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Frithjof Netzer

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Marketing of chemical parks: Challenges and perspectives

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Design thinking as driver for innovation in the chemical industry

Sebastian Eidam, Klaus Kurz and Eva Brockhaus

Implementation of Open Innovation in Chemical B2B Companies

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Letter from the Editors

Medication for the sick patient

Does the chemical industry lose its future? The ongoing wave of consolidation is profoundly changing the landscape of the chemical industry. Companies in the industry are more and more focused on M&A activities. But what are the reasons for this development? One might assume that the interest level is one decisive contributing factor. Another reason could be the lack of embedded innovative capabilities within the industry. Overall chemical companies nowadays seem to be more into financial engineering than chemical engineering. Over the last decade no chemical blockbuster has reached the market. In the wake of this development two trends are apparent. Firstly, companies focus on improving their operational efficiency by M&A activities. Secondly, players in the market align and restructure their product portfolios towards higher specialization. The present issue of the Journal of Business Chemistry addresses the chemical's industry current dilemma and provides some helpful insights for managers.

The first article of this issue is the commentary „Digitalization of the chemical industry" by Frithjof Netzer, Chief Digital Officer BASF Group, which on the one hand highlights the importance of digitalization and on the other hand presents how an international operating German company is facing the challenges arising from it. Furthermore, it provides insights into three different approaches on how the chemical industry can benefit from applying digital technologies.

In the practitioner's section Andreas Konert and Harald Kaiser from the Infraserv Höchst GmbH shed light on the topic of "Marketing of chemical parks: Challenges and perspectives". The authors present how site managers create and implement an effective and efficient marketing strategy. In this context, they also emphasize on the importance of defining the target group, specifying adequate value proposition and using the most promising communication channels.

The article „Design thinking as driver of innovation in the chemical industry" by Benedikt Waerder, Sigrid Stinnes and Oliver Erdenberger shows the relevance of systematic thinking during the innovation processes. In addition, they present empirical evidence for Design Thinking as an adequate instrument to overcome barriers as well as including stakeholders in a company's innovation process.

Sebastian Eidam, Klaus Kurz and Eva Brockhaus offer in their research paper „Implementation of Open Innovation in Process B2B Industries" an overview of applied open innovation approaches and the motivation for implementing them. In the executed study based on data from 42 online surveys, they assess the potential to use open innovation for exploration and exploitation purposes and the need of top management support for suc cessful implementation.

Please enjoy reading the second issue of the fourteenth volume of the Journal of Business Chemistry. We are grateful for the support of all authors and reviewers for this new issue. If you have any comments or suggestions, please do not hesitate to contact us at contact@businesschemistry.org.

Ruth Herrmann (Executive Editor)	Thomas Kopel (Executive Editor)	Bernd Winters (Executive Editor)

Journal of Business Chemistry

Commentary

Digitalization of the chemical industry

Frithjof Netzer*

* Chief Digital Officer BASF Group, Project Leader BASF 4.0,
BASF SE, Carl-Bosch-Str. 38, 67056 Ludwigshafen, Germany, http://www.basf.com/digitalization

The chemical industry – much like all other industries as well – has entered the digital age. The targeted use of data in order to create growth or increase efficiencies is at the very core of digitalization. The term “data is the new oil” describes the strategic importance of access to data, skills to store and process it and to turn it into valuable customer-centric solutions.

Key trends like an ever-rising connectivity, increasing transparency, quantification and profiling as well as mass customization impact the way business is done. These trends are fueled by technological step changes in computing speed, data storage and mobile data transmission rates – to name but a few.

Chemical companies have embraced this development at a later stage than many other industries. They often operate several market steps away from end consumers who are closely linked to some of the key digital trends. Additionally, enterprises place a high value on safety and security issues due to the nature of chemical production (e.g., toxicity, risk of explosion, dual use) – a concern that has impacted the development speed of data-driven applications in the IT and OT (Operations Technology) environment of these companies.

The anticipated potential of digitalization in the chemical industry is high (see figure 1). Revenue growth of 3.1% p.a. and cost reductions of 4.2% p.a. are quoted in a PWC study (2016) focusing on digital business models, smart supply chain solutions, smart manufacturing applications and a digitalized R&D as sources of such opportunities. Lifting this potential requires the skilled use of digital core technologies and foremost the readiness of an entire company for a digital transformation.

Digital core technologies typically include cloud technology, IoT (internet of things), big data analytics, mobility devices, augmented reality and artificial intelligence. Depending on the industry context 3D printing and robotics can be added to this non-comprehensive list. All of them are enabling companies to create solutions that differ from the status quo of running supply chains, production, R&D, marketing and sales.

Readiness of a chemical company to drive a digital transformation can be linked to four different factors:

1.) Digitalization is reflected in the corporate strategy
2.) Organizational structure embeds digital

Figure 1 Digitalization is driving growth (adapted from an internal graphic provided by BASF).

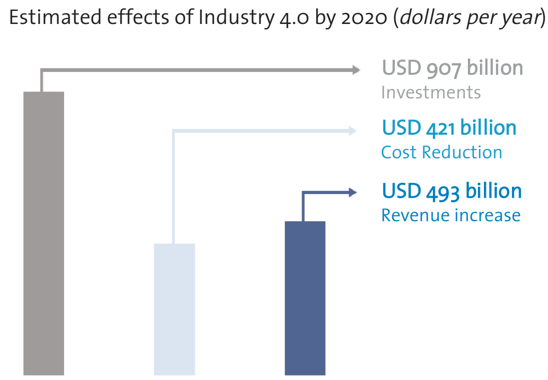
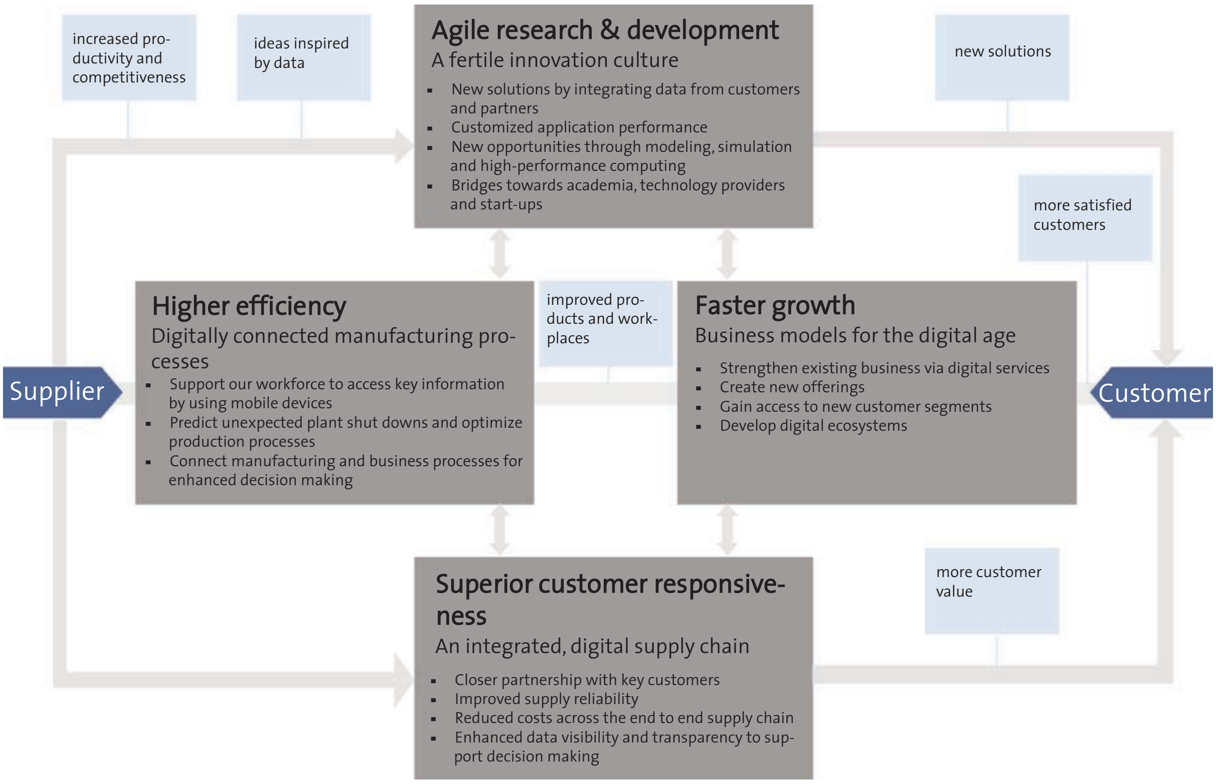


Figure 2 Digital Transformation at BASF (adapted from an internal graphic provided by BASF).



roles & responsibilities in a sustainable way
3.) IT systems support agile solutions and safeguard the company with a resilience-based security system
4.) Corporate culture embraces iterative improvements, agility and data literacy

BASF has included digitally enabled solutions, horizontal and vertical connectivity as well as workforce enablement to recognize and capture the value of data in its Digital Vision (see figure 2). Based on this vision more than 15 lighthouse projects with a dedicated business case were generated in 2015, followed by a total of more than 100 projects in 2016/17. A few examples can showcase this approach.

Digital Business Model: OASE connect.

In the near future, BASF will be able to support customers in the gas treatment business through the OASE connect online platform. With the help of the platform, the business team strengthens its service and offers BASF's customers real-time access to important information. The functionalities include, for example, a software that helps customers find the optimum settings for their system and adjust important parameters accordingly.

Depending on the need, customers can use one or more OASE connect functions. BASF is currently testing the offer together with some of its customers. Their feedback is used to develop and further enhance the software.

Smart Innovations.

In catalyst research, BASF implements quick tests based on mathematic models and experiments. A much simpler view of complex connections through networked data structures is the result. This enables BASF scientists to test hypotheses much earlier and in a much more targeted manner, making better use of innovation opportunities and shortening development time.

For automotive paints, BASF uses real time data from customers' painting line to optimally adjust the color based on customer needs. This allows BASF to ensure that the vehicle is painted in exactly the right color in a shorter amount of time.

In enzyme research, BASF has combined its own and external information into huge data records. On this basis, and using simple tools, researchers can quickly identify the most promising candidates for further development.

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Smart Manufacturing.

BASF's Ludwigshafen Verbund needs roughly 20 million metric tons of steam per year, which are generated by the production plants and the site's three power plants. In addition, the power plants produce the majority of electricity needed at the site – and sometimes more than is required, so that electricity can be fed into the public grid.

However, electricity is a complex business as market prices fluctuate every 15 minutes. Computer programs help to buy and sell at the best times. For this, however, a precise forecast is required as to how much steam and waste heat the production plants supply at the site, how much steam the power plants have to contribute and how much electricity is needed. This also fluctuates depending on the time of year, the weather and the economic conditions.

To date, the total requirements have been determined manually combined individual forecasts of the plants. A new statistical model, based on large amounts of data, now provides even more precise calculations: The software takes into account, among other things, historical and up-to-date information on production shutdowns, weather data and economic indices. The program searches for relationships and establishes connections with the energy demand.

This has been very successful: The forecast for steam demand has already improved by up to 60 percent. The former procedure will now be gradually replaced and applied to other areas. The new program supports BASF also in electricity trading to make better price forecasts.

These use cases demonstrate the potential of digitalization in a chemical industrial context. Making digital transformation a key priority of the CEO is paramount to a successful implementation. BASF has started a journey that builds awareness, understanding, practical skills and good practice sharing amongst all employees. Different formats and messages are used to reach a broad range of communities with the overarching claim "We have a challenging route ahead but the confidence of the right direction".

Digitalization is here to stay. It is in everyone's hands to contribute to its shaping.

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PWC (2016): *Industry 4.0: Building the digital enterprise: Forest, paper and packaging key findings*, 2016 Global Industry 4.0 Survey - Industry key findings, p. 5

Practitioner's Section

Marketing of chemical parks: Challenges and perspectives

Andreas Konert* and Harald Kaiser*

* Infraserv GmbH & Co. Höchst KG, Brüningstraße 50, 65929 Frankfurt am Main, Germany

Managing industrial parks is a multi-billion euro business with special importance to the asset intensive chemical and pharmaceutical industry. Site managers face many challenges, one of them being attracting new investments to the site. This article describes how site managers may create and implement an effective and efficient site marketing strategy by defining the relevant target group, specifying the adequate value proposition and using the most promising communication channels. The authors illustrate their recommendations with their site marketing experience from one of the most suc cessful industrial parks in Europe, the Industriepark Höchst.

1 Introduction: Marketing specifics of industrial parks

Industrial parks can be found worldwide. In Germany, the chemical industry has 37 (VCI, 2012) industrial parks. Industrial parks are clusters of research, production/manufacturing and service activities of several companies that share one physical location (see for instance, Wildemann 2016, or Suntrop 2016). From the outside an industrial park is seen as "one entity". One can distinguish between so called major-user parks that are operated and often owned by the largest tenant at the site. The most prominent example in Germany is the BASF Ludwigshafen site. Sometimes, several large tenants provide services to each other and the minor users at the site, as is the case at CHEMIEPARK.LINZ. On the other hand, there are multi-user parks that are owned and operated by a professional service company that does not have chemical production assets at the site, as is the case with Infraserv Höchst, the owner and operator of the Industriepark Höchst in Frankfurt.

Site service companies at industrial parks offer a range of different services (see Hofmann/Michel 2016). The site service company may organize the management of the facilities, the treatment of waste water, the grids and pipelines for all companies on site, as well as heating and cooling, warehousing, logistics or health and safety services (see figure 1). In addition, the site company may provide recruitment and training activities and organize learning processes between companies on site and the relevant external stakeholders (e.g. academia, policy makers).

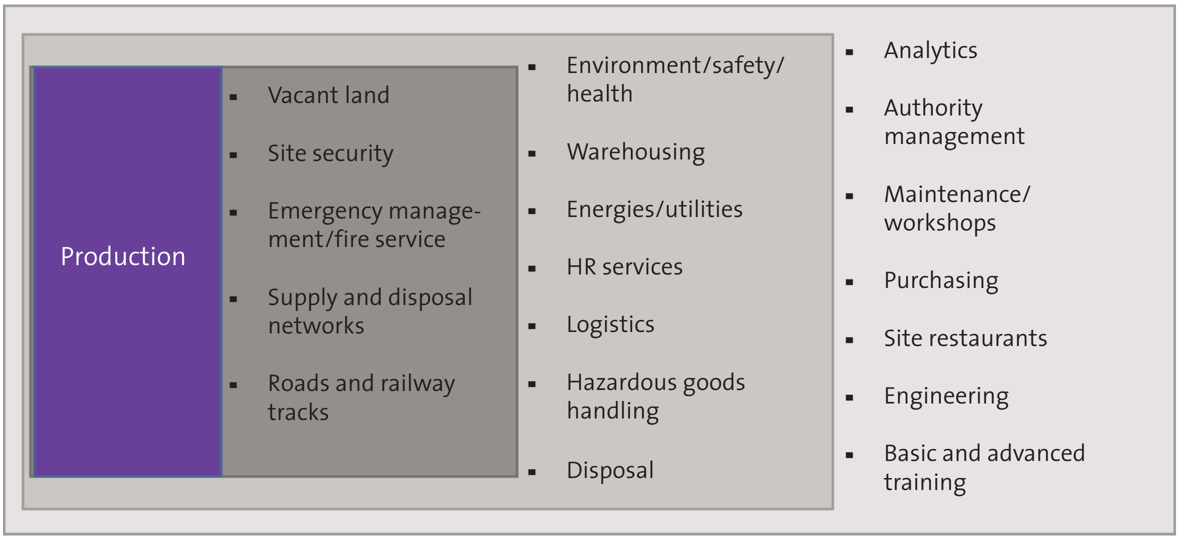
Service operators argue that outsourcing site operation activities to a specialized site operator, allows companies in the chemical and pharmaceutical industry to focus on their core competencies of developing, producing and selling goods. Furthermore, it creates cost and risk synergies in shared infrastructure assets and provides a sufficient mass for holding expert knowledge available at the site. Operationally, industrial park operators highlight the potential for reducing customers' costs, increasing their speed and flexibility and improving the quality of services.

And the leverage site operators are working on is significant to their customers in the chemical and pharmaceutical industry: Analysis shows that costs of infrastructure and services outlined above are between 10-15% of the revenues of chemical companies (with core costs in the field of energy, waste management, logistics and facility management) and around 5% of pharmaceutical sales (Wildemann, 2016).

In the following, the term marketing will be used to characterize (a) the general challenge of creating and managing business to business relationships between the industrial park operator and his potential customers and (b) to characterize the tasks of the respective department within the industrial park operator company.

Industrial park operators face specific market-

Figure 1 Site services at industrial parks (source: VCI Sector Group of Chemical Parks, 2013).



ing challenges. They act on business-to-business markets and offer their services to customers in the chemical and pharmaceutical industry. The demand for services in industrial parks ultimately depends upon the development of the consumer markets where chemical and pharmaceutical products are used. If consumers or regulation, for example, decide against plastic bags in Europe, the corresponding production will decrease and there will be lower demand for the related industrial services. For the chemical industry customer, a buying center structure is typical, with multiple persons on the customer side having influence on the buying decision. The decision making process on the customer side is highly formalized and professionalized in terms of methods and tools used for selecting the right production site. The services offered are highly individualized and cannot be stored (Peters et al. (2013), Homburg (2017), Zeithaml et al., 1985). Some of the services may only be offered within an industrial park (e.g. site security, firefighting), some others may be offered to external locations as well (e.g. facility services, consulting). Typically, long-term relationships between industrial parks and their (potential) clients can be observed; personal interaction prevails over mass media marketing.

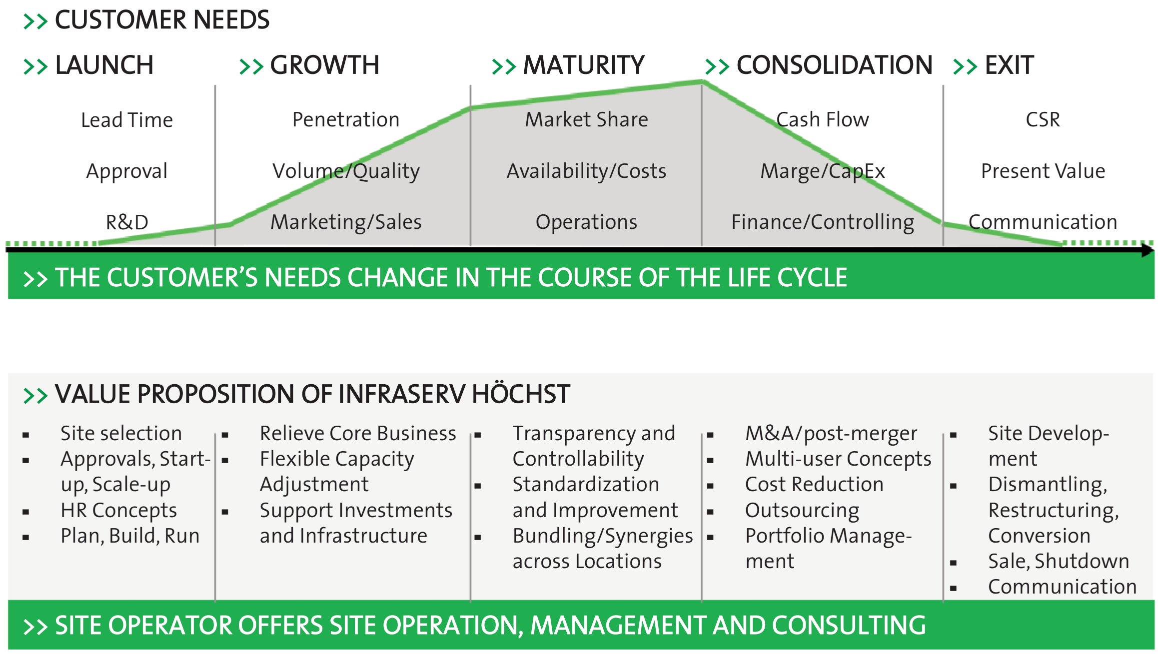
When an industrial park attracts a new client to its location and the client builds his production facility in the industrial park, a significant lock-in effect occurs after the investment in the park, due to the capital-intensive production assets. Furthermore, the producer is in some cases bound to the service offered within the park. Changes in quality and costs will directly affect the producer's profit situation. Another important aspect is the path dependency of industrial park development. Some industrial parks exist for more than 150 years; different production activities have been built over the years, hazardous goods have been produced, the land has been used in different ways over time. All these aspects have to be taken into account when an industrial park tries to attract new investments. So marketing of industrial parks is interesting from a broad range of marketing perspectives, encompassing business-to-business marketing, service marketing, information economics, principal agent theory and path dependency theory to name but a few (Hutt/Speh 2003).

2 Case study: Site Marketing at Infraserv Höchst

The Infraserv Höchst Group developed from Hoechst AG in 1997 and is the operator of the industrial park in Frankfurt Höchst. In 2016, it had a turnover of approximately 1 billion Euros and 2,500 employees organized in eight business segments, including energy and waste management, site services, logistics and real estate, as well as education and training specialist Provadis GmbH.

This highly diversified portfolio with at first glance seemingly unrelated services under one roof does, however, add superior value to clients. How so? Rather than just focussing on steady site operation, Infraserv Höchst puts its focus on partner-

Figure 2 Life cycle of an industrial park (source: own representation).



ing with clients to dynamically develop their sites. Every client business and every client site undergoes one or even several cycles over time. One way to describe this site development is to differentiate between launch, growth, maturity, consolidation and termination/exit phases, as depicted in figure 2. Obviously, however, businesses and sites have different lifespans, investment cycles, profit-risk-profiles and so on. From our understanding, one key to successful site development is to align both aspects – the needs of the chemical and pharmaceutical company in a specific phase of the product life cycle on the one hand, and the site parameters on the other hand - in the most effective and sustainable way.

For example, in the launch phase a product transitions from the development/approval stage into the production phase. In pharmaceuticals, for instance, when new active ingredients are involved the clock tends to be ticking as patent protections are limited and pharmaceutical companies try to sell the patent protected drug as long as possible in order to generate profit. Speed in scale up of production activities is therefore of the essence for companies in the pharmaceutical industry. But sub-optimal sizing of production facilities or lack of flexibility of infrastructure assets, for example, may prove to be costly in the future. Site partners like Infraserv Höchst can play a vital role in making the launch fast, successful and finding flexible and thus sustainable solutions for the site as a whole. The site management company may also help with all legal and regulatory requirements that need to be fulfilled for creating new factories and may find a flexible solution for the infrastructure as well, based on their experience and reputation gathered from multiple projects with many clients in the past.

The growth phase is characterized by market penetration. The volume and/or the quality of the products offered are seen as key success factors. Therefore, the marketing and sales departments lead on this, with production keeping pace as much as possible. Site operators must be able to offer flexible capacity adjustments while relieving the core business activities. During the maturity phase customers are confronted with intensified competition. Thus, availability and costs of products shift into focus. Infraserv Höchst, for instance, provides the ability for continuous improvement and standardization as well as the exploitation of synergies across secondary processes. In order to remain competitive in the consolidation phase customers focus on cash flow, margin, finance and controlling. The site service provider's value proposition consists of developing multi-user concepts after M&A activities, initiating cost reduction processes and adapting the service portfolio to changing needs. The last phase is described as the termination/exit phase. For customers, present value of their business is of utmost interest. Accordingly, services like dismantling, restructuring and conversion, in addition to sale and shutdown, are in high demand. All in all, in the course of the lifecycle the site operator must be able to respond to the varying customer needs and must offer an integrated solution to enable clients to adapt to their changing business needs, not just at Frankfurt-Höchst, but nationwide at other client sites and parks.

One gauge for the success and long-term performance of a site operator is the amount of investments attracted to the site it is managing. In the case of the Industriepark Höchst with more than 90 chemical, pharmaceutical and services companies and approximately 22,000 employees on around 460 acres, this number totals 7 billion Euros of investments since the year 2000, representing an average of more than 400 million Euros per year.

Each investment strengthens the site´s base and points to a promising future, attracting further investments in turn. Investments are in fact very hard to come by, however. Many sites therefore invest strongly in site marketing activities. But what strategies can the marketing department use in order to attract investments? Chapter 3 will give some methodological background on finding out “where to play”. Chapter 4 will go into more detail on customers’ decision making processes and ”how to win” from a marketing perspective. Chapter 5 will look at the buying centre in more detail and offer some guidance on “where to put your money” in the most cost-effective way.

3 Where to play: Selecting the most promising target segments

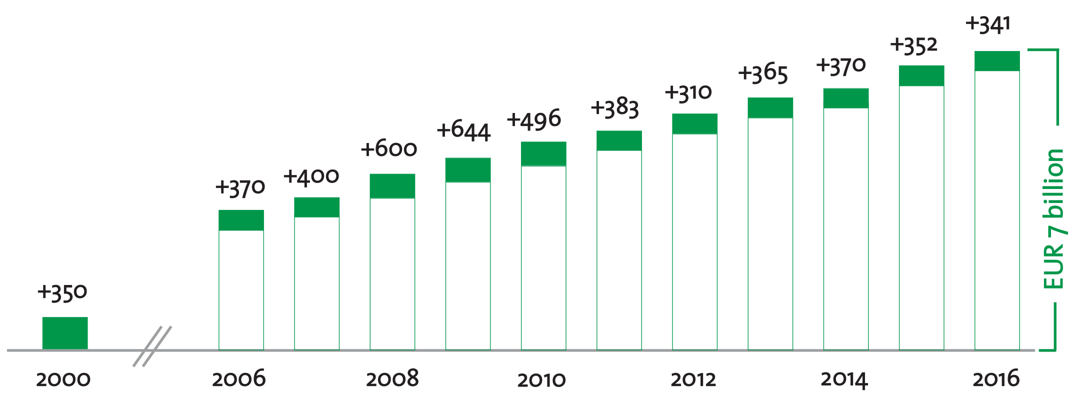
Since 2010 the chemical industry has been growing in Germany and Europe at a rate of 2.5 % per year. The German association for the chemical industry predicts only 1.5% growth per year until 2030 (VCI, 2016). Compared to Asia with a predicted annual growth rate of 4.5%, we can consider the German and European chemical industry to be at a mature stage (VCI, 2016). Given this macroeconomic environment, attracting new investments to existing industrial parks in Germany must be understood to be a very difficult task.

Marketing managers at industrial parks should be aware that overcoming general investment barriers for the chemical industry in Germany is hardly possible. To put it simply, most investments in industrial parks stem from existing customers, expanding, overhauling or replacing their existing production assets, as well as subsequent investments by the site operating company. Following a recent study from German Trade and Invest, on average there are 6 new large production facilities built in the chemical industry per year out of which only 1-3 are relevant for industrial parks (GTAI, 2014).

So site operators are correct in putting a major focus on this most important segment and in closely following and accommodating the development of their existing key accounts. Infraserv Höchst, for example strives to achieve close links between management, key account management, sales and operations and the various levels of the client organization to best anticipate and support all developments in order to facilitate growth. Marketing has an important but supporting role focused on activities advancing customer satisfaction, loyalty and promotion.

Beyond that, Infraserv and the business development agency of the region FrankfurtRheinMain carry out a value chain analysis together with customers at the site in order to further develop the production network at Höchst, to identify blind spots or gaps which can be filled by new additions

Figure 3 Investment in Industriepark Höchst since 2000: approx. €7 billion (source: own representation).



to the value chain. One example of this logic is shown by one company investing into a small plant to capture the surplus CO2 from the production process of another company at the site, as is the case with Westfalen AG and Celanese Corporation at Frankfurt-Höchst.

In order to develop an effective strategy for attracting new customers to existing industrial parks, industrial parks need to combine their knowledge about company's external developments (investment probability by industry segments; decision criteria for selecting industrial parks; knowledge about buying center structures on the site of the customer) with the knowledge about internal conditions (knowledge about available land; knowledge about goals for attracting new investments; knowledge about one's own company profit function). Infraserv Höchst developed a five step approach for attracting new customers to the Industriepark Höchst – this approach can be individually adapted for use in other industrial parks too:

Step 1: Define target segments

Firstly, Infraserv Höchst has identified 7 potential target segments with 36 sub-segments in total. Examples of these segments include pharmaceuticals (the production of active ingredients), specialty chemicals (e.g. construction chemicals, fragrances, food additives, pigments) and other process industries.

These potentially attractive market segments have been profiled according to their patterns of consumption of services offered by Infraserv Höchst. Eight profiles with a specific need structure in the fields of production, energy, waste management, logistics, safety, space (square meter) have been identified. These encompass, for example, volume oriented specialty chemistry with a continuous production system, a high energy demand and need for waste management, logistics, safety and space. Another example consists of research based drug producers using batch production, with a high demand for logistics service and medium need for energy, safety and space. Production profiles of smaller research based entities with lower production activities and logistics companies with large-space requirements but little need for energy or waste management services have also been profiled. All market segments have been matched to a specific production type.

Step 2: Determine profit potential/customer lifetime value

The market segment profiles have been evaluated on the basis of Infraserv Höchst's profit function. This profit function includes the dimensions "profit per square meter", "revenue per square meter" and "growth potential over the next five years". The different dimensions were weighted by board room members and applied to the 36 market segment profiles. Eight market segments were excluded from further analysis as they did not signify adequate profit potential.

Step 3: Estimate the probability of an investment in Europe

In order to further narrow down the list of potentially relevant market segments, the probability of an investment by a company – belonging to one of the prioritized production profiles – was analyzed in a multi-method, multi-source approach. While the basic work was done in 2010, the results are frequently updated to readjust the site marketing activities. This approach screens publicly available data sources such as ebsco.com, chemie.de, chemanager-online.de. In addition a semi-standardized questionnaire was used for expert interviews to evaluate the probability of investment in production facilities in Europe. As a result, new production activity and growth is predicted in innovative fields such as pharmaceuticals, specialty chemicals, biotechnology (medical and industrial uses) and green technology (with renewable energy). The following table summarizes Germany's competitive position and lists the strongest competitors.

As a result investments seemed likely to result from around 17 out of the initial 36 industry segments analyzed.

Step 4: Identify relative competitive strength

Finally, the competitive position of Industriepark Höchst was analyzed from a customer perspective (concept of competitive advantage, see von der Gathen/Simon, 2002). Therefore, in-depth interviews were conducted with existing customers (site managers) in order to better understand

a) the importance of different criteria when selecting a production site and
b) the perceived performance of the indus trial park compared with that of the next best alternative.

The results of the interviews were integrated into a matrix of competitive advantages. Each decision criterion was depicted according to its relative importance (as evaluated by all respondents in a specific market segment) and according to the industrial park's relative performance (as compared with the strongest competitor evaluated in a specific segment). Consequently, the industrial park's competitive advantages (above average importance of a criterion and better performance than competitors), competitive disadvantages (above average importance but performance lower than competitors), fields of overperformance (low importance of the criterion but performance beyond competitors) and the levels of consistency (low importance with low performance) were identified.

The analysis showed that the industrial park's competitive position varied significantly depending on the market segment studied.

For example, respondents in segment A – high quality, research intensive development and production of active ingredients for pharmaceuticals – highlighted relevant competitive advantages in the field of fast and reliable construction of new facilities, and access to high quality personnel and research collaborations in the neighborhood as relevant competitive advantages of the Industriepark Höchst compared with all other production sites analyzed. These characteristics supported the company's goal of ensuring a short time to market for patent protected new drugs produced at Industriepark Höchst. Competitive weaknesses such as, for example, the higher tax burden compared with low cost production sites abroad, were not seen as very significant. The direct proximity to end consumer market was not seen as an important characteristic, the park was seen to be "overperforming" in this area from the customer perspective.

Step 5: A focused marketing strategy

As a result of this four step approach, 12 market segments have been identified as most important for active site marketing activities. The list of these target segments is updated yearly. It goes without saying that new customer insights are then worked into the industrial park's value analysis and marketing and sales materials. In order to develop a precise value proposition, a matrix of competitive advantages is very helpful: Those aspects identified on a segment basis as competitive advantages (thus receiving high relative importance scores and representing a stronger performance compared with the strongest competitors) form the basis for the value proposition. These aspects are used in the individual sales pitch and can be adapted to specific customer requirements.

4 How to win: Finding the right marketing strategy

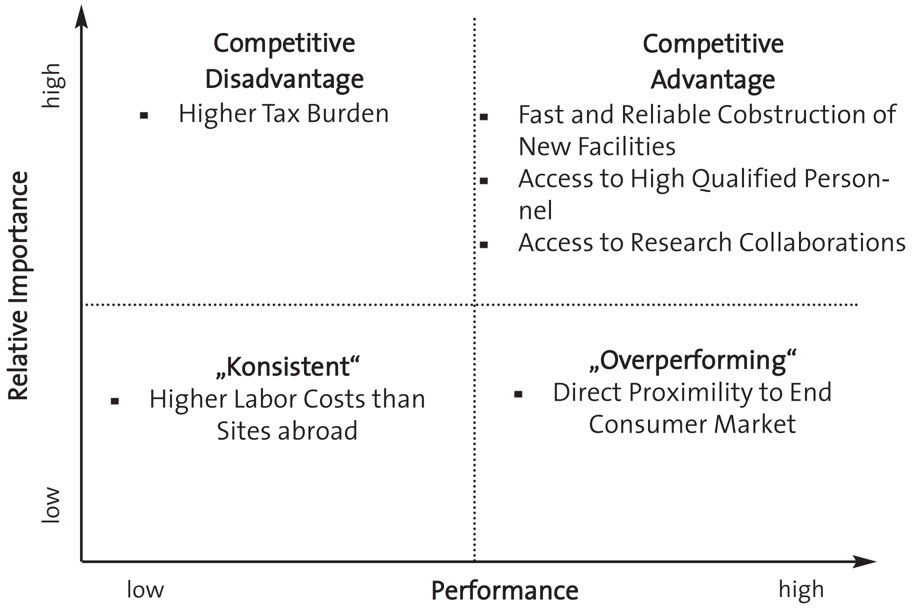
For the selected target segments, a detailed customer acquisition strategy was developed. For each segment, the market specifics were identified and answers to the following questions were found:

Figure 4 Competitive assessment of chemical industry regions (source: own representation).

	Pharma Biotech Renewable Energy	Agro	Specialty Chemicals	Polymeres	Basic Chemicals	Bulk Plastics	Petrochemicals
Competitiveness of Chemical Industry in Germany	High	High	High	Medium	Medium (only if production network exists)	Medium to low	Medium to low
Strong Competitors	USA	USA	USA, Asia	USA, Middle East, Asia	Middle East, Asia	Middle East, Asia	Middle East, Russia
Category	Strong Position			Head on position			Difficult position

→ **Germany's competitive strengths:**
Process-, R&D-, customer-knowledge and employee qualification

Figure 5 Matrix of competitive position (source: own representation).



1) Who are the main players in the relevant market arena?
2) What are the phases of the customer deci sion process?
3) How can the industrial park influence the different actors in the buying center?

In order to answer these questions, internal workshops were held with Infraserv Höchst sales managers, key account managers and relevant market partners. The decision process and the role of different actors were analyzed through semi-structured interviews. On this basis, a segment-specific marketing strategy was developed.

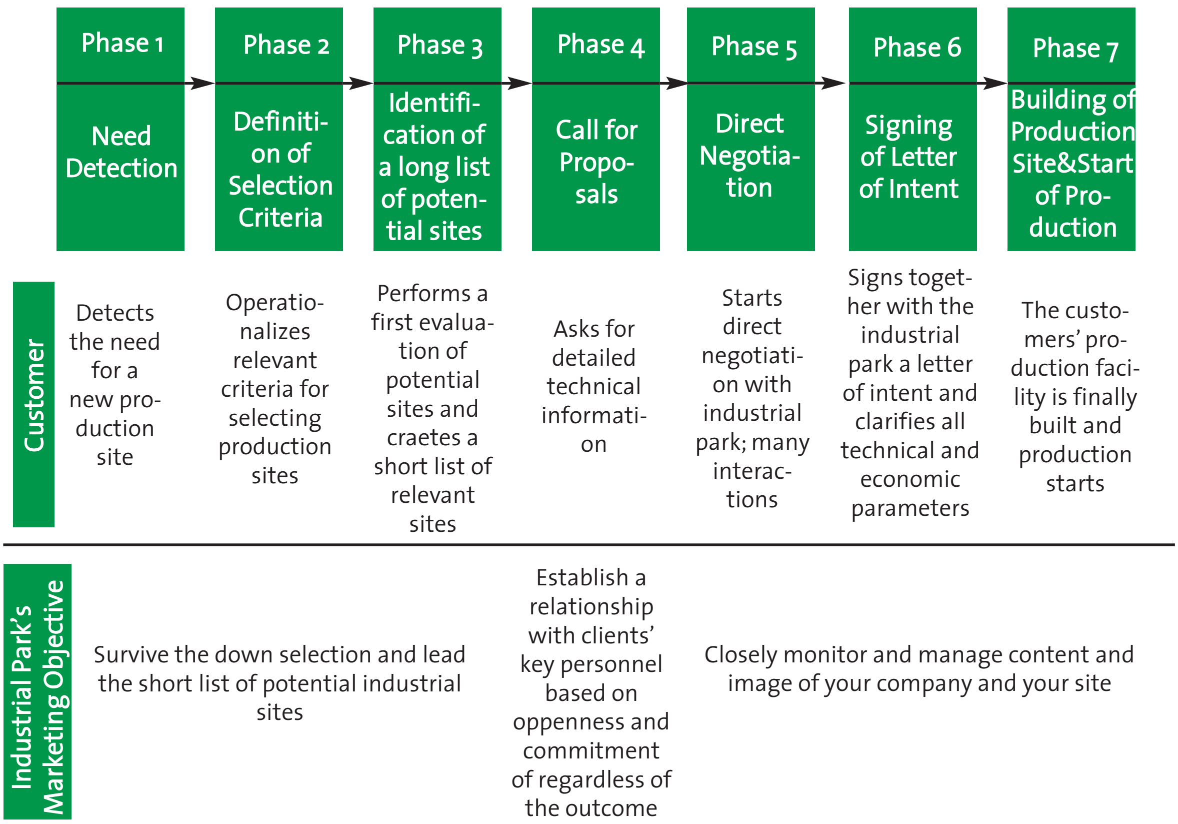
The decision making process of the potential customer was taken as a starting point, i.e. the chemical or pharmaceutical company looking for a new production site. Even though the chemical or pharmaceutical company may have experience in selecting production sites, this is typically an extensive and highly formalized decision process (Robinson/Faris/Wind, 1967).

The site selection process can be structured into seven phases. From the customer's point of view, the process starts with the perceived need for a new production site (phase 1). Then the relevant criteria for searching and evaluating potential sites are defined and operationalized by the customer (phase 2) before the customer actively invests time and money in searching and defining a long list of potential sites (phase 3). Phase 3 ends with an initial evaluation of the potential sites and the creation of a short list of up to 10 sites that will be evaluated in more depth. Most of these activities will be conducted undetected and with an air of great secrecy, involving only few people within the client organization below board level and maybe a handful of external partners. This is done with good reason, as adding capacity is a competitive maneuver in any market and may be subject to counter-measures by competitors. Also, listed companies may want to pay close attention to timing their announcements just right so that they can avoid the need to react to market rumors with adhoc notices.

So by now we have prioritized market segments and have a solid understanding of the general decision making process. But how can the industrial park be positioned best in the sphere of the buying center and its influencers without spending enormous amounts of money? First off, industrial parks have to realize that the target segments will share some similarities but will probably be quite different in the detail. Chemical companies, for example, organize the site selection process in various ways. Typically a formal team is installed for screening and selecting potential production sites. This team consists of experts in the field of production planning, controlling, research & development and purchasing and is often formally structured as a project within the company. This team defines the site selection criteria, searches for the relevant information (stages 1-3 in the above mentioned site selection process) and proposes a short list of potential locations for the new production site. While all relevant competencies are represented in this team, the final decision on the short list is made by the chemical company's board and the head of the production units. After this decision a core team with experts from the production and purchasing departments is put together to gather in-depth information, make on-site visits and start the negotiations with potential production sites. Again, the final decision is made by the board.

Sometimes, the process is steered by a company's "site selection and benchmarking department". Thus, while the board of the chemical company may be characterized as the key promoter of the site selection decision, the team also consists of expert promoters and they are coordinated by the site selection department as expert and process promoters (Webster/Wind, 1972; Backhaus/Voeth 2014). Important influencers in the process are plant manufacturers that, together with the chemical company, develop the new production facility and share their expertise with different industrial sites worldwide. Further important influencers include industry associations and business development agencies. Relevant information sources for chemical companies in the site selection process include international databases summarizing the technical characteristics of industrial parks (homepages e.g. VCI, ECSPP), industry associations conventions, industry publications and personal networks and experiences of the actors involved. The confidential nature of the site selection process on the customer side rules out any direct marketing and sales approaches geared at lead generation. Imagine an outbound marketing campaign centered upon calling up companies asking them for upcoming investment projects. Chances of not talking to the right person are high and even if you were, he or she would not want to let you know or even talk to you. Chances of not making a good impression this way are also very high. Regarding these first phases, the main marketing task is to make as much information as possible publicly available and position the industrial park in the relevant networks so as to be in the relevant position to enable the potential client to make an informed decision. Chapter 5 will provide more details on this.

Figure 6 Phases of site selection process (source: own representation)



Marketing objective: Survive the down selection and lead the short list of the potential industrial sites.

The other phases are no longer characterized by marketing activities but mostly driven by sales and top management. The customer makes the first move in phase 4 with the call for proposals. Here the customer lists his needs and describes his requirements in a technical manner. This is also usually the first time he or his consultants will speak with the industrial park directly. This will always be a lengthy and time consuming process that will go back and forth, but reaching a more detailed level each time. This process helps the client evaluate the different proposals and reduces the number of names on the list. This process should be used to build up trust and establish viable relationships with the potential customer. The goal of the industrial park in this phase is to be a good host, give open and honest answers to all potential client questions and ask the right questions in return. Ultimately, the potential client's needs are highly specific and often the potential client will not continue to the later stages because their project does not fit the site. Nevertheless, the industrial park wants to leave a good impression in case the potential client ever comes back or is asked about his experiences with the industrial park.

Marketing objective: Establish a relationship with clients' key personnel based on openness and commitment regardless of the outcome.

In phase 5, the customer starts negotiations directly with an even shorter list of industrial sites. In phase 6, a letter of intent is signed and all technical and economic parameters are clarified. In phase 7, the production facility is finally built and production eventually starts. These final stages are exclusively driven by top management, sales and finance. However, the number of employees involved directly or indirectly on the client side will grow during these stages. A good marketer will make sure that client information needs are met in a consistent manner and all information promotes the site in the best possible way. This is a complex process as it may range from between 18 months and five or more years for major projects. A consultative selling approach is used by Höchst industrial park during this process, with the aim of continuously adapting to the potentially changing specifications of customer demand (Moncrief, Marshall and Lassak, 2006).

Marketing objective: Monitor and manage closely content and image of your company and your site.

5 Where to put your money: defining an efficient communication mix

Even though the most important decision makers for site selection are the chemical company's board and the head of the production department, a broad variety of actors need to be influenced using marketing measures to increase an industrial park's success in acquiring new potential production activities for its site. Four directions for any marketing communications mix can be defined according to the marketing activity goals (push vs pull marketing) and the character of the communication activity (direct vs. indirect customer communication).

If the industrial park focuses on a direct communication line with the (potential) customer, the activities may be defined as:

A) customer push-marketing activities (e.g. newsletters; trade fairs; activities of sales representatives) which are designed to promote the industrial park's services directly to the customers' buying center or as
B) customer pull marketing activities that address a customer need, highlight the industrial park's benefits indirectly (e.g. by using case studies) and thereby create a pull for the industrial park's services.

Another important way to promote an industrial park's service is to work with intermediaries such as the agency Invest in Germany, chambers of commerce or business development agencies. Depending on the character of a specific activity, the activities may be characterized as:

c) push marketing activities which focus on influencing intermediaries directly with the goal of using the intermediary as an ambassador for the industrial park's services.
d) pull-marketing activities for intermediaries. Typical activities here focus on supporting the intermediary in creating demand for the industrial park's services. For this goal, industrial parks may support industry studies, create joint internet sites or become involved in joint activities.

Infraserv Höchst uses all four options in its communications mix. The "Site Excellence Newsletter" may be understood as a push-oriented medium aimed directly at potential clients. It is a regular push medium to engage with the site marketing network and (potential) clients about current park developments and best-in-class service examples.

In addition, a range of other push-oriented activities focusing on the indirect client are also used. Infraserv participates in and hosts regular networking events with site marketing partners, such as on-site business breakfasts or invitations to trade fairs and events. A pull-oriented approach is illustrated through the presentation of content on the website and via other relevant channels. Here all relevant information that is showcased is highlighted in such a way which supports screening processes and builds brand preference. Pull-oriented communication activities aimed at indirect clients are also used. Infraserv makes sure that all relevant multipliers have access to the relevant information conveyed via the various relevant network partner media channels based on standardized templates.

6 Summary and Outlook

This paper has presented the marketing insights of a site service operator. The established concepts in the field of business-to-business marketing, service marketing, personal selling as well as the underlying theories of information economics, principal agent theory and path dependency theory have all been helpful in developing the marketing strategy and implementing it effectively.

As the chemical and pharmaceutical industry faces more and more pressure from competitors outside Germany and Europe, site service companies have to position themselves in the best possible manner to be shortlisted by relevant customers. Growth opportunities exist not only externally through acquiring new customers, but also internally through offering extended or better services to already existing customers. The past has shown that it is very difficult to realize large site settlements by companies. Therefore, focusing on gaining "smaller" investments from existing customers might be the better option.

Marketing of industrial parks is a challenging endeavor, facing a high level of market and technical complexity. Insights from a variety marketing perspectives can be applied to support practical decisions in this context.

1. Marketing of industrial parks means that industrial services are to be sold. These services have a high impact on a client's profit position and are subject to extensive decision making process-

Figure 7 Effective marketing communication mix (source: own representation).

	Direct customer communication **Direct contact with the customer**	Indirect customer communication **Work with intermediaries e.g. Invest in Germany**
Push **Offer the product directly to the market**	Newsletters Trade fairs Sales representatives / personal selling Promotion (phone / e-mailing marketing) Example: Infraserv's Site Excellence Newsletter	Intermediaries (e.g. German trade and invest; chambers of commerce) Incentive programmes for marketing partners Example: Networking Events
Pull **Create demand for the product/service**	Focus on image /reputation Success stories / publications / presentation at industry conferences Advertising / sponsoring Example: Content on Websites and through other relevant channels	Collaborate in industry studies with economic development agencies / Invest in Germany / Consultants Be listed in rankings and site-selection data bases Example: VCI chemical parks association

es. Insights from service and business to business marketing have proven to be very helpful to better understand the marketing situation. The market size for industrial park is determined by the general market development for chemical and pharmaceutical companies in a specific segment. These general market developments on the customer side determine local investments in research&development and production facilities. Marketing of an industrial park thus cannot easily broaden the market for industrial site services. However, in this given and externally determined market having a precise picture of what market segments fit best to a specific site and have the highest probability to invest is the prerequisite for focusing site marketing activities. The Infraserv Höchst approach has proven valuable for identifying the most attractive target segments and can be adapted to further sites.

2. Understanding and managing the customers' buying center is crucial for professional site marketing: As selecting and building a new site is a highly complex, costly and risky decision, several departments are involved on the side of the customer. The industrial site operator, thus, has to collaborate with different departments with specific roles (technical experts, decision maker, influencers) and decision criteria. In the early phases of the decision making processes, the marketing department has to make sure that the industrial park is in the relevant set of decision makers in the chemical and pharmaceutical industry. When the direct interaction begins, the steering role lies with the site marketing departments and the general marketing department takes a supporting role of securing consistent messages to the potential client. The applied selling approach can be characterized as consultative selling where the industrial park adapts to the demand of the individual customer.

3. A variety of communication measures can be used for creating awareness and preference for a specific industrial park. With regard to the identification of the adequate marketing mix, industrial parks have to decide about the right mix of push- or pull marketing activities in order to achieve their communication goals. This depends largely on the targeted market segments. In this context, findings on social media marketing in the business to business context have proven to be helpful for developing a viable marketing mix. But estimating the return on marketing remains difficult.

The concept of the industrial parks is a multibillion business around the globe. Experiences of successful site marketing are shared across the different locations and help to further refine the positioning of the industrial parks. This fascinating task desires further attention from theory and practice.

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Practitioner's Section

Design thinking as driver for innovation in the chemical industry

Benedikt Waerder*, Sigrid Stinnes* and Oliver Erdenberger*

* Accenture GmbH, Campus Kronberg 1, 61476 Kronberg im Taunus, Germany, benedikt.waerder@accenture.com, sigrid.stinnes@accenture.com, oliver erdenberger@accenture.com

In a time of increasing market pressure, managers value innovations as a precious currency. While shifting the focus away from incremental innovations at the level of molecules, companies in the chemical industry should consider a more systematic approach to the development of ideas during the innovation processes. However, solely aligning all research activities with the upcoming megatrends for the industry is not sufficient. This article empirically demonstrates the strategic relevance of Design Thinking as a method to not only overcome typical barriers in the innovation process but also to guide stakeholders through all iterative stages required for innovation.

1 Necessity of innovation for chemical companies

The chemical industry has undergone large scale change since the 1990s. Up until then, the focus of innovation lay on the discovery of new molecules, and certain major improvements such as heterogenic catalysis, new purification methods and new forms of spectroscopy which drove the development of the chemical industry.

Nowadays improving the efficiency of existing production processes has become the main priority and there have been no major breakthroughs in new products since the 1950s (Whitesides, 2015; Schröter, 2007). As Lehr and Auch have pointed out, these incremental efficiency improvements will result in increased earnings in the short-term, but may not be sufficient for sustainable success (Lehr and Auch, 2017). Hariolf Kottmann, CEO of Clariant, holds the opinion that "a company that seeks to be sustainably successful must [...] change and develop permanently" (Kottmann, 2016), underlining the importance of innovation and transformation in the chemical industry.

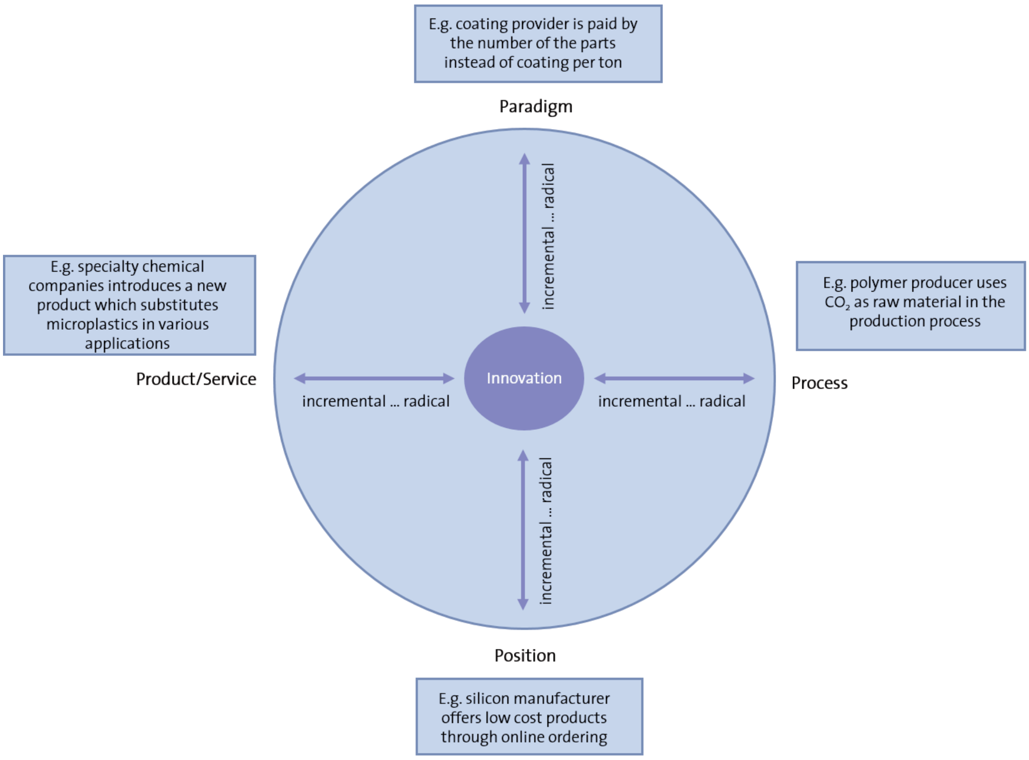
Taking the innovation management perspective into account, chemical companies have predominantly been good at incremental innovations in products and processes. However, innovations can be characterized in several ways. Besides thinking in the aforementioned categories, managers and decision-makers should also consider position and paradigm innovations as sources of competitive advantage. Figure 1 demonstrates the four categories of innovations, namely:

- *Product* innovation: changes in products/services that an organization offers
- *Process* innovation: changes to the ways in which products/services are created and delivered
- *Position* innovation: changes to the context in which the products/services are introduced
- *Paradigm* innovation: changes in the underlying mental models which frame what the organizations does

The other dimension depicted in Figure 1 indicates the degree of novelty for the respective categories, ranging from incremental ("do what we do but better") to radical ("new to the world"). As the representation illustrates, there is no strict demarcation for either dimension. (Tidd and Bessant, 2013).

Another influencing factor is the increasing concentration of chemical production in Asia. While in 2005 the EU held the biggest world market share at 28.2%, this value almost halved by 2015, reaching 14.7%. In 2016 the EU occupied third place behind China (39.9%) and the NAFTA region (16.5%). Local industry struggles to participate in the overall

Figure 1 Dimensions of innovation (adapted from Tidd et al. 2013).



growth of chemical sales. The €434 billion increase from 2014 to 2015 was mainly driven by China's high growth levels, the rest of the world accounted for only 25%. And this trend is expected to continue as the Cefic predicts China's market share will grow to 44% and the EU's will drop further to 12% by 2030 (Cefic, 2016).

At the same time the chemical industry is experiencing a decline in sale prices, mainly caused by falling oil and naphtha prices (Bock, 2016). The expected continuation of rising energy and labor costs accounts for additional pressure on the profit situation (BAVC 2013/2014, BAVC 2016).

Therefore, European chemical companies need to find innovative business models to position themselves and their products on the market and find new ways to sustain competitive advantages. Otherwise, they will be easy prey for investors and takeovers, as Gapper recently argued in the Financial Times (Gapper, 2017).

2 Drivers for innovation

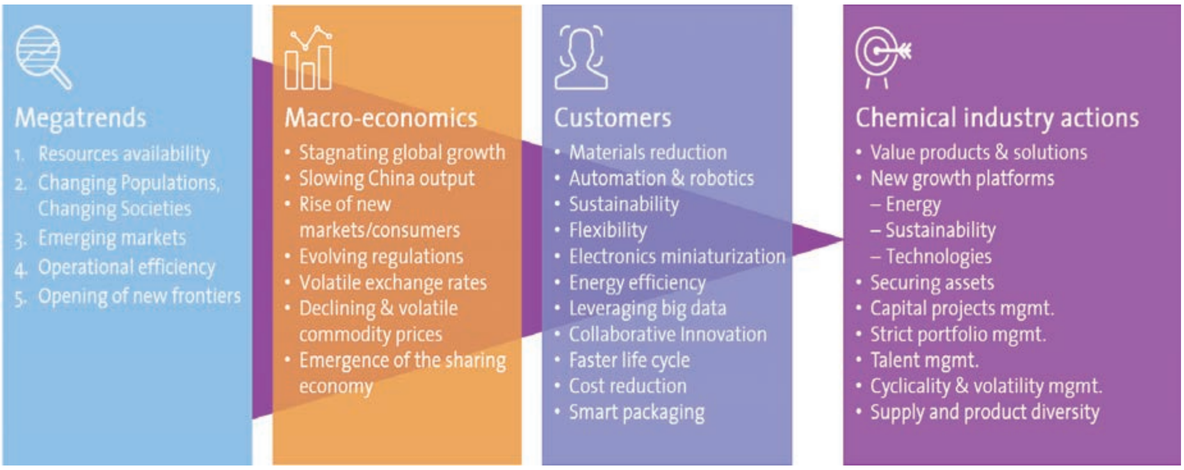
The best way to understand the changes in the chemical industry is to look at the underlying megatrends that form the framework for innovation activities. The Accenture Chemical Industry Vision 2016 identifies these megatrends as "Resource availability", "Changing populations, changing societies", "Emerging markets", "Operational efficiency" and "Opening of new frontiers" (Accenture Chemical Industry Vision, 2016).

Resource availability describes the current situation that some resources are available in abundance while others are becoming – or predicted to become – scarce. The finite amount of fossil fuel left as feedstock is one example for how this trend affects the chemical industry directly. Water- and carbon emissions management, as well as renewable energy sources are further ones. The result of these trends will be the emergence of circular processes where product design enables feedstock generation from waste.

Changing populations, changing societies summarizes trends like the aging of the population in Europe, urbanization and the changed expectations of generations that grew up with technology, a rapidly evolving world and environmental responsibility. The effects are shorter production lifecycles and the necessity for companies to provide an unmistakable product experience.

The increasing demand for chemicals in **emerging markets** like China, India or Mexico is both opportunity and threat. The former entails chances to participate in growth, while the latter involves increased competition from new players emerg-

Figure 2 Megatrends and their implications for the chemical industry (source: own representation).



ing together with those markets.

The convergence of software, hardware and communication technologies leads to increased and improved automation (e.g. through robots and 3D printing) and thereby to a higher level of **operational efficiency**. A side effect is that labor as a factor of production will decrease in meaning.

The **opening of new frontiers** involves, on one hand, the exploration of previously inaccessible commodity sources, such as the seabed or deep-earth mining. On the other hand, these techniques, together with the pushing of the boundaries in both private spaceflights and the aerospace industry, require new high performance materials and thus offer new opportunities for the chemical industry.

To remain relevant and competitive, the current and next generation of CEOs must manage these megatrends and drive innovation activities forward (Utikal and Leker, 2015). Key to such innovation is the digitalization of both the administrative and – more importantly – the production processes, Track & Trace, sensors, analytics and the internet of things (IoT) are just a few examples of the vast range of possible applications, with IoT being among the most important for it represents the connection between a digitally enabled enterprise and the physical world (Accenture Chemical Industry Vision, 2016).

The digitalization of production processes fosters greater efficiency and flexibility, as well as higher levels of automation; it also provides real-time insights into operations, leading to increased uptime and reliability of production plants. Another advantage is the data stock that can be used in practices like business analytics, predictive maintenance and demand sensing, which offer new opportunities to reduce the capital employed and improve capacity management. Additionally, the flexibility and automation advantages of digitalization make smaller production quantities cost effective, thereby facilitating new levels of product personalization.

The next step after the digitalization of processes is to create new business models making the most of the resulting possibilities. As Hariolf Kottmann, CEO of Clariant, said: "Digitalization will succeed in turning a customer's requirements into entirely new business opportunities reaching far beyond the actual products" (Kottmann, 2016). One resulting opportunity for chemical companies is to move from being a simple supplier to being a service provider that guarantees a certain outcome instead of selling a one-off physical product. These outcome-based business models require the performance of the service provided to be measurable, which in most cases can be achieved by digitalizing the affected processes. Close collaboration between supplier and customer is also necessary. Such collaboration in combination with high levels of personalization leads to customer bonding through relatively high switching barriers and can be the first step to building intra-supply-chain partnerships. Rachael Bartels, Global Chemicals & Natural Resources Lead at Accenture, thinks that "companies will need 'connected innovation', which breaks down internal silos to include more areas of the organization, and also forms external links with alliance partners, universities, customers and customers' customers". This collaboration can offer new opportunities, including the possibility to innovate the traditional R&D process to become more open, agile and disruptive (Accenture Chemical Industry Vision, 2016).

Technology and processes are not the only areas that require innovation. The workforce must be adapted to the changes as well. Digitalization requires skills in new fields like advanced analytics, artificial intelligence, machine learning, cyber security and robotics technology, as well as data engineering, computer science and data modelling. These can be provided by a new type of employee; the "data scientist" (Kersten et al., 2017). In general, workforces must become more flexible and build their own innovation ecosystems, including freelance engineers, researchers, students and strategic-partner employees. Especially when bearing in mind that a big wave of retirement is coming up, with loss of experience, knowledge and customer relations, companies would do well to practice employer branding to augment their attractiveness for new talents and be aware that they are in competition with companies from other areas of the digital economy (e.g. Google and Amazon) for these future employees.

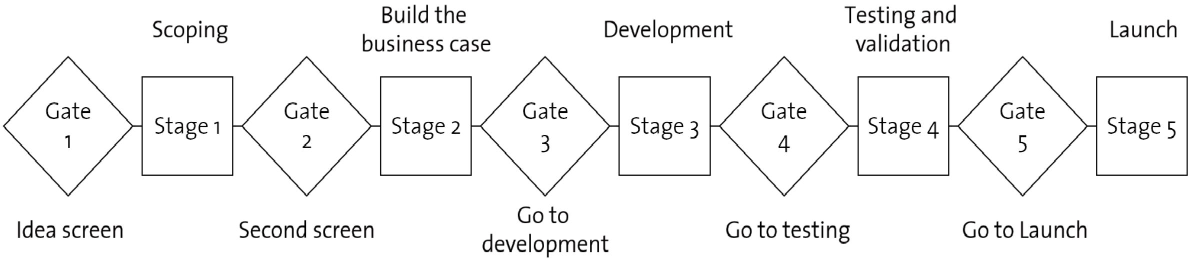
3 Typical barriers in the traditional innovation process

The stage gate model by Cooper will serve as an example to provide an overview of the traditional innovation process in the chemical industry. Here, the innovation process is divided into five stages: "Scoping", "Build the business case", "Development", "Testing and validation" and "Launch". After each stage, there is a so-called gate, representing the decision to continue or to stop the project (Cooper, 1986). Cooper found that many companies had deficient or nonexistent evaluation procedures for their projects. So, by implementing defined stage gates for "Go/Kill" decisions in the process, situations could be avoided whereby projects run like unstoppable "express trains" (Cooper, 1990). On the other hand, this formalized approach can lead to inflexible, lengthy and risk minimizing innovation processes.

In their development of new products companies often encounter barriers that hamper the processes. These barriers can be divided into two categories: Internal and external ones. For the chemical industry, the most influential of the external barriers is the increasing restrictiveness of regulations, especially since the introduction of the REACH in Europe in 2007. The costly and timely authorization processes for new products can act as a deterrent from developing new products and provide an additional risk factor on the way to the market. In Europe, as elsewhere, weak venture capital markets are responsible for further difficulties affecting companies that do not have the necessary capital for bigger innovation projects. This restricts them to smaller incremental innovations. Another factor is regulation and the public acceptance of new products. In a society that is increasingly concerned about safety, health and environmental responsibility, companies must develop sustainable products if they are to remain meaningful.

The internal barriers should not to be neglected either. There is, for example, the cannibalization effect, referring to a situation where a new product consumes the sales and demand of an existing or related product, potentially leading to a push back to support the existing business. This can be illustrated at the example of Kodak. Kodak once was the leader of its industry. Nowadays, Kodak serves as an example, where the management has failed to react adequately to external triggers (e.g. changing technology and customer expectations). Business schools study companies like Kodak and dissect their strategies to see why they were not successful to adjust in time. Analogous to Kodak, the chemical industry is now confronted with fundamental change. Another example is described by the filtering effect that the existing business model can have on the flow of information in R&D and innovation teams. Prahalad and Bettis (1995) call this effect the "dominant logic", which results in situations where new opportunities not fitting the current business model are more likely to be dismissed or even not thought about in the first

Figure 3 Cooper's stage gate model (source: Cooper 1990).



place (Chesbrough, 2010). While this can be solved quite easily by building innovation teams consisting of both long-term members of the company and new hires (Govindarajan and Trimble, 2010), another barrier cannot: The limited resources of the company – both of the human and the financial kind – have to be split between the ongoing business and the innovation projects. Accenture's Chief Strategy Officer, Omar Abbosh, has just recently released a blog article on this topic (Abbosh, 2017).

Companies are driven by their shareholders to maximize short-term earnings. This effect has increased since the 1990s and forces companies to focus on incremental rather than disruptive innovation, as has been stated by Christensen (Christensen, 2011). Where this is the case, company leadership has to be more courageous in order to prevail in a climate of mergers if they are to remain independent and develop their business.

Normally, the new business model is far less profitable than the established one, so the reallocation of resources clearly contradicts the goal of making (short-term) profit (Chesbrough, 2010). This often leads to rivalry between the employees in R&D and operations and, when paired with an inadequate interdivision information flow, can even cause animosity (Govindarajan and Trimble, 2010).

Traditionally there is a "no failure culture" established in many firms with the effect that risky, disruptive innovations with the potential to achieve breakthrough are not pursued, and only incremental improvements are made. Kersten et al. (2017) propose a "fast failing culture" to overcome the barriers, meaning that innovation projects are allowed to fail at an early stage which may prevent them from being pushed to launch once it becomes clear that they won't bring the expected outcome. This would enable the opportunity to learn from the failing projects and additionally foster the eagerness to experiment and take risks (Kersten et al., 2017). Additionally, companies will have to break down silos and build a more diverse workforce with respect to ethnicity, gender, age and profession. New ideas require open minds, freedom for cooperation and risk taking. Companies need scouts to observe, discover and understand new business model trends (Utikal and Woth, 2017).

Innovation takes place at the intersection of departments and is facilitated by an innovation eco-system. As Accenture's CEO, Pierre Nanterme, said at the last Accenture SAP Leadership Council in June 2017, "The challenges businesses face today are so complex, no single company can navigate them without partners who share a common vision. The innovation ecosystem is a powerful part of the new reality we operate in [...] and key to a successful ecosystem is collaboration between technology providers and business and, of course, clients. In other words, disruptors who are not afraid to disrupt each other to drive innovation and growth."

Besides new products, business models can and should also be innovated in order to sustain customer centricity. As Gassmann postulated in 2013, "In future, competition will take place between business models, and not just between products and technologies" (Gassmann, 2013). Therefore, new methods to ideate products and solution design are necessary. One method that is more and more widely used in different industries is the approach of "Design Thinking", which needs to be embedded in a broader structure.

4 Design Thinking as a method

Design Thinking is not a new approach per se, but put into context, it is a form of product design that has been established over many years. What is new is the specific field in which Design Thinking is applied, which goes beyond the application of product design. The roots for "Design Thinking" were established in the year 2005, with Hasso Plattner`s establishment of Design Thinking at SAP and his engagement for raising awareness about Design Thinking, for instance through founding the D-School at Stanford and the Hasso-Plattner-Institut in Potsdam. Ever since, Design Thinking has been increasingly put into practice in the IT-service industry (e.g. Software, Hardware, IT-Consulting).

The Hasso-Plattner institute refers to Design Thinking as a systematic approach to complex problems from all aspects of life. In contrast to conventional approaches, starting with technical solvability, Design Thinking puts customers' needs as well as user-centered inventions at the heart of the process. Furthermore, Design Thinking requires a steady back coupling between the innovator and the customer (see www.hpi.de).

At the same time, also since 2005, we are observing how traditional industry borders are unwinding: companies like Google, Amazon, Facebook and Apple have stepped into several "Markets" with their new products and services, and have proven extremely successful with their user-centric functions and user-friendly application design, taking away a considerable amount of market share from well established companies within traditional industry segments. These new products differ from existing ones in the market for the following reasons: they meet the needs of the individual, solve day to day challenges, make the life of the individual easier, and, because the individual`s needs are at the core of such products and services, they are, in a nutshell, truly customer-centric. The „Total Perceived Pain of Adoption" (TPPA) for those products is extremely small (see Pit Coburn, The Change Function: Why Some Technologies Take Off and Others Crash and Burn). Often, customers are willing to pay an additional amount for these kinds of products and services as they realize the value of their benefit.

This is the crux of Design Thinking, from its underlying mindset and culture, to the design and selection of tools and exercises, all the way to the implementation of a project: the unconditional focus on the user group of these products or services, where the user's needs are researched and understood from the very beginning in the best possible way. The idea-generation to follow is built upon the implicit needs of the future user. The technology to be applied for the solution is secondary, and so is the business model. Nevertheless, both aspects are of essential meaning and the innovation (per Schumpeter = invention plus market success) emerges as all three aspects overlap: focus on the end user & application of a suitable new technology & marketing of a functioning business model.

Accenture's Design Thinking process follows different phases, from "Discover" through to "Implement", while embedding feedback loops and early prototypes (see figure 4). The crucial aspect of difference compared to other processes (e.g. Stage-Gate) is the flexibility – and encouraged – procedure of going back and forth in the phases, depending on the feedback from prototypes and user testing.

All of this happens in a unique work culture, which is unfamiliar in Germany, as well as in many other countries. This culture is defined through:

a) the combination of experts or expert knowledge from diverse areas –a vital basis for disruptive innovation, amongst other things – instead of the silo mentality familiar to all traditional industry segments;

b) "early" prototypes, built based on a minimal heuristic basis, with new products tested right away as well as improved iteratively – instead of a "waterfall approach", where a product is created only at the end of a project and may not necessarily work as desired by the user, yet often needs to be implemented, as the project budget has often been used up;

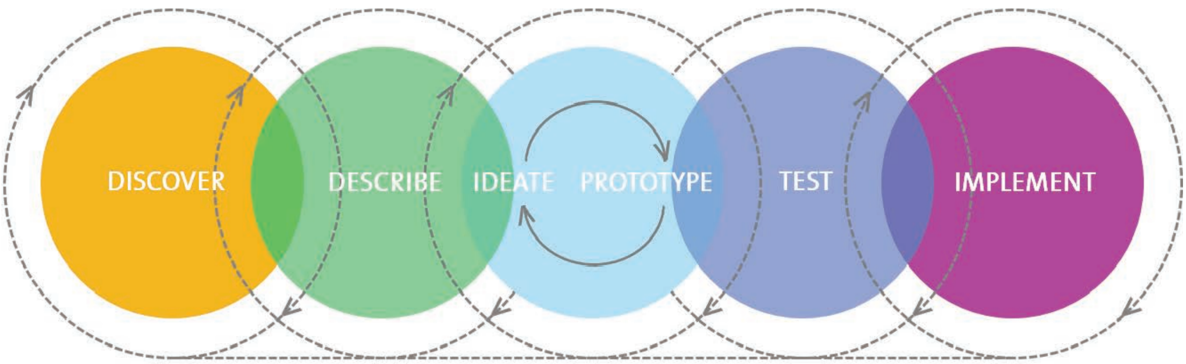
c) an iterative,agile and fully aware project management team, with the application of one of the established DT-Phase-Models – instead of a gradual "waterfall" based project management team;

d) the "permission" to fail, often and early, or better yet: the opportunity for quick success, by working with an "early" prototype, which is purposely not perfect, but rather built to be continuously improved in an iterative process all the way to its market maturity, with all learning from early prototypes fed back into the process through closed feedback loops – instead of a mentality which is solely success-driven.

The success of this work culture, identifiable in several Apps, MP3-Players, etc. speaks for itself. Moreover, the DMI Design Value Index shows that companies that apply Design Thinking achieve "Outperformance", as this approach facilitates out-of-the box thinking and collaboration, thus easing the way towards more radical innovations (see figure 5), while a stage gate process usually enables a more incremental progress.

However, Design Thinking is "not only" about product -and service innovation. It is a matter of increasing the problem-solving competence for the user, or for the companies using it for all kinds of product and service innovation. Design Thinking is

Figure 4 Accenture's Design Thinking Process (adapted from own representation).



also increasingly used in revising internal company processes, especially in areas such as Finance & Accounting, Supply Chain, Personnel Administration, and Client Management, thereby complementing what traditional methods, such as Lean Six Sigma, have to offer.

It should be emphasized, that the application of Design Thinking is a fundamental building block for Lean "User Experience" (UX): for some time now, many products have no longer been defined through their hardware and product composition, but rather through the integrated software, the User Interface (UI) and, moreover, the overall UX, which is developed for the user of a device or service. For more information on this topic, see Accenture's Technology Vision 2017 (Accenture, 2017).

Overall, the "Chemical" industry is relatively steady and has not yet been challenged by disruptive innovators, unlike, for instance, the telecommunications and media industry, automotive industry, energy industry etc. Nevertheless, pressure on this industry is increasing. With regards to the different fields of innovation in the chemical industry, Design Thinking seems to be especially valuable if innovation is encouraged not only at the product-, but also at the system level. To create encompassing solutions for customers in the relevant arenas of the chemical industry such as farming, treatment of illnesses or mobility, the boundary spanning approach of Design Thinking seems especially valuable: experts from different departments and companies could work together using the Design Thinking method for creating valuable solutions for relevant customers.

The business divisions of many chemical companies demand support from their IT departments in the forward-looking modernization of their infrastructure and in the utilization of the new technologies which are needed to create innovation and to establish those innovations in the market. Digital technologies are heavily discussed amongst the chemical industry players, both for the support of business segments, as well as the modernization of the support of business processes like Finance, CRM, SCM and HR. Therefore, current technology trends and traditional competition, rather than "New Entrants", are above all the driving forces that trigger the application of Design Thinking in the chemical industry.

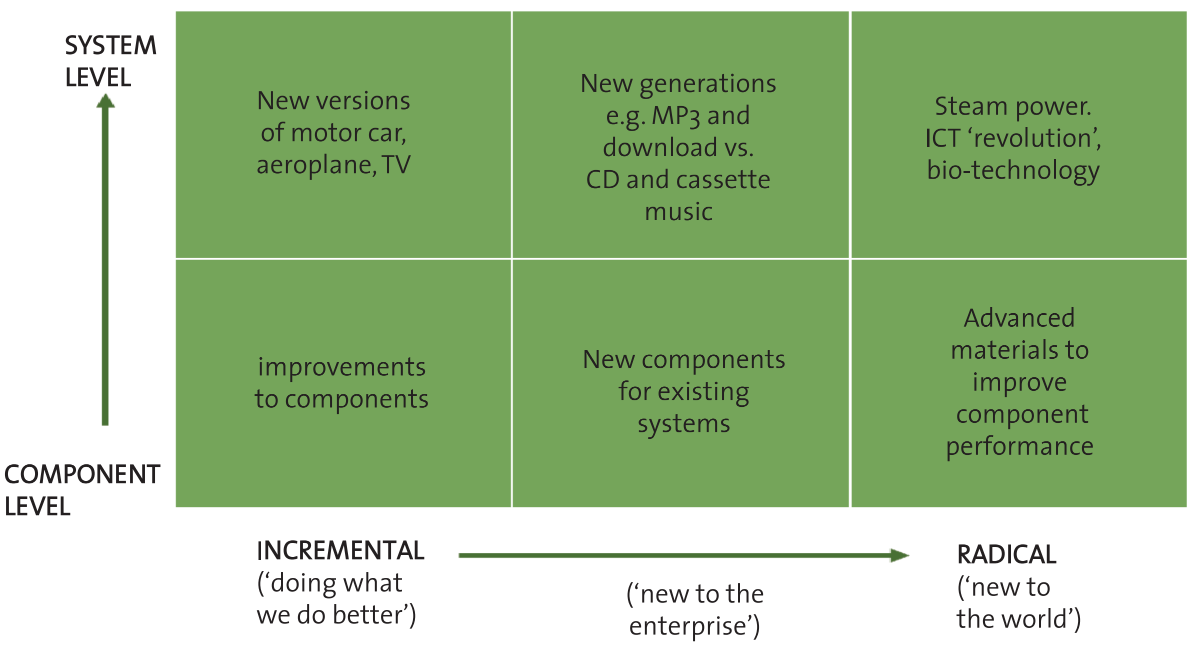
5 Use Cases of Design Thinking in the Chemical Industry

Three current project examples may illustrate the application of Design Thinking in the chemical industry:

1) Design Thinking for Process Innovation - A leading, global vendor of specialty chemicals:

At their annual meeting in Germany, Accenture was asked to execute a creativity workshop about UX for the existing SAP architecture of a vendor of

Figure 5 Examples of level and impact of innovations.



specialty chemicals.

In a series of workshops a team of Accenture consultants worked together with global IT experts from the client company. In different iterations, the As-Is-Situation was developed in interdisciplinary groups and a vision for the further development of the system was created.

Outcome: The client praised the collaborative approach and the professional performance. He concluded that highly innovative solutions had been created in an agile way. The collaboration with members from different departments prepared the way for a smooth implementation.

2) Design Thinking for Process Standardization - One of the TOP 10 chemical companies, which is, amongst others, a leader in the chemical agriculture sector (e.g. fertilizer, herbicides):

The global regulation of herbicides demands a gapless tracking of the distributed chemicals across all supply chain levels. This encompasses the delivery of the products to clients and the storage of the product at the client site as well. Even though the parent company provides a Supply Chain Track & Tracing System, the different basic components are not satisfactorily integrated for the end user in the production part of the process. Furthermore, the NatCos of the parent company partly developed non-standard solutions in a local language. As a result, a gapless tracking of the products was impossible. This situation was analyzed in a Design Thinking project. Various subject matter experts were brought together to analyze the status quo and to develop viable solutions. Design ideas for the UI were developed, that consisted of appropriate functionalities for the end user. The end users in different context situations were always integrated into the development of the solution.

Outcome: The Design Thinking approach led to impressive results. Soon after starting, the paper prototype was transformed into a wireframe/mockup and could be tested with the end user. A new basic architecture was developed as byproduct, which now is also being discussed within the company. The Design Thinking method came up with creative but pragmatic solutions.

3) Design Thinking for Business Model Innovation - A mid-sized provider of specialty chemicals:

The IT department of a mid-sized provider of specialty chemicals identified a profit and growth potential for their company due to the "Artificial Intelligence" trend. They wanted to explore and evaluate the opportunity and wanted to identify and implement some initial projects to test the assumptions. In collaboration with Accenture`s subject matter experts and the German Research Center for Artificial Intelligenc (German: Deutsches Forschungszentrum für Künstliche Intelligenz, DFKI), an ideation workshop with Design Thinking tools was conducted. The initial possible applications were identified and assessed from multiple perspectives. Based on the workshop result, a roadmap for future pilot projects was developed. These pilots can now be iterated quickly and learning can be integrated in the ongoing pilot design.

The overall feedback that was provided by these and other clients was that Design Thinking enabled the diverse teams from different parts of the respective organizations to quickly align and get into a productive working mode. This created a productive and collaborative environment and enabled impressive ideas and prototypes to come to life.

6 Outlook

As a leading industry consultant, Accenture is often approached by chemical companies who want to re-evaluate their business models, product portfolio or go-to-market strategy. These chemical companies consider new approaches to customers, business models, innovation, operations and the workforce. They will need to take advantage of evolving new methods, like Design Thinking, to achieve and sustain high levels of business performance.
Two current trends may be used to illustrate the benefits of Design Thinking:

The area of Circular Economy holds a lot of potential, e.g. with renewable sourced materials, a mass balance approach or the growing trend of "Eco Design", meaning product design in a way that already considers easy and complete recycling processes at the end of the product lifecycle. Accenture has recently published an extensive study on the topic of Circular Economy with the CEFIC (CEFIC 2017). Design Thinking approaches may help to bring the different players in the value chain together in order to analyze the business potential of the "circular economy approach". By working together in diverse teams with a very strong customer focus and in an iterative manner, viable business models may be identified that will succeed in the market. The boundary-spanning and focused approach of Design Thinking will help to bring the "grand ideas" down to "viable profits".
The area of Outcome-based product design means that a product is not sold based on volume any more – as has been the predominant mode of transaction until now – but based on measurable performance. This can for example entail, that a coating is not paid by the ton but by the number of readily coated parts. This means a paradigm shift in the suppliers' logic from the goal to sell as much

coating as possible towards a most effective use of chemicals to achieve the best results and a predefined quality level with as little use of chemicals as possible (CheManager 2017b)

In order to capitalize on the current trends, Accenture considers technology as a key enabler. The targeted application of digitalization capabilities is seen as a necessary condition to reap the benefits thereof. This is in accordance with the evolving customer needs. As Accenture has learned from Andreas Zöller, Strategic Marketing and Business Development Leader EMEA at DuPont, the next level of innovation in plastic products might be the creation of smart products with service innovation bundled to the polymer. Here, untapped potential could be leveraged to reduce costs, increase revenue as well as to minimize risk of new product introduction while decreasing the development time.

For this approach, raw material suppliers need to collect real-world data about the behavior of the product in end-user applications, complement those with existing data models raw material supplier typical generate and introduction of the entire dataset into the model that is being used in product design. Machine learning could enrich existing data models with the new incoming performance data and related met data from the use application. With the application of Big Data Analytics, designers and raw material suppliers will be able to create new and improved designs and getting new insights of the raw material in end-use application which would lead into modification of the polymer DNA to enable optimal product properties combined with perfect part design. The goal in this endeavor would ultimately be to create smart materials that could be steered to adapt to a changing environment. So, predictive engineering for instance of polymers, that harden under impact, but just in the regions where it is necessary, would lead to new step change in materials science, design thinking due to functional integration and enable major development breakthrough and reduced development time for part producer. (Dupont, 2016)

This could ultimately lead to a new business model and market buster for raw material suppliers to offer their polymers bundled with different levels of insight into product specifications. The customer can then choose whether to acquire basic product knowledge together with the polymer or license different levels of sophistication of data models through the applied software vendors to pay exactly for the level of data – in terms of quantity and quality – that he needs. (For this, also see "Marketbusters" by Rita McGrath and Ian MacMillan.)

In summary, Design Thinking might help to identify the customer needs and to indicate – in close collaboration with the customer - how a valuable solution may look like. The close collaboration with the customer, the frequent testing of assumptions and the strong collaboration of experts from different company divisions may open up the chemical company's view on how they might deliver the best value – to their industrial clients, but as well to the end consumer and society as a whole.

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Researcher's Section

Implementation of Open Innovation in Chemical B2B Companies

Sebastian Eidam*, Klaus Kurz** and Eva Brockhaus***

* Grosse-Hornke Private Consult, Am Dornbusch 54, 48163 Münster, sebastian.eidam@grosse-hornke.de

** Technology & Innovation Engineered Materials, Celanese, Brüningstarße 50, 65926 Frankfurt am Main, klaus.kurz@celanese.com

*** Projektträger Jülich, Neue Materialien und Chemie (NMT), Forschungszentrum Jülich GmbH, 52425 Jülich, e.brockhaus@fz-juelich.de

In a survey-based study including 42 companies of the chemical B2B industry, the usage and dissemination of Open Innovation (OI) initiatives are investigated. The article focuses on strategies and the motivation to implement OI tools. By summarizing the empirical evidence of OI, the success of projects and perceived satisfaction with the chosen approach is assessed using qualitative comparative analysis (QCA). The results show a very diverse picture of OI approaches in the chemical B2B industry, as only 52% of the participants' state to use OI at all. However, the potential to use OI for exploration and exploitation purposes is revealed, which is especially of interest for a productive and successful implementation. In addition, the need of top management support to successful implement an OI approach is shown.

1 Introduction

Open Innovation (OI) is a major trend in innovation management and is meanwhile widely accepted as a viable approach to cope with current innovation challenges (Chesbrough and Crowther, 2006). Exemplary, increased innovation cycle speed, rising customer expectations or sustainability demands require more flexibility and efficiency in innovation management. Although the willingness to use OI approaches is high, the remaining question is why many companies still rely on the traditional closed innovation approach (Huizingh, 2011). In practice, the difficulties of implementing OI approaches are often explained by the existing boundaries of firms and the failure of management to adequately adjust the organizational setting (Munsch, 2009).

Especially process industries, such as the chemical industry, are confronted with many challenges as their traditional business-to-business models (B2B) are characterized by a high level of secrecy and patenting activity. Consequently, the resulting scale and scope of OI approaches might be different here compared to generally more open industries, like fast developing high tech industries or service providers (Chesbrough and Crowther, 2006). Therefore, to tackle the phenomenon of OI and its still existing shortcomings, it is necessary to look beyond general trends identified across different industries by focusing on the dissemination of OI approaches in traditional B2B-industries, in particular the chemical B2B-industry.

Initially, a literature review on OI is presented in chapter 2. Introducing the general OI concept, the significance of the modern innovation management for the chemical industry with a special focus on the B2B sector is outlined. Chapter 3 presents the focused research objectives. Chapter 4 summarizes the research methodology, which includes the concept of the attached survey and illustrates the empirical analysis on the application and acceptance of OI tools in the chemical industry. Finally, chapter 5 discusses the results, presents the conclusions, reflects on the limitations and offers an outlook on future research.

Table 1 Open and Closed Innovation principles (source: Chesbrough, 2003).

Closed Innovation Principles	Open Innovation Principles
The smart people in our field work for us	Not all the smart people work for us, we need to work with smart people inside and outside tour company
To profit from R&D, we must discover it, develop it and ship it ourselves	External R&D can create significant value; internal R&D is needed to claim some portion of that value
If we discover it ourselves, we will get it to market first	We don't have to originate the research to profit from it
The company that gets an innovation to market first will win	Building a better business model is better than getting to market first
If we create the most and best ideas in the industry, we will win	If we make the best use of internal and external ideas, we will win
We should control our intellectual property (IP), so that our competitors don't profit from our ideas	We should profit from others' ude of our IP, and we should buy others' IP wwhenever it advances our own business model

2 Theoretical Background

2.1 Forms of Open Innovation

The general idea of OI is that organizations are more successful while innovating if they cooperate with external partners to explore, exploit and utilize new ideas to keep up with the market development (Chesbrough, 2003). In this article the definition of West and Gallagher (2006) is used to define Open Innovation. They specified OI as "systematically encouraging and exploring a wide range of internal and external sources for innovation opportunities, consciously integrating that exploration with firm capabilities and resources, and broadly exploiting those opportunities through multiple channels". The degree of openness remains indeterminate.In table 1 the characteristics of the paradigm change from closed to open innovation are summarized.

To change a firms' orientation towards an open approach, external stakeholders play a crucial role by leveraging a firm's investment in internal R&D through the combination of knowledge and capabilities (Fleming, 2002). Consequently, searching for new ideas widely and deeply across a variety of external search channels, e.g. other companies or universities can provide ideas and resources that help firms to explore and exploit opportunities, especially for more radical innovations. Broad and deep OI search, however, comes with a cost. It can be time consuming, expensive, and laborious (Laursen and Salter, 2006). At the same time, further downsides of openness can be resources being available for others to exploit, intellectual property being difficult to protect and resulting benefits from innovations difficult to assign (Dahlander and Gann, 2010).

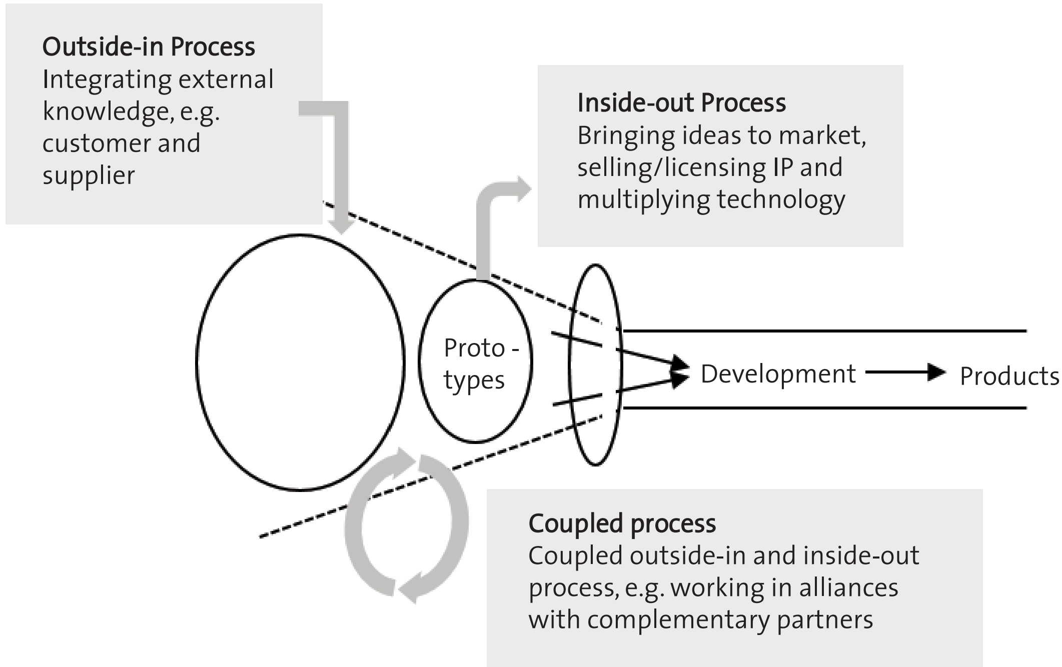
The scope of implementation can be described by the process itself, comprising the flow of information from the outside and inside of a company (see figue 1, Gassmann and Enkel, 2004). West and Bogers (2014) point out, that even over a decade after Chesbroughs original study, "[...] researchers know very little about why or how often these two activities coexist in one firm, let alone how they are linked within the firm."

In addition, the successful implementation requires certain tools to operationalize the OI process within companies (Bianchi et al., 2011).

2.2 Open Innovation in Chemical B2B Industry

To use the advantages and overcome the barriers, many different implementation tools for OI approaches have been developed, to integrate the

Figure 1 Open Innovation processes, (source: Gassmann and Enkel 2004).



new concept into the organizational structure (e.g. (ICE, 2008)). A recent study showed, that open innovation is most widely adopted in high-tech manufacturing sectors and wholesale, trade and retail (Chesbrough and Brunswicker, 2013).

Many companies in the chemical industry work in the business-to-business (B2B) sector, since the majority of products are intermediates (Albach et al., 1996). Also, the industry is characterized by the heterogeneity of products and the high R&D intensity. The top players in the chemical sector are operating globally, even though they only reached 18% of the total market sales in 2006, which shows that the consolidation level is very low compared e.g. with the automobile or pharmaceutical industry (Hofmann and Budde, 2006). Albach et al.'s (1996) study indicates that before 1993 most innovations in the chemical industry came from inside the company due to a Closed Innovation strategy. In recent years more and more companies therefore see an OI strategy as an opportunity.

Open innovation can be equally exploited by large companies, small- or mid-sized companies and therefore offering chances to all chemical B2B companies. Brunswicker and Vanhaverbeke (2015) showed in their recent study focussing on SMEs, that "[...]engaging in external knowledge sourcing is a sensible move for SMEs as it offers performance benefits and can improve innovation performance in two dimensions, namely the success of launching an innovation and the appropriation of financial value from new products and services". However, besides single-case studies and multi-industry large number studies also covering chemical companies on a general basis, there is a lack of evidence on the degree of openness in the chemical industry. Likewise, the uncertainty about the strategy of chemical companies – whether the development is towards a more open approach in general or if just a few large enterprises are applying this approach – needs further research.

Another field for further in-depth research is the development of tools and analysis of its usage. In literature the tools are mainly researched by applying case studies close to the end consumer and therefore in less business-to-business orientated settings (Sørensen et al., 2010). Beside those there exists also studies which focus on individual tools, such as e.g. crowd sourcing (Zhu et al., 2016) or special forms of collaboration, such as e.g. university-industry collaboration (Niedergassel and Leker, 2009).

3 Research objectives

To derive a better picture on the value and status of usage of open innovation approaches in chemical B2B industry, a specific assessment of current practices is key. As Tucci et al. (2016) point out, especially the tools used for implementation (e.g.

for usage of crowdsourcing) and the scope of OI (i.e. exploration vs. exploitation) are major areas of interest for decision makers in industry and scholars alike (Tucci et al. 2016).

Therefore, it shall be investigated to what degree open innovation is used and what forms of open innovation tools serve best to be implemented in the special setting of process industry companies, such as chemical B2B firms.

Consequently, the following research questions are investigated in this explorative study:

1) What are the reasons for the use or not-use of OI approaches in chemical B2B industry?

2) What is the scale and scope of the OI approach used in the chemical B2B industry?

3) Can patterns in strategic implementation be detected that explain the satisfaction with and success of the use of OI approaches?

4 Research design and results

4.1 Research design and data sources

A list of common tools for implementation of OI in management practice, such as institutional research activities, OI competitions, workshops, strategic alliances, publicly funded projects, technology scouts, patent research, ethnography, customer visit teams and lead users are identified from meta-analysis and expert interviews with 4 executive innovation managers in the chemical B2B industry (see Appendix, table 7).

Based on the initial results from the expert interviews and the additional consideration, a structured online survey is developed to answer the research questions (see section 3).

First addressing research question 1 – the reasons for and against the implementation of OI methods as well as prejudices in business practice, are assessed through a combination of pre-defined answers and open choice items. The second section addresses research question 2 and asks for the scale and scope of OI approaches and tools used. Therefore, the dissemination (open or closed innovation approach), the motives (offensive or defensive), the underlying process as scope (inside-out, outside-in or coupled process), and the scale of usage (number of OI projects in past 5 years) are investigated. The third part of the questionnaire asks for the outcomes of the use of OI tools in business practice and the degree to which expectations have been fulfilled. Therefore, directed questions and scale items using perceived satisfaction were utilized. This knowledge can be used to provide an answer to research question 3 – the strategic fit of specific tools to reasons for OI use.

In addition, firm parameters (e.g. size, relative R&D budget), position of the participant in the company, top management support in implementing OI and experience of the survey participant in the firm are taken as moderating variables and allow controlling for possible biases within the survey.

The structured online survey was send via e-mail to innovation managers (4 answers), R&D managers (22 answers), chief executive officers (3 answers) and others (e.g. technical sales managers; technical marketing) (13 answers) in the chemical B2B industry in Western European countries. Out of 147 companies contacted per telephone 42 (29%) completed the online-questionnaire, using telephone calls as reminder.

The potential problems inherent in an online-survey make the analysis of position of the respondents and non-respondents a crucial exercise. A *t*-test comparing early respondents (first one-third) against late respondents (last one-third) is performed in order to check for non-response bias (Armstrong, and Overton, 1977). A special focus is set on the usage of an OI approach, since the possible bias is seen strongest in this aspect, since the survey was proclaimed as a survey on OI usage in the chemical B2B industry.

For further investigation of the strategic fit of different management strategies and aims of OI usage, the answers are analyzed for patterns concerning motives, chosen OI approach in scale and scope, and top management support using qualitative comparative analysis (QCA) (Ragin, 1994; Ragin, 1998; Schneider and Wagemann, 2010). The structured groups of companies are then analyzed for patterns in success rate of OI projects and perceived satisfaction of the respondent with the implemented OI approach. Even though this is a comparable subjective measure, it gives valuable insights on the usage of OI approaches in a company and gives a more complex answer to the functionality of OI in the chemical B2B industry.

In contrast to statistical methodology, QCA is based on Boolean algebra and treats cases in terms of their multiple memberships in sets (Ragin, 1994; Ragin, 1998). This allows viewing a single case according to his multiple memberships in multiple dichotome (“crisp”) sets, viewed as configuration. The underlying interest now is how different sets combine in each case to give a rationale for resulting mechanisms (Ragin, 1998).

The selection of causal conditions is quite broad to capture factors that connect to the outcomes as well as conditions that provide context for the operation of these factors (Schneider and Wagemann, 2010). Therefore, the underlying purposes

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Table 2 Reasons for not implementing OI strategy.

Reasons for not implementing OI strategy	Number of answers (multiple answers possible; n=20)
Loss of intellectual property	10
Resources are not available	8
Others (e.g. not functioning in chemical B2B industry)	8 (X)
Balancing daily business vs. new OI approach	6
No support of top management	2
Bureaucratic and administrative barriers	2

for implementing an OI strategy, the scope of the implemented OI strategy, the frequency of usage (scale) and the moderating top management support as a context providing parameter are considered as possible sets with dichotome causal conditions for the cases using an OI strategy.

4.2 Reasons for not implementing OI

In the responding companies of the chemical B2B industry the usage of OI approaches is quite divers. Only 52% (22 of 42) of the respondents' state that their companies use (at least partially) an OI approach, resulting in 48% (20 of 42) of companies still following a closed innovation process.

The reasons for not implementing are partly based on the high sensitivity for secrecy in the chemical industry. 50% of respondents not using OI see the loss of intellectual property as a main reason for not engaging in a more open process (see table 2). This may be due to the fact, that chemical companies' competitive advantage is based on process innovations, which are hard to protect by patents. Another major reason is the perceived lack of resources, which is named by 40% of the respondents as a reason for not using an OI approach. This statement in combination with 25% of companies expressing their concerns about the usability of OI in the chemical B2B industry exposes still existing doubts about the applicability and possible advantages in this industry. The reason for this impression of OI, which is contradictory to the 52% of companies actively using OI, are not further investigated. Perhaps there is a difference in customer structure, internal organization or simply in managers' personal belief in charge of innovation processes.

4.3 Motivation to use OI in chemical B2B companies

In contrast to the findings from chapter 4.2 22 companies actively use OI. To study the implementation of open innovation according to Huizingh (2011) the reasons why firms open up their innovation processes are investigated. Huizingh (2011) defines: "[...] one distinction is for offensive motives (e.g. stimulating growth) or for defensive motives (e.g., decreasing costs and risks)". In the given sample, firms using OI mainly focus on offensive motives as creating new product ideas or exploring new markets (see table 3). Just a few aim at defensive motives to stay competitive (combined with decreasing their time to market or reducing their R&D expenditures). However, in most cases there is a combination of defensive and offensive motives. Just 3 companies use OI for purely defensive motives.

There is also a clear trend, that OI is seen as a tool for exploration[1] (e.g. create new product ideas, create new product fields) as well as for exploitation (decrease time-to-market, increase innovation rate, reducing R&D expenditures) within the chemical B2B industry. This finding is highly interesting as it shows that the full potential is visible and actively fostered by innovation managers across the industry. Especially the reasons aiming at an exploitation of innovation capabilities are often seen as most important (10 of 22 cases).

1 Cohen and Levinthal (1989) define the activities exploitation and exploration as the two sides of R&D: innovation and learning. These two different activities not only imply different organisational designs, but also differ in the underlying innovation processes.

Table 3 Reasons for implementing OI strategy.

Reasons for implementing OI strategy (offensive/defensive); (exploration [A]/exploitation [B])	Number of answers / Number of reason chosen as most important (multiple/single answers possible; n = 22)
Create new product ideas (off) (A)	16 / 9
Explore new markets (off) (A)	16 / 0
Stay competitive (def) (A/B)	14 / 0
Create new product fields (off) (A)	13 / 0
Decrease time-to-market (def) (B)	12 / 3
Increase innovation rate (off) (B)	12 / 6
Gain new business development partners (off) (A/B)	11 / 1
Expand in existing markets (off) (B)	9 / 1
Reduce R&D expanditures (def) (B)	7 / 1
Improve image of the company (def) (A/B)	6 / 0
Others (off/def) (A/B)	0 / 0

4.4 Scale and scope of OI processes

The 22 companies who state to use an OI approach all try to internalize external knowledge, representing the outside-in process. 15 of the companies also say they try to use the inside-out process to externalize ideas, in example if research projects cannot be continued internally without external support, representing the coupled process (see table 4).

It is further shown that, even though 68% of firms say they use a coupled process, a majority of these firms clearly focuses on internalizing existing ideas from the external world rather than to give ideas created in-house to potential competitors. This is reflected by the major use of OI tools that aim at exploration of ideas and exploitation of new knowledge, rather than utilization of ideas and innovations by out-licensing or publishing of results. The major tools for incorporating knowledge are expert workshops, patent analysis and customer visit teams (see table 5). Regularly used concepts by other industries as innovation challenges for end-consumers (e.g. using social media or the own website (Slowinski et al., 2009)) are rather rare. The main outflow of ideas and knowledge (as described by the inside-out-process) is done in joint-development projects (63%) and institutional research projects (50%). However, some companies seem to make good experiences with this approach, as 8 respondents say these are the most important OI tools for their company.

Table 6 shows the usage of OI tools in projects conducted within the last 5 years by the investigated companies. The most chemical companies who frequently (more than 10 projects) use OI are large companies. Nevertheless, 11-20 projects is a rather small number in 5 years compared to their total research projects' volume, suggesting that only 23% of the large companies pursuing an OI approach do it with high intensity. Surprisingly, two OI champions (40%) belonging to the group of SME seem to do OI on a regular basis. However, it is shown that in most of the companies the number of projects actively using OI tools is rather limited.

Asked for their future expectations of OI in the

Table 4 Implemented OI process.

Implemented OI process	Number of answers (single answers possible; n=22)
Outside-in process	7
Inside-out process	0
Coupled process	15

Table 5 OI tools used in the chemical industry.

OI tools	Not used	Minor use (1-4 projects)	Frequent use (> 4 projects)	Chosen as most important tool
Own homepage	10	9	3	1
Workshops	1	10	11	8
Publicly funded projects	8	10	4	0
Joint development	5	14	3	7
Institutional research	5	11	6	1
Broker	15	7	0	0
Technology scout	11	7	4	1
Patent analysis	1	8	13	2
Lead users	11	10	1	0
Ethnography	12	6	4	0
Customer visit teams	3	6	13	1
Others (internal cross functional teams)	21	0	1	1

chemical B2B industry, 16 of 22 respondents see an increase in importance. 5 of 22 do not see a major change towards OI and only one respondent expects a decrease of importance of OI in this business field.

4.5 Qualitative comparative analysis

In total, innovation managers who use OI tools are quite diverse in their opinion about the outcomes, as a quite big group of still sceptical respondents (50%) does not see a positive or even see negative effects of applying OI tools (see Appendix, table 8). Therefore, the success rates and perceived satisfaction is matched over qualitative comparative analysis (QCA) with the previous findings.

The *t*-test showed no significant difference in response behavior between early and late respondents. Therefore, a respondent bias is not further considered.

The purpose of the implementation of an OI approach can be done either to offensive or defensive reasons. To form a crisp set, offensive reasons are positive, if at least one of the reasons create new product ideas, explore new markets, create new product fields, increase innovation rate, gain new business development partners or expand in existing markets is named (see Appendix, table 3, table 8), others are marked as non-offensive purpose (~offensive). Further the scope is defined as coupled process for companies using both approaches and non-coupled (~coupled) for companies using just one way of open interaction. While there are no companies in the sample using solely the inside-out process, ~coupled equals outside-in process. The scale of usage is defined as frequent usage, if more than 10 OI projects have been carried out within the last 5 years, resulting in non-frequent usage (~frequent) of companies with 10 or less con-

Table 6 Scale of OI usage.

		OI projects in past 5 years				
		1-3	4-10	11-20	> 20	total
Number of employees	50-250	1	2	0	2	5
	251-1000	2	1	1	0	4
	> 1000	1	7	2	3	13
	Total	4	10	3	5	22

ducted projects using OI tools. The moderating variable top management support is set positive for strong and medium support and set to non-support (~approval) for values representing neutral attitude of top management or even rejection (see Appendix, table 8).

The dependent variables considered are perceived satisfaction, measured on a 5-point scale (1 – very unsatisfied to 5 – very satisfied), and success rate of OI projects in past 5 years, measured in percentage of overall OI projects.

These variables are used to construct a "property space" that constitutes all potential locations as a different kind of type (Lazarsfeld, 1937). To construct this table listing the possible logically combinations of configurations together with the cases comprising the respective configuration (see Appendix, table 9), the factors have to be split in dichotome sets (Ragin, 1998).

Each row of table 9 (see Appendix) with the assigned cases is afterwards examined on whether the outcomes show substantial differences to get confidence that a viable specification of causal conditions is realized (Ragin, 1998). As all cases within one row do not display widely divergent outcomes the specification of causal conditions can be used for further analysis. Naturally, not all theoretically possible cases appear in practice, because some combinations of factors induce a greater likelihood of specific shaping of corresponding factors (e.g. defensive use intention without top management support will probably not result in a very frequent usage).

The analysis shows that most cases are in sets having offensive motives as an underlying rational to implement OI, which is in line with the findings in chapter 4.3. However, success rates as well as the perceived satisfaction of involved managers differ widely between these groups.

Analysis using an strict assessment[2] for sufficiency of conditions following Ragin (1998) in combination with Schneider and Wagemann (2010), shows that high perceived satisfaction results from offensive purposes combined (* representing logical AND) with top management support:

*Positive perceived satisfaction = offensive*approval*

The success rate cannot be matched to a single combination of causal conditions. This can be due to the natural risk of projects, which can result in strong fluctuation of the success rate in the sample size given. However, the suspected effect of frequent usage of OI tools does not show an increasing effect on success rates. It is striking, that the frequent as well as the not frequent use of an outside-in process for offensive purposes in combination with top management support (see Appendix, table 9, rows 5 and 7) show above average success rates and high perceived satisfaction (statistically significant one-tailed significance level of 5%).

High success rate = offensive~coupled*approval*

However, this result is to be handled with care due to the fact that just 3 of the 22 cases belong to these rows. Still, it is unrealistic to expect that all cases in a row display the same outcomes, as only some very broad factors are considered and it is very difficult in such a small sample to capture all causally relevant conditions in such a cross-case analysis (Ragin, 1998). At the same time different additional conditions can further contribute to outcomes, even if they are not present in the first analysis. As other cases also show high success rates with different combinations of causal conditions, the equation for high success rate (+ representing logical OR) has to be extended to:

High success rate = offensive~coupled*approval+combination with unknown conditions*

Further, it is highly interesting that in two cases a coupled process is used for solely defensive purposes on a non-frequent basis.

5 Conclusions

The results presented in chapter 4 show a very divergent picture of the chemical B2B industry concerning the use of OI approaches. Many companies in the industry are still sceptical about the use of OI while about half of the companies make a decision against implementing an OI approach. The main reason for this is still the fear of losing relevant intellectual property to competitors. This is especially relevant for the B2B chemical industry, as many value drivers are specialized knowledge not openly accessible or highly exploited production processes. A very transparent innovation process can result in a loss of relevant value drivers to competitors as well. Furthermore the big efforts to protect intellectual property in an OI process may result in slow and complex processes as well as mistrust among the all involved.

However, as innovation cycle times decrease, also traditional industries such as the chemical B2B industry start to open up their innovation processes in large companies (Mortara and Minshall, 2011)

2 A strict assessment implies no allowance for discordant outcomes among the cases conforming to a causal combination to confirm the sufficiency assessment of a causal combination. The probabilistic approach, which also tolerates outliers, needs a larger sample size or at least a higher number of cases in each row to be applicable.

and also in SMEs (Narula 2004). This holds true in this sample of chemical B2B companies. The motives to use OI approaches are shown to be growth rather than cost savings. However, exploration does not prevail as exploitation of innovation processes and existing products is often named as the most important reason for a usage of OI. Still, the dissemination and frequency of usage is not as high as it is in prominent case samples closer to the end consumer.

While many large companies try to use OI as an approach to further develop their innovation processes, some small companies reveal the possibility to use accessible external resources for their products. Analyzing the commonly used tools like customer visit teams, patent analysis and workshops, shows that companies mainly try to internalize external knowledge and ideas, even though the majority says of themselves to use a coupled OI process. The companies actively opening up in both ways do this by participating in joint research and development projects either with industry partners or in publicly funded projects with academic partners. The experiences from these approaches seem promising, as many companies active in these collaborations see them as their most important OI tool. A possible reason for this selection of tools might be based in the higher contractual security of intellectual property, which is fixed in advance of the collaboration. Further, from an innovators point of view it might be easier to open up and let out knowledge and ideas, if the setting was mutual with other innovators. In explicit a setting in which the counterpart is able and willing to share knowledge, too, as in the described joint research and development projects or publicly funded projects in collaboration with academic institutions.

Furthermore the design and practical configuration of innovation approaches in chemical B2B companies are linked to their perceived satisfaction with their OI approach and given innovation results. Unsurprisingly, the perceived satisfaction is greatest, if offensive motives are the reason to use OI and the needed resources to advance with the OI approach in forms of financing and time for the implementing manager (expressed through top management support) is given to support the activities and fosters the approach to open up.

However, the usage of a pure outside-in process seems also promising in some companies. For these one-sided approaches long term contemplation with special regards to their future development would be of highest interest. No distinction whether permanent or single project approaches positively influence success rate or satisfaction is found. This raises the question whether the explanation can be found in differences of firm characteristics or whether a more frequent use despite this finding usually eases the use of OI tools and companies are just not ready to do so now.

Therefore, the following implications can be given to innovation managers willing to implement an OI strategy in a process B2B company:

1) Clearly define the goals and motives for the use of OI. Make sure the goals do not contradict each other and are achievable.

2) Select which information you are willing to share and what information you want to gain by using an OI strategy (degree of openness). Define which function in the company is in charge and whether the strategy is aiming at exploration or exploitation activities. Keep in mind that exploiting production processes using OI requires highly specialized external resources and often implies deep insights for external into internal procedures and processes.

3) Develop and align existing tools (a selection can be found in this article) to your strategic purposes and identified needs. Keep in mind that tools developed for large customer bases with little understanding of the product might not work for the purposes in highly specialized B2B products. Depending on the tool/activities: Search for possible OI partners, providing the knowledge and resources you need. Clearly define the risks (ideas, patents, products, processes, image of the company, etc.) resulting from the usage of tools and interaction with partners and possible countermeasures upfront.

4) Assess the resources and time needed to implement the activities resulting from your OI strategy (internal and external), from the usage of specific tools and also from the planed countermeasures (e.g. to protect intellectual property in OI projects).

5) Make sure to have top management support (including the financing, manpower and infrastructure) and the support of key players in the process. Think of the reaction of top management and key players, if implementation is behind schedule out of external reasons and possible solutions.

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Appendix

Table 7 Definition of OI tools.

Open innovation tools/concepts	Short definition	Source literature
Institutional research activities	Joined research collaboration carried out by a network or cluster	(Simard and West, 2006; Saxenian, 1996)
Open innovation competitions	Mainly homepage/internet based search for general ideas and solutions to specific needs for the company	(Slowinski et al., 2009)
Brokers	Entities (organizations and individuals) that faciliate the sharing of different types of knowledge between knowledge sources and knowledge needs	(Sousa, 2008; Schroll and Römer, 2011)
Workshops	Jam sessions of different participants in a closed environment. Can target specific problems or be of more general ideation purpose	(Ertl, 2012; Gassmann and Enkel, 2004)
Strategic alliances	Voluntary arrangements between firms involving exchange, sharing or co-development of products, tevchnologies or services	(Gulati, 1998; Herzog and Leker, 2010)
Publicly funded projects	Research partnership (normally involving university partner) which is at least partly funded by a public institution	(Perkmann and Walsh, 2007)
Technology scouts	Independent agents which can be included in searching and intermediation process to find new technologies	(Shohet, 2008; Rohrbeck, 2007)
Patent research	Can be used to search in structured patent databases to detect new or similar technologies or to select potentila collaboration partners	(Rohrbeck, 2007; vom Stein et al., 2015)
Ethnography	Observation of customer product usage to get a deeper insight of users unmetor unarticulated needs, applications and problems	(Cooper and Edgett, 2008)
Customer visit teams	Customer visits or interviews to identify user problems and expectations of new products. In contrast to ethnography this requires active involvement of custmers	(McQuarrie, 2008; Cooper and Edgett, 2008)
Lead users	Lead users recognize future trends ahead of time and are able and willing to provide these information to the company	(von Hippel, 1998; Cooper and Edgett, 2008)

Table 8 Causal conditions of 22 cases using OI.

	Causal conditions			
Case No.	Purpose	Scope	Scale	Top Management Support
1	offensive	coupled	~frequent	approval
2	offensive	~coupled	~frequent	~approval
3	offensive	coupled	frequent	approval
4	offensive	coupled	frequent	approval
5	offensive	coupled	~frequent	approval
6	offensive	coupled	~frequent	~approval
7	offensive	coupled	~frequent	~approval
8	~offensive	coupled	~frequent	~approval
9	offensive	~coupled	~frequent	approval
10	offensive	~coupled	~frequent	~approval
11	offensive	~coupled	frequent	approval
12	offensive	coupled	frequent	approval
13	offensive	coupled	frequent	~approval
14	offensive	~coupled	~frequent	approval
15	offensive	coupled	~frequent	~approval
16	offensive	coupled	~frequent	approval
17	offensive	~coupled	frequent	~approval
18	~offensive	coupled	~frequent	approval
19	offensive	coupled	~frequent	~approval
20	offensive	coupled	frequent	approval
21	offensive	coupled	frequent	approval
22	~offensive	~coupled	~frequent	~approval

Table 9 Logic for QCA analysis; rows representing possible combination of conditions.

Causal conditions						Outcome	
Row	Purpose	Scope	Scale	Top management support	Cases No.	Success rate	perceived satisfaction
1	offensive	coupled	frequent	approval			
					3	20	5
					4	55	4
					12	30	4
					20	60	4
					21	70	4
2	offensive	coupled	frequent	~approval			
					13	40	1
3	offensive	coupled	~frequent	approval			
					1	20	4
					5	55	3
					16	75	4
4	offensive	coupled	~frequent	~approval			
					6	25	2
					7	35	4
					15	45	2
					19	30	3
5	offensive	~coupled	frequent	approval			
					11	80	4
6	offensive	~coupled	frequent	~approval			
					17	30	2
7	offensive	~coupled	~frequent	approval			
					9	85	5
					14	40	4
8	offensive	~coupled	~frequent	~approval			
					2	35	2
					10	0	1
9	~offensive	coupled	frequent	approval			
					none		
10	~offensive	coupled	frequent	~approval			
					none		
11	~offensive	coupled	~frequent	approval			
					18	30	3
12	~offensive	coupled	~frequent	~approval			
					8	20	3
13	~offensive	~coupled	frequent	approval			
					none		
14	~offensive	~coupled	frequent	~approval			
					none		
15	~offensive	~coupled	~frequent	approval			
					none		
16	~offensive	~coupled	~frequent	~approval			
					22	20	3

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