)

Uppsala internationalization process model

Developed by the researchers Johanson and Vahlne in 1977, the Uppsala internationalization process model tries to explain the characteristics of the internationalization process of the firm, assuming a dynamic learning process of the firm (Johanson & Vahlne, 2009). Thus, internationalization ends up being a result of the relationship of the development of learning, the acquisition of experience, and the commitment of resources (Johanson & Vahlne, 1977).

In addition, internationalization begins in the domestic market and the emergence of new opportunities allows the firm to make new investments in the foreign market (Johanson & Vahlne, 1977; Johanson & Wiedersheim-Paul, 1975). Rezende (1999) points out that the internationalization process involves learning and successive acquisition of skills to enter the new market. This process occurs in three stages: obtaining information about the country of destination, choosing the product, and choosing a form of entry (Rezende, 1999).

Thus, the internationalization process occurs in a gradual manner and with the growth of information regarding the market to be exploited. This information can be derived through the company's own experience and through research and reports, thus increasing the company's abilities to identify the opportunities and threats of the market, thus establishing strategies for action (Johanson & Vahlne, 1993).

Export barriers

Increasingly, recurrent and essential export practice among countries contributes to capital movements and economic development, given that the world economy functions in an integrated manner and national economies are interconnected. The growth of the world economy depends on the trade between the countries, and the main way for the growth of the economies ends up being the expansion of international trade.

International trade has been playing an increasingly important role in the world economic scenario. In this sense, the liberalization of trade in goods and services, mainly through the dismantling of the barriers imposed on the frontiers of trade between countries, is necessary (Thorstensen, 1998). However, according to Mazon, Jaeger, and Kato (2010), companies venturing into international trade find themselves facing new barriers or at least barriers that are different from those of their domestic market. In this context, Leonidou (1995) states that export barriers are the reason for many failures in the international market, leading to financial losses together with a negative perception of companies in international trade.

In addition, Leonidou (2004) states that the concept of export barriers encompasses all the restrictions that hinder the ability of the company to initiate, develop, or preserve business operations in foreign markets. Machado and Scorsatto (2005) cite that companies whose executives perceive high barriers are less likely to export or, if they did, would remain at preliminary levels of export activity. Leonidou (1995) argues that export barriers can be divided into two main groups: internal and external. According to that author, the internal barriers are those related to the organizational resources and with the capacity and approach that the company possesses with regard to the export business. On the other hand, external barriers, according to Leonidou (1995), are associated with the obstacles that the company faces in its country of origin and the host country in which it operates.

Internal barriers can be subdivided into functional, informative and marketing barriers (Leonidou, 2004). The functional barrier refers to the inefficiencies of the various business functions, such as human resources, production, and finances when it comes to exports (Vozikis & Mescon, 1985). An information barrier, on the other hand, refers to problems in the identification, selection, and contact with the international market due to inefficiency of information (Morgan & Katsikeas, 1997). The marketing barrier essentially extends to product, price, distribution, logistics, and dissemination of the company's activities in the international market (Moini, 1997).

Leonidou (2004) divides external barriers into four subitems: procedural, governmental, task, and environmental barriers. The procedural barrier highlights the operational aspects regarding the transaction with foreign clients (Kedia & Chhokar, 1986). Government participation and encouragement in the choice of appropriate trade policies for export promotion is necessary. In this sense, Leonidou (2004) affirms that government barriers allude to action or omission by the government of the country of origin. In addition, Leonidou emphasizes two issues pertaining to government influence on export: limited government interest in assisting and encouraging potential exporters and the restrictive role of the regulatory framework in export practices.

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According to Uner and colleagues (2013), economically emerging countries have demonstrated major regulatory, regulatory, and incentive barriers that act as a stumbling block to internationalization. Leonidou (2004) points out a third sub-item related to external export: the service barrier. The divergence of habits and attitudes in the various countries around the world is prominent. In this sense, Leonidou (2004) defines it as being related to the company's customers and external market competitors and the effect they exert on export operations.

Environmental barriers include several obstacles, mainly economic and financial. Leonidou (2004) places special emphasis on the following topics: economically deprived foreign markets, foreign exchange risks, political instability and strict regulations in the foreign country, high tariff and non-tariff barriers, foreign business practices, socio-cultural characteristics, and different verbal language of the country of origin.

In alignment with the above, Oviatt and McDougall (1994) reiterate that a company in conducting transactions in a foreign country faces some disadvantages compared to local companies, among them governmental, legal, language barriers and in business practice. However, when properly conducted, cultural differences can lead to innovative practices within the organization and become a competitive advantage (Cox & Blake, 1991).

Startups

Not long ago, “a startup” was synonymous with a small business in its initial stage (Gitahy, 2010). The concept has evolved and, today, experts, investors, and entrepreneurs adopt the idea that startup is basically an enterprise that faces an environment of extreme uncertainty, that is, it is a group of people seeking to undertake business in markets where little is known about key variables. Startups are early-stage organizations focused on a scalable business model (Antonenko et al., 2014). As a source of innovation, a startup uses emerging technologies to invent products and reinvent business models (Kohler, 2016); it is an institution “designed to create a new product or service under conditions of extreme uncertainty” (Ries, 2011).

This definition says nothing about the size of the company, so it may be assumed that anyone who is involved in creating a product or service where great uncertainty prevails is involved in a startup. Another important consequence of the definition is that innovation is implied as a key component. It is not about creating something revolutionary, even though it can happen, but at least the activity seeks to bring a new source of value to customers, either by providing a solution in a previously overlooked market or by making use of existing technology. Also, we highlight the fact that startups deal with extremely uncertain environments, with little information, and where it is often not clear who the customer is (Ries, 2011).

As a final note, consider how recently the startup concept became commonplace, especially in Brazil. According to Gitahy (2010), the concept of a "startup" in entrepreneurship gained popularity in the United States starting in 1990, in step with the emergence of the “Internet bubble”. However, it was only in the period from 1999 to 2001 that the term began to be diffused in Brazil.

Research Methodology

The approach used in this research is qualitative and descriptive. The definition of qualitative research for Yin (2015) considers five characteristics: i) study the meaning of the real life of individuals; ii) represent opinions and perspectives of individuals in a study; iii) encompass the contextual conditions in which individuals live; iv) contribute with revelations about existing or emerging concepts that can help explain human behaviour; and v) strive to use multiple sources of evidence instead of relying on a single source. In this sense, qualitative research subjects should be individuals or groups that are involved in similar experiences (Creswell, 2014).

For Sampieri, Collado, and Lucio (2013), the qualitative approach is used when trying to understand the perspective of individuals about the phenomena that surround them, under their experiences, points of view, opinions, that is, how participants subjectively perceive their reality. For Antonello and Godoy (2011), this technique gains prominence among the various existing techniques, due to the subjective context of the individual, based on experiences, based on their feelings, beliefs, ideals, and propositions.

Descriptive research seeks to describe the characteristics of a particular population or the facts and phenomena of a reality, which may provide a greater familiarity with the problem, making it more explicit and favouring the improvement of ideas and considerations of the most varied aspects linked to the fact studied (Triviños, 1987).

Data collection was done in November 2017 using a semi-structured script for interviews with the founding directors of the startup being researched. It was composed of open questions in which the interviewee had the opportunity to discuss the proposed topic without answers or conditions prefixed by the researcher (Minayo, 2012), and it was guided by basic questions about the proposed theme (Triviños, 1987). The semi-structured interviews started with broad questions, so that the interviewee felt free to talk; in addition, the researcher–interviewer did not interrupt the interviewees. The interviews were deep, with an average duration of one hour and occurred in in places of preference of the interviewee. Interviews were only carried out with the consent of the interviewee, a previous appointment was made with each one, in which the objective of the research was presented, at which time a commitment was established between the two parties: interviewer and interviewee.

The choice of interview technique is based on Belk, Fischer, and Kozinets (2013), who suggest that the interview has become popular as a way of collecting qualitative data in research on behaviour in the applied social sciences, whether it is considered open, in-depth, or semi-structured. Triviños (1987) states that the semi-structured interview "favors not only the description of social phenomena but also their explanation and understanding of their totality".

The interviews were recorded, transcribed, and subsequently analyzed using the technique of content analysis, which comprises a set of communication analysis techniques aiming to obtain – by systematic procedures and objectives of description of speech content – indicators that allow the inference of knowledge regarding the conditions of production or reception of these messages (Bardin, 2011). The content analysis was performed with emphasis on categorical analysis and the enunciation. The categorical analysis is structured based on the interviewees' reports, and the categories of analysis are established to represent similarities between the reports of the majority of respondents and similarities between their behavioural characteristics and their perceptions about the phenomenon that is being studied. The enunciation analysis is the process of segmenting the texts of the interviews, already summarized, into smaller units, which can be phrases, sentences, paragraphs and even topics. The analysis of data was structured by the procedures of organization, treatment and analysis of the data collected to understand them, answer the research questions, and generate knowledge (Sampieri et al., 2014).

Results and Discussion

Case overview: Chip Inside

The Guedes brothers, Leonardo (an electrical engineer) and Thiago (a mechanical engineer), were born in the interior of Rio Grande do Sul, in the south of Brazil, and always had the will to undertake challenges. It was within a research group that they participated in a technology transfer project for animal monitoring equipment. The brothers saw that technology had the potential to become a product and decided to start a company, which they named "Chip Inside".

Chip Inside Technology (pt.chipinside.com.br) develops animal-monitoring products for precision livestock management. The startup was created in August 2010 with the objective of developing "innovative high-technology solutions, integrating embedded electronics and software". The startup's solutions focus on the stages of design, development, manufacturing, sales, and after-sales support. In 2018, after eight years of operation, the company has a team of more than 30 employees at the technical, undergraduate, master's, and doctoral levels. It is considered one of the most promising startups in Brazil's technological segment.

The company is currently incubated at Pulsar Incubator (coral.ufsm.br/pulsar/) in partnership with the Agency of Innovation and Technology Transfer (AGITTEC) at the Federal University of Santa Maria in the south of Brazil. In its portfolio, Chip Inside offers two services: C-Tech HealthyCow and CowMed Assistant. C-tech is a collar that enables a farmer to monitor each of their animal's rumination, activity, temperature, and reproductive parameters. The C-Tech HealthyCow collar is available for purchase or loan.

The client has the option of paying a monthly fee per animal for a "full monitoring package". This package enables the C-Tech system, which guarantees the operation or replacement of the equipment, including collar batteries, in addition to providing access to CowMed Assistant.

CowMed Assistant is the first remote health care assistance plan for dairy cattle. CowMed Assistant's team of veterinarians, zootechnicians, and technicians remotely monitor herds and assist farmers with decision making. Through the C-Tech HealthyCow System, the technical team accesses the property data online and exchanges information with its technical staff on a daily basis. CowMed Assistant is not intended to replace the farmer's expertise or the expertise of their staff, but it provides information that helps in decision making.

The value of the product is in the information, as the brothers Guedes explain:

> *"Value is information – value is the database of animals. It is this thing to ask the cow which diet is good for her, which remedy works best. The idea is to have a considerable number of cows monitored so that they no longer need to ask, and can tell the farmer in the future which animal will perform better under certain conditions on such a diet and, if it becomes sick, which remedy more indicated. But, this in a while, because we need to have a lot of cows monitored. Information has value for us, much more than the product or the service. When we sell to the producer, I do not have access to that information, so we prefer to earn a little less now, but have the information."*

Today, the startup's collars monitor approximately two thousand cows. The projection for the year 2018 is ten thousand monitored cows, and for 2021 it is one hundred thousand cows monitored through CowMed Assistant. For the Guedes brothers there is a great potential demand, given that the national dairy herd is 22 million animals, and that is only considering the potential for growth within Brazil. Even greater growth may be realized through internationalization.

In 2017, the startup became the first company selected to obtain resources from the Criatec 3 investment fund. The startup will receive R$2 million (approximately $800,000 CAD) from the fund over five to six years, during which the fund becomes a minority partner of the company, injects money, and participates in decision making. At the end of the participation period, the fund sells its interest either to the majority shareholders or to new investors. From the investment, the next innovation of the startup is to develop a technology related to artificial intelligence, so that robots can monitor the data of the thousands of cows scattered throughout Brazil without interruption. The funding will also be applied to international trade expansion.

To internationalize or not to internationalize?

To answer this question of whether or not the startup should internationalize, we reflect on our discussions with one of the founders of Chip Inside, Leonardo Guedes, who is currently Director of the startup. He shared his previous experience of internationalizing the startup, the option to try again, and future plans for the company. The analysis of the interview is based on Johanson and Vahlne's (1977) theory of internationalization through learning.

Given the uncertainties and imperfections in a new market, Johanson and Vahlne (1977) argue that the internationalization process should occur incrementally. In this way, the companies initially develop in their internal market and the internationalization ends up being a consequence (Monticelli et al., 2017). This pattern matched the Guedes' experience:

> *"We serve, for the time being, the southern region of Brazil (Rio Grande do Sul, Santa Catarina, and Paraná) and intend to expand to other regions of the country (Minas Gerais, Mato Grosso, and Goiás, for example). From next year, [2018] we intend to resume the process of internationalization of our company."*

From internationalization through learning, the process of internationalization is based on the gradual acquisition and use of knowledge in foreign markets. Therefore, companies invest resources and acquire knowledge in a certain foreign market and the commitment increases as knowledge grows (Johanson & Vahlne, 1977), as confirmed by the Guedes brothers:

> *"Our first contact with Uruguay took place in 2015 at a fair in which we were participating [Expointer]. Thus, the idea came to expand our business to Uruguay. We translated all software and graphics into Spanish. We were founding our company at the time and we wanted to enter the Uruguayan market through Selecta [an international dairy products company]. We did not make any sales during the time we stayed in Uruguay. We had insights that came out of this international partnership, but we ended up making no concrete sale."*

Among the difficulties perceived in Uruguay, Guedes mentions:

> *"We went to the wrong place because we were starting to put the product on the national market – we had no basis abroad. As much as Selecta wanted to represent us there, the system had just been launched in Brazil. It was much more in the heat of the moment – 'Let's go to Uruguay! Let's internationalize the brand!' – than an actual plan to go."*

Faced with frustration, the directors chose to withdraw from Uruguay and keep the business only in the national market. In Brazil, failure still carries a stigma (Minello & Scherer, 2014). Over the last few years, the startup has focused on improving the product and expanding in the domestic market.

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Currently, the scenario in Brazil regarding milk cattle is unstable due to the high production levels and the low national demand, which results in a low price for the rural producer. In addition, Brazil imports the lowest value product, mainly coming from Uruguay. These factors indicate that perhaps it is time for Chip Inside to internationalize.

As far as the publicity and sale of the products and services the startup participates in fairs. Because it is an innovative product, newspapers and magazines are keen to publish stories about the company, which ends up being a form of free marketing. In addition, the startup emphasizes product quality and better results for its customers. A satisfied customer will talk favourably about the company to other potential customers. This word-of-mouth marketing demonstrates greater credibility with customers, because people do not trust companies, people trust people. Based on this observation, the management decided to work with other companies in the sector, such as Ourofino Saúde Animal and Cargill. Through such partnerships, the sale of products and dissemination of information increases because they are targeted to the right audience.

Conclusions

Faced with an increasingly technological global economy, the risk is the deepening of economic differences between developed and underdeveloped countries. Countries with few resources run the risk of being further marginalized from economic development, created from innovation centres. In this sense, it is important to promote the expansion of technology startups in the most diverse countries, developing and underdeveloped, to reduce this distance.

This study describes the experience of a startup in the face of internationalization and the desire to return to internationalization. The theoretical basis is centered on the Uppsala model, examining failure and learning in the face of internationalization, and the need for a technology startup to become global. In spite of its initial failure with internationalization, this experience served as learning for a greater maturation of the direction of the startup. Years later, also driven by an investor, Chip Inside's management aims to return to the global market, now with its feet on the ground, given the potential of its product and the limitations of the market.

The results of this study contribute to the field of international research on entrepreneurship through a better understanding of how and why technology startups in developing economies, such as Brazil, can act in the face of the desire for internationalization. Of course, success is obviously the preferred outcome, but failure should not carry a stigma; rather, it should be considered an important learning experience. In addition, the results also increase the managerial practice because they will help the directors of other startups who intend to enter the international market.

Although they were unable to serve the Uruguayan market at that time, the internationalization attempt ultimately served as a form of apprenticeship. Among the positive and negative experiences acquired during this process, some stand out. On the positive side, the startup developed its knowledge of the needs of the Uruguayan market, as well as the country's customs and regulations. On the negative side, the startup found that it was not prepared to enter the Uruguayan market and suffered as a result of an impetuous decision.

The research was limited to studying a Brazilian startup with a focus on its unsuccessful experience of internationalization and its desire to return to internationalization. Future studies may contemplate a larger sample, comparing experiences of internationalization among technology startups in different cultural contexts, including developed countries. It draws attention to the fact that in replicating the study one must take into account countries that have a smaller psychic distance, such as between Brazil and Uruguay, where perceptions of risk, imperfect information, and cultural barriers may be similar. In addition, it would be interesting to analyze the relationship between the different failure variables regarding the internationalization of technology startups. The attempt of internationalization addressed in this study – although a case failure – can serve as an instructive example for other companies and situations in different countries.

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Start by asking yourself:

- Does my research or experience provide any new insights or perspectives?
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