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Accelerating chemical start-ups in ecosystems: the need for biotopes

Accelerating
chemical
start-ups in
ecosystems

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Abstract

Purpose – The purpose of this paper is to clarify the relationship between start-ups and an innovation ecosystem. Start-ups need resources available in the ecosystem to grow, but experience organizational capacity limitations during their open innovation practices. This study frames the “open innovation” interface and discloses ways to accelerate the process of connecting start-ups’ demands to ecosystem’s supplies.

Design/methodology/approach – A case study was used to describe the development of a conceptual ecosystem model to frame the “open innovation” interface and its subsequent implementation at nine start-up hotspots in the Dutch chemical industry. To develop the ecosystem model, the system of innovation concept was enriched with the perspective of a chemical start-up to pinpoint critical resources for growth.

Findings – It is suggested that the most relevant “open innovation” interface for start-ups looking to grow is an innovation biotope: a well-defined, business-oriented cross-section of an ecosystem. All stakeholders in a biotope are carefully selected based on the entrepreneurial issue at stake: they can only enter the secured marketplace if they are able to provide dedicated solutions to start-ups. The biotope enables “open innovation in a closed system” which results in acceleration of the innovation process.

Originality/value – This is the first study to report on the definition and implementation of an innovation biotope as the “open innovation” interface between an ecosystem and start-ups. In addition, it provides a powerful tool, the ecosystem canvas, that can help both regional and national innovation systems to visualize their ecosystem and identify blind spots.

Keywords Technological innovation, Chemical industry, High tech start-ups, Innovation biotope, Innovation ecosystem

Paper type Case study

1. Introduction

Innovation is an essential element of a modern society. More than ever economic prosperity is linked to major leaps in technological development. Start-ups play a vital role in the process of transforming scientific inventions into innovation (Hunt, 2013). These high tech, knowledge-intensive firms are capable of making new products and services available to society, which is far more difficult for established industries due to their risk-averse and static behaviour. The number of innovations, for example, by start-ups based on developments in information technology is high. Examples like Apple and Hewlett-Packard, and more recently, WhatsApp, are well-known. Nevertheless, the trend of young innovative firms that shake up the market and outsmart incumbent firms does not happen in every sector yet. In the chemical industry, incumbents firms still appear to profoundly rule the game. Start-ups in this sector are also working on radical innovations, but hardly reach breakthroughs in the market. Explanations for this phenomenon are manifold: the young innovative firms, for example, lack the financial means (Radas and Božić, 2009) and do not possess the manufacturing hardware and distributions channels that incumbent firms have (Perez *et al.*, 2013). Nevertheless, new firms based on novel developments in chemistry continue to start throughout Europe every day. Despite the rather unclear future perspective they face, entrepreneurs are willing to embark on a long and uncertain innovation journey.

An important enabler for this trend is that many initiatives have been deployed by policy makers to stimulate entrepreneurship in high tech sectors like chemistry and biotechnology.



An environment supportive to entrepreneurship, for example, has been created at many universities. In most cases, former stand-alone programmes aiming at new business creation gave rise to networks consisting of organizations that support start-ups. These environments are generally referred to as innovation ecosystems, a term that was first coined by Moore (1993) and is widely used nowadays. In line with the open innovation paradigm, start-ups need to interact with an ecosystem to access resources that facilitate growth acceleration (Audretsch, 2015). If start-ups fail, they may remain too small and risky for larger firms to be (joint) venture prospects. The growing businesses, or so-called gazelles, are generally lacking in the European chemical industry. This phenomenon hinders the industry's transformation as gazelles, even more than start-ups, are considered to be the future engines for growth at the sector level (Nightingale and Coad, 2014). Creating more gazelles is therefore imperative to secure the future competitiveness of the European chemical industry.

At the level of the small company aiming at radical innovation, however, it is typically unknown what is required to go from start-up to gazelle. Several studies have focussed on small, knowledge-intensive companies (Brown and Mawson, 2013), but these studies suggest little in terms of positive action beyond, in short, "more management". The literature frames what entrepreneurs should do in terms of business objectives, but does not include guidelines for an ecosystem embedding that enables start-ups to access resources for growth. A research gap exists regarding concepts that outline the "open innovation" interface for the interaction between the start-up and ecosystem. This study aims to contribute to this topic by first conceptually developing and then practically implementing a model that frames this interface. Moreover, we present the "ecosystem canvas" tool to visualize ecosystems as spin-off result. To develop the conceptual model, we applied the perspective of a start-up to pinpoint critical resources for growth and used the innovation system model (OECD, 1999) to explicate the ecosystem. We describe an actual intervention in the chemical industry based on the model and argue that the most relevant "open innovation" interface for a start-up to accelerate its growth is an innovation biotope: a well-defined, business-oriented cross-section of an ecosystem. The crucial aspect is that all partners in a biotope are carefully selected based on the entrepreneurial issue at stake. The process ongoing in the biotope could be described as "open innovation within a closed system".

2. The chemical industry: the era of start-ups has started

The chemical industry has played an enormous role in the development of the world. The discovery of a purple dye by William Henry Perkin in 1856 was the start of a long tradition of science-based breakthrough innovations in this sector. The introduction of plastics, for example, helped to rebuild the world after the Second World War. The number of innovations, however, slowly started to stagnate from the 1980s onwards. The main reason was the increasing global competition which finally resulted in a price-cost squeeze and restructuring of firms (Hofmann and Budde, 2006). The position of in-house R&D changed: corporate research declined and the remaining decentralized research became closely linked to firm's development activities. Internal cultures started to push efforts towards more low risk, immediate reward projects of which the targeted outcomes were more incremental (Swan and Allred, 2003). The protection that corporate research had offered to basic research on high-risk developments with an uncertain return on investment disappeared almost completely within firms. The balance between long- and short-term R&D-tasks became seriously disturbed. As a consequence, the number of breakthrough innovations originating from the chemical industry seriously declined (Bröring and Herzog, 2008).

Radical innovation, however, has repeatedly been identified as the key driver for a sustainable future of the European chemical industry (KPMG, 2014). With competitors

emerging in Asia and the Middle East and low natural gas prices in the USA, the industry has to regain its innovative power. In this process, universities as sources of basic research and new skills play a crucial role. Industry-science collaboration has therefore been profoundly stimulated by policy makers since the end of the 1990s (Debackere and Veugelers, 2005). The Dutch Government, for example, pioneered by founding four theme-specific (e.g. catalysis, polymers) technological institutes for the chemical industry. These institutes were aimed at stimulating knowledge transfer between firms and universities. This mission succeeded: a vast public private network arose and a large number of collaborative projects were successfully accomplished (van Gils *et al.*, 2009). Nevertheless, the direct impact on radical innovations was less evident. The significant public funding of the institutes (up to 50 per cent) required, due to EU-legislation, that the research was of a precompetitive nature. As a consequence, the results of this collaborative research hardly ever surpassed the point of proof-of-concept: the small scale preparation of new products and processes.

This relative early “end-stage” of development in public private partnerships (PPP) turned out to be problematic for innovation at the firm’s side. Since radical innovation processes in the chemical industry are characterized by long-term development times of 15 to 20 years (O’Connor and McDermott, 2004), firms still would have to invest substantial amounts of time and money to transform the concept into an innovation. Moreover, corporate research used to be the firm’s absorptive capacity that was necessary to monitor, evaluate and apply externally available scientific knowledge. This department was considered to be the natural partner for universities in collaborative projects aimed at radical innovation (De Wit *et al.*, 2007). By diminishing corporate research, chemical firms became less equipped to adopt completely new developments. The results originating from collaborative projects therefore often did not lead to new projects at the firms’ side. Many proof-of-concepts ended up on the shelf: firms were and are still only willing to adopt a new product or process if it fits the short-term time-to-market horizon of their business units. In practice, this means that the first steps towards pre-commercial scale-up have to be taken. Exactly this gap, from the proof-of-concept up to the so-called pilot plant scale, is the main challenge to address for start-ups and gazelles in the chemical industry (Van Gils *et al.*, 2015).

3. Developing a framework to link the start-up and the ecosystem

After clarifying the quest for chemical start-ups, we need to identify the critical resources for growth and discover how these resources can be accessed in the ecosystem. We will develop a conceptual framework to address the required interface by applying the entrepreneur’s perspective to pinpoint five critical resources (3.1), discussing their changes during the innovation process (3.2) and using the innovation system model to explicate the ecosystem concept (3.3). Finally, the innovation biotope is presented as the most relevant interface for a start-up to accelerate its development: a well-defined, business-oriented cross-section of an ecosystem. In the perspective of the open innovation paradigm, one could define the process ongoing in a biotope as “open innovation within a closed system”.

3.1 *The start-up revisited: what are resources needed to succeed?*

A start-up is a company, a partnership or temporary organization designed to search for a repeatable and scalable business model (Blank, 2010). Once identified, the start-up implements the model and transforms into an economically sustainable company. Regarding the chemical industry, as it was argued, a start-up only covers a part of the innovation process. Instead of bridging the whole process from idea to product, the newly founded company probably originates from a research environment – for instance, a university that is looking to create business from its research (Perkmann *et al.*, 2013) – and needs the resources of a large company for the final commercial scale-up, market entry and

expansion (Kask and Linton, 2013). Even though this development path seems short, many chemical start-ups get stuck and do not continue to grow. Start-ups have to interact with the ecosystem to obtain the resources that are needed for growth. These resources have to be identified in order to be able to frame the required “open innovation” interface. Many lists of critical resources have been produced so far, containing well-known success factors such as an innovative idea (Abetti, 2000), a clear market focus and customer involvement (Song *et al.*, 2008) and seed capital (Lasch *et al.*, 2007). No list, however, appears to be exhaustive and no taxonomy to be shared.

An interesting approach to come to a basic classification of success factors is provided by Groenewegen and De Langen (2012). They state that in order for a start-up with a radical innovation to be successful, there has to be an innovator, an innovation with unique advantages for the (potential) customers and an organization with certain characteristics. Bearing in mind the capital-intensive character of the chemical industry, those organizational characteristics should be divided in “funding” and “business operations”. In addition, the need for large-scale production processes (Gavrilescu and Chisti, 2005) makes that facilities like laboratories and analytical equipment should be added as a success factor as well. As such, five success factors can be discerned for chemical start-ups:

- (1) idea: the technological solution to a problem that has unique advantages for customers;
- (2) innovator: the person who leads the team in the pursuit of fulfilling the identified business opportunity;
- (3) funding: the money needed for the technological and commercial development of the idea;
- (4) facilities: the physical location having the infrastructural resources required for technological production; and
- (5) business operations: the collection of processes and artefacts that constitute a market-oriented, sustainable organization.

Once an innovator succeeds to address all challenges related to these technological (idea, facilities) and business-related (funding, operations) factors, the chemical start-up should be able to grow into a gazelle and bridge the gap from proof-of-concept to pilot plant product.

3.2 *The success factors explored: what happens in time?*

According to Edwards and Gordon (1984, p. 1), innovation is “a process that begins with an invention, proceeds with the development of the invention, and results in the introduction of a new product, process or service to the marketplace”. Over the years, various models have been developed to conceptualize this process. It all started with a linear model. Initially this model was based on the assumption that innovation was pushed by new technological insights, while later on, it had to be pulled by market needs to obtain the best results (Herstatt and Lettl, 2004). The critiques on this simplistic model, e.g. no feedback loops between phases and no interactions between departments, were addressed in the chain-linked model for innovation (Kline and Rosenberg, 1986). Subsequently, the open innovation paradigm (Chesbrough, 2006) transformed the – in a globalized world no longer feasible– in-house character of the chain-linked model. Nevertheless, despite all variations regarding linearity and openness, the core of the process remained the technological development as the idea has to transform into a product. A useful model to frame that part of the process was developed by NASA: the technological readiness level (TRL) model (Sadin *et al.*, 1989). This model divides the development process in nine levels, which are categorized using five main “appearances”

of the idea: the initial concept (TRL 1), proof-of-concept (2-3), prototype (4-5), pre-commercial series (6-7) and end-product (8-9). The product portfolio, consisting of variations based on the initial innovation, can be added as the sixth form.






The progress of the technological development is obviously interrelated with the other success factors: the idea will only make it to a commercially successful product, if the innovator is able to address all technological and business-related challenges. That, however, is not as straightforward as it may seem. It is, for example, often stated that a true scientist alone cannot make a start-up grow. To develop a feasible prototype, somebody has to take care of the technology, while another has to focus on the business (Marmer *et al.*, 2011). This business person, however, is not yet needed when a scientist is doing basic research, while he has to be in the lead when turning the start-up into a gazelle. So, the type of person who is best equipped to take up the main challenges – and should manage the team in the pursuit of fulfilling the business opportunity – changes over time. This phase-dependency appears to apply to the other success factors as well. The facilities, for example, show a similar pattern of change: a university offers the perfect setting for realizing a proof-of-concept, while to accommodate pilot plant runs – in the chemical industry meaning handling tons of material – an industrial area with all environmental permits in place is needed (Puig *et al.*, 2004). In between, the setting of an incubator is seen as the best place for a start-up to grow into a gazelle (Cohen, 2013).

Studies on the business-related success factors confirm the change in challenges. According to Bygrave *et al.* (2003), for example, many innovators waste their time seeking venture capital too early in the development process. They are simply hunting for the wrong funding source as grants are more appropriate in early phases. The type of document needed to raise funding, one of the business operations' artefacts, also differs in time. The Small Business Innovation Research (SBIR) programme provides a good example. Initially, a scientist can apply for a small grant to study and report on the commercial feasibility of the proof-of-concept. A larger sum becomes available once the start-up is founded, a business plan is available and an entrepreneurial team is working on the product prototype (Toole and Czarnitzki, 2007). The SBIR-programme also identifies a phase 3, but does not provide financial means for this stage in which the actual market launch has to be realized. Here, start-ups are dependent on raising private equity based on a detailed business case underpinning the launch (Human *et al.*, 2004). In conclusion, the exact challenges related to all five success factors change in time. Even though many challenges have been reported, no studies so far coupled these challenges to the phases of the innovation process. We have displayed the main challenges per success factor per innovation phase in Figure 1. The six innovation phases are labelled according to the nomenclature of the financial community (Halt *et al.*, 2014).

3.3 *The ecosystem: how does it relate to the start-up?*

Ever since Moore (1993, p. 9) coined the term business ecosystem to describe “an economic community supported by a foundation of interacting organizations and individuals [that] produces good and services of value to customers who are themselves member of the ecosystem”, it has received increasing attention. An emerging body of literature engaged in the examination of the dynamic set of interactions between the members and the influences of the context within which the members operate. Diverse research angles originated, but a shared belief is that entrepreneurial organizations like start-ups have to pay attention to the wider context in the design and implementation of their strategy for innovation (Carlsson and Corvello, 2011). Several models have been developed to map this wider context which resulted in lists with ecosystem factors like success stories, financial and human capital and moral support (Isenberg, 2010; Suresh and Ramraj, 2012). None of the present studies, however, took the perspective of the resources needed for the

Figure 1.
The development
of the critical success
factors during an
innovation process

innovation phase success factor	idea	pre-seed	start	develop	growth	consolidate
 tech.idea	conceptual idea	proof-of-concept ('milligrams')	prototype ('grams')	0-series ('kilograms')	product ('tons')	product portfolio
 innovator	fundamental researcher	researcher	entrepreneurial researcher	researching entrepreneur	entrepreneur	manager
 bus.operat.	imperfection market/technology	feasibility study market/technology	exploration market and business model	market launch	market breakthrough	market share
 facilities	university knowledge institute	public-private-partnership	incubator corporate lab	accelerator	pilot plant	plant
 funding	science/research funding	pre-seed funds (≤25 k€)	seed funds (≤250 k€)	1st round (≤2.5 M€)	2nd/3rd round (≤25 M€)	share swap

innovative activity when discussing the relation between the entrepreneurial organization and ecosystem. The model presented by the OECD (1999, p. 23), based on the national system of innovation approach, offers a useful basis to explore the relationship between start-ups and the ecosystem.

In the centre of the OECD-model, the innovation process is represented rather simplistic by showing linkages between the main actors. More interesting to see is that this “innovative heart” is directly influenced by five factors in the wider context or ecosystem. These five factors are:

- (1) macroeconomic and regulatory context: the context for innovative activities formed by means of public innovation policy;
- (2) communication infrastructures: the business networks consisting of persons and/or organizations related to innovation;
- (3) factor market conditions: the virtual market giving access to production factors like capital, labour and raw materials;
- (4) product market conditions: the virtual end market where products, processes and services are to be sold to customers; and
- (5) education and training system: the group of research and/or teaching organizations like universities and governmental labs.

The five factors are the pillars of the ecosystem in which the “innovative heart” is beating. By replacing the rather basic heart of the OECD-model by Figure 1, a new model originates (Figure 2). This refined model appears to reveal interesting relationships between the needs of the innovative start-up that faces technological and business-related challenges (micro level) and factors in the ecosystem that influence this process (macro level). For example, by relating the education and training system to the challenges in the start and development phase, the policy discussion on human capital can be enriched with the perspective of start-ups. Such a discussion, however, will not directly lead to growth of start-ups. The concrete interface to enable start-ups to interact and profit from resources available in ecosystem needs to be organized by means of implementing an innovation biotope at the meso level.

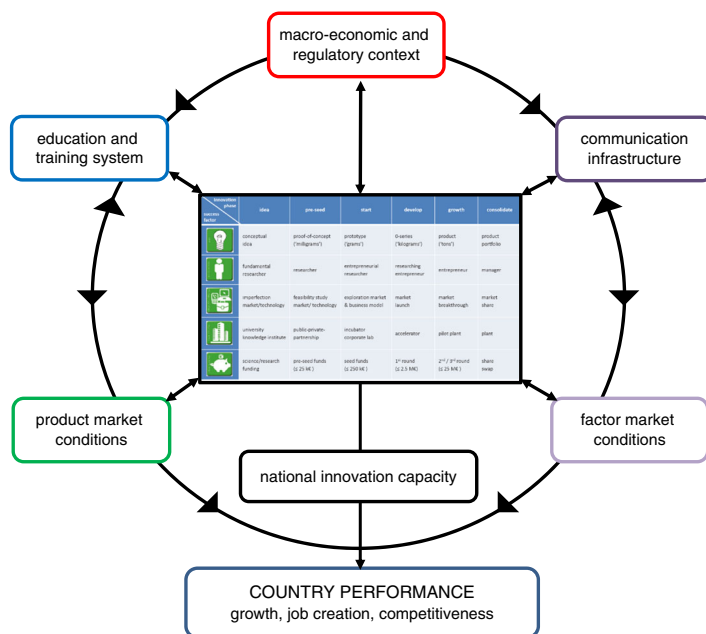


Figure 2.
The ecosystem model

3.4 The biotope: what makes this “open innovation” interface successful?

No firm is able to innovate on its own anymore. Collaboration and being connected to other stakeholders – such as universities and governmental agencies, but also innovation intermediaries (Janssen *et al.*, 2014) – have become crucial factors for firms aiming to advance their technology and accelerate innovation. Van der Vrande *et al.* (2009) were among the first to focus on open innovation in small and medium enterprises (SMEs) drawing on a large survey database. They concluded that open innovation practices had been heavily adopted by SMEs as they often lack resources to develop and commercialize new products in-house. To engage in open innovation, SMEs have to deploy the dynamic capabilities for this practice in order to signal, seize and implement external opportunities (Grimaldi *et al.*, 2013). The allocation of the required organizational resources, however, is a great challenge for micro firms (< 10 employees) like start-ups. In those firms, this allocation is a continuous trade-off between internal day-to-day operations and open innovation efforts. This balance is further complicated by the overkill of network meetings nowadays. Entrepreneurs could spend all their time attending those gatherings, often not knowing what the meeting can exactly bring them. Start-ups are faced with too many options and hardly any guidance to choose regarding their open innovation practices, while already having limited organizational capacity.

Brunswick and Vanhaverbeke (2014) have addressed these organizational capacity issues and identified a solution when stating (p. 1259): “Considering the liabilities represented by SME’s smallness and lack of resources, future research should consider in more detail how organizational and also industry factors help or hinder a firm’s decision to open up to external knowledge sources”. The suggestion of industry factors is interesting as it was recently confirmed that each ecosystem is different and idiosyncratic (Mason and Brown, 2014). The focus on a single industry ensures that the divergent effects relating to industrial differences are ruled out. The “open innovation” interface between the ecosystem and individual firm will be less variable and therefore easier to analyse. Nevertheless, such a

focus does not tell how to organize this interface. Empirical data on the exact mechanisms of the open innovation process, which would yield valuable knowledge about the interface needed, are lacking for start-ups. A literature review by Greco *et al.* (2015) showed that only one study between 2003 and 2013 focussed on open innovation processes in micro firms, while West *et al.* (2014) concluded that future research should aim at developing multilevel perspectives on open innovation. We therefore propose an instantaneous blend of the macro level ecosystem and the micro level individual firm by introducing the innovation biotope as the interface to enable open innovation in a closed system.

The innovation biotope is, in analogy to the real-life biological classification, a cross-section of an ecosystem. Where an ecosystem includes all stakeholders that are somehow related to innovation processes in chemical industry, a biotope makes a business-oriented selection of stakeholders that can participate. This selection is based on issues entrepreneurs are facing: only stakeholders that can directly provide solutions and thus accelerate the innovation process are allowed to join the biotope. By putting one of the five critical success factors of a start-up (i.e. idea, innovator, business operations, funding or facilities) central to a biotope, the selected participants are often professional, but also competing colleagues. Due to the high added value offered by linking them directly to excellent entrepreneurs that have issues they can solve (i.e. business opportunities), participants accept the presence of some competitors in the biotope. Moreover, since all participants have the same frame of reference, the knowledge level in the secure environment is rather high which makes communication easier and profound and thus more relevant. The biotope as “open innovation” interface connects demand (a distinct challenge of start-ups in the innovation process) and supply (stakeholders that can provide direct solutions) at a well-defined, secured marketplace. This way, it should be possible to greatly reduce time spending and organizational efforts of start-ups at network meetings searching for business partners to advance their innovation process.

4. The framework in practice: the case of the Dutch chemical industry

In 2011, a small project team (including the authors) was asked to effectuate the strategy to stimulate innovation that had been designed by the Chemistry Directive Group. This national triple helix – with representatives from many segments of the chemistry field – had been assigned by the Ministry of Economic Affairs to prepare the Dutch chemical industry for the future. The strategy was focussed on accelerating start-ups and gazelles as the future engines of the sector. The concept of the innovation biotope was leading when we started to build an environment supportive to business acceleration. We finished building only recently, resulting in one nation-wide innovation biotope with 14 hotspots: nine dedicated to stimulate start-ups (focus of the paper) and five focussed on accelerating gazelles.

4.1 Methodological considerations

A case study model is the most suitable research strategy to describe an intervention (Yin, 1994). This approach provides the opportunity to describe the intervention itself, but also to capture the real-life context in which the intervention has occurred. We therefore start in the next paragraph (4.2) by describing the Dutch chemical industry in more detail: its size, outreach and future plans to consolidate this position by stimulating innovation. Subsequently, we describe the project team and its preparations, based on the conceptual ecosystem model, for the intervention at local innovation hotspots (4.3). Lastly, we describe the intervention itself and discuss the current results (4.4). Despite our accuracy in reporting this descriptive single case, subjectivity almost inevitable plays a role, while the results might also be prone to concerns regarding methodological rigour in terms of validity and reliability. We, however, hold on to Flyvbjerg (2006, p. 230) who states in response to the general notion that a descriptive single case cannot contribute to scientific development:

“One can often generalize on the basis of a single case, and the case study may be central to scientific development via generalization as supplement or alternative to other methods. But formal generalization is overvalued as a source of scientific development, whereas ‘the force of example’ is underestimated”.

4.2 *Setting the scene: the Dutch chemical industry*

The chemical industry, being an advanced and increasingly knowledge-intensive industry, plays a central role in the Dutch economy. Its almost 57,500 employees generated a turnover of 55 billion euro in 2013 (VNCI, 2014). The Dutch chemical industry is a player at the global scale, which is confirmed, for instance, by the housing of a large number of headquarters of corporate firms. To keep this prominent position, the chemical industry was appointed as a “topsector” by the Dutch Government which had developed a “topsector” policy to strengthen business sectors in which the Netherlands excels globally. The government, industry and knowledge institutes in the chemical industry started to work closely together as the Chemistry Directive Group, a national triple helix, for this purpose. A Top Team (four members originating from a multinational, government, SME and academia) was formed from the Chemistry Directive Group to orchestrate the initiatives in the topsector on a daily basis at the end of 2010. The Top Team formulated in its report “New earth, new chemistry” (Chemistry Directive Group, 2011) two central ambitions for the Netherlands in 2050. The chemical industry as enabling sector should play a key role in the transition towards a nation that is, on the one hand, acknowledged worldwide as a nation of green and sustainable chemistry and on the other, in the global top three manufacturers of smart materials.

A sector-wide approach based on the industry’s foundations, a vigorous business community and excellent academic research, was coupled to these ambitions for their realization. In total, four action lines were suggested by the Top Team. The common thread in these action lines was the focus on stimulating and accelerating innovation. In particular, the need for and role of SMEs in the innovation process was emphasized. An existing framework was used to demonstrate the connection between academic findings, SMEs and multinationals’ market access (Chemistry Directive Group, 2006, p. 13). This framework, depicted as the famous Erasmus Bridge in Rotterdam, shows the knowledge and innovation infrastructure that should enable the transformation of excellent scientific ideas into successful commercial products. Four physical loci of innovation were discerned on the bridge, each focussing on a specific part of the innovation process. The parts and their descriptions are:

- (1) fundamental research institutes: academic organizations aimed at preserving leading research positions;
- (2) PPP: joint industry-science efforts on strategically driven basic research;
- (3) Innovation Labs (iLAB): locations equipped to allow chemical start-ups to take the first business steps; and
- (4) centres for open chemical innovation (COCi): brown-field sites aimed at housing firms that are ready to grow and scale up.

This focus was needed as it was already recognized that facilities – the success factor describing the location with the infrastructural resources needed for production – are crucial in the development and upscaling of innovative ideas in the chemical industry.

4.3 *Identifying the requirements for an iLAB: the use of the ecosystem model*

The effectuation of the bridge was ongoing by the end of 2011: fundamental research had received extra funding, the future of PPP had been secured and the first two COCi-locations had been opened. The Innovation Labs or iLABs, however, lagged behind: only one had

been opened and clearly did not flourish. Therefore, the Top Team was looking to use their momentum to restart the iLAB-agenda. They installed a small project team, consisting of a professor in chemistry who had been awarded “the most entrepreneurial scientist of the Netherlands” as respected and acclaimed chairman, the secretary-general of the Top Team as the linking pin to the triple helix and a strategic advisor who did his PhD on open innovation in the chemical industry as innovation expert. This experienced team received the instruction to elaborate on the iLAB proposition and subsequently implement it in the field. The team decided, based on the conceptual ecosystem model, to ask input on the concept of “facilities in the start-up phase” from all possible stakeholders. As a result, they did not limit themselves to interviewing the future residents of an iLAB and the direct “neighbours” (PPPs and COCi’s), but also involved representatives of the five ecosystem factors. This way, input on the potential added value of an iLAB was received from universities (education and training system), policy makers (regulatory context), property owners (factor market), multinationals (product market) and organizers of the communication infrastructure like industry associations.

The interviews gave clear insights in the wishes and expectations of all stakeholders with regard to an iLAB (Figure 3). The aspirant residents summed up a list of basic infrastructural elements they would require (fume hoods, IT-connections, a joint restaurant, etc.), but also addressed the need for general agreements between the iLAB and the university about environmental permits for handling chemicals and the use of expensive equipment. The direct neighbours (PPPs and COCi’s) indicated that iLABs had to be thematically labelled and clearly framed in the innovation process (i.e. start-up/develop phase) as this would increase the lucidity in deal flow passing the “bridge”. Universities expressed the hope that iLABs could help them reaching their valorization objectives by having a clear “outlet” for chemical start-ups (inside-out), but also by obtaining a new

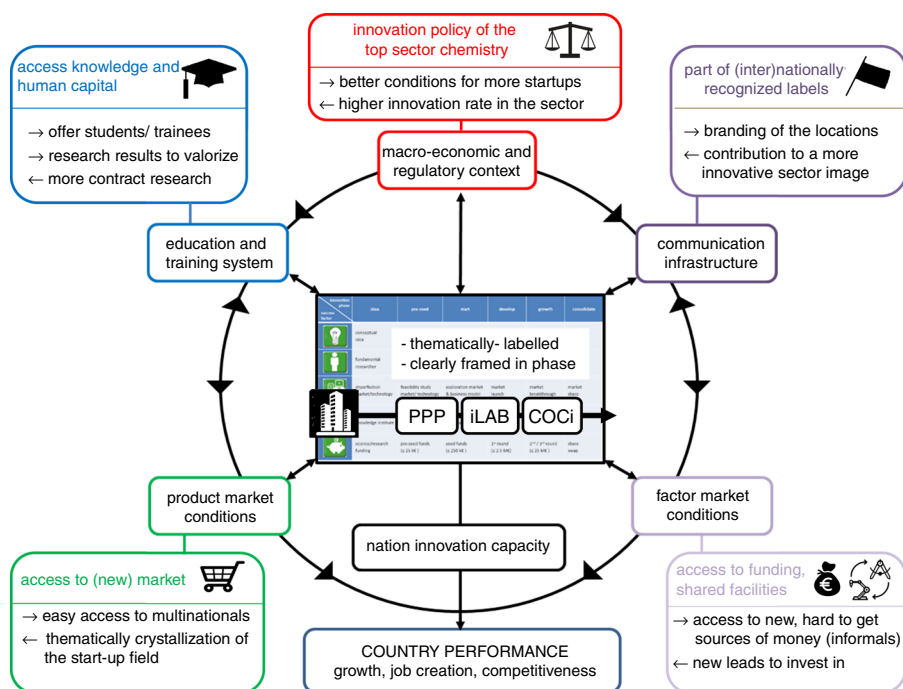


Figure 3. Results of the interviews regarding the added value of an iLAB

proposition which would help them to attract more contract research from industry (outside-in). Multinationals pinpointed that they would be highly interested in this, as they would call it, crystallization of the start-up field. After all, their future leads for collaboration or acquisition would be concentrated, ideally by chemical theme, on a number of locations. This would offer them a window-on-innovation. They suggested to firmly screen the (aspirant) start-ups at the gate in order to reach a high-quality level.

An iLAB was, based on all input, defined as a thematically labelled, physical location in the vicinity of a university. A location where chemical start-ups can accelerate the process from a viable proof-of-concept into a scalable prototype. Or in short: a chemistry-specific incubator. By providing excellent infrastructural facilities in the iLAB[1], the residents run their experiments and business as stand-alone firms, while making use of expensive equipment and the high-knowledge level at the university. The iLAB, however, should not just be a stand-alone location, but be well-positioned and riveted in the ecosystem of the chemical industry. Therefore, an iLAB cannot exclusively welcome academic spin-offs, but has to focus on acquiring start-ups from other origins like company spin-outs as well. It should fulfil a role as the physical locus of innovation in the region. Aspirant residents have to be screened at the gate in order to select the best start-ups for housing. During their stay, start-ups are monitored to map their progress and advise them about their next step. Moreover, an iLAB should help its residents regarding the other success factors by enclosing, for example, relevant technology experts, funding options and entrepreneurship training. From a nationwide perspective, there should be an iLAB at each university that is involved in chemistry research to reach optimal use of new scientific inventions and entrepreneurial potential. Finally, to overcome domestic competition, each iLAB must select a theme that is unique in the overall iLAB-proposition.

4.4 *Building the iLAB-biotope: practice what you preach*

The Top Team did not have the intention to build entirely new incubators at all eligible universities. Instead of financing bricks, it chose to offer locations free support of the topsector's project team during the process of transforming existing assets into an incubator consistent with the iLAB-concept. Once the makeover was accomplished, the location would receive the sector's iLAB-status. This quality mark provided selected stakeholders (i.e. start-ups, incubator manager, head of technology transfer office, director of chemical institute) direct access to the innovation biotope: the acknowledged cross-section of the topsector's ecosystem based on the criterion "facilities for start-ups". Being a part of this biotope would directly offer three types of advantages: at the micro level, it would give individual start-ups direct access to members of the Chemistry Directive Group that are in influential positions at key players in the sector. At the level of the biotope itself (meso), the topsector would offer the stakeholders an informal, but secured environment to share knowledge, pitfalls and best practices with other iLABs. Finally, on the macro level, the biotope would offer the stakeholders additional exposure at (inter)national podia that belong to the sector's communication infrastructure. In addition, the biotope would offer them one powerful voice in future discussions with policymakers concerning the way public money should be spent on national initiatives for start-ups.

The project team selected only a few stakeholders at each location to develop the iLAB-proposition. In all cases, the owner/manager of the local incubator, the director of the chemical institute (in general a professor) and the head of technology transfer office were invited to discuss the local possibilities for start-ups. That way, a clear picture could be made of the available facilities, the organization of the deal flow process (for instance, awareness programmes for academics and promising research lines) and the actual benefits the iLAB-label would yield. After initial discussions, the delegations of all ten universities in the Netherlands involved in chemical research decided to start the process that could lead to the iLAB-status (Table I). These delegations, which often installed a coordinator for

the daily operations, were made responsible for developing a business plan for the iLAB[2]. They did not receive financial compensation for the process of writing, but could make unlimited use of the project team's strategic advisor. Halfway the process, the complete project team of the topsector would attend a progress meeting, in which they discussed a concept plan with the local delegation. This meeting was often used as well to gain the (financial) commitment of other regional stakeholders including public administrators, innovation networks and corporate firms. Once the business plan was finished and approved by the Top Team, a grand opening was organized with the chairman of the Top Team and many regional notables to open the iLAB.

4.4.1 Current results. At the moment, nine iLABs have been opened and two will be opened within the next six months. In total, approximately 50 start-ups are located in the iLABs which together have more than 250 employees. All locations agreed on the statement that obtaining the iLAB-status helped them to build a strong, locally driven proposition for aspirant entrepreneurs in chemistry and closely related sciences. With help of the topsector's project team and the iLAB-concept that was clearly embedded in the ecosystem framework, the local iLAB-stakeholders felt better equipped to discuss the best local implementation. They received sufficient guidance and input, regarding both content and process, to advance the process, but were themselves in charge of the exact timing and final proposition. To preserve and propagate their iLAB-proposition, most locations employed an account manager for the iLAB. This manager acts as contact person for those interested – mainly entrepreneurs, but also (semi) public organizations, multinationals and network organizations – and is responsible for maintaining and making use of links with the stakeholders involved. In practice, the account manager is the personification of the iLAB and helps entrepreneurs in finding their way to stakeholders at the location. If necessary, the account manager directs them towards the infrastructural biotope for start-ups, consisting of all iLABs in the topsector's ecosystem. He or she acts as a “linking pin” between the question of entrepreneur and the secured environment that has the answer.

At the level of the biotope itself, a number of activities have been employed. First of all, the iLAB-stakeholders were brought together twice for an informal session in which they could meet and share their knowledge, pitfalls and best practices. These meetings were invitation only to create a secured setting and were visited both times by delegations of all iLABs. The COCi-locations, the brown-field sites where start-ups can go to scale up, were involved as well so direct links could arise. Moreover, three iLABs have entered into a partnership with a corporate firm: initially to share knowledge on a regular basis, but eventually with the intention to create new business. Next to knowledge sharing within the

City	Host	Theme	Opening
Nijmegen	Radboud University	Organic chemistry and life sciences	13-Oct-2011
Eindhoven	Eindhoven University of Technology	Process technology	13-Oct-2011
Amsterdam	University of Amsterdam and VU University	Emerging chemical sciences	30-Oct-2013
Delft	Delft University of Technology	Industrial biotechnology	13-Nov-2013
Zwolle	Windesheim University of Applied Sciences	Plastics, fibres and composites	15-Nov-2013
Wageningen	Wageningen University & Research	Biobased products	10-Apr-2014
Groningen	University of Groningen	Enabling chemical sciences	26-Sep-2015
Utrecht	Utrecht University and HU University of Applied Sciences Utrecht	Life sciences and chemistry	13-Nov-2015
Enschede	University of Twente	Chemical micro- and nanotechnology	14-Sep-2016
Leiden	Leiden University	Life sciences and biochemistry	2017-Q2

Table I.
Overview of the
iLABs in the
Netherlands

biotope, stakeholders were offered exposure via the topsector's communication infrastructure. Two start-ups were given the opportunity to present their business and challenges at highly acclaimed meetings. These presentations were successful: one entrepreneur gained numerous valuable contacts in the field of nano-filtration, the other successfully launched a crowd-funding campaign by selling over 70 per cent of his prototypes at once. These case-by-case successes were the reason for the Top Team to invest in the strengthening of the biotope. A full-time coordinator was appointed to develop a digital environment for online knowledge sharing (www.chemielink.nl), to organize bus trips to take SMEs out in the field to iLABs to let them get acquainted with possibilities and to work on a programme to link start-ups to experienced sector experts. The Top Team is considering the project team's suggestion to build a biotope suited for funding chemical start-up, meaning large investments with long-term returns.

4.4.2 *Spin-off result: the ecosystem canvas as tool to visualize ecosystems.* Next to the implementation results, the project team discovered that the ecosystem model (Figure 2) in combination with the modular biotope view made it also possible to literally illustrate the "open innovation" interfaces available for entrepreneurs. By drawing the biotopes at the point in the central matrix they address (e.g. SBIR phase 1: access to finance in the pre-seed phase; iLAB: access to facilities in the start phase), the entire package of solutions can be visualized. This method helped in explaining the iLAB-concept to locations. Moreover, it gave them direct added value by making their current proposition (including blind spots) more transparent. This "spin-off" method was branded as the "ecosystem canvas" and used to help locations as well as the Top Team to plot their current situation and define their desired future situation. An example, depicting the situation of the topsector chemistry and demonstrating the need for the start-up funding biotope, is shown in Figure 4.

5. Discussion and lessons learned

The case of the Dutch chemical industry described the practical implementation of our conceptual ecosystem model. The applied modular view on ecosystems by distinguishing biotopes as secured marketplaces that offer dedicated solutions to real challenges of start-ups, helped focussing on what an ecosystem should do and not solely on discussing what it is. The need to describe integrated functions rather than describing the innovation system as a group of components serving a common purpose was already remarked by

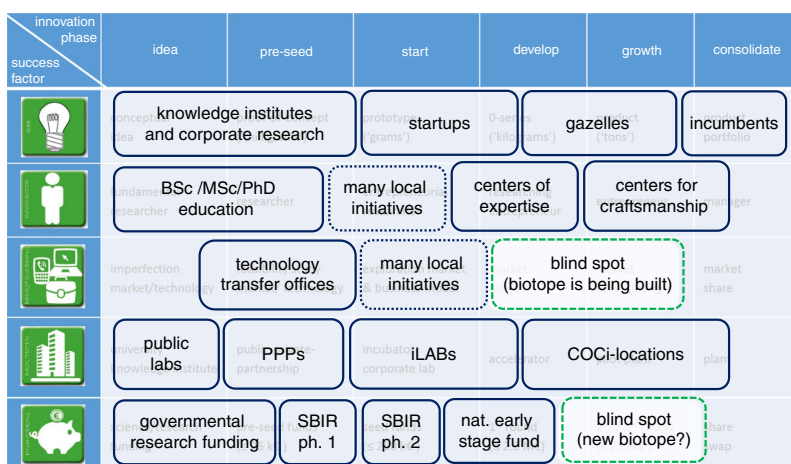


Figure 4.
An example of the
ecosystem canvas

Bergek *et al.* (2008). Although a systemic concept may suggest collective and coordinated action, it is primarily an analytical construct. The collaborative interactions between its components determine what is actually achieved in the system with regard to its goal. Our ecosystem model offered a concept for framing and building the interface between resources in the ecosystem and the individual entrepreneur who is in need of many things, but not all at the same time. Nevertheless, the true innovation was in its actual implementation as it provided detailed insights in the build-up and initial operation of the biotope as interface for open innovation. Taking into account the basic model for analysing collaboration of Wood and Gray (1991), it is interesting to focus on the preconditions and process of implementing the biotope. Regarding the outcomes, one has to conclude that the initial results are promising, but it is too early to determine the overall effectiveness.

The project team paid much attention to the preconditions before starting the collaborative process at a location. The most important aspect was that the project team decided to leave locations significant freedom to operate to enrich the iLAB-concept with their own, bottom-up originating initiatives and strengths. Even though the implementation of the iLAB-concept was a top-down initiated development, the acceptance of the iLAB-process implied no straightjacket or truck system regarding other initiatives of the topsector. The locations were and remained autonomous in their decision-making regarding the iLAB development, albeit that a number of agreements were made, for example, on reporting. This was simply to ensure that the high-quality level and oneness of the final biotope could be preserved. The need for this balancing of the complementary top-down and bottom-up approach in forming the operations strategy, as in our case, was recently addressed by Kim *et al.* (2014). Next to this balanced approach as precondition, the project team made sure that they were well-informed about possible embedding of the iLAB at a location as well as in the biotope. The team obtained information about regional policies and local research strengths. With this bigger picture in mind, the project team did not experience an information asymmetry that might hinder an effective process (Armstrong *et al.*, 2014) and could directly enter into concrete dialogues with local decision makers.

At all locations, the process was framed in a project. The salient aspects of that process, using the five characteristics of a project according to Grit (2008), were linked to the resources and organization of the project; the timing (each individual process took between 6 and 18 months), documenting of information and quality of the practical development were less remarkable. Locations were, for example, very self-critical and considered the plan as their ticket for the biotope. This resulted in high-quality reports that were almost all approved at once by the Top Team. The interplay between the project's resources and organization was more remarkable. The topsector chemistry, as it was stated, only supported the local development in an in-kind manner. Although all locations asked for an in-cash commitment at the start, the non-availability turned out not to be a showstopper. By accepting this condition, however, the local team turned itself into the true problem-owner: instead of working for the topsector in return for some (future) monetary reward, the local team required an intrinsic motivation to become and stay part of the biotope. As a result, the project team acted much more as a coach ("you did well, you can add this next time") than a hands-on expert ("I will tell you what to do") (Champion *et al.*, 2010, p. 59). To fulfil this coaching role convincingly, the members of the project team had to play their part and constantly orchestrate their actions.

6. Conclusion, implications and future research

Henton and Held wrote in their article (2013, p. 539): "Each region does not have to strive to be Silicon Valley, but instead should build on its strengths and invest in innovation infrastructure and human capital in order to become its own Silicon Valley". This inspiring statement quite neatly described our handling style while building the iLAB-biotope. We did

not try to impose our conceptual ecosystem model, but rather aimed at strengthening locations by offering a new perspective on how an ecosystem could help start-ups to accelerate. The biotope was introduced as the business-oriented interface to connect demand (a challenge related to a success factor of start-ups) and supply (stakeholders that can provide direct solutions) at a well-defined, private marketplace. By creating biotopes, it will be possible to greatly reduce time and organizational capacity spending of start-ups at network meetings searching for partners in the ecosystem having resources that could advance their innovation process. We called this process “open innovation in a closed system”. The initial results confirming this view have been achieved, even though the build-up of the iLAB-biotope is only to be completed officially when the last iLAB will open. That opening will be approximately ten years after the birth of the iLAB concept, just like almost every radical innovation in the chemical sector. The new era for the biotope, that of intensification, already started and will undoubtedly lead to more results.

The topsector chemistry case showed that the conceptual ecosystem model, in combination with a balanced implementation strategy, is of added value in the real world. Moreover, the ecosystem canvas turned out to be a powerful tool to visualize the ecosystem, identify blind spots and even direct future actions of the Top Team. By confining the study to an actual intervention in a single industry, we have to accept limitations on the generalizability of findings (Dess *et al.*, 1990). We have initial proof, however, that our model and ecosystem canvas tool are applicable to other sectors as well. Based on discussions with industry experts in the life sciences and semi-conductors fields, we strongly believe that the backbone of the model is also applicable in those sectors. What needs to be adapted are the concrete sector-specific issues for start-ups. The challenge, for example, for a life sciences start-up regarding business operations in the development phase is complying with issues required by law like a health technology assessment and certification. Our adjustment of the model’s content to the life sciences drew the attention of a region focussing on life sciences as well as of the corresponding topsector itself; both asked for an ecosystem canvas session and used the results as input for their strategic agendas. Whether the ecosystem model and canvas would also be applicable outside technology-based sectors with long-term development times, is an interesting question for future research. Moreover, concepts about how case-by-case developed biotopes can be linked to form an optimally functioning innovation ecosystem have to be developed to enrich this new direction for research and strengthen its implications for practice.

Notes

1. These facilities are: offices, ICT infra, lab infra (fume hoods, cupboards), environmental permits, analysis equipment (NMR, UV/VIS), maintenance services, catering facilities and meeting areas.
2. The plan had to include at least: a description of the region and the actual location for the iLAB, an analysis of the new business potential, a thorough explanation for the central theme, a roadmap for setting up and running an iLAB, a marketing plan and a financial overview.

References

- Abetti, P.A. (2000), “Critical success factors for radical technological innovation: a five case study”, *Creativity and Innovation Management*, Vol. 9 No. 4, pp. 208-221.
- Armstrong, C.S., Core, J.E. and Guay, W.R. (2014), “Do independent directors cause improvements in firm transparency?”, *Journal of Financial Economics*, Vol. 113 No. 3, pp. 383-403.
- Audretsch, D.B. (2015), *Everything in Its Place: Entrepreneurship and the Strategic Management of Cities, Regions, and States*, Oxford University Press, Oxford.

- Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S. and Rickne, A. (2008), "Analyzing the functional dynamics of technological innovation systems: a scheme of analysis", *Research Policy*, Vol. 37 No. 3, pp. 407-429.
- Blank, S. (2010), "What's a start-up? First principles", available at: <http://steveblank.com/2010/01/25/whats-a-start-up-first-principles/> (accessed 14 October 2015).
- Bröring, S. and Herzog, P. (2008), "Organising new business development: open innovation at Degussa", *European Journal of Innovation Management*, Vol. 11 No. 3, pp. 330-348.
- Brown, R. and Mawson, S. (2013), "Trigger points and high-growth firms: a conceptualisation and review of public policy implications", *Journal of Small Business and Enterprise Development*, Vol. 20 No. 2, pp. 279-295.
- Brunswick, S. and Vanhaverbeke, W. (2014), "Open innovation in small and medium-sized enterprises (SMEs): external knowledge sourcing strategies and internal organizational facilitators", *Journal of Small Business Management*, Vol. 53 No. 4, pp. 1241-1263.
- Bygrave, W., Hay, M., Ng, E. and Reynolds, P. (2003), "Executive forum: a study of informal investing in 29 nations composing the global entrepreneurship monitor", *Venture Capital: An International Journal of Entrepreneurial Finance*, Vol. 5 No. 2, pp. 101-116.
- Carlsson, S. and Corvello, V. (2011), "Open innovation", *European Journal of Innovation Management*, Vol. 14 No. 4, available at: www.emeraldinsight.com/doi/full/10.1108/ejim.2011.22014daa.001
- Champion, D., Kiel, D. and McLendon, J. (2010), "Choosing a consulting role: principles and dynamics of matching role to situation", in Ubels, J., Acquaye-Baddoo, N.-A. and Fowler, A. (Eds), *Capacity Development in Practice*, Earthscan, London and Washington, DC, pp. 57-64.
- Chemistry Directive Group (2006), "Business plan" (in Dutch), available at: www.mborraad.nl/media/uploads/companybranchgroup/PMLF/RegieGroepChemie_businessplan.pdf (accessed 21 February 2016).
- Chemistry Directive Group (2011), "New earth, new chemistry: action agenda topsector chemistry" (in Dutch), available at: www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2011/06/17/new-earth-new-chemistry/rapport-topsector-chemie.pdf (accessed 21 February 2016).
- Chesbrough, H.W. (2006), "Open innovation: a new paradigm for understanding industrial innovation", in Chesbrough, H.W., Vanhaverbeke, W. and West, J. (Eds), *Open Innovation: Researching a New Paradigm*, Oxford University Press, Oxford, pp. 1-14.
- Cohen, S. (2013), "What do accelerators do? Insights from incubators and angels", *Innovations*, Vol. 8 Nos 3-4, pp. 19-25.
- Debackere, K. and Veugelers, R. (2005), "The role of academic technology transfer organizations in improving industry science links", *Research Policy*, Vol. 34 No. 3, pp. 321-342.
- Dess, G.G., Ireland, R.D. and Hitt, M.A. (1990), "Industry effects and strategic management research", *Journal of Management*, Vol. 16 No. 1, pp. 7-27.
- De Wit, J., Dankbaar, B. and Vissers, G. (2007), "Open innovation: the new way of knowledge transfer", *Journal of Business Chemistry*, Vol. 4 No. 1, pp. 11-19.
- Edwards, K.L. and Gordon, T.J. (1984), "Characterization of innovations introduced on the US market in 1982", final report for the US small business administration, The Futures Group, Washington, DC.
- Flyvbjerg, B. (2006), "Five misunderstandings about case-study research", *Qualitative Inquiry*, Vol. 12 No. 2, pp. 219-245.
- Gavrilescu, M. and Chisti, Y. (2005), "Biotechnology – a sustainable alternative for chemical industry", *Biotechnology Advances*, Vol. 23 No. 7, pp. 471-499.
- Greco, M., Grimaldi, M. and Cricelli, M. (2015), "Open innovation actions and innovation performance: a literature review of European empirical evidence", *European Journal of Innovation Management*, Vol. 5 No. 2, pp. 150-171.
- Grimaldi, M., Quinto, I. and Rippa, P. (2013), "Enabling open innovation in small and medium enterprises: a dynamic capabilities approach", *Knowledge and Process Management*, Vol. 20 No. 4, pp. 199-210.

- Grit, R. (2008), *Project Management, A Practical Approach*, Noordhoff Uitgevers, Groningen/Houten.
- Groenewegen, G. and De Langen, F. (2012), "Critical success factors of the survival of start-ups with a radical innovation", *Journal of Applied Economics and Business Research*, Vol. 2 No. 3, pp. 155-171.
- Halt, G., Donch, C.J., Stiles, A. and Robert, F. (2014), *Intellectual Property in Consumer Electronics, Software and Technology Start-ups*, Springer-Verlag, New York, NY.
- Henton, D. and Held, K. (2013), "The dynamics of Silicon Valley: creative destruction and the evolution of the innovation habitat", *Social Science Information*, Vol. 52 No. 4, pp. 539-557.
- Herstatt, C. and Lettl, C. (2004), "Management of" technology push" development projects", *International Journal of Technology Management*, Vol. 27 Nos 2-3, pp. 155-175.
- Hofmann, K. and Budde, F. (2006), "Today's chemical industry: which way is up?", in Budde, F., Felcht, U.H. and Frankemölle, H. (Eds), *Value Creation: Strategies for the Chemical Industry*, Wiley-VCH, Weinheim, pp. 1-10.
- Human, S.E., Clark, T., Baucus, M.S. and Eustis, A.C. (2004), "Idea or prime opportunity? A framework for evaluating business ideas for new and small ventures", *Journal of Small Business Strategy*, Vol. 15 No. 1, pp. 59-80.
- Hunt, R.A. (2013), "Entrepreneurial tweaking: an empirical study of technology diffusion through secondary inventions and design modifications by start-ups", *European Journal of Innovation Management*, Vol. 16 No. 2, pp. 148-170.
- Isenberg, D.J. (2010), "How to start an entrepreneurial revolution", *Harvard Business Review*, Vol. 88 No. 6, pp. 41-50.
- Janssen, W., Bouwman, H., van Buuren, R. and Haaker, T. (2014), "An organizational competence model for innovation intermediaries", *European Journal of Innovation Management*, Vol. 17 No. 1, pp. 2-24.
- Kask, J. and Linton, G. (2013), "Business mating: when start-ups get it right", *Journal of Small Business & Entrepreneurship*, Vol. 26 No. 5, pp. 511-536.
- Kim, Y.H., Sting, F.J. and Loch, C.H. (2014), "Top-down, bottom-up, or both? Toward an integrative perspective on operations strategy formation", *Journal of Operations Management*, Vol. 32 No. 7, pp. 462-474.
- Kline, S.J. and Rosenberg, N. (1986), "An overview of innovation", in Landau, R. and Rosenberg, N. (Eds), *The Positive Sum Strategy: Harnessing Technology for Economic Growth*, National Academy Press, Washington, DC, pp. 275-305.
- KPMG (2014), "The European chemical industry in 2014 reaction", in KPMG Global Chemicals Institute (Ed.), *Chemical Magazine*, KPMG, London, pp. 2-19.
- Lasch, F., Le Roy, F. and Yami, S. (2007), "Critical growth factors of ICT start-ups", *Management Decision*, Vol. 45 No. 1, pp. 62-75.
- Marmar, M., Herrmann, B.L., Dogrultan, E. and Berman, R. (2011), "Start-up Genome report: a new framework for understanding why start-ups succeed", Start-up Genome, Stanford, CA, pp. 1-67.
- Mason, C. and Brown, R. (2014), "Entrepreneurial ecosystems and growth oriented entrepreneurship", final report, OECD, Paris.
- Moore, J.F. (1993), "Predators and prey: a new ecology of competition", *Harvard Business Review*, Vol. 71 No. 3, pp. 75-83.
- Nightingale, P. and Coad, A. (2014), "Muppets and gazelles: political and methodological biases in entrepreneurship research", *Industrial and Corporate Change*, Vol. 23 No. 1, pp. 113-143.
- O'Connor, G.C. and McDermott, C.M. (2004), "The human side of radical innovation", *Journal of Engineering and Technology Management*, Vol. 21 No. 1, pp. 11-30.
- OECD (1999), *Managing National Innovation Systems*, OECD, Paris.

- Perez, L., Whitelock, J. and Florin, J. (2013), "Learning about customers: managing B2B alliances between small technology start-ups and industry leaders", *European Journal of Marketing*, Vol. 47 Nos 3-4, pp. 431-462.
- Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R. and Hughes, A. (2013), "Academic engagement and commercialisation: a review of the literature on university – industry relations", *Research Policy*, Vol. 42 No. 2, pp. 423-442.
- Puig, S., Vives, M., Corominas, L., Balaguer, M. and Colprim, J. (2004), "Wastewater nitrogen removal in SBRs, applying a step-feed strategy: from lab-scale to pilot-plant operation", *Water Science & Technology*, Vol. 50 No. 10, pp. 89-96.
- Radas, S. and Božić, L. (2009), "The antecedents of SME innovativeness in an emerging transition economy", *Technovation*, Vol. 29 No. 6, pp. 438-450.
- Sadin, S.R., Povinelli, F.P. and Rosen, R. (1989), "The NASA technology push towards future space mission systems", *Acta Astronautica*, Vol. 20, pp. 73-77.
- Song, M., Podoyntsyna, K., Van Der Bij, H. and Halman, J.I. (2008), "Success factors in new ventures: a meta-analysis*", *Journal of Product Innovation Management*, Vol. 25 No. 1, pp. 7-27.
- Suresh, J. and Ramraj, R. (2012), "Entrepreneurial ecosystem: case study on the influence of environmental factors on entrepreneurial success", *European Journal of Business and Management*, Vol. 4 No. 16, pp. 95-101.
- Swan, K.S. and Allred, B.B. (2003), "A product and process model of the technology-sourcing decision", *Journal of Product Innovation Management*, Vol. 20 No. 6, pp. 485-496.
- Toole, A.A. and Czarnitzki, D. (2007), "Biomedical academic entrepreneurship through the SBIR program", *Journal of Economic Behavior & Organization*, Vol. 63 No. 4, pp. 716-738.
- Van der Vrande, V., De Jong, J.P., Vanhaverbeke, W. and De Rochemont, M. (2009), "Open innovation in SMEs: trends, motives and management challenges", *Technovation*, Vol. 29 No. 6, pp. 423-437.
- van Gils, M.J.G.M., Vissers, G. and De Wit, J. (2009), "Selecting the right channel for knowledge transfer between industry and science: consider the R&D-activity", *European Journal of Innovation Management*, Vol. 12 No. 4, pp. 492-511.
- Van Gils, M.J.G.M., Vissers, G. and Dankbaar, B. (2015), "Industry-science collaboration for radical innovation: the discovery of phase-dependent collaborative configurations", *Innovation: Management, Policy & Practice*, Vol. 3 No. 17, pp. 1-15.
- VNCI (2014), "Chemie in Nederland", available at: www.vnci.nl/chemie/beschrijving-sector (accessed 21 February 2016).
- West, J., Salter, A., Vanhaverbeke, W. and Chesbrough, H. (2014), "Open innovation: the next decade", *Research Policy*, Vol. 43 No. 5, pp. 805-811.
- Wood, D.J. and Gray, B. (1991), "Towards a comprehensive theory of collaboration", *Journal of Applied Behavioral Science*, Vol. 27 No. 2, pp. 139-162.
- Yin, R. (1994), *Case Study Research: Design and Methods*, Sage Publishing, Thousands Oaks, CA.

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2. Antonio Arciénaga Morales, Janni Nielsen, Hernán Bacarini, Silvia Martinelli, Sergio Kofuji, Juan García Díaz. 2018. Technology and Innovation Management in Higher Education—Cases from Latin America and Europe. *Administrative Sciences* **8**:2, 11. [[Crossref](#)]