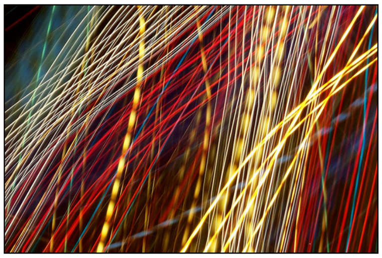
Technology Innovation Management Review

July 2016
Volume 6 Issue 7



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Insights

Welcome to the July 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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Technology Innovation Management Review

July 2016
Volume 6 Issue 7

Publisher

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

ISSN

1927-0321

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Chris McPhee

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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.

Contribute

Contribute to the TIM Review in the following ways:

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

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

About TIM

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

Editorial: Insights

Chris McPhee, Editor-in-Chief

Welcome to the July 2016 issue of the *Technology Innovation Management Review*. The articles in this issue were developed from papers presented at the 2016 ISPIM Innovation Forum (Box 1), which was held in Boston, USA, from March 19–22, 2016 under the theme of "Charting the Future of Innovation Management".

The authors in this issue share insights on innovating business models for the circular economy, assessing co-operation between industry and research infrastructures, designing value networks, managing intellectual property, and driving open innovation ecosystems.

In the first article, **Maria Antikainen** and **Katri Valkokari** from VTT (Technical Research Centre of Finland) provide a framework for sustainable business model innovation in the circular economy: a novel economic model aiming to foster sustainable economic growth, boost global competitiveness, and generate new jobs. They also present the results of a case study with a startup company, which was designed to test the framework and provide a concrete example of its usage and future development needs.

Next, **Csaba Deák**, Associate Professor at Corvinus University of Budapest, Hungary, and Chancellor of the University of Miskolc, Hungary, and **István Szabó**, Head of Department at Hungary's National Research, Development and Innovation Office, assess the degree of co-operation between industry and research infrastructure in Hungary. They share results of a nation-wide survey carried out in support of a National Infrastructure Roadmap. Their analysis provides a starting point for developing new measures, setting goals for individual scientific fields, and making comparisons with other countries.

Then, **Martin Kage**, **Marvin Drewel**, **Jürgen Gausemeier**, and **Marcel Schneider,** from the Heinz Nixdorf Institute in Germany present, a methodology to design value networks for innovations, including approaches to identify necessary competences, find suitable partners, and bundle them to powerful alternative value networks. As illustrated by the case used to validate their methodology, companies that want to create smart products or services must arrange the value network such that the customer obtains a unique value while all participants profit from their engagement.

Box 1. About ISPIM (ispim.org)

The International Society for Professional Innovation Management (ISPIM) is a network of researchers, industrialists, consultants, and public bodies who share an interest in innovation management.

Recent events

- Innovation Summit (Brisbane 2015): Featured in the June 2016 issue of the TIM Review on Innovation and Entrepreneurship in Australia (timreview.ca/issue/2016/june)
- Innovation Forum (Boston 2016): Featured in this issue of the TIM Review
- Innovation Conference (Porto 2016): To be featured in an upcoming issue

Upcoming events

- ISPIM's next major event, the Innovation Summit (summit.ispim.org) is being held in Kuala Lumpur, Malaysia, from December 4–7, 2016. The submission deadline for outlines is September 16.
- Next year's Innovation Forum (forum.ispim.org) will be held in Toronto, Canada, from March 19–22, 2017.

Next, **Daniel Eckelt**, **Christian Dülme**, **Jürgen Gausemeier**, and **Simon Hemel**, from the Heinz Nixdorf Institute in Germany, propose an approach to help companies identify "white spots" in innovation-driven intellectual property management and provide recommendations to help companies improve their intellectual property portfolios. White spots represent unaffected/untainted and circumscribed areas on an intellectual property technology landscape. Thus, they offer great opportunities for innovative and creative companies seeking to gain competitive advantage.

Finally, **Gonzalo León** and **Roberto Martínez** from the Technical University of Madrid (UPM) in Spain answer

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the question "How can a university drive an open innovation ecosystem?" By examining the general characteristics and specific dimensions of university-driven open innovation ecosystems, they show how different types of such ecosystems can be created and evolved to suit individual and system-level goals.

We are proud to be associated with ISPIM and are grateful for their assistance in putting together this issue. We hope you will enjoy and find value in the insights provided through these articles.

For our 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.

Chris McPhee
Editor-in-Chief

About the Editor

Chris McPhee is Editor-in-Chief of the *Technology Innovation Management Review*. He 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. Chris has over 15 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.

Citation: McPhee, C. 2016. Editorial: Insights. *Technology Innovation Management Review*, 6(7) 3–4. http://timreview.ca/article/999

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Keywords: innovation management, circular economy, business model innovation, industry, research infrastructure, cooperation, value network design, intellectual property, open innovation

A Framework for Sustainable Circular Business Model Innovation

Maria Antikainen and Katri Valkokari

> *"Sustainability is not a luxury; it is a basic human right."*
>
> Jim McClelland
> Editor, journalist, and futurist

The circular economy concept is a novel economic model aiming to foster sustainable economic growth, boost global competitiveness, and generate new jobs. In order to make the circular economy mainstream, radical and systemic innovation is needed. Currently, a majority of the business modelling tools and methods lack at least some of the identified and needed elements for innovating business models in a circular economy. In this article, we build a framework for sustainable circular business model innovation by adding important perspectives: recognizing trends and drivers at the ecosystem level; understanding value to partners and stakeholders within a business; and evaluating the impact of sustainability and circularity. We present the results of a case study with a startup company, which was designed to test the framework and provide a concrete example of its usage and future development needs.

Introduction

The dominant linear economic model is running out of road, with non-renewable natural resources dwindling and becoming more expensive. The need for a circular economy is evident given that a significant proportion of non-renewable resources is diminishing and natural resource price volatility is increasing (EMF, 2012). Current trends, such as increasing consumption, new generations of consumers, urbanization and employment, tightening legislation, and technological leaps, accelerate the transition to a circular economy. But this is not a new discussion: Lovins and colleagues already stated, in their 1999 article titled "National Capitalism", that business strategies built around the radically more productive use of natural resources will solve many environmental problems at a profit. McDonough and Braungart (2002) continued this discussion in their well-known book *Cradle to Cradle* by suggesting that industry should preserve and enrich ecosystems and nature's biological metabolism while also maintaining a safe, productive technical metabolism for the high-quality use and circulation of organic and technical nutrients. Similarly, lifecycle thinking and a broad range of lifecycle assessment (LCA) methods have been utilized for assessing the environmental impacts of a product, service, business, policy, or process (Cooper & Fava, 2006). Recently, the Ellen MacArthur Foundation (2012) facilitated this discussion about the circular economy, making a major contribution in familiarizing the concept to academics, businesses, legislators, and finally also to consumers. The main challenge is to rethink how to maximize the value of products and materials and this way to contribute to reducing the usage of natural resources and create positive societal and environmental impact (Kraaijenhagen et al., 2016). To accelerate the transition towards a circular economy, the European Union has launched an ambitious Circular Economy Package, which will contribute to "closing the loop" in product lifecycles through greater recycling and re-use, and bring benefits for both the environment and the economy (European Commission, 2016).

In order to enhance the transformation of companies, industries, and whole economies to adapt and succeed in application of a circular economy, a system-wide innovation changing the whole processes of value cremultiple, if not all aspects of the current business models of companies (Stahel, 2014). Changes have to be made ation is often needed, while the circular economy is grounded to the feedback-rich (non-linear) systems (EMF, 2012). In reality, business model innovation is quite often piecemeal or incremental, rather than transformational, fundamental, and system-wide. System-wide innovations can only be realized in conjunction with related complementary innovations; in other words, these innovations are not autonomous. Thus, the introduction of a single innovation can result in a systemic innovation if it generates or requires changes in one or more areas of a system.

The entire transformation towards a circular economy sets challenges for established companies. In some cases, it might even destroy the usefulness of their existing capabilities, networks, and business models. For instance, how can an economy that does not create waste make sense for businesses of manufacturers or retailers? Both systemic and radical innovations may open up whole new markets and potential applications. In companies, new ideas and technologies are commercialized through their business models (Chesbrough, 2010). It is clear that radical innovations and disruptive business models are needed in order to tackle the current challenges and move towards the circular economy model; one example could be providing a solution such as "mobility as a service" instead of selling means of transport such as cars, motorcycles, etc.

The big question is how to innovate new disruptive business models in this environment when the whole business ecosystem and its dynamics are changing? Excellent examples of disruptive business models based on a sharing economy, such as Uber and Airbnb, are already changing the whole value network. Therefore, the sharing economy and service business have been identified not only as trends that support our transformation towards a circular economy but also a source of huge, still untapped, opportunities for existing companies as well new players. The first step in many cases could be that companies would perceive their customers as users rather than buyers. Transformation from product-orientation towards service-provider in many ways supports reaching the objectives of the circular economy, for example by motivating companies to extend product lifetime by repairing and remanufacturing, and by more efficient use of resources (Tukker & Tischner, 2006). To understand and support the business world in this transition, deeper understanding of how to develop disruptive circular economy business models is needed. Closing material loops often affects concerning products or services, relationships with customers and partners, and different production processes and revenue models. In other words, new players or changing roles create a need for re-designing existing value networks and related business models. Managing these changes requires companies to engage in a process of circular business model innovation, which starts by designing the elements of business models. The main objective of this study is to provide a framework for circular business model innovation. Thus, the following question is posed: *What are the key elements of sustainable circular business model innovation?*

In this article, we first define and describe what a sustainable circular business model is and outline the related literature streams. Then, we examine the existing business modelling tools in general, in particular those related to sustainability and a circular economy. After that, we propose our framework for circular economy business model innovation that is tested with one Finnish startup to evaluate their circular economy business model. Finally, we draw conclusions and provide future research paths.

Framework: Business Model Innovation in a Circular Economy

The circular economy in a nutshell

We presently live in a non-sustainable “Take-Make-Waste” paradigm based on a linear economic model, which causes many environmental problems that will eventually reach a sustainability dead-end as Earth’s resources will be overloaded. This obsolete model will be replaced with a circular economy: an industrial system that is restorative or regenerative by intention and design. In brief, a circular economy is a novel economic model in which the focus is to keep materials in use for as long as possible and also to preserve – or even upgrade – their value through services and smart solutions (Figure 1). As a system-level phenomenon, circular economy business models require interaction between all involved actors, including both the core-business network and other stakeholders.

The circular economy will offer extensive business possibilities for both existing and new actors. In a circular economy, the closed loops consist of two supply chains: a forward and a reverse chain. In a reverse chain, a recovered product re-enters the forward chain (Wells & Seitz, 2005). Possibilities open up, for instance, for businesses that provide solutions and services along the reverse cycle. The service business has already been seen as a superior business model in many ways compared to selling products, and with the mindset of the

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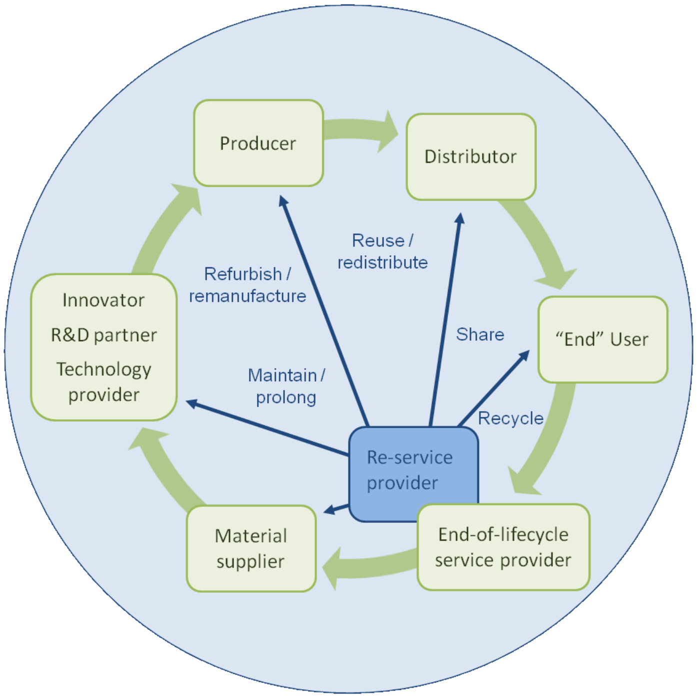

Figure 1. The idea of the circular economy as a feedback-rich (non-linear) system (adapted from Aminoff et al., 2016)

circular economy, the potential is even larger. It can be said that one of the major changes in a circular economy will concern consuming and the role of consumers. The relationships between consumers and products and services will change significantly as the concept of owning will be replaced with buying access and performance. In other words, instead of paying for ownership, consumers will pay per use or pay a fee for monthly access (for example, like the model used by the on-demand Internet streaming media service, Netflix). The transformation towards service businesses can be seen as one of the key solutions in accelerating a circular economy because companies could have incentives to create products that have a long service life, which are used intensively and which are also cost- and material-effective (Tukker & Tischner, 2006). However, on the negative side of servitization, there might appear the effect called "rebound". The rebound effect refers to a behavioural or other systemic response to a measure taken to reduce environmental impacts that offsets the effect of the measure, for example due to excessive and incorrect use (Hertwich, 2005). Solutions for minimizing this rebound effect are, for instance, co-creation and close relationships with customers in order to build a joint understanding about the importance of enabling a long lifecycle.

Current understanding of a circular economy business model

A business model represents the rationale of how an organization creates, delivers, and captures value (Osterwalder & Pigneur, 2010). Business model innovation is the novel way of creating, delivering, and capturing value that is achieved through a change of one or multiple components in the business model (Osterwalder & Pigneur, 2010). It is apparent that radical innovations and disruptive business models are needed in order to tackle current challenges and move towards the circular economy model (Boons et al., 2013).

Instead of concentrating purely on creating economic value, the literature on sustainable business model innovation concentrates on creating value for a broader range of stakeholders and takes into consideration the benefits from societal and environmental perspectives. Thus, the archetypes of sustainable business models have been identified and named in order to accelerate the development of sustainable business models in practice and theory. The archetypes are: maximize material and energy efficiency; create value from waste; substitute with renewables and natural processes; deliver functionality rather than ownership; adopt a stewardship role; encourage sufficiency; re-purpose the business for society/environment; and develop scale-up solutions (Bocken et al., 2014). Engagement with end customers and stakeholders (Stubbs & Cocklin, 2008), such as collaborating with local non-governmental organizations to improve integration into the community and understanding of the local culture, is highlighted in order to understand how sustainable business models create value for a broader set of stakeholders (Valkokari et al., 2014).

Sustainable business models and circular business models are closely related literature streams and they can be regarded as a subcategory of business models. A circular business model can be defined as the rationale of how an organization creates, delivers, and captures value with and within closed material loops (Mentink, 2014). The idea is that a circular business model does not need to close material loops by itself within its internal system boundaries, but can also be part of a system of business models that together close a material loop in order to be regarded as "circular" (Mentink 2014). Circular business model innovations are by nature networked: they require collaboration, communication, and coordination within complex networks of interdependent but independent actors/stakeholders. The challenge of re-designing business ecosystems is to find the "win-win-win" setting (Antikainen et al., 2013) that finds a balance between the self-interests of involved actors and thereby influences and facilitates their actions in order to cooperatively shape the circular business model. Yet, in reality neither 100% circular business models nor 100% linear business models exist due to physical and practical reasons. In prior literature on the circular economy, the focus has been on identifying characteristics of circular business models based on longevity, renewability, reuse, repair, upgrade, refurbishment, capacity sharing, and dematerialization (Accenture, 2014). Yet, there is a lack of academic literature on the circular economy, especially as it relates to novel business opportunities.

Current tools and methods for circular economy business modelling and challenges

Over the last decade, the business model has been actively discussed as an important unit of analysis in innovation studies. Overviews of the most important methods and tools for general business model innovation can be found in the (academic) literature. Business model innovation has twofold activities: the design of a new business model or its re-configuration (Massa & Tucci, 2014). Both academics and practitioners have proposed a multitude of avenues and tactics to support business model innovation. The most well-known tool for business model description is the business model canvas, which is a generic and easy-to-use tool, which has been applied in different industries (Osterwalder & Pigneur, 2010).

Based on the business model canvas, Sempels (2014) has created a sustainable business canvas that extends the original canvas by proposing 10 elements. In his canvas, he adds the perspective of organizational effectiveness and efficiency, positive and negative externalities, as well as drivers of productivity. Mentink (2014) has conducted an extensive analysis of the existing business modelling tools and their suitability in the context of circular business model innovation. Based on his findings, he proposes the business cycle canvas, which emphasizes the ideas related to the importance of understanding the circularity of the loop. This loop includes the roles of suppliers and stakeholders, as well as the importance of having an integrated business model for the whole supply chain. This approach requires an understanding of each of the actors' motives and how the value is co-created for them. The multiple-stakeholder value perspective is also included in the value mapping tool developed by Bocken and colleagues (2015), introducing three forms of value (value captured, destroyed, and missed) and value opportunities for major stakeholder groups (environment, society, customer, and network actors). One of the main benefits of their tool is to raise awareness of the potential for unintended impacts on external stakeholders, as well as to propose alternative solutions that might offer greater alignment between stakeholder interests. Furthermore, the play-it-forward tool (Dewulf, 2010) is also derived from the business model canvas, adding the building blocks for a triple bottom line, which means taking into account the perspectives of sustainability, in other words, integrating environment, business, and society views.

The Framework for Sustainable Circular Business Model Innovation

Our framework is built upon the ideas and the structure of the business model canvas, other tools, and studies on the circular economy and sustainability. The idea is to provide a generic model for business model innovation to support companies in designing, as well as reconfiguring, their business models.

The whole business ecosystem is changing and the circular economy needs systematic innovation, and therefore, a multilevel analysis is needed. The change towards sustainable and circular business model innovation should integrate elements from macro (global trends and drivers), meso (ecosystem and value co-creation) and micro (company, customers, and consumers) levels (Valkokari et al., 2014). Trends and drivers include the analysis of the business environment and scanning current trends. For example, new legislation might have a significant influence on the business model. The impact of the business model is divided into sustainability costs and benefit, adding the perspective of a triple bottom line to business model development.

The framework includes the idea of continuous iteration with sustainability and circularity evaluation of the business model (Figure 2). These aspects are needed in order to gain factual data about the sustainability of the business model in order to optimize the processes and to understand the dynamics of the processes needed. For example, change in one link in the supply chain may dramatically influence the whole model. The sustainability part of this evaluation can be conducted by using the evolving literature of lifecycle-assessment tools. The circularity perspective focuses on visualization of the model in order to understand the needed actors, relationships, cycle stages, and flows of material and information. For instance, three environmental strategies – closing, narrowing and slowing the loop

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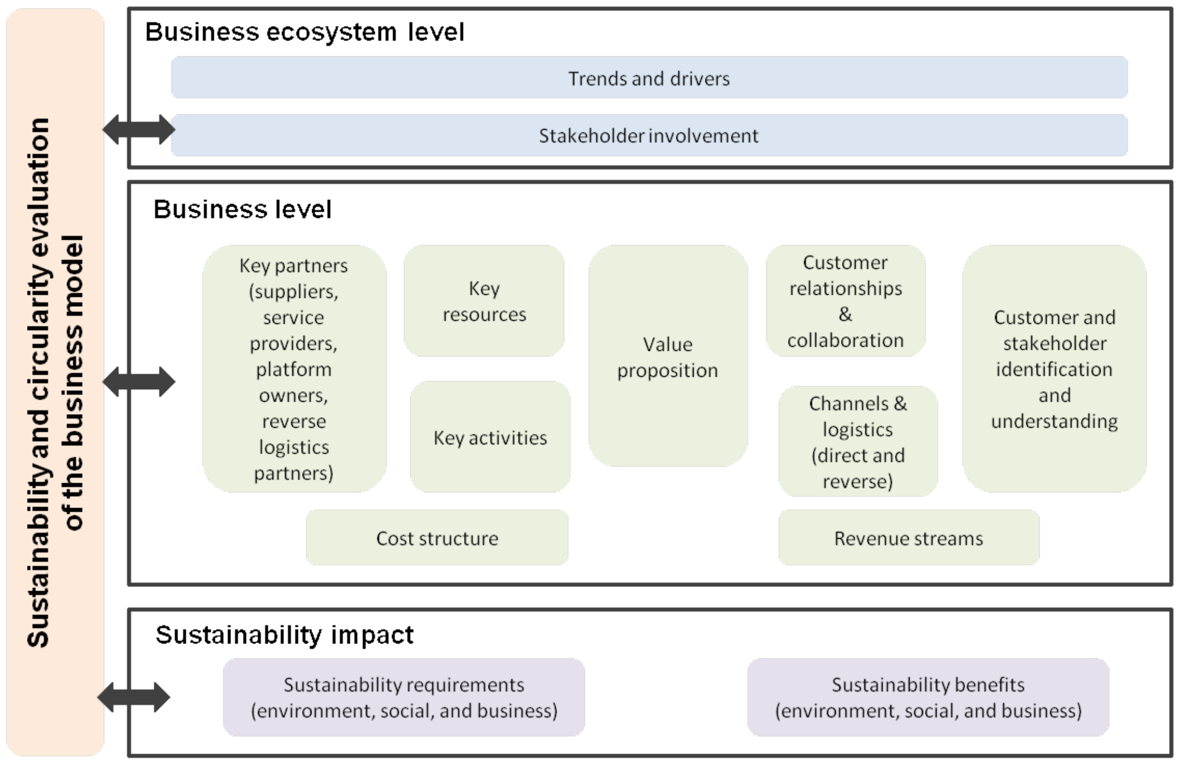

Figure 2. Framework for sustainable circular business model innovation

within circularity, as suggested by Kraaijenhagen, Van Oppen, and Bocken (2016) – can also be evaluated. Or, when taking a more quantitative approach to the evaluation of circularity impacts, there is a toolkit for circularity indicators currently being built in the European Union project called "The Circularity Indicators Project" by the Ellen MacArthur Foundation (2015).

Case Example

Case selection and methodology

A single case study method was chosen as the method for the study. A case study approach is the most suitable in situations where the main research questions are depictive (Yin, 2014). A case study is also known as a method where data triangulation is often used to increase the quality of the study. Instead of using sampling methods, the case selection maximizes what can be learned in the period of time available for the study. The case we chose for this study was one innovative startup company implementing a circular business model in Finland. The case company was already familiar to us through collaborations with the owner in our current research programme. Thus, we had easy access to the case and at the same time we were able to utilize our earlier knowledge.

Our main data was collected in a three-hour interview and discussion session with the entrepreneur. We had three researchers representing different backgrounds (consumer research, environmental impacts and business, and innovation) participating in the session. We used a semi-structural research guide, however, the session was more similar to a discussion than an interview. The session was recorded and one of the interviewers also was responsible for taking notes. In addition to the interview, secondary data was derived from the company’s presentation material, websites, and several earlier informal discussions with the entrepreneur.

Case description

Company X is a social enterprise established in 2011 and located in Finland. It provides fully scalable solutions for accelerating product reuse and recycling. One of its main services is the digitalized concept aimed at recycling centres or other second-hand market actors selling, buying, and swapping products. The concept enables recycling centres to increase the efficiency of the process of adding new products for sale on the Internet. Its aim is also to accelerate the flow of the products by justifying their price based on the time they have been available. The concept is also easy to use and this is important because recycling centres employ people with various skills sets and backgrounds.

Analysis and results
The analysis is presented in Figure 3. The entrepreneur was very familiar with ecosystem thinking, trends, and drivers. Value propositions for different stakeholders took most of the time during discussions. Particularly, understanding end user needs and value creation for consumers was regarded as beneficial and seemed to open new insights for the entrepreneur. Also, the different possibilities for revenue models were discussed extensively. All in all, the framework seemed to work well in this case, being still rather simple. The framework can be filled in during a three-hour period, but each of the blocks could easily take more than three hours of thinking and brainstorming about different options and evaluating them. In addition, the sustainability and circularity iteration and more detailed cost-benefit analysis is with the business model will take time, and is therefore beyond the scope of this article. As such, the framework can be regarded as a good way for communicating a business model to stakeholders, including financers and the media.

Findings and Conclusions

Currently, there is a lack of frameworks for supporting business model innovation in companies in the context of a circular economy. The current tools do not offer the needed understanding in the changing business environment and breaking up of current value chains. Furthermore, the impact of the circular economy models and sustainability should be understood through value creation for all stakeholders. The challenge of re-designing business ecosystems is to find the "win-win-win" setting (Antikainen et al., 2013) that balances the self-interests of involved actors and sustainability impacts. Thereby, the need for change communicated through business model influences and facilitates their actions in order to shape activities towards joint goals. Based on the results, instead of a single business model innovation, the role of systemic innovations was emphasized. Thus, re-design is often challenging for established companies within an existing business ecosystem and model, and therefore newcomers quite often are the ones who are able to disrupt and re-design the value chains as shown by the well-known examples of Uber or Airbnb.

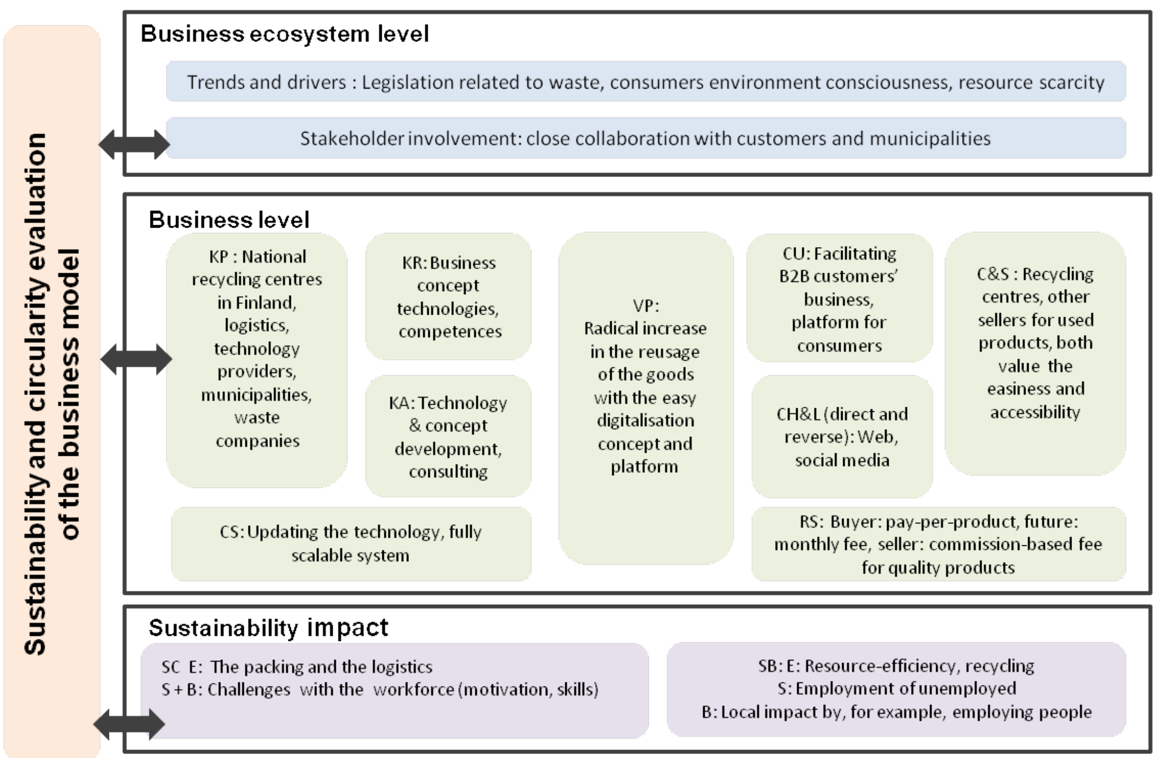

Figure 3. Framework for sustainable circular business model innovation: Case example of Company X

Furthermore, business model innovation practices often focus on incremental changes in areas such as key activities, key resources, and distribution channels. By its definition, system innovation, which is often needed in sustainable circular business models, should be considered at the multiple levels of system, which encompasses the cradle-to-cradle use of resources. A systems perspective to business model innovation exhaustively and holistically considers the entire system, which has several levels that need to be considered. Therefore, the suggested framework complements current business model tools by adding the business ecosystem level, analysis of sustainability costs and benefits, as well as iterative cycles of sustainability and circularity evaluation (see Figure 3).

There are several interesting paths to take related to business model innovation in a circular economy. In order to innovate in a circular economy, taking a multidisciplinary perspective plays a central role; thus, the framework presented combines views from foresight, business, consumers, and sustainability. The findings of this research describe the emerging practices for business model innovation based on a circular economy and thereby point to several research issues that appear worthy of further study. First, the framework should be tested in several other cases with different companies and industries. Second, longitudinal studies could straighten out the key stages of business model innovation processes by design or re-configuration. Third, especially for the sustainability and circularity evaluation parts/tasks in the framework, novel methods need to be developed in order to facilitate continuous iteration.

Acknowledgements

This research has been conducted as a part of the AARRE (Capitalising on Invisible Value – User-Driven Business Models in the Emerging Circular Economy) project. The authors would like to express their gratitude to the Green Growth Programme of the Finnish Funding Agency for Innovation (Tekes), Technical Research Centre of Finland (VTT), and other parties involved in AARRE project for their financial support.

An earlier version of this article was presented at the 2016 ISPIM Innovation Forum in Boston, United States of America, March 13–16. ISPIM (ispim.org) – the International Society for Professional Innovation Management – is a network of researchers, industrialists, consultants, and public bodies who share an interest in innovation management.

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Citation: Antikainen, M., & Valkokari, K. 2016. A Framework for Sustainable Circular Business Model Innovation. *Technology Innovation Management Review,* 6(7): 5–12. http://timreview.ca/article/1000

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Keywords: circular economy, sustainability, business model, business canvas, innovation, case study

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> *Research is four things: brains with which to think, eyes with which to see, machines with which to measure and, fourth, money.*
>
> Albert Szent-Györrgyi (1893–1986)
> Hungarian Nobel Laureate in Physiology or Medicine (1937)

In developed countries, a large share of R&D work is performed in universities, but the real significance of their contribution is larger, because they conduct most of the fundamental research. In this article, we examine one aspect of the academic sector that is visible to most outsiders, a field that requires usually the most resources as well: the research infrastructure. Hungary is currently in the process of forming its own National Infrastructure Roadmap. We present the results of a nation-wide survey carried out in 2014 by the National Innovation Office in support of the National Infrastructure Roadmap. The results represent a good starting point for developing measures and setting up goals for scientific fields. With the identification of research infrastructure usage by industry, this method might provide a best practice for other countries to undertake similar evaluations for their respective infrastructures.

Introduction

Business–academia collaborations are nowadays viewed as key factors in bringing R&D results to companies, through the universities "third role" of supporting economic development and the supporting of the national competitiveness (Ambos et al., 2008; Etzkowitz, 2003; Rasmussen et al., 2006). These collaborations between industry and universities lead to more intense R&D (Bozeman, 2000) and also to an increase in licensing activities, and through them an increase in R&D's impact on innovations for the business sector as well (Bonaccorsi et al., 2014). Regardless of the innovation model we examine, be it science-push or the (relatively) new networked model, the core of these theories is the major role of academia in innovation. All models conclude – as is logical – that basic R&D has an impact on innovation, although they differ significantly on how exactly this happens (Caraça et al., 2009; Kline & Rosenberg, 1986). We can assume that it is true that basic research has an impact on innovation. But in this article, we examine one aspect of "how" and try to answer the question "to what extent".

Governments and industry increasingly perceive universities as "a major agent of economic growth": the knowledge factory, as it were, at the center of the economy. In such an economy – one in which ideas and the ability to manipulate them count for more than the traditional factors of production – the university is seen as an increasingly useful asset. It is not only the nation's R&D laboratory, but also the mechanism through which a country augments its "human capital" to better compete in the global economy. A large share of R&D work, about 25 to 35 percent, is performed in universities (Eurostat, 2016), but the real significance of their contribution is larger, because they conduct most of the fundamental research.

Some authors analyze the relationship between universities and industry on the basis of case studies (e.g., Meyer-Krahmer & Schmoch, 1998); various publications dealing with the problem of how to improve the technology transfer from universities to industry have conducted broad surveys at universities regarding their industrial contacts (e.g., Chapple, 2005; Guerrero et al., 2015; O'Kane et al., 2015).

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In this article, we examine one aspect of the academic sector that is visible to most outsiders, a field that requires usually the most resources as well: the research infrastructure. Research infrastructure usage is one of the most logical and apparent usages of academic resources besides research contracts with scientists and their institutions. The role of research infrastructure is widely considered as important as basic R&D for innovation, if not more important. It can also be used as an "indicator" for understanding science and technology policy (Jacob & Hallosten, 2012). Still, it has only been partially studied, and literature on it is limited (Hallonsten & Heinze, 2012).

In this article, we share the results of a survey conducted in 2014 among the Hungarian research infrastructure owners: it is our attempt to define the cooperation levels between industry and academia. First, we examine the role of research infrastructure. Then, we describe the context of the survey: the development of a National Infrastructure Assessment and Roadmap in Hungary. We next describe the survey itself and present the results before finally offering conclusions and discussing the implications of the work.

The Role of Research Infrastructure

The problem of deriving value from research infrastructure has a long history dating back to at least the 1940s, and the approaches range from basically giving lots of money to research infrastructure to demanding income from them (Hallonsten & Heinze, 2012). Most countries spend huge sums to upkeep, build, or upgrade their research infrastructures in order to provide the necessary equipment for scientists. And some fields of science, such as physics, require relatively large amounts compared to other fields, such as social sciences. Given that spending on R&D for the academic sector comes from governments, it is politically important to make people understand what comes out of this spending. One of the explanatory factors is the usefulness of research infrastructure to industry and therefore its ultimate impact on the economy.

The usefulness and importance of research infrastructure is emphasized through various initiatives, such as the European Strategic Forum for Research Infrastructures (ESFRI) roadmap, a European Commission forum for research infrastructures (ESFRI, 2010). The roadmap aims to identify new research infrastructures of pan-European interest corresponding to the long-term needs of the European research communities, covering all scientific areas, regardless of possible location. Economic importance is not a key factor in selecting the infrastructures for the roadmap – which is fully acceptable, because these infrastructures in almost all cases support basic research, and their industrial relevance is not a priority. Although it is not a factor in selecting the infrastructures to the roadmap directly, the evaluation process and the connecting application the research infrastructures (buildings, lab equipment, etc.) have to show their relevance to industrial users. The industrial aspect arises mostly from the political side – governments and their citizens wish to see a return on their investment, and not through scientific achievements that are poorly understood by the general public. Take, for example, the lack of general understanding about the Higgs boson (wikipedia.org/wiki/Higgs_boson) despite a simple explanation being called for and provided to make the concept more comprehensible. Rather, citizens wish to see the impact of such investment through products and technologies that boost industry. Many of those responsible for making science policy prefer to view innovation in the spirit of the science-push model, or the linear model at best. Although the linear model is obsolete by now, because it draws a single direct line between basic research and innovation (not considering the organic nature of the process) and there are many new models trying to take its place – such as the multi-channel interactive learning model or the revisited contingent effectiveness model (Bozeman et al., 2015) – its simplicity gives it an advantage over the other models.

Nevertheless, looking either of the above-mentioned models, we find that the importance of the academic sector and higher education is undoubted, but still, the public has to be convinced of this fact from time to time. In the case of research infrastructure, one interesting example is that of a major infrastructure under construction, the European Spallation Source (ESS; europeanspallationsource.se), a multi-disciplinary research centre based on the world's most powerful neutron source. Currently under construction in Sweden, this new facility will enable new opportunities for researchers in the fields of life sciences, energy, environmental technology, cultural heritage, and fundamental physics. A key factor in the decision for building the ESS in Sweden was "to explain the purpose and usefulness of the facility and the research" (Agrell, 2012). However, the linear innovation model leaves a very strong and not very positive mark on public science communication, which can be summed up as "the assumed 'unexplainable' nature of advanced scientific projects and activities" and "the power of catchwords and compelling non-scientific arguments" (Agrell, 2012). This situation sometimes results in decisions that are suboptimal, not only from the scientific side but also from the economic side. For instance, certain studies indicate that the decision to build ESS in Sweden was much more of a political decision than one that was based on scientific evidence on the optimal location (Hallonsten, 2014). This decision has a component that is interesting from the industry–science cooperation side as well – before the decision was made, the idea of public–private partnership was brought up so that it would boost Swedish industry partners' potential to become partners for the ESS completion, but it was found that their added value would be doubtful. This fact was not taken into consideration during the final decision making either.

The overall situation in "big science policy" is the logical consequence of policy change over time from "justifying investment in basic science by reference only to the utility of basic research" (Elzinga, 2012). With the financial restrictions appearing after the Cold War was over, the "old arguments" (or the old communication panels) could no longer be used by scientists, who admitted that "OECD represents the economic and political interests of its members, not the intellectual interests of scientists" (Elzinga, 2012). From about the late 1990s, it has become a more and more demanding question to see how science contributes to the economy and to society as a whole. Although there is a certain danger to the academic sector in the cooperation with industry, namely the delaying or even the suppression of scientific publications (Banal-Estanol et al., 2015), the expected gain from using these infrastructures for applied research outweighs scientific reasoning.

Nowadays, the arguments on science's business orientation include greater cost consciousness, flexibility, and efficiency (Barzelay, 2001). The result is higher education acting more and more as a private company from a public relations view: institutions hire managers to oversee scientific budget and projects, form profit centres and build "brands". One prominent example in the case of "big research infrastructures" is their use of acronyms to "code" their infrastructures so that they are easy to say and remember, such as ALLEGRO, FAIR, ALICE, CLARIN, VIRGO, CESSDA, PRACE, and so on.

Science (and research infrastructures) face the dilemma of how to commercialize their knowledge and show their usefulness to the public (Huzair & Papaioannou, 2012). The usefulness of science is usually shown through open days and various events to the public, but they also have to prove to decision makers that the science they do is important for the economic actors as well.

This importance is hard to measure, however. What is the desirable level of cooperation with the industry? If we ask a policy maker, then the answer will be likely "as much as possible". But, until now, there has been no attempt to define what "as much as possible" really means. By developing a robust dataset, we seek to define the current and expected amounts of cooperation for each science field's level of industrial cooperation.

Hungary's National Infrastructure Assessment and Roadmap

Hungary is currently in the process of forming its own National Infrastructure Roadmap, which would be a natural addendum to that of the ESFRI. In 2014 a nationwide online survey was carried out by the National Innovation Office within the framework of the National Infrastructure Assessment and Roadmap project (known in Hungary by the acronym NEKIFUT). The survey targeted the owners of research infrastructure to gather data on their scientific relevance, demand for improvements, openness for usage by researchers, and so on.

The online survey was completed by 450 infrastructure owners, from which a scientific board selected the ones that could be considered as "research infrastructure". Infrastructures that were of scientific importance but were not research-oriented were omitted from the analysis; for instance, we did not include infrastructure used for educational purposes only. The selection process was guided by the following definition of research infrastructures:

> *"Those facilities or families of facilities, live and physical material repositories, data repositories, as well as information systems and services which are indispensable for scientific research activities and for the dissemination of the results. Those human resources which are necessary for the professional operation, use and services of research infrastructures are considered to be an integral part of Research Infrastructures."*

The structure and size of research infrastructures depend largely on the specificities of the given scientific field, as well as the needs of the research community using it. The entire process was carried out in broad cooperation with the scientific community. The project was led by a steering committee, while the three main academic branches (physical and engineering sciences, life sciences, and social sciences and humanities) were examined by separate working groups (with a total of 83 members). Overall, the project contacted several thousand researchers.

This process has resulted in numerous valuable outputs, including the development of indispensable tools and methodologies for the governmental research infrastructure development programme; the definition of various infrastructure categories with an internationally unique system for their classification; and the assessment and classification of existing research infrastructures. It has further resulted in IT development for the register itself.

After the evaluation of the online survey results, 328 infrastructures were taken into the Register of Research Infrastructures and their data are currently used to provide background information for the national roadmap. This number of research infrastructures can be considered as the vast majority of Hungarian research infrastructures, considering that there are 44 Academic (Hungarian Academy of Sciences) Research Institutes including all scientific fields and 12 higher education units (universities and faculties) involved in basic research in Hungary.

Our ability to compare this volume internationally is currently limited. However, there is one survey on research infrastructure at the European level: the Mapping European Infrastructure Landscape (MERIL; portal.meril.eu). The MERIL portal gives open access to an inventory of "research infrastructures of more-than-national relevance in Europe across all scientific domains", including the humanities and social sciences. One main goal of MERIL is to "allow policy-makers to assess the state of research infrastructures throughout Europe to pinpoint gaps or duplications and make decisions about where best to direct funding", therefore it can be considered a policy-making tool as well. From 27 European countries, it lists 495 operational research infrastructures, 26 of which are Hungarian. If we compare our figure to MERIL's figures, the Hungarian database can be considered a robust one – to our knowledge, no other national or international database exists containing this number of research infrastructures.

Analysis of National Research Infrastructure

The online survey was filled out mostly by universities and academic research institutes, giving us a good overview of the division of research infrastructure across the various scientific disciplines. All research infrastructure were categorized by their main discipline; interdisciplinary work was not taken into account even though there are certain fields that regularly use interdisciplinary approaches. According to the survey design, each infrastructure was asked to provide its main discipline only; respondents were not obliged to describe connections with other disciplines, and the detail provided by respondents varied widely in this regard.

Natural Sciences made up more than half of the examined infrastructures (Figure 1), which is not surprising given that this branch requires the most research infrastructure. Engineering Sciences come second; this branch has a strong connection to applied research and has a relatively high need for a diversity of research infrastructures. Medical Sciences and Agrarian Sciences also have connections to applied research, but each has fewer research infrastructures than Engineering Sciences. The number of research infrastructures devoted to Social Sciences and Arts & Humanities is less than 10% of the number devoted to Natural Sciences and represents only 5% of total research infrastructures in Hungary.

From these figures, it can already be seen that, the biggest need for "stand alone" research infrastructure comes from the Natural Sciences. As we "shift" towards more and more applied research areas, the demand for a dedicated research infrastructure lessens – medical infrastructure is usually used for actual medical practice as well, agrarian infrastructure is usually used for actual agrarian processes, and infrastructure in engineering is used for production and development besides basic research. The case of Social Sciences and Arts & Humanities is somewhat special because the low amount of infrastructure means that there are only a few infrastructures (in this case databases) dedicated to these

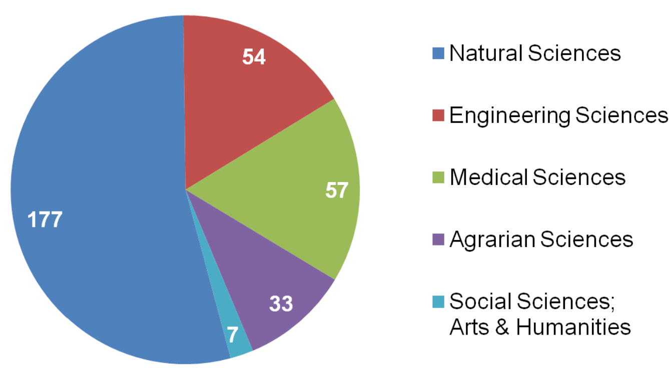

Figure 1. Distribution of scientific branches among national research infrastructures in Hungary (n=328)

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fields. They require fewer databases, but the databases must be more comprehensive and mostly international.

The above analysis provided us with evidence on the characteristics of each branch. Common sense also tells us that basic research has a bigger infrastructural need in the Natural Sciences, whose research activities involve basic research more often than those branches with other possible applications. The problem is that, until now, no attempt has been made (mainly because the lack of data) to assess the current and expected amount of usage of these infrastructures beyond basic research.

This matter can be answered by looking at the cooperation levels of discipline fields with companies. We can assume that the usage of a research infrastructure by companies provides a good indicator for infrastructure usage beyond basic research. Cooperation with companies usually takes the form of applied research or experimental development; only seldom does basic research come into the picture. Applied research and experimental development in optimal cases result in a new or advanced products and thus the cooperation will have an economic impact as well. With the usage of data gathered from the survey, we can measure current levels of cooperation with industry for each branch (OECD, 2015).

Among the many other data asked from the research infrastructures' owners, we use the following equation to calculate a scientific branch cooperation index, which measures the levels of cooperation with industrial partners and desired partnership intensity:

$$\mathrm{SCI} = \sum \frac{\mathrm{CU} * \mathrm{TU}}{N}$$

where

SCI = scientific branch cooperation index
CU = company utilization of research infrastructure (%)
TU = total utilization of research infrastructure (%)
N = number of infrastructures in scientific branch

For instance, research infrastructures in Physics have an average scientific cooperation index of 7.3% for 45 infrastructures, containing figures as high as 86% of total usage and 40% of company usage. However, some infrastructures in the same scientific branch are not used by companies at all.

Other data were considered for use in the determination of the scientific cooperation index, but were later rejected upon testing. For instance, the actual number of researchers was originally thought to provide a good weighting number for the infrastructure usage. This figure, however, was found to have no impact on the industrial usage. In most cases, industrial users do not directly use the infrastructure, but rather ask for its usage and the additional knowledge of the scientists, because they simply do not have the skills to use, for instance, a spectrometer. A scientist can cooperate in various projects at any given time, or may not get involved in any project at all; therefore, the total number of scientists at a research infrastructure is not taken into consideration in calculating the scientific cooperation index.

Results

The data from the 328 infrastructures were used, divided among disciplines after the data consolidation. Figure 2 shows the results comparing each of the branches. The results of the analysis are not surprising in the sense that they support the expectations of industrial partnership levels in the scientific branches. However, with the exact level of cooperation defined, we can provide a good basis for any further expectations for industrial usage in certain scientific branches.

The overall extent of cooperation between industry and research infrastructure is very low, with an average scientific cooperation index of 6.8% (Figure 2). Thus, cooperation, with slight differences among the scientific branches, is an exception rather than a rule. In the case of the Natural Sciences, the index is 7.3%; this above-average score can be considered good performance given that the majority of the examined research infrastructures came from this branch. With this score, Natural Sciences are second in cooperation levels with industry; however, this figure also suggests that, despite policy's demand for more and more industrial usage and income generation, the cooperation levels are still very low. Given that the costs of infrastructure upkeep or improvement in the Natural Sciences are among the highest of all the branches, it is expected by policy makers that these infrastructures should "overperform" – performing better by 7.1% than the overall (as seen, already very low) average is certainly not the expected score.

Within the Natural Sciences branch, Earth & Environment Sciences perform very well, and not surprisingly, the discipline with the strongest orientation towards ba-

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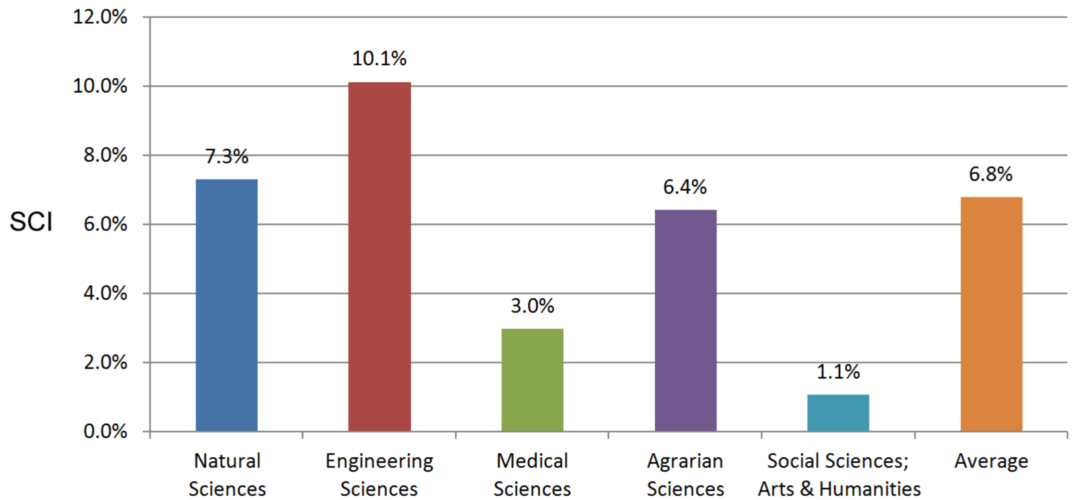

Figure 2. Levels of cooperation with industry by scientific branch, as measured by the scientific cooperation index (SCI)

sic research – mathematics – lags behind with an index score of only 2.2%. (Because we weighted the infrastructures with their numbers, this latter figure has little influence on the overall score – deducting it, the 7.3% of usage still remains firmly in place.)

Engineering Sciences definitely take the lead in this comparison, with an index of 10.1%, which is by almost 50% better than the average. We can assume that these infrastructures are designed (though perhaps not consciously) to be used not only for basic research but for research into applied science questions as well. This design results in a closer relationship to industrial partners and a more effective usage of the infrastructure. The usage model of engineering infrastructures should be examined in more depth, because this higher level of cooperation could be used to boost industrial usage in other disciplines' infrastructures as well.

Agrarian Sciences underperform, though one would expect that the index should be higher because of its relatively close relationship with applied research. It is important to note that this field has two main parts: crops and livestock. These fields perform very differently, with crops reaching an index of almost 12%, whereas the index for livestock infrastructure is only 2%, and the number of sample units are almost equal. In Hungary, livestock numbers have decreased in recent years, and it is obvious that not much research has been done in this field. On the other hand, crops remain a key factor in Hungary's GDP, as can be seen in its R&D involvement – and through it in the research infrastructures' cooperation levels as well.

Medical Sciences and Social Sciences and Arts & Humanities range around the same modest levels of cooperation, though the reason for this is likely to be different. In the case of Medical Sciences, although the total utilization of the research infrastructures is high, the company usage is low. On the one hand, these infrastructures are mostly used for actual medical practice; on the other hand, these infrastructures are dedicated solely to basic research – other infrastructures that are used not only for basic research are used in most cases in applied medicine (mainly through measurements). Therefore, only a small part of the "dedicated" basic research infrastructure can be used for company research, and it can be assumed that companies would rather use infrastructures that are closer to applied medicine.

Social Sciences and Arts & Humanities have very low levels of cooperation with industry – in this case, the reason is that these disciplines mostly use either databases that are international or have a strong national characteristic (e.g., linguistic databases). In the case of company cooperation, these databases are usually not directly used by the companies; the added value of the scientists for the data plays a key role in the collection and evaluation of the gathered data.

Conclusion

In general, research infrastructure usage in Hungary is quite low, but the question remains, compared to what? This study provides a good starting point for making measures and setting up goals for each scientific field. Also, we hope similar assessments and surveys will be

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made by other countries, thereby making international comparisons possible. The exact cause of the "underperformance" of research infrastructure in Hungary has yet to be identified. Nonetheless, our results are based on a robust dataset and lead us to some conclusions to form a realistic picture of the level of cooperation demand for the discipline categories.

First, it would be wise to agree on a level of expected industry–infrastructure cooperation between the infrastructure's stakeholders. It has been shown that the "old model" of financing these infrastructures cannot be maintained for various reasons (e.g., communications, politics); however, the other extreme, namely the demand for all-industrial usage of infrastructure designed for basic research, can cause more harm than good. When determining the desired levels of cooperation, it always has to be taken into account which discipline is using the infrastructure. Nowadays, decision makers put demands based mainly on building or upkeep costs of the infrastructure, which generates unrealistic demands.

Taking the above figures into consideration, it might be a fair expectation that infrastructures designed primarily for basic research should reach at least 5% company usage as a starting point, whereas those that can be used more for applied research should reach an industrial usage of 10%.

Second, in certain disciplines (Medical Sciences and Social Sciences and Arts & Humanities), it would be useful to drop demands for industrial cooperation – the existence of some basic research infrastructure makes it possible to form company cooperation, though not necessarily directly linked to the infrastructure itself. Also, we can assume that infrastructures that are used and designed primarily for basic research can be used for applied research with certain limits. Although licensing is taken into account, the actual company usage of it is not always clear to either of the stakeholders. There is a gap between scientists and company managers, and neither of them realizes the possible potential or results of such cooperation. A possible solution for this issue would be use of technology transfer officers at each research infrastructure, and, if possible, the "redesigning" of research infrastructures to better serve the identified needs of business users.

After determining the "desired level" of cooperation, certain innovation methods should be put into practice, much like the forming of technology transfer offices at the universities. Without these, no cooperation strategy can be built and the gap between science and industry will not close. Although the survey described here did not ask whether research infrastructure has dedicated management staff, this is a critical question and might be added to similar future surveys. However, we now have data on the services provided by the research infrastructures, which is a good starting point to have the research infrastructure more open towards the business sector.

This article provides a basis for assessing research infrastructure by estimating the desirable level of research infrastructure involvement in industry, which is also a level for their likely maximum involvement. With the identification of research infrastructure usage by industry, the usage of this method might provide a best practice for other countries to undertake similar evaluations for their respective infrastructures.

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Acknowledgements

An earlier version of this article was presented at the 2016 ISPIM Innovation Forum in Boston, United States of America, March 13–16. ISPIM (ispim.org) – the International Society for Professional Innovation Management – is a network of researchers, industrialists, consultants, and public bodies who share an interest in innovation management.

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Keywords: research infrastructure, university, Hungary, national infrastructure, assessment, survey

Value Network Design for Innovations: Developing Alternative Value Network Drafts

Martin Kage, Marvin Drewel, Jürgen Gausemeier, and Marcel Schneider

"You are my friends if you do what I command you."

John 15:14

Information technology increasingly permeates established products and services, thereby making them "smart". For companies, this trend necessitates new know-how in unknown fields. Hence, traditional manufacturing companies are increasingly forced to cooperate with new players within new value networks. In contradiction to value chains, value networks oftentimes exhibit no clear hierarchies and are characterized by rather weak ties between the participating players. For a company that wants to create smart products or services, the key challenge is arranging the value network such that the customer obtains a unique value while all participants profit from their engagement. In doing so, companies have to find new partners (companies, research institutes, etc.). In this article, we present a methodology to design value networks for innovations, including approaches to identify necessary competences, find suitable partners, and bundle them to powerful alternative value networks.

Introduction

The well-known concepts of value or supply chains do not do justice to describing how value is created in today's complex networks. Whereas traditional value chains have been characterized by strict upstream and downstream relationships, organizations nowadays interact as networked intermediaries (Porter, 1980; Yassine & Braha, 2003). These networks not only consist of companies; any player such as a research institute can partake in the process of value creation (Fjeldstad & Ketels, 2006).

Recently, two independent developments have boosted the interest in value networks and have led to a surge in attention for the discipline of value network design:

1. Networked technologies that only function within a network, such as smartphone networks (Breschi & Malerba, 2005). Today, the integration of networked technologies into established products, like production machines, turns the latter into "smart products" (Hui, 2014; Porter & Heppelmann, 2014).

2. Technology firms expanding their know-how through R&D alliances with other technology firms and open (innovation) networks (Granstad & Sjölander, 1990; Holmstrom & Roberts, 1998).

By collaborating in value networks, companies enlarge their technological know-how (Sattler et al., 1992; Gausemeier & Plass, 2014; Sell, 1994), establish an advantage in time (Zentes et al., 2003), address multiple markets (Zentes et al., 2003) and lower costs and barriers of market entry (Sattler et al., 1992; Sell, 1994). For the following reasons, a practitioner would be ill-advised to design the value network for an innovation only after fully developing the innovation:

1. The decision of which role(s) within the network a company occupies automatically predetermines which partners are needed for the remaining roles and how the relationships with these partners should be shaped. When identifying external players for a value network, companies face a notorious lack of reliable information. This is aggravated by the fact that innovations in the context Internet of Things often require cooperation across established industries. The information quality about possible partners will only become more reliable incrementally (Höfer, 1997). Moreover, the decision of which role is to be occupied predetermines which competences the company has to develop internally in the long run. The process to develop these competences takes time and has to be planned ahead early on (Rübbelke, 2016).

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2. A partner organization can provide valuable knowledge for the innovation itself (i.e., open innovation). The earlier this knowledge is available, the less costly the adaptation of the innovation (Büchel & Raub, 2002; Ehrlenspiel et al., 2014).

3. A value network can hardly be imitated by competitors (Kumar, 2004). The sooner an organization starts to identify its partners, the higher are the chances that these partners do not already cooperate with a competing organization.

4. Companies only know their true competitors after identifying which role(s) within the value network they will occupy in the future. Also, only when the roles in the value networks are determined, can search fields for technological foresight be determined. Naturally, this knowledge is needed as early as possible (Gausemeier & Plass, 2014).

The aim of this article is to present a methodology for the design of a value network in the early stages of the development process of products and services. The salient feature of this methodology is that it does not identify single companies for a specific job but rather allows for bundles of companies to fulfill the imposed requirements. The research question is therefore: *What is a methodology that devises different bundles of partner companies to realize external key activities for a business idea?*

In the following section, we briefly review the relevant literature. Next, we present our proposed methodology. And finally, we discuss the implications from a practitioner's viewpoint.

Literature Review

According to Allee (2015), a value network is "a web of relationships that generates economic value and other benefits through complex dynamic exchanges between two or more individuals, groups, or organizations". It visually describes how value is generated for the consumer. What the business model is for the individual organization, the value network is for a set of interacting organizations (Müller-Stevens & Lechner, 2005). Value networks can either be developed as a consequence of an innovation idea (i.e., innovation pull), but theoretically could also be used as a strategic tool to evaluate entire branches and collaboratively develop innovation ideas (i.e., value network push). This relationship is illustrated in Figure 1, which shows that our approach can be attributed to the innovation pull stream on the left.

When designing value networks for innovations, approaches from two disciplines are naturally of interest: i) value network design and ii) mergers and acquisitions. The following subsections briefly introduce relevant approaches from these disciplines.

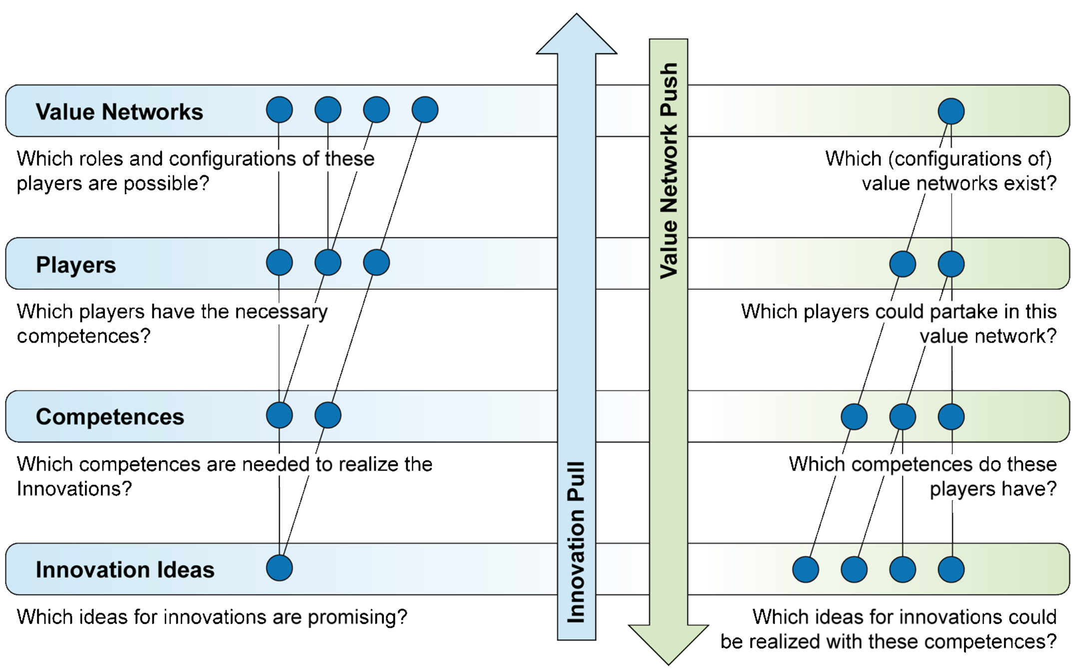

Figure 1. The principles innovation pull and value network push (Heubach et al., 2008; Kraus, 2005)

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Value network design

Normann and Ramirez (1993) acknowledged the continuous (re-)design of complex business systems as the key strategic task of successful companies. To differentiate from competitors, organizations need to develop solutions, consisting of products and services, and shape their business system accordingly. An approach that focuses on possible future scenarios has been developed by Kraus (2005). Organizations draft future scenarios and convert them to value potentials. The organization then identifies the roles it wants to occupy in the future value network and can thereby identify the crucially needed strategic assets (Kraus, 2005). A concept to measure and to generate value within a network that includes tangible as well as intangible components has been provided by Möller (2006). The approach contains the timeframe, arrangement, and content of value generating networks. Deutskens (2014) devised a decision model to configure the creation of value for disruptive innovations. The model provides concrete guidance to design the way an organization creates value for disruptive innovations. The principle of value network push has also been brought up by Müller-Stevens and Lechner (2005); they identified six basic maneuvers organizations can use to (re-)shape their value network (Figure 2).

The manoeuvres can be distinguished along the axes *Value Network Configuration* and *Value Network Coverage* (Müller-Stevens & Lechner, 2005). The potential of each manoeuvre cannot be calculated across-the-board (Deutskens, 2014). The manoeuvres however very nicely depict that value networks are not just a mere consequence of a product, service, or business model and can in fact be used as a strategic tool to actively shape a company's future.

Mergers and acquisitions

As pointed out above, the configuration of value networks requires laying out the cooperation between companies. That is why, naturally, approaches from mergers and acquisitions are relevant.

Essential basic knowledge about strategic alliances and networks and how they can be designed is provided by Zentes, Swoboda and Morschett (2003). On a much more detailed level, Höfer (1997) developed partner profiles that can be used to evaluate a single organization, according to a certain cooperation scenario. The profiles contain a partner's strategic as well as the cultural fit. Once a possible partner organization needs to be identified, various possibilities are available. Sattler and colleagues (1992) provide a general view of these possibilities. Approaches to plan, conduct, and integrate a partner organization within a merger or an acquisition are provided by Picot (2002) and Jansen (2001). The general idea of their approaches can be adapted to the process of identifying partners.

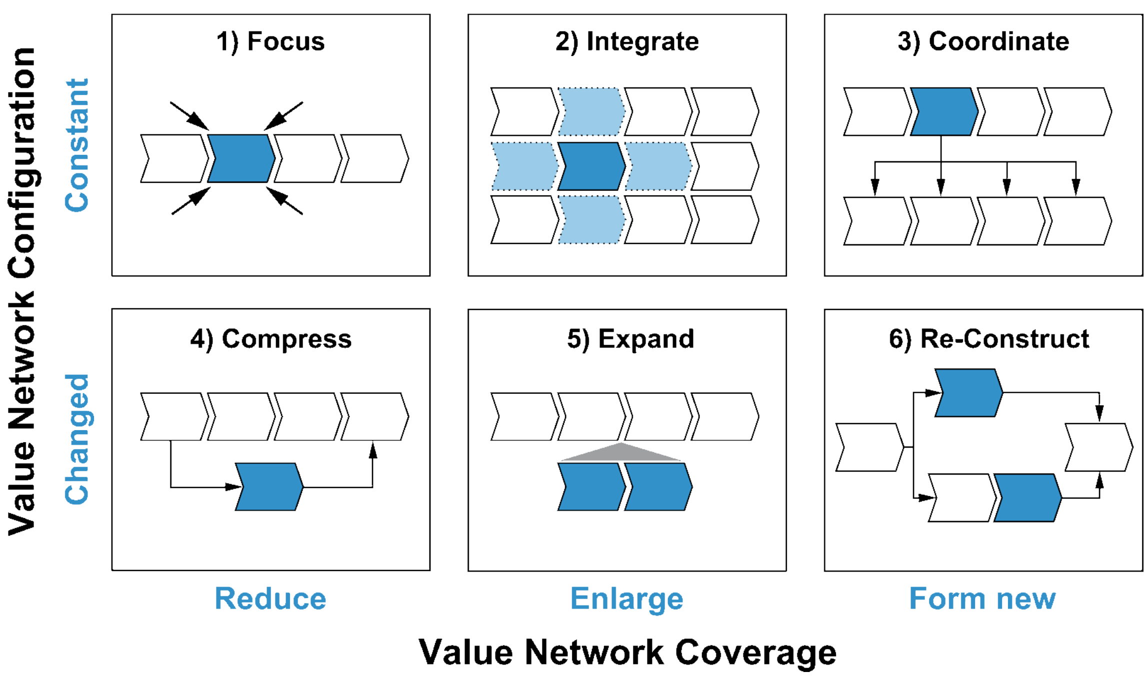

Figure 2. Value network manoeuvres (according to Müller-Stevens & Lechner, 2005)

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Methodology for Value Network Design for Innovations

As introduced above, ample theory on value network design and mergers and acquisitions has been published. However, the presented methods and approaches fall short of addressing the following challenges:

1. Finding concrete partner organizations. Methods for value network design aid in arranging the general streams of a value network, however they offer little help for the identification of concrete partners. Oftentimes they also focus on partner companies, although partners in value networks might also be complementarians.

2. Creating different options for the design of value networks. The well-known methods from mergers and acquisitions offer concrete advice on how to find partners for a concrete competence gap and in which ways to engage in a partnership with them. But, they fail to allow for the identification of bundles of partners to fill in a competence gap.

Our methodology to bridge this gap consists of four phases, or milestones, as presented in Figure 3: i) determination of cooperation demand, ii) partner pre-selection, iii) partner evaluation, and iv) implementation planning. We will next discuss each of these four phases of the methodology, which has been validated in projects with a medium-sized German household appliance manufacturing company. In this article, the company name has been anonymized to H.A.M.

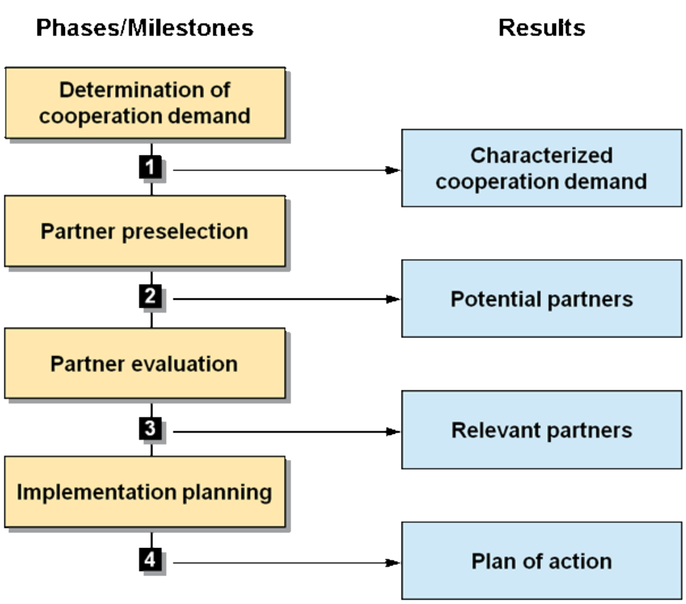

Figure 3. Methodology for designing value networks for innovation

Phase 1: Determination of Cooperation Demand

H.A.M. is looking at ways of improving the marketability of their kitchen appliances. The company currently prioritizes innovations from the search field Internet of Things, due to the Internet of Things changing the way customers interact with household appliances in the "Smart Home" (Esche & Henning-Thurau, 2014; Gartner, 2015). From their current innovation ideas, one idea is considered especially promising. Called “Recipe2U”, the idea is to link the company's appliances to an online platform that coordinates the delivery of fresh ingredients according to specific dishes the consumer wishes to make. H.A.M.'s kitchen appliances would offer the ability to download specific programs to optimally prepare the ingredients.

Recipe2U requires certain competences, which H.A.M. does not feature at the moment. These required competences are indicated in the lower left corner of Figure 4. These competences were identified in a preliminary functional decomposition of the planned innovation (Figure 5). We have found that this preliminary functional decomposition works for product, process, and business model ideas in the earlier stages of the innovation process.

The analysis of the functional decomposition revealed six competences. These competences can either be provided by H.A.M. or by a potential partner. For each competence, a decision of whether to develop it in-house or to obtain it from an external partner has to be made. For that purpose, the strategic relevance and the relative level of each competence are rated. The strategic relevance describes the future importance of a competence. The relative level of competence qualifies how effortful it would be to develop a certain competence in-house. A relatively low strategic relevance and a low relative level of competence result in a high degree of externalization. Competences with these characteristics should therefore be acquired externally. On the other hand, competences with a high importance in the future and thereby a high strategic relevance, combined with an appropriate relative level of competence, result in a low degree of externalization and should therefore be developed internally. The results are visualized in a bubble chart (Figure 6).

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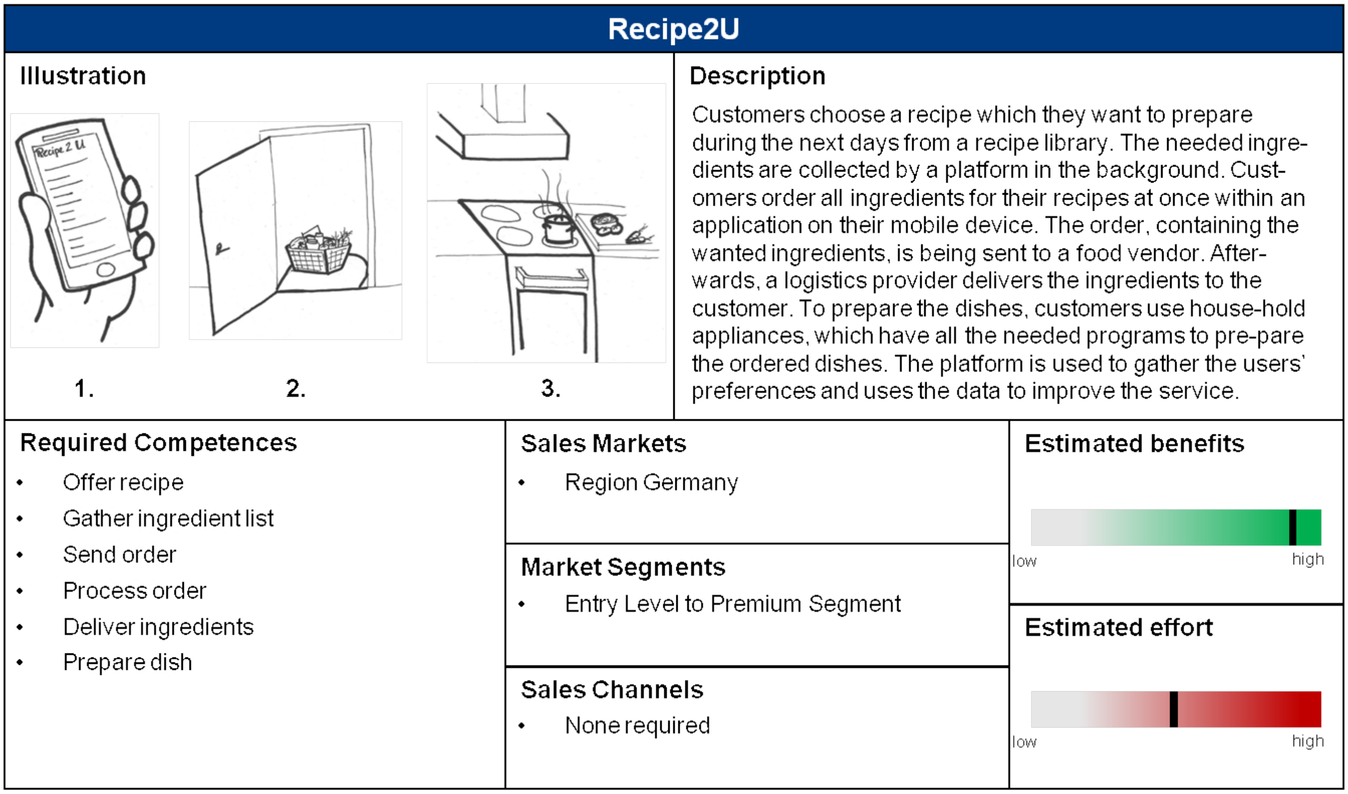

Figure 4. Innovation profile of the Recipe2U business idea

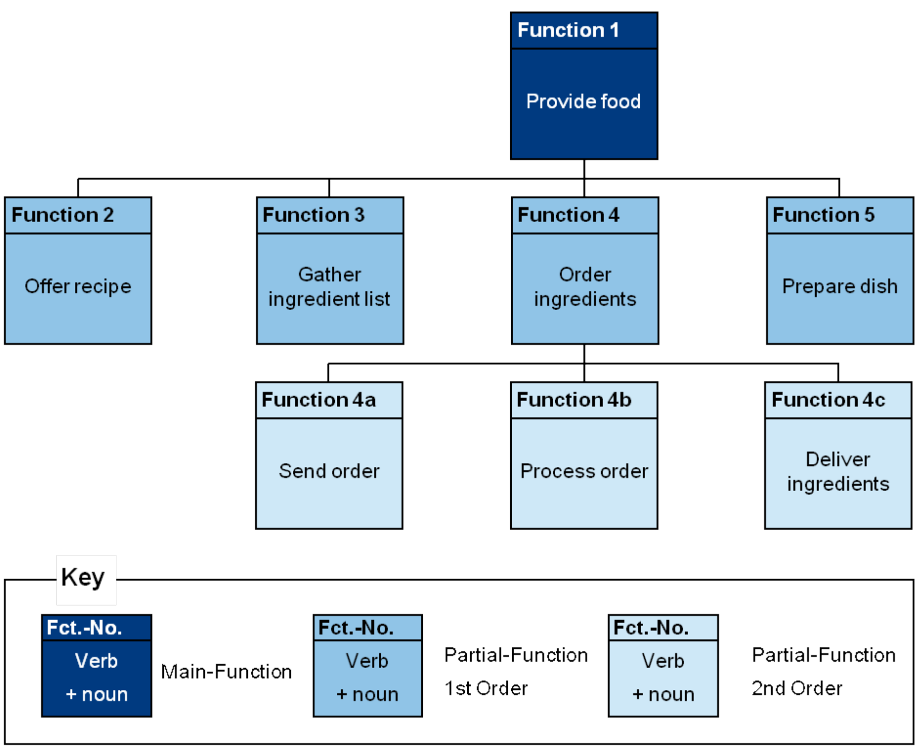

Figure 5. Functional decomposition of the Recipe2U business idea

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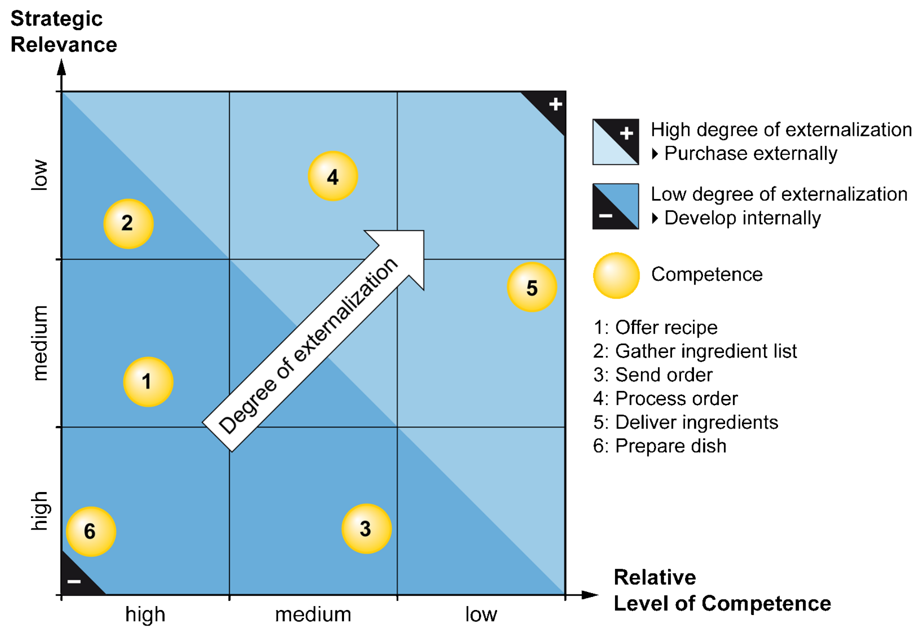

Figure 6. Externalization portfolio for the Recipe2U business idea (according to Hermes, 1995)

In our case, six competences are necessary for the Recipe2U business idea. As Figure 6 indicates, two of these should be provided by external partners and four should be developed or provided internally. At least partly, the latter four are already available for the company. That is, H.A.M. is looking for an organization that is able to deliver ingredients (Competence 5), by using orders from consumers of H.A.M. products (Competence 4). Both groups of competences are later on needed to evaluate possible partners.

Phase 2: Partner Preselection

A partner is an external organization providing the competences that are not to be built up internally. A five-stage process adapts the effort to identify the relevant partners accordingly:

1. Research
2. Applying knock-out criteria
3. Performance evaluation
4. Attitude evaluation
5. Motivation evaluation

The first two stages are part of the partner preselection; the following phase, partner evaluation, contains stages 3 to 5. To minimize the effort for the following stages, ineligible partners are eliminated from further consideration at the end of each stage, yielding the partner-selection funnel shown in Figure 7.

Partner profiles are the groundwork for the research into possible partners. They describe which requirements are imposed on the external partners in the value network. Naturally, they are unique for every innovation and have to be adapted accordingly. The partner profile contains the required competences, which can be obtained from the innovation itself (see Figure 4). Also, it contains “soft skills”, such as the favoured culture and the partners’ organizational structure. Also, the partner profile includes a section that outlines features and competences offered by the searching company, H.A.M.. The reason behind this is that a cooperating party is more likely to engage in a partnership if it is interested in H.A.M.’s competences and features. Generally, a partner profile consists of variables and target characteristics. To determine the weighted importance of each variable, their relevance is rated and converted to a percentage relevance by dividing the single valuation by the sum of all valuations of each section.

Databases, personal contacts, specialist journals, online research, etc. can be used to identify possible partner companies for a cooperative project (Sattler et al., 1992). In the validation project, the project team decided to identify possible partner companies for the Recipe2U business idea by online research and by interviewing experts from H.A.M. These experts either know the food-delivery market or have experience with cooperative projects.

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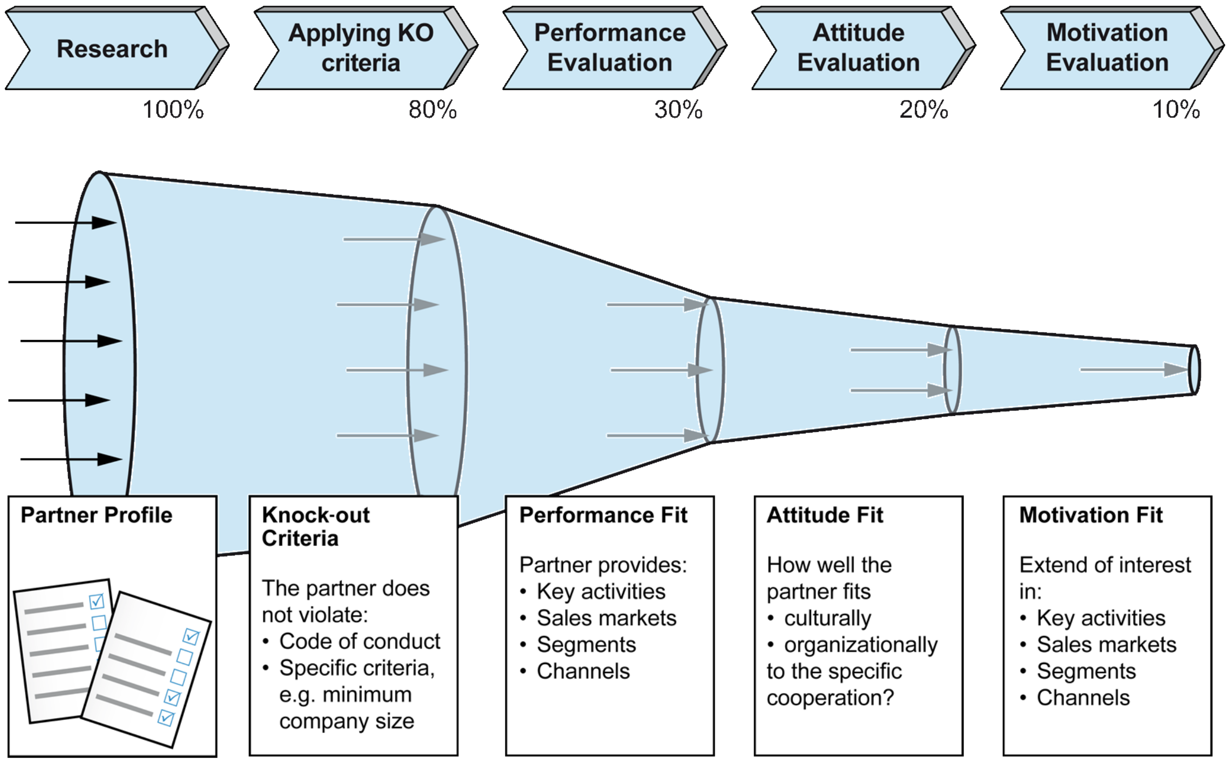

Figure 7. Partner selection process

Once possible partner organizations are identified, knock-out criteria eliminate ineligible companies. Examples of knock-out criteria are the organization's financial status, the existence of hints towards questionable practices, or the size of an organization. These knock-out criteria can be applied to review each partner independently from the innovation (Albrecht, 1994). Optionally, each target characteristic can be selected as a specific knock-out criterion, for example if a minimal size of the partner is required to exclude startups.

Phase 3: Partner Evaluation

Once knock-out criteria have been applied, the remaining organizations are rated with regard to all variables in the profile. The degree to which an organization fulfills each characteristic is converted to a profile that indicates the percentage fulfillment per section. The result is a performance fit, an attitude fit, and a motivation fit for each potential partner. The final partnership fit combines all three section fits and is the result of the relevance of each section, multiplied by its degree of fulfillment. The gradations of the valuation standard are used to assure that a complete fulfillment results in a high partnership fit (Kühnapfel, 2014). In the validation project, the weighting amounted to 60% for the performance fit, 25% for the attitude fit, and 15% for the motivation fit (Figure 8).

The performance section will be further regarded within the next phase; attitude fit and motivation fit will be used later on. As Weber (1996) states, the attitude of two organizations is important for long-lasting relationships: if a cooperation has to be established in a short amount of time, the motivation fit can be the crucial factor, because a partner organization is more likely to cooperate if it has an intrinsic motivation. An adaptable minimum for the attitude and motivation fits excludes ineligible organizations. These ineligible organizations are not considered for a possible cooperation, because collaborations with these organizations have very low chances for success (Weber, 1996).

Phase 4: Implementation Planning

As mentioned previously, the performance section contains factors that are necessary to realize the targeted innovation. Oftentimes, only a combination of organizations (i.e., a network) is able to provide all necessary competences. In our validation project, it is very unlikely that just two companies can run a platform, real-

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Partner Evaluation

Question:
How well does the partner fulfill the required target characteristic?

Valuation standard:
0 = no fulfillment at all
1 = partial fulfillment
3 = largely fulfillment
9 = complete fulfillment

Variable	Target Characteristic	Relevance	Hot Air Productions SE	Your Food Company	Fresh Up Inc.	Regional Food Corp.
Performance						
Needed Competencies	Process order	4%	9	9	9	9
	Deliver ingredients	38%	9	9	9	1
Sales Markets	Germany	13%	9	3	9	3
	[illegible]	4%	9	[illegible]	[illegible]	[illegible]
Market Segments	Premium	4%	1	1	3	3
	Luxury	4%	0	0	1	3
Performance Fit		**60%**	**67%**	**59%**	**82%**	**38%**
Attitude						
Customer Orientation	Commendable	41%	3	3	9	9
Innovation Orientation	Distinctive	14%	3	1	9	9
Leadership [illegible]	Owner-Managem[illegible]	[illegible]	[illegible]	[illegible]	9	9
Nationality	German	14%	9	9	9	9
Attitude Fit		**25%**	**50%**	**47%**	**97%**	**97%**
Motivation						
Offered Competencies	Offer recipe	38%	9	3	3	3
	Gather ingredient list	0%	-	-	-	3
	Prepare dish	[illegible]	[illegible]	1	3	3
Sales Markets	Access to Germany	4%	3	0	1	9
Market Segments	Access to all customers	38%	9	3	9	9
Motivation Fit		**15%**	**81%**	**27%**	**63%**	**71**
Partnership Fit		**100%**	**65%**	**51%**	**83%**	**57**

Figure 8. Partner evaluation

ize (regional) food delivery to the customer, program a web service, process orders, produce the necessary kitchen appliances, and develop a broad base of recipes on the platform. As stated earlier, one of the core drawbacks of methods from the fields of mergers and acquisitions is that they do not provide advice on how to form bundles of companies for a specific task. As devised by Dülme (2013) in the context of strategy-compliant acquisition strategies, combinations of possible partner organizations are sought on the basis of the partner evaluation. In the following step, these combinations (i.e., bundles of organizations) will be created and prioritized (Figure 9). (The last step, sequencing, is not covered within this article.) For each bundle, a sequence in which the cooperation is to be approached is calculated. Note that each bundle contains H.A.M. (#1 in Figure 9) and any combination of other organizations that fulfill the desired competences.

At the Heinz Nixdorf Institute (www.hni.uni-paderborn.de), software was developed to generate all possible bundles of partner organizations that fulfill the desired performance section based on the partner evaluation. The algorithm is made such that the bundling stops once all target characteristics are achieved (Sarkar, 2008), thereby allowing it to keep the bundles as small as possible. Naturally, there is a trade-off between bundle length and network effectiveness. On the one hand, the network's capabilities grow with each new partner, while on the other hand, managing the network becomes increasingly complex (Johnson & Selnes, 2004).

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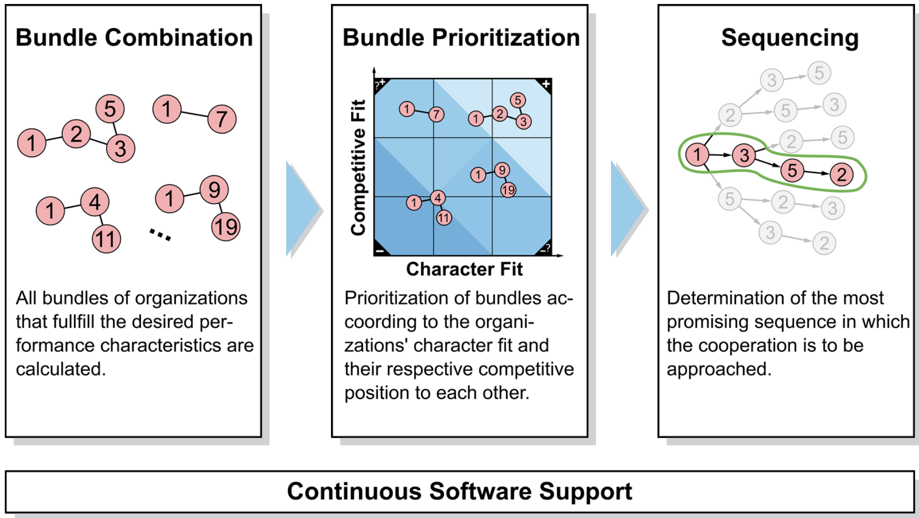

Figure 9. Implementation planning process

The possible bundles are prioritized to identify the most promising ones, the dimensions character fit (*How well do the characters of the organization match?*) and competitive fit (*Do the organizations compete against each other in any market?*) are being used for that purpose. To determine character and competitive fits, a pairwise comparison is being applied. For instance, a bundle exhibits a high character fit, if the characters of all organizations within a bundle match very well. In a similar manner, the competitive fit of a bundle is being determined. An arithmetic example is provided in Figure 10. Bundles that contain any rating of 1 (i.e., two organizations exhibiting a very low character fit or competitive fit with each other) are sorted out automatically.

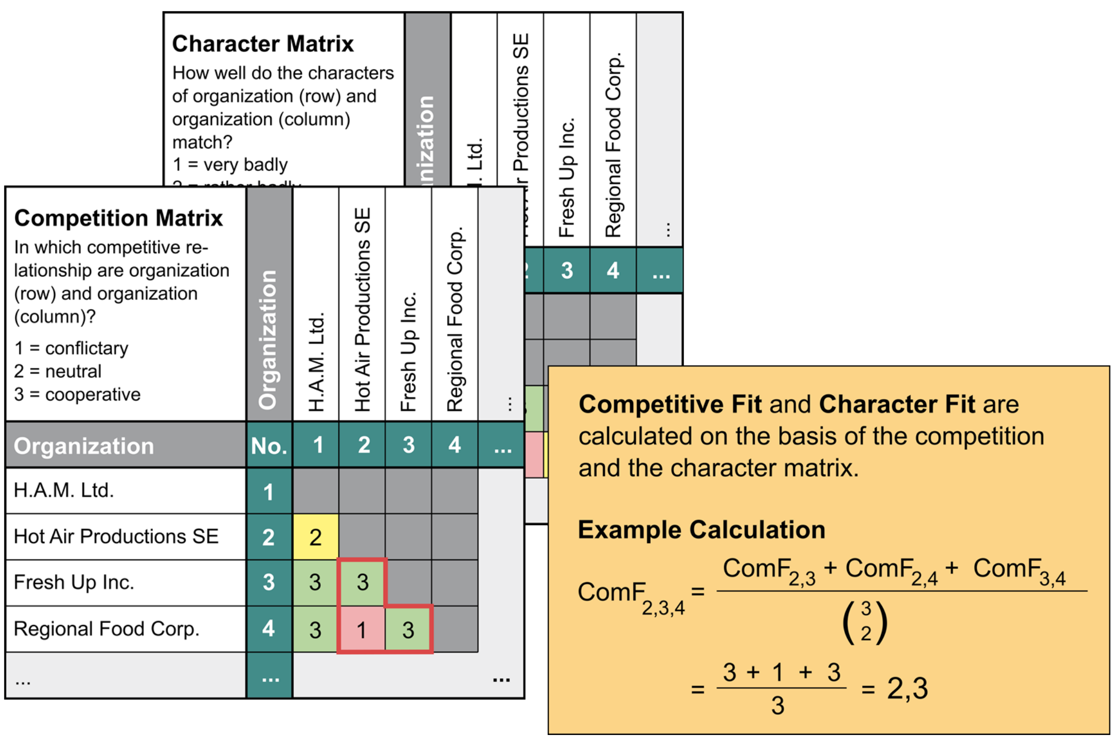

Figure 10. Character and competition matrices

The chart in Figure 11 yields recommendations of actions for each bundle. The favoured bundles exhibit a high competitive fit and character fit. We thereby narrow down the number of possible bundles. Hence, no ineligible bundles are further reviewed.

In the validation project, the bundle {1;3;4} scored the highest competitive and character fits (with Organization 1 being H.A.M.). Organization 3 (Fresh Up Inc.) is a startup that delivers food boxes. Their strength is the delivery of basic ingredients for a chosen amount of people and meals. Fresh Up already provides the logistics for the whole German market. Organization 4 (Regional Food Corp.) is also a startup. It focuses on the delivery of fresh and healthy ingredients of the season, which are provided by a network of regional farmers. Regional Food does not deliver basic ingredients at all times of the year, while Fresh Up does not provide fresh and healthy ingredients directly from farmers. Obviously, bundle {1;3;4} would be suited well for the realization of the innovation, as the combination of both organizations provides a unique service.

Naturally, the final step of value network design would be approaching the selected organizations and setting up an intra-company business case (i.e., developing sustainable business models for each partner and formulating the value network). Therefore, it is important to guarantee that the business models of the participating organizations are compliant with each other.

As Figure 12 indicates, H.A.M. occupies the role of the recipe supplier, platform operator, and application provider. Fresh Up and Regional Food have been identified as the optimal bundle. Both occupy the role of the food vendor and logistics provider.

Conclusion

Nowadays, companies in the manufacturing industry have to face the challenges of digitalization: the need to develop “smart products” forces these companies to cut across traditional product boundaries and unleashes a new era of competition. In many cases, the know-how to develop a smart product exceeds the competences of manufacturing companies and forces them to enter cooperative relations. Usually, there are plenty of possible cooperation partners that can be permutated in various arrangements to realize an innovation. Value networks are the result of these permutations. Still, one of the core problems of cooperation planning is that, once a company starts searching for possible cooperation candidates, it will be confronted with a lack of reliable information. The information gathered will only incrementally become reliable over time as soon as the possible partners get in touch and engage in some form of collaboration.

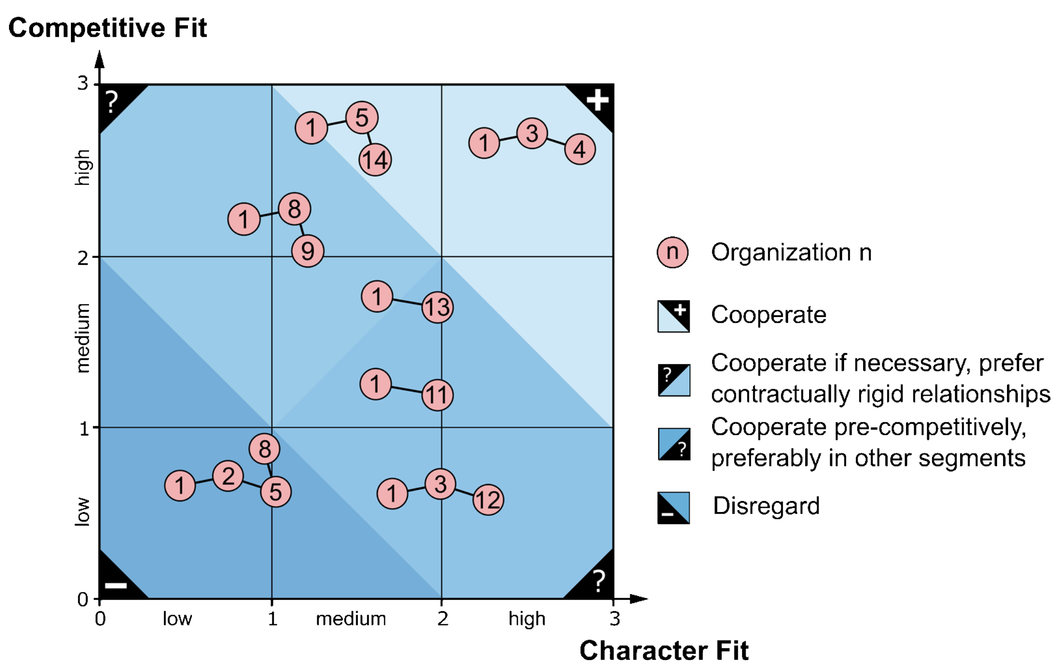

Figure 11. Bundle prioritization

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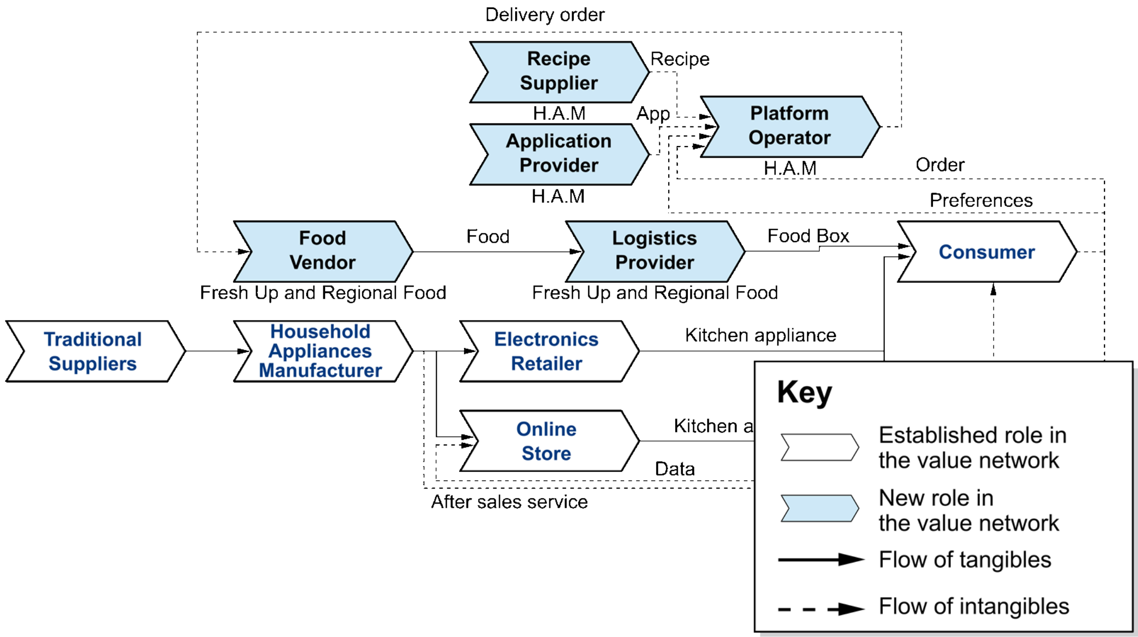

Figure 12. First draft of the value network for the Recipe2U business idea

We introduced a methodology for the design of value networks induced by an innovation (i.e., innovation pull). As a result of an innovation idea (i.e., a product, process, or business model innovation), the cooperation demand is deduced systematically. The cooperation demand determines the ideal partner profile that is used to preselect and later on evaluate potential partners. We also showed that an ideal sequence can be calculated, which denotes the order to approach partners. Eventually, a first draft of the value network can be drawn. A consistent tool support accounts for the naturally low degree of information quality. The method can be adapted once new or more concrete information becomes available. Thus, an innovation-oriented value network can be designed. From a practitioner's perspective, it is worth mentioning that the methodology does not alleviate the work of searching for possible partner organizations (i.e.. developing the so-called "long list") or rating them. However, the methodology can be used to find possible arrangements of partner companies and sensitizes for the fact that an innovation idea can be realized with, for example, either two big partners or five smaller ones. Especially when entering new markets (which implies that there are no existing long-term relationships with any of the incumbents), the methodology is a valuable extension.

One research stream which has yet to be covered from our perspective is the principle of *value network push,* as shown in Figure 1. Value networks themselves are usually merely used descriptively, and rarely for analytical purposes. One interesting application would be analyzing branch value networks for market entries. Once typical roles have been identified, a company can either choose to occupy one of the existing roles or deliberately position itself somewhere else in the value network and thereby create a new role, find partners for it, and cooperatively find innovations.

Acknowledgements

An earlier version of this article was presented at the 2016 ISPIM Innovation Forum in Boston, United States of America, March 13–16. ISPIM (ispim.org) – the International Society for Professional Innovation Management – is a network of researchers, industrialists, consultants, and public bodies who share an interest in innovation management.

Value Network Design for Innovations

Martin Kage, Marvin Drewel, Jürgen Gausemeier, and Marcel Schneider

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Citation: Kage, M., Drewel, M., Gausemeier, J., & Schneider, M. 2016. Value Network Design for Innovations: Developing Alternative Value Network Drafts. *Technology Innovation Management Review,* 6(7): 21–33. http://timreview.ca/article/1002

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Keywords: value networks, Internet of Things, inter-company collaboration, innovations

Detecting White Spots in Innovation-Driven Intellectual Property Management

Daniel Eckelt, Christian Dülme, Jürgen Gausemeier, and Simon Hemel

> *“Every morning in Africa, a gazelle wakes up, it knows it must outrun the fastest lion or it will be killed. Every morning in Africa, a lion wakes up. It knows it must run faster than the slowest gazelle, or it will starve. It doesn't matter whether you're the lion or a gazelle – when the sun comes up, you'd better be running.”*
>
> Christopher McDougall
> Author and journalist

Technology companies scan the competitive arena for patents to discover research activities and technology trends. Patents are the outcome of innovation processes that take several month or even years, depending on the industry. The process of publishing patents usually lasts longer. A huge time gap of up to several years between early research and development activities and published patents is the consequence. Therefore, a patent is a weak indicator for the identification of early innovation activities. However, the inventor needs intellectual assets such as data, knowledge, and expertise to carry out an innovation process. It is likely that these intellectual assets can improve the competitor analysis – rendering them primary targets. In this article, we introduce a systematic approach to detect intellectual property (IP) activities of stakeholders in selected technology fields (e.g., hiring experts, taking part in research projects, gathering specific data). A technology field with a low intensity of IP activities offers great opportunities, which we call a "white spot". Our proposed approach can help identify the white spots in innovation-driven IP management and thereby help devise recommendations to improve a company’s IP portfolio.

Introduction

Creative and innovative companies are most successful worldwide. Most of these companies rank innovation as a top strategic priority (BCG, 2013). Nevertheless, the innovation object itself is changing. In former times, physical product and production innovations have been most relevant. Today, we can observe that service and business model innovations are increasing and become even more important (The Economist, 2015; Osterwalder et al., 2014). Companies carrying on service and business model innovations are among the largest and most influential worldwide (BCG, 2009).

What we observe is the transformation from a product manufacturer to a solution provider, and intellectual property management is one of the success factors executing this paradigm shift. In the past, intellectual property management has not been more than the documentation of innovation processes (Sonneck, 2014). However, the transformation needs an active management of intellectual property (IP) – even more, it has to lead and direct the innovation processes (Wurzer & Berres, 2011). Successful companies are showing what can be done. For example, Vorwerk (vorwerk.com), an international retail and direct-distribution company founded and headquartered in Germany, has invented a new IP strategy especially for their currently most important product: “Thermomix”. The key aspect of their new strategy was a decision to stop applying for patents in an arbitrary way. Technical invention no longer trigger their patent process. They integrate IP management in the innovation process and, today, they use IP rights to protect their value proposition. Furthermore, the technical inventions follow Vorwerk's IP strategy (Wurzer & Schaeffner, 2015). Their subsequent success shows it was a wise move: there is no competitor who is able to offer a product with the same value proposition.

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A company's IP strategy forms part of the innovation strategy and thus significantly increases the innovative capability of the company (Wurzer & Berres, 2011). The most important habits of IP winners in the innovation context are: a focus on value; freedom to operate; an eye on the future; a lean and focused organization; putting a premium on speed; and emphasizing quality over quantity (BCG, 2014).

To win, companies must manage their internal IP while having an eye on the external IP activities of stakeholders, competitors, and suppliers. Appropriate actions might include hiring experts in new technology fields, taking part in collaborative research projects, gathering specific data, and – of course – applying for patents. IP activities can be defined as the professional management of the whole IP of a company with the aim to create new high-quality organizational worth from immaterial assets (Mittelstaed, 2016). The evaluation of such external IP activities in upcoming technology fields creates different insights. On the one hand, there are technology fields with a high intensity of IP activities. On the other hand, there are technology fields with a minimal intensity or even no IP activities. In other words, there are upcoming technology fields where no competitor has (or is building up) IP in this area. We call such technology fields, which are mostly free of competitor IP, "white spots". White spots represent unaffected/untainted and circumscribed areas on an IP technology landscape.

White spots offer great opportunities for innovative and creative companies. Innovation projects around a white spot can lead easily to competitive advantages. But the key question is: how does a company detect white spots? In this article, we present a systematic approach to innovation-driven IP management that is designed to detect white spots. In the following section, we provide an overview of existing approaches to external IP evaluation. Next, we give some insights into our understanding of strategic IP management by introducing the IP management process and framework. This is followed by the main part of this article: the approach for innovation-driven IP development. The approach consists of five phases: i) technology preselection, ii) stakeholder analysis, iii) stock-of-IP investigation, iv) stock-of-IP display, and v) decision support. The result of the approach is an IP technology landscape that is the basis for recommendations for action. Finally, we discuss the key findings and provide conclusions.

Existing Approaches to External IP Evaluation within the Competitive Arena

In this section, four relevant scientific approaches and methods are reviewed with a focus on the identification and evaluation of (technological) IP activities of stakeholders in the competitive arena:

1. *Technological competitor analysis:* The technological competitor analysis helps to early identify technological innovations of relevant competitors. It is divided into five phases: i) determining the information needs, ii) provisioning resources, iii) extracting information, iv) evaluating information, and v) utilizing information (Lange, 1994). This is one of the first approaches that focuses on a comprehensive utilization of information about the technological innovation process of competitors. But the publication of this method was in 1994, when the role of the Internet was not significant. Therefore, this concept describes a manual identification of information that differs significantly from a semi-automated and Interned-based search process. Furthermore, the limitation of this method on technology aspects differs from the approach presented in this article, which considers the whole range of immaterial assets or IP in relation to selected technologies.

2. *Competition monitoring:* The provision of current, former, and future information about competitors in order to support strategic, operative, and tactical decisions is the aim of the competition monitoring process (Deltl, 2011). In particular, the derivation of key intelligence topics is a useful tool to define the observation field. However, the documentation of the method and the visualization of findings and results are insufficient. In addition, the method does not focus on the identification of technological activities – resultant specifics are not taken into account.

3. *Competitive intelligence cycle:* The competitive intelligence cycle has the aim to achieve competitive advantages by identifying and analyzing (fragmented) information. Competitive intelligence includes competition analysis, competitor analysis, competitive analysis, and strategic foresight (Michaeli, 2006).

4. *Digital intelligence:* Digital intelligence helps to detect traces of human or machine activity left in digital media. Traces can be found in patents, scientific articles, or on websites, for example. The digital intelli-

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gence supports the decision maker by identifying complex connections and weak signals (Walde, 2010). It also opens the opportunity to detect technological changes around the company.

These approaches give an overview of the research into identifying and evaluating competitor information within the competitive arena. They all pursue the idea of gathering this information to create competitive advantages. But what are the main challenges regarding that target? First, the observation field must be clarified. Second, the identification and evaluation must be efficient – ideally supported by IT tools. And third, the graphic preparation must fit management requirements. The method presented in this article combines this three prerequisites:

1. It uses the definition of IP to determine observation fields.

2. It uses automatic search algorithms in the identification process.

3. It creates a visualization concept to present the IP landscape to management.

Next, we describe the process of strategic IP management and the framework behind the method.

Strategic IP Management

Today, the intangible value of a company amounts to approximately half of its market value, which has risen from the 1980 value of 20% and is set to further increase in the future (Wurzer & Berres, 2011). Therefore, the strategic management of IP is one of the most valuable efforts a company can make, particularly if its focus is technology or even manufacturing. The strategic management of IP is the synergetic combination of IP rights, customer, management, and brand management – especially communication and marketing (Mittelstaedt, 2009). IP management is a part of modern strategic product planning and innovation management (BCG, 2014). In light of this combination, we describe strategic IP management as a holistic approach for the *identification, protection,* and *activation* of intellectual property or rather intellectual capital (Eckelt & Gausemeier, 2015). The process of strategic IP management is described below and is illustrated in Figure 1.

1. IP identification
The first phase in strategic IP management is IP identification (both internal and external). The goal of this phase is to increase the transparency of already existing IP and to discover IP requiring greater attention in the future. Therefore, IP identification includes steps to take stock of the IP inventory and to forecast future IP.

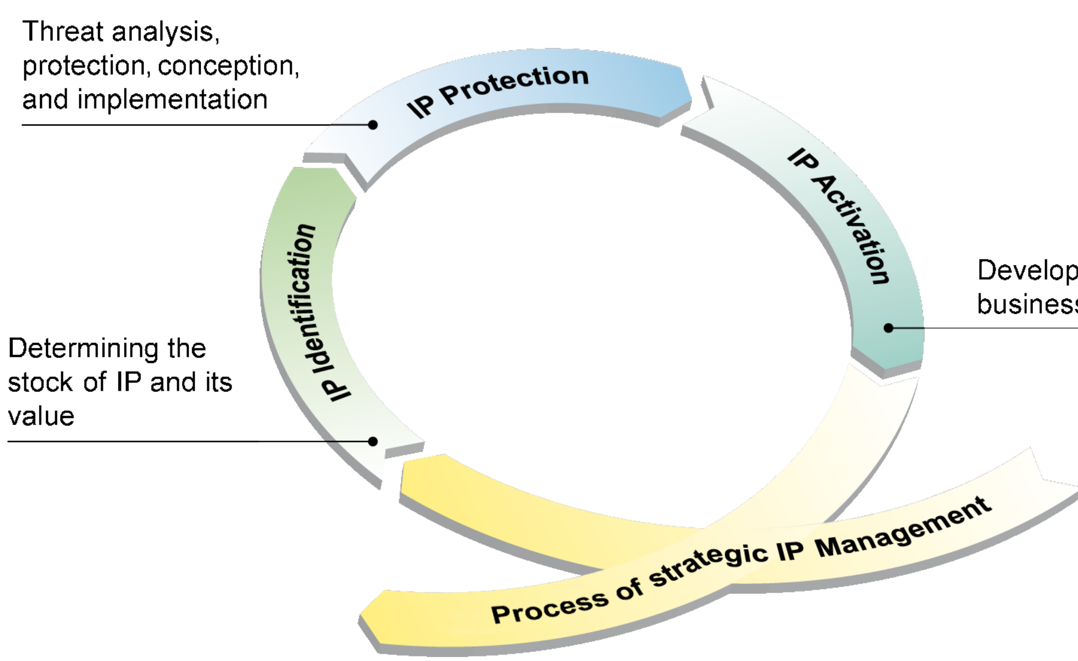

Figure 1. Process of strategic IP management

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In the literature, there are already approaches that describe this aspect of the approach, such as "Knowledge Balance – Made in Germany" (BMWi, 2013) and "Intellectual Capital Collection" (Kneisel et al., 2012). Nevertheless, these approaches do not consider the IP forecast nor the identification of white spots. Besides the identification of IP, we furthermore suggest the identification of intellectual *capital* (IC). IC can be divided into three sections: human capital, structural capital, and customer capital (Stewart, 1997). Human capital describes personal-influence factors that affect the intangible assets of a company. It includes, among other things, the competencies, skills, and motivation of the employees. Structural capital includes IP and externalized knowledge in the form of procedures and processes. Customer capital describes influence factors that have an external effect on, for example, relationships with suppliers or customers (Nagel, 2012).

2. IP protection

Technical innovations, brands, and designs as well as human, structural, and customer capital should be protected to retain competitive advantages. Whereas the classical protection of inventors focuses on IP rights, modern protection efforts create a holistic set of organizational, technical, and legal measures, among others. To develop this set of measures, three steps are necessary. First, a threat analysis detects influence factors that affect the security of IP. Influence factors include customer proximity, the business model, and the price strategy. For example, a weak customer proximity has a negative influence on the security of IP. Within a catalog of 76 influence factors the 10 most critical factors are selected. Second, measures are combined to a consistent protection concept, which is tailored to the threat situation. Another catalog with over 100 measures is available for this step. Third, the launching of different measures is visualized in an action plan or a roadmap (Eckelt et al., 2014; Gausemeier et al., 2012; Meinwald, 2011).

3. IP activation

There are always opportunities for capitalization, innovation, or optimization behind IP. Very often, many of these opportunities are unused. For example, data is a structural capital with a high potential but it frequently has low utilization. Microsoft and many other firms provide further examples: they identified the potential of their customer relationships and the large knowledge base of their customer by building a platform or online community where customers can share their experiences with other customers (e.g., Microsoft Community; answers.microsoft.com). The wealth of firms can increase by this approach (Manchanda et al., 2015); however, the goal of this phase is to develop new business opportunities.

Alongside the process of strategic IP management, we developed a documentation canvas, which we call the IP management framework (Figure 2). The framework includes five models: property, resource, protection, offer, and finance. By carrying out the process in Figure 1, the framework is filled in box by box; the colors indicate which process pays into which model. In the next section, we provide a more precise description of IP identification with an emphasis on external IP.

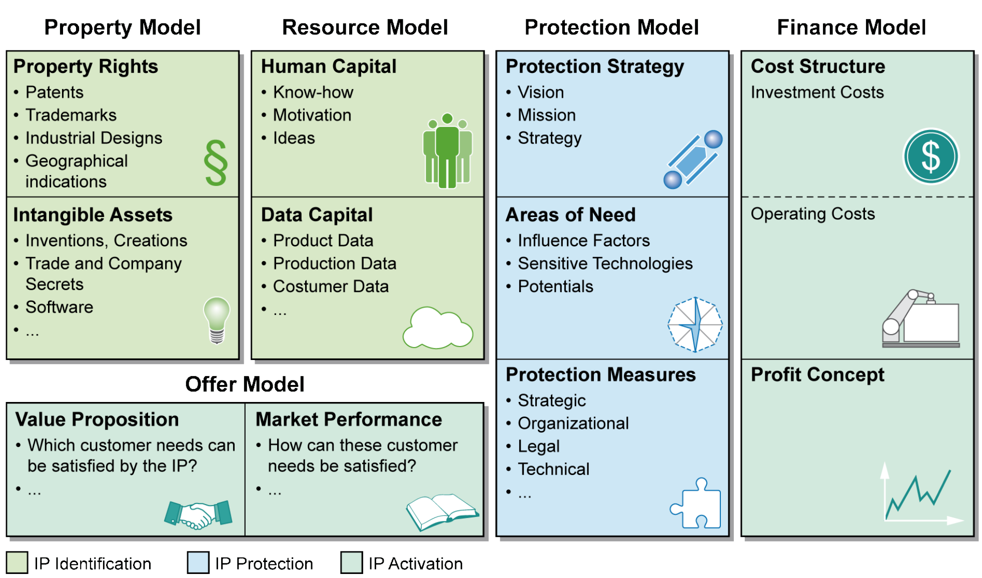

Figure 2. IP management framework

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Approach for Innovation-Driven IP Development

These days, the acceleration of the technological progress, the increase of global competition, and the exponential growth of knowledge are key challenges for companies. Innovative technologies provide excellent possibilities for companies to face these challenges by enabling competitive advantages, at least temporarily. To remain successful in the market over the long term, a company must identify changes in the corporate environment as early as possible. The process of identifying and evaluating strategically relevant information is usually named competitive (technology) intelligence. The aim of competitive (technology) intelligence is to provide a reliable basis for the decision makers of a company (Gausemeier et al., 2014; Wellensiek et al., 2011; Zollenkop, 2006). In this context, one fundamental issue is the amount of IP held by participants in the competitive arena of certain technology fields – and how it changes over time. Such knowledge, including which participants in the competitive arena are working on which technology field, is of high value for a company.

The challenge of this work is to provide a methodology that enables a company to identify relevant participants in the competitive arena in certain technology fields and to identify and evaluate the stock of IP held by relevant participants in specific technology fields. Technology fields that are not yet covered by IP from their participants IP are potential innovation fields. Therefore, the exponential growth of knowledge – more specifically, the huge amount of available and potentially relevant information – must be managed. Relevant questions in this context are:

- Who are the relevant participants in the competitive arena?
- What stock of IP do they have in certain technology fields?
- How will the stock of IP of the relevant participants change/develop in the future?
- Which technology fields are so far not (or are nearly not) covered with IP by participants?

The five phases of our methodology for innovation-driven IP development are described below and are illustrated by Figure 3. An iterative process enables the company to detect dynamic changes, as highlighted by carrying one example (additive manufacturing) through the explanations of the methodology.

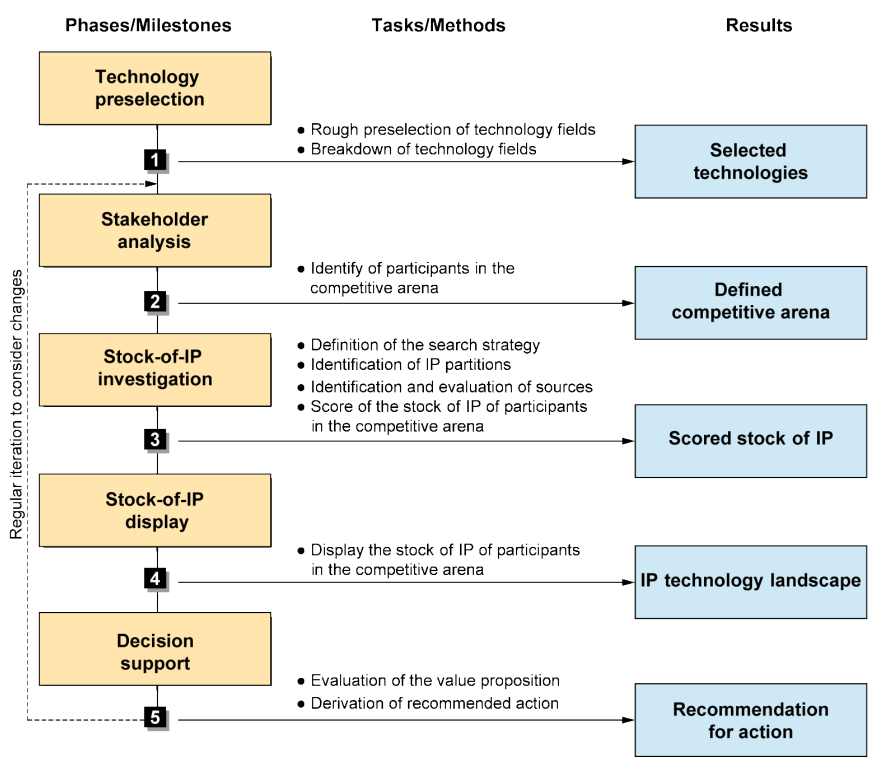

Figure 3. Process model for defining IP recommendations for action

Phase 1: Technology preselection
The broad observation of a company's environment is linked with a huge amount of potentially relevant information. Because of this, it seems not to be useful to identify and evaluate the IP of the whole company environment in relation to a reasonable expense of a company. So, as a first step, the observation area has to be reduced. For the development of an IP technology landscape, a rough preselection of technology fields raises the practicability of the methodology considerably (Zeller, 2003). Possibly relevant technology fields can be ascertained by the company itself or by looking into well-known scientific publications, such as the McKinsey Global Institute's (2015) “Disruptive Technologies: Advances that Will Transform Life, Business, and the Global Economy”, Gartner's (2015) “Hype Cycle for Emerging Technologies”, or Siemens' (2015) “Pictures of the Future” (Siemens, 2015). For the example used in this article, we use the McKinsey technology fields, knowing they are too diverse for a single company.

To select the technology field(s) to monitor, a bubble chart can be used, as shown in Figure 4, which illustrates a hypothetical example of the classification of technology fields for a medical-technology company. The bubble chart classifies different technology fields by the two axes: estimated prospects of success (e.g., cost-saving potential) and estimated implementation costs (e.g., required know-how). Technology fields in the bottom-right corner (low prospects of success and high implementation costs) usually can be disregarded. Technology fields placed in the bottom left or top left are useful to gain operative or tactical technological improvements over the near term or medium term. For strategic, long-term planning, the top right technology fields are most promising (Peitz, 2015).

In the example shown in Figure 4, the technology fields of additive manufacturing, advanced materials, and energy storage now can be selected for further monitoring. Depending on the specific requirements of the company, a breakdown of each preselected technology field is useful to select a practical observation level (i.e., a suitable abstraction level). For each of the preselected (broken down) technology fields, a profile is built, as shown in Figure 5.

Phase 2: Stakeholder analysis
The aim of Phase 2 is to identify relevant participants in the competitive arena, which can be divided into three groups:

1. Competitors

2. Technology suppliers

3. Others (customers, research institutes, etc.)

Initially, known participants are sorted into the three groups. At first, the list of potentially relevant participants does not need to be complete, because further participants can be added easily during subsequent iterations of the process. Because of the high number of participants, it is helpful to cluster very similar participants. For a rough assessment, the relevance of each participant can be represented in an aim-power matrix. Therefore, the competition policy of each participant is assessed on a scale from -5 (very high conflict potential) to +5 (very high cooperation potential) and is shown on the y-axis (*aim*). The x-axis of the matrix describes the estimated position of *power* for each participant on a scale of -5 (dominant power position of the participant) to +5 (dominant power position of the company). The assessment of competitors can use sales or market segments, for example. Participants that are placed in the top right corner of the matrix (called "followers"), offer a high potential for cooperation; participants in the top left (called "godfathers") are able to exercise significant influence in a potential cooperation. Participants in the bottom left have a dominant market position and are called "killers"; participants in the bottom right (called "cannon fodder")

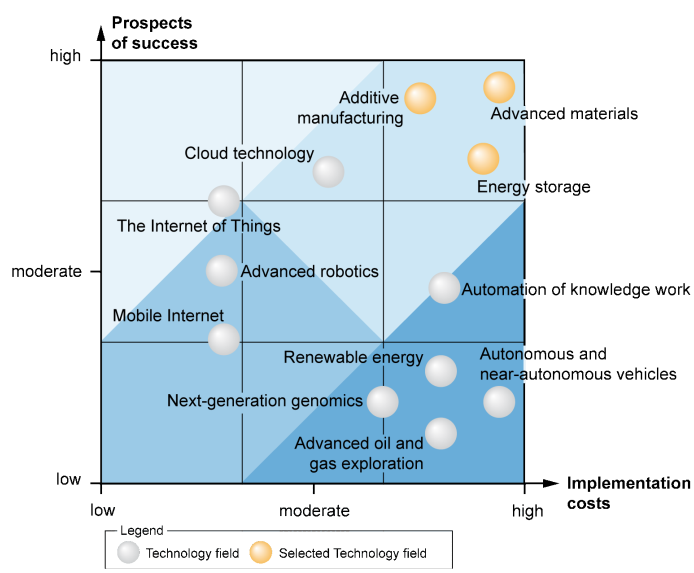

Figure 4. Hypothetical classification of technology fields for a medical-technology company

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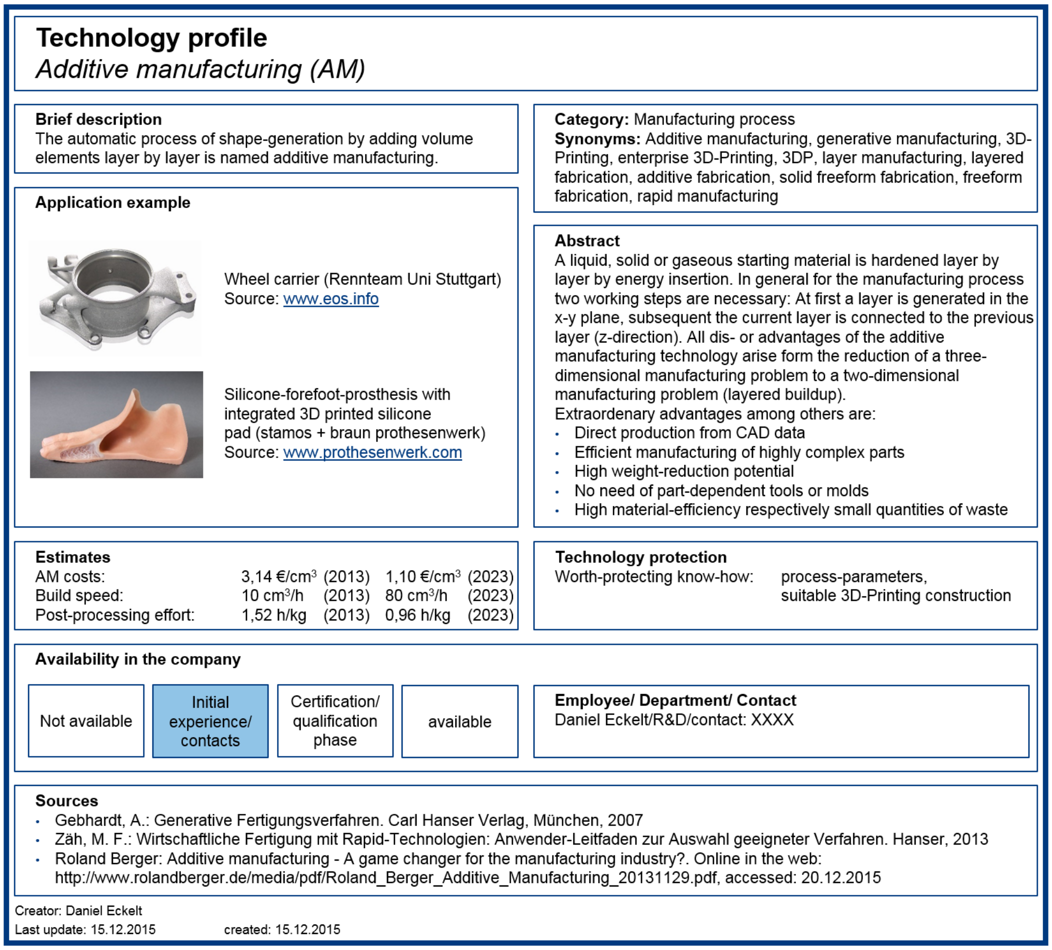

Figure 5. Example profile of the additive manufacturing (3D printing) technology field

are perceived as weak. Figure 6 shows an extract of an aim-power matrix of participants in the competitive arena of a medical-technology company for the technology field additive manufacturing.

As a result of this process, the relevant participants for further monitoring can be selected. Monitoring of participants that are located at the four corners of the matrix (marked light blue) is recommended. The investigated intelligence about each (relevant) participant is stored in a participant-profile (see Figure 7).

Phase 3: Investigation of participants' stock of IP

Phase 3 is the main part of the procedure. The aim of this phase is to investigate the stock of IP for participants in the competitive arena. Therefore, the *search strategy* and the *search query* must be defined. Afterwards, the *stock of IP* of participants in the competitive arena is scored.

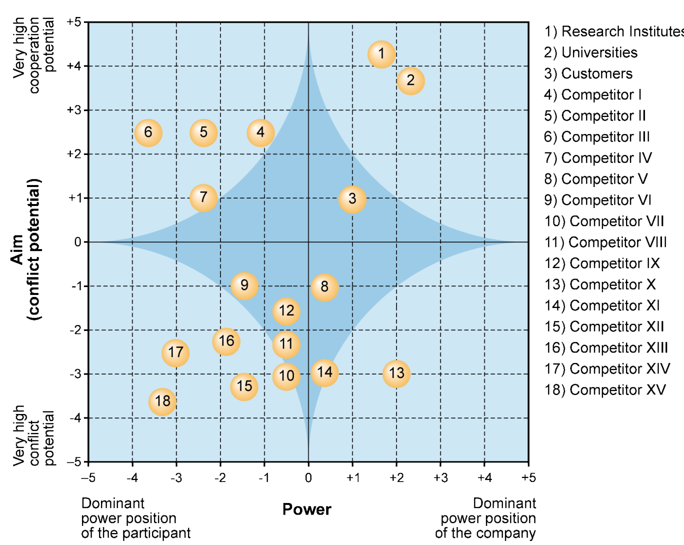

Figure 6. Aim-power matrix for participants in the competitive arena of a medical-technology company

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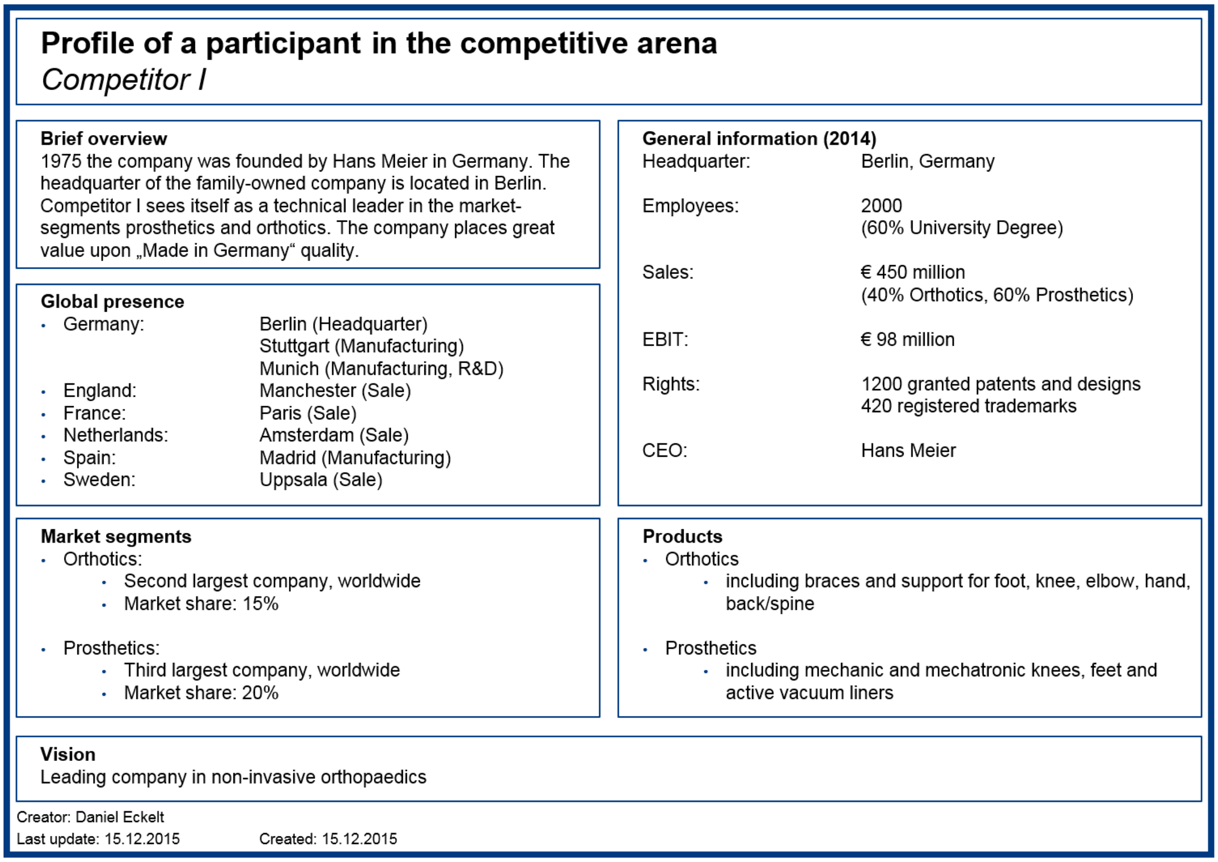

Figure 7. Profile of a participant of the competitive arena

Phase 3.1: Definition of the search strategy
To search for the stock of IP, it is necessary to define a search strategy, which starts by determining *who* searches *how, for what,* and *where*? (Echterhoff, 2014).

The answer to the question of who searches depends very much on the company's skills and resources. Basically, two possibilities exist: either the search is realized by the company itself or the company commissions an external service provider (Echterhoff, 2014). The presented method is designed to enable companies to perform the search on their own.

The question of how the search is executed refers to either a manual or a (semi-) automatic search process. To face the previously named challenges such as the exponential growth of (potentially relevant) knowledge, the focus of this work is on an (semi-) automatically search process.

To answer the question what is searched for, different partitions of IP must be considered. The what-question is linked very closely to the where-question. It must be considered that (in some countries) some very useful sources cannot be accessed; for example, it is not possible (or allowed) to contact the employees of another participant in the competitive arena in which the stock of IP shall be investigated. Therefore, the what-question is limited by the where-question. In the context of the presented procedure only public, disposable intelligence is used to investigate a participant's stock of IP.

Interim conclusion: The process requires a (semi-) automatic search process that considers the different partitions of the IP of participants in the competitive arena by accessing only public, disposable intelligence and that easily can be executed by a company itself.

As shown in Figure 2, this work uses a broad understanding of IP. There are three types of intellectual capital (IC): *human capital, structural capital,* and *customer capital.* Some types of these types can be investigated externally (by the company as an external observer). For example, to investigate components of the *human capital* of a competitor, the current vacancies of the competitor can provide important intelligence.

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Components of the *structural capital*, for example, can be investigated by looking at a competitor's research cooperations. Customer lists as a part of *customer capital* are another useful source of intelligence about competitors. To assess a competitor's current vacancies, online job portals run by the competitors themselves or by third parties may be examined. Subsidy databases or press releases can be used to collect intelligence about cooperation of or between participants in the competitive arena. Press releases of a competitor can also be used to identify their customers. Figure 8 shows how the different types of competitor IC can be investigated, including example components and information sources.

Next, the different sources must be scored in regard to practicability. For a (semi-) automatic search process, a source can be rated on the basis of two aspects: automatic evaluability and intelligence content. Automatic evaluability refers to existing possibilities to extract search results from different sources. Some sources only allow (legally or technically) a manual download of search results or an automatic export may be possible only with considerable time or expense. In terms of intelligence content sources may differ in terms of the quantity and quality of intelligence about a participant in the competitive arena. In addition, the currency of the source is an essential factor in this context.

For the example of current vacancies of a competitor, it has to be considered that not every competitor or participant advertises vacancies on its own website or a commercial job platform. The intelligence content of sources and the automatic and manual download of search results from the different sources are scored in the bubble chart example shown in Figure 9. The website stepstone.de (shown in the top-right corner of Figure 9) is selected because of its high intelligence and automatic evaluability.

Types of IC	Human Capital	Structural Capital	Customer Capital
Components	• **Vacancies** • **Knowledge** • ...	• (Research-)**Cooperations** • **Patents** • ...	• **List of customers** • **List of suppliers** • ...
Sources	• Online Job Platform of Participants • Commercial Online Job Platform: ▪ stepstone.de ▪ monster.de ▪ ... • Career-Oriented Social Networking Sites ▪ xing.com ▪ linkedin.com	• Subsidy Database ▪ cordis.europe.eu • Patent Database ▪ espatisnet.com ▪ depatisnet.com • Press Releases of Participants • RSS Feeds of Participants • ...	• Press releases of Participants • RSS Feeds of Participants • ...

Figure 8. Excerpt of an investigation into a competitor's three types of intellectual capital (IC)

The actual investigation of a participant's stock of IP is undertaken by text and data mining, for example using an open source tool such as KNIME (knime.org). Such tools allow a company to identify relevant words and important patterns in a set of files (e.g., PDF files or webpages of job vacancies), and automated workflows can be created to repeatedly visit and parse particular websites.

Phase 3.2: Definition of the search query

The next step is to consider the search query. Sources usually offer a search field where a user can insert one or more words to filter potentially relevant information, such as vacancies in online job platforms. The recommended practice is just to filter for the name of the participants in the competitive arena and all relevant intelligence using a text and data mining tool. For participants who offer specific sources, such a competitor's an own online job platform, all vacancies should be extracted. The collected intelligence is filtered afterwards with a consistent search query in KNIME.

To specify a search query, the aim is to develop a list of terms that relate to the different technology fields selected in Phase 1 and that correspond to the different components of each type of intellectual capital.

Phase 3.3: Scoring of the stock of IP of participants in the competitive arena

The next step is to score each relevant participant in the competitive arena concerning their stock of IP. For competitors, three different considerations are evaluated: static, dynamic, and linking. The static consideration refers to the absolute build-up of the stock of IP in

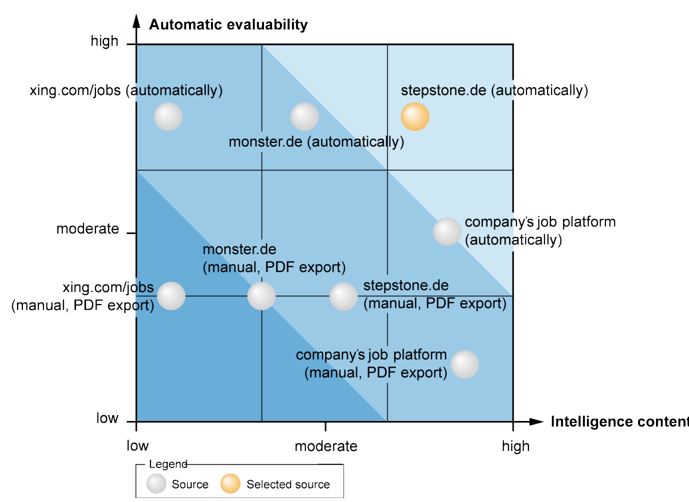

Figure 9. Scoring of potential sources of intelligence on competitor's human capital (via current vacancies)

one technology field. The dynamic consideration refers to the period over which the build-up of the stock of IP in one technology field takes place. The linking consideration refers to the endeavours of participants to build up the stock of IP in a combination of more than one technology field.

For the example, in the context of job vacancies, appropriate aspects to score are the absolute number of current vacancies and the concretization of the technology field in the vacancy description: for example, whether the vacancy descriptions refer to a research cooperation or funding project, whether the number of vacancies for a specific technology field is increasing or decreasing, etc. Moreover, the endeavours of a competitor to link more than one technology field together (e.g., linking additive manufacturing and advanced materials). These different aspects of the "vacancies" component of human capital are scored as are the other components of human capital, such as "knowledge" (Figure 8). However, each aspect can be weighted differently.

Furthermore, for the other participants in the competitive arena (e.g., technology suppliers and others such as research institutes), the different aspects of Phase 3 must be considered differently. For example, the lists of search terms have to be adapted – in this context, it might be more relevant for a medical-technology company to investigate whether a specific technology supplier searches for employees in the medical sector. In this case, the list of search terms should contain medical-orientated terms such as "invasive" or "noninvasive".

At the end of Phase 3, a multidimensional vector with percentage values of [structural; human; customer] capital defines each participant in the competitive arena.

Phase 4: Display of the stock of IP of participants in the competitive arena

To display the stock of IP of the different participants in the competitive arena, a zoomed version of the bubble chart, shown in Figure 4, is created. Figure 10 shows the top right corner of this chart with the three technologies *additive manufacturing, energy storage,* and *advanced materials.*

Around each technology field, an IP radar is drawn (Figure 10, right). The IP radar is the presentation level for the evaluation results. Each participant in the competitive arena is sorted in the radar by its multidimensional vector. Each participant of each group in the competitive arena is arranged in the radar in relation to each other. The different groups in the competitive arena can be added in layers. For example, layer 1 can show the stock of IP of the different relevant competitors, layer 2 can show the stock of IP of technology suppliers, and layer 3 can show the stock of IP of other participants. Figure 11 shows a filled-in IP-technology landscape. The positions of the triangles, circles, and rectangles describe the quantity of IP held by the participant organization (whether competitor, technology supplier, or other). The closer a symbol moves to the middle of the IP radar, the higher the quantity of IP. Organizations that are not shown on the IP radar do not have IP around the technology field (or it is not identifiable from outside). Symbols close together have a very similar structure of IP.

Phase 5: Decision support

The filled-in IP-technology landscape is used to provide a clear description of the competitive arena. This visualization makes it clearly evident which participant in the competitive arena deals with which technology field(s) and what stock of IP it has in every (monitored) techno-

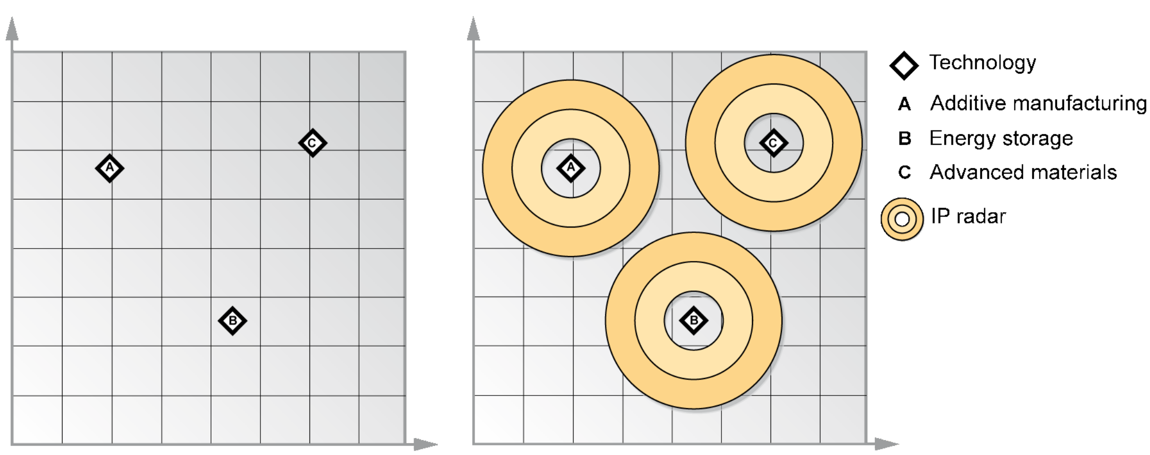

Figure 10. Raw IP-technology landscape without (left) and with IP radar (right)

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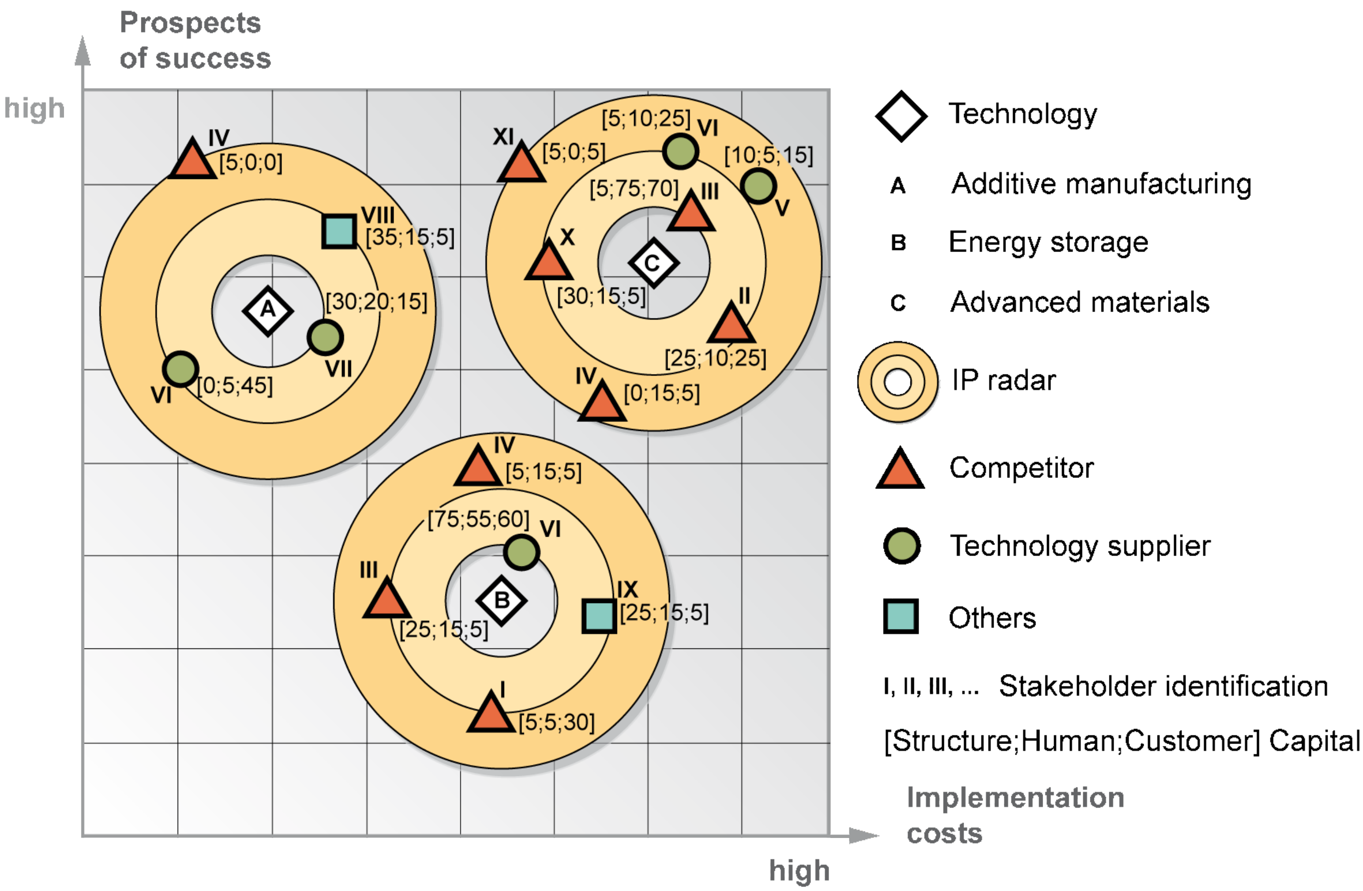

Figure 11. Example IP-technology landscape

logy field. The greater the distance between the participants, the greater the difference in the value of the vector. The closer a participant in the competitive arena is arranged towards the heart of a specific technology field, the more important the participant is. The interpretation of the importance depends on the group in the competitive arena. The closer a competitor is located to the heart of a technology field, the higher its potential threat on the technological development of the company. Therefore, the landscape enables the company to detect which technology field is sparsely covered with IP from participants in the competitive arena (fundamentally, the IP of competitors) – in other words, the methodology is ideal for detecting white spots.

For the groups of technological suppliers and others (such as research institutes), the landscape must be interpreted as follows: the closer the participant is located to the heart of the technology field, the greater the benefit of a potential cooperation. Therefore, the landscape can be used to identify the most beneficial cooperation partners.

Regular iterations of Phases 2 to 5 enable the company to detect temporal changes in the stock of IP of participants in the competitive arena. New participants may appear on the IP-technology landscape while the position of existing participants may change.

Taking strategic action

Once the analysis is complete, the final step is to develop a strategy. Figure 12 shows how the interpretation of the IP-technology landscape is combined with an evaluation of the technology fields concerning the value proposition. The latter refers to the question of how important the investigated technology fields are regarding to the value proposition of a product field – we describe this as business importance. Four characteristic areas of the bubble chart lead to the following recommended strategies with regards to the technology fields positioned in each area:

1. *Fight with the gloves off:* Technology fields that are placed top right are very important for the company's own business. But many competitors and

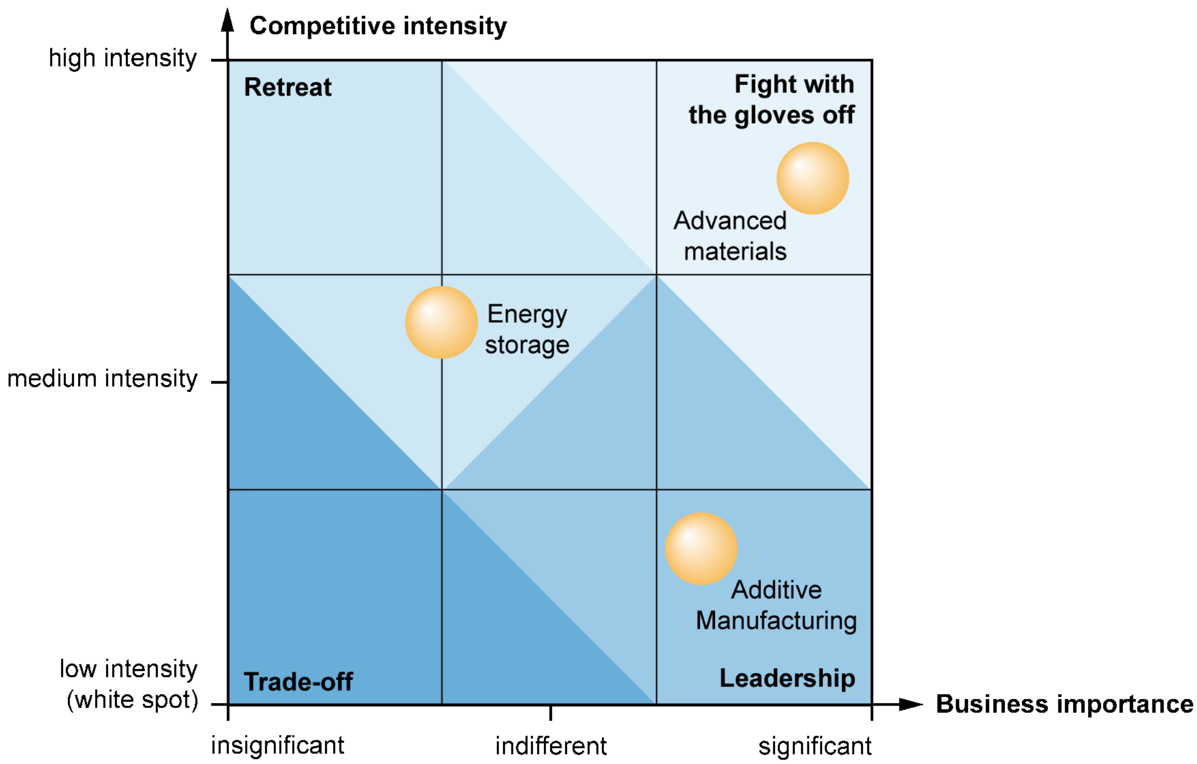

Figure 12. Recommended strategies based on positioning of technology fields

technology suppliers are building up IP or they may even have IP in this field. For this reason, the company has to gain IP as soon as possible or aspire to other strategies such as cross licensing.

2. *Retreat:* Technology fields that are placed top left are less important for the company's own business and the competitive intensity around this technology is high. Any effort to build up or secure the IP is not worth the trouble.

3. *Trade-off:* Technology fields that are placed bottom left are less important and the competitive intensity is low. The company has to decide if they want to spend money and time for IP in these fields.

4. *Leadership:* Technology fields that are placed bottom right are most important for strategic planning. The business importance is high and the competitive intensity is low. Spending resources for IP in technology fields in this area can give the company a high competitive advantage. The strategy is to invest resources in these fields.

Conclusion

We are experiencing a time of opportunities. The digitization of the economy will substantially change the way we live and work, and new players will position themselves in the competitive arena. Against this background, a forward-looking approach is of special importance for long-established companies. Weak signals provide important information for the future-oriented design of companies. The Internet is a useful tool to detect these signals over time. However, we are still missing methods to use this instrument smartly. In this article, we present a way how such weak signals can be systematically and easily identified using IP as an access point to this goal. But the approach considers not only patents and trademarks. We also consider human, structural, and customer capital. As a result, we can detect white spots that represent technological directions for the design of the innovation strategy. Strategic actions within these white spots can create competitive advantages and ensures the survival of the company in a dynamic market.

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At the core of the method, we use text mining. Text mining is already used successfully in many disciplines. It is a powerful tool to find the intelligence in a huge amount of data, and the volume of assessable data will increase in the future. Companies will be well-advised to extract more information from this data than their competitors. Our approach will enable them to detect the IP activities of different stakeholders in order to improve their innovation strategy. Based on the presented procedure, recommendations for the development of IP were presented. In further research, it will be necessary to expand the IP indicators and the implementation of the recommendations.

Acknowledgements

An earlier version of this article was presented at the 2016 ISPIM Innovation Forum in Boston, USA, March 13–16. ISPIM (ispim.org) – the International Society for Professional Innovation Management – is a network of researchers, industrialists, consultants, and public bodies who share an interest in innovation management.

Citation: Eckelt, D., Dülme, C., Gausemeier, J., & Hemel, S. 2016. Detecting White Spots in Innovation-Driven Intellectual Property Management. *Technology Innovation Management Review*, 6(7): 34–47. http://timreview.ca/article/1003

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Keywords: intellectual property, intellectual capital, innovation management, competitive arena, competitive advantage, business model, value proposition

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Q&A

Gonzalo León & Roberto Martínez

Q. How Can a University Drive an Open Innovation Ecosystem?

A. Increasingly, universities are seeking ways to play a more proactive role in the transfer of knowledge from academia to industry (and vice versa) and to create opportunities for direct collaboration in innovation activities with diverse stakeholders. The concept of an "open innovation ecosystem" holds promise as a means for universities to play a driving role in creating such opportunities and realizing broader outcomes not possible under traditional models of university–industry interactions. The origins of the innovation ecosystem and open innovation concepts yield insights into how universities can play a driving role in future collaborations toward outcomes of common interest.

Scholars use the term “innovation ecosystem” to refer to a network of relationships through which information and talent flow through systems of sustained value co-creation (Russell, 2011). However, the simple context of industrial ecosystems characterized by large industries and a set of smaller entities working for them was not enough to accelerate knowledge generation and it has been deeply transformed with the evolution of the so-called “open innovation ecosystems”.

The role of open innovation in the triple helix model
Here, we define the notion of “openness” as “the pooling of knowledge for innovative purposes where the contributors have access to the inputs of others and cannot exert exclusive rights over the resultant innovation” (Chesbrough & Appleyard, 2007). In these ecosystems, other actors play also a crucial role, such as research organizations (both public and private) or public administrations. They are based on rich interactions among stakeholders where the majority of them (because subcontracting chains could also appear) adhere to open innovation principles (Chesbrough & Brunswicker, 2013), as areas of “coopetition” combining cooperation and competition connected to an institutional framework.

To be considered as open innovation, it is necessary to allow for free movement of ideas and to allow for co-creation of products and services with a flexible intellectual property regime. The capacity of analyzing to what extent an open innovation ecosystem is truly open remains based on very high-level qualitative perceptions. The open innovation process, as it was proposed by Chesbrough (2006), is not limited to enterprises or research centres; other actors play a prominent role as (organized) users’ communities, shaping the so-called user-driven open innovation (Gassmann, 2010). Under this concept of co-creation, selected users take active part in the innovation process and help in reducing the time-to-market of advanced products and services (von Hippel, 2005).

The introduction of this new component in the innovation process represents an evolution of the well-known “triple helix” model (Etzkowitz & Leydesdorff, 2000), which is formed by a trilateral network of university–industry–government relations towards a “quadruple helix” model. Even if authors disagree on the exact definition of the quadruple helix model (e.g., Arnkil et al., 2010; Carayannis & Campbell, 2009; Füzi, 2013; MacGregor et al., 2009), all of them point to the user and community as the new protagonist to be addressed. In the university context, the appearance of “users” in the innovation process has been usually related to living labs. A living lab is an open innovation environment in a real-life setting, in which user-driven innovation is fully integrated within the co-creation process of new services, products and societal infrastructures (European Commission, 2009). Here, in the context of university-driven open innovation ecosystems, we refer to the approach in which university, industry, public administration, and user community collaborate in a shared (virtual or physical) space to addressing common interests.

University-driven open innovation ecosystems
Historically, industry-driven ecosystems appeared when one large company has the will and capability to attract many other actors (public and private) around it to facilitate and increase its rate of innovation. These companies usually provide platforms or subsystems where other companies or actors can develop their own products or services (faster and cheaper) but also to

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share ideas with other members of the ecosystem. The cases of Phillips in Eindhoven (The Netherlands), Siemens Deutsche Telecom in Munich (Germany), or Microsoft in Seattle (USA) are well known examples. Even when the origins of these industry-driven ecosystems had a clear geographical reference framework, their evolution (and the wide use of information and communication technology tools) has relativized the links to narrow territories to involve other actors located in other regions, even organized in "satellite ecosystems" located in other countries in order to improve access to local talent or to gain other specific advantages.

The same ideas can be applied to university-driven ecosystems generated when one worldwide recognized research university acts as an attractor for developing and transferring disruptive ideas through spin-offs or other partnerships with consolidated high-tech companies. The well-known cases of MIT in Boston (Massachusetts, USA) or Stanford University in Palo Alto (California, USA) are examples imitated in other places over the world. In the United Kingdom, something similar is happening in the Cambridge and Oxford universities, for example. Here, the driver depends on the high quality of deal flow of disruptive technologies coming from the university and the cultural context where these ideas could grow up. More recent cases in Sweden around Lund University or in Switzerland around the federal universities such as the École Polytechnique Fédérale de Lausanne in Lausanne or the Eidgenössische Technische Hochschule in Zurich constitute good examples of converging interests between national or federal authorities and the universities themselves with the support of industrial partners across the concept of a triple helix.

How universities can drive open innovation ecosystems

Elements put in place by universities to create long-term innovation ecosystems can be very different in form, function, and efficiency. In addition, important but difficult-to-measure challenges appear, such as the role that social networks can have in strengthening certain ties between the different components of the ecosystem. It is important to remember that when Henry Chesbrough introduced the term "open innovation" in 2003, he recognized innovation as a nonlinear phenomenon and shifted the focus of innovation away from companies and towards individuals. For this perspective, the introduction of co-creation spaces in university campuses appears as a useful element to bring together students, scientists, entrepreneurs, and other industry partners that inspire each other with different perspectives on the same subject (Huhtelin & Nenonen, 2015). These supportive spaces with relevant services are needed to support open innovation with other stakeholders.

University-driven open innovation ecosystems also can promote informal technology transfer between academia and industry (Frenkel et al., 2015), in contrast to more formal licensing and collaborative agreements. Behind those processes lives the need to create a sense of pride in membership, which reinforces links between participants and generates long-term partnerships. This idea underlies the philosophy of the so-called "co-location centres" of the knowledge innovation communities launched by the European Institute of Innovation and Technology to enforce knowledge triangle activities with an emphasis on entrepreneurship (EIT, 2012). Therefore, as happens in knowledge innovation communities, it is necessary to incorporate other actors that support the funding of promising research results to convert them into commercial products or services.

We understand a university-driven open innovation ecosystem as having the following characteristics:

- a stable network of actors led by a university in which industry, public administration, and a user community are also present at different levels of commitment
- a common (virtual or physical) space in which know-how and talent flow through the adherence to open innovation principles
- a common strategy and support tools driven by the university to accelerate immature technologies through systems of sustained value co-creation
- a commonly accepted governance scheme where each actor keeps its independence but alignment of objectives is pursued
- the university acting as the "glue" and taking responsibility for maintaining common infrastructures and programmes
- emphasis on applied research and technology development and not on fundamental research
- public support due to the not-for-profit entities (universities) playing a driving role
- technology specialization to ensure the smooth connection to research activities performed by the university

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- long-term commitments to ensure innovation activities merge with educational support (i.e., Master and PhD theses) aligned to industrial interests

Thus, many different types of university-driven open innovation ecosystems could be created that will differ along specific dimensions. Through our research, we are currently developing and using the following eight dimensions to reflect several drivers for the ecosystem evolution. Each needs to be simultaneously considered to understand and pursue the global aims defined for one specific ecosystem:

1. *Industrial empowerment:* the level of presence of large high-tech industries (or many technology-based small and medium-sized enterprises) with territorial commitments in terms of R&D, manufacturing facilities, interaction with other entities, and high-level educated (technical) employment.

2. *Technology specialization:* the existence of one or more key enabling technologies where public and private stakeholders of the ecosystem have demonstrable knowledge to develop and cooperate with.

3. *User involvement:* the participation of innovative users (early adopters of products and services) who could participate in demonstrators, pilots, public procurement, etc.

4. *Long-term commitments:* the existence of formal agreements between actors in order to facilitate long-term cooperation (in education, research or innovation) based on common commitments with enough time to produce the intended results.

5. *Geographic scope:* the links and impacts in one specific territory where public administrations could complement the actions performed by executing actors.

6. *Public support:* the availability of well-funded programmes for research and innovation from local, regional, or national administrations focused on the region or area where the ecosystem is located.

7. *Openness:* the existence of an open innovation culture embedded in key industrial or academic partners of the ecosystem to co-operate and co-create new products and services with other entities.

8. *Sectorial specialization:* the concentration of enterprises (and capabilities of public departments) in one specific industrial or entrepreneurial sector.

Altering these dimensions in strategic ways may allow a university to drive an open innovation ecosystem towards individual and system-level goals. In our own research, the next step is to use such dimensions to evaluate and compare the performance of different university-driven open innovation ecosystems.

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Q&A. How Can a University Drive an Open Innovation Ecosystem?

Gonzalo León & Roberto Martínez

Acknowledgements

This Q&A was developed from a paper presented at the 2016 ISPIM Innovation Forum in Boston, United States of America, March 13–16. ISPIM (ispim.org) – the International Society for Professional Innovation Management – is a network of researchers, industrialists, consultants, and public bodies who share an interest in innovation management.

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Citation: León, G., & Martínez, R. 2016. Q&A. *How Can a University Drive an Open Innovation Ecosystem? Technology Innovation Management Review,* 6(7): 48–51. http://timreview.ca/article/1004

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Keywords: open innovation, public–private partnerships, university–industry cooperation, ecosystems, technology transfer

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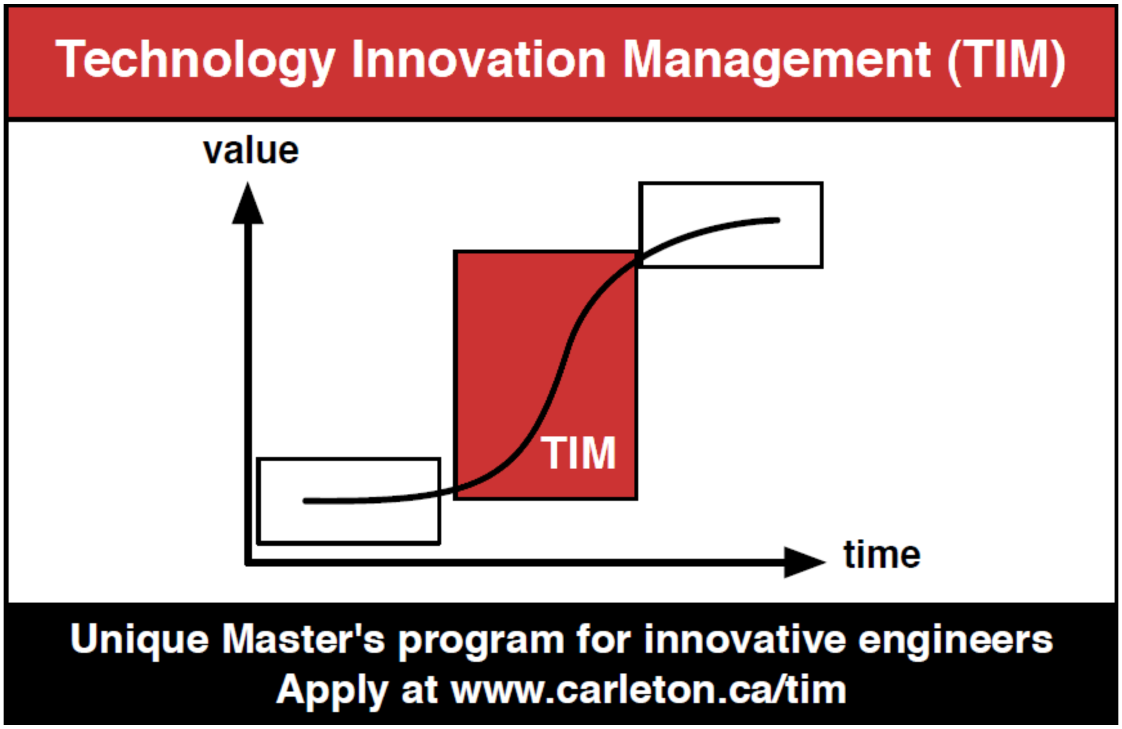

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