[Journal of Business Chemistry]
Vol. 14, Iss. 1
www.businesschemistry.org
02.2017

The academic journal for management issues in the chemical industry

Dorit Lehr and Christoph Auch

Novel approaches in professional education to foster innovation in the chemical industry

Clara Hiemer and Carsten Suntrop

The future of German chemical sites: Potential pathways and organizational readiness

Jürgen Vormann

Successful management of chemical sites: A challenge for management theory and practice

Published on Behalf of the Institute of Business Administration at the Department of Chemistry and Pharmacy, University of Münster and the Center for Industry and Sustainability, Provadis School of International Management and Technology

Aim and Scope

The Journal of Business Chemistry (JoBC) focusses on current developments and insights at the intersection of management and chemistry, biotechnology or pharmacy.
The JoBC provides an international forum for researchers and practitioners in companies, research institutes, public authorities, consultancies or NGOs to present and discuss current challenges as well as potential solutions in an interdisciplinary manner. Thus, the JoBC aims to foster the dialog between science and business, to support management practice in the chemical and pharmaceutical industry and to indicate where further research from academia is needed. The JoBC offers high quality publications with academic standards, a fast publishing process and global reach. With this multidisciplinary and boundary-spanning approach, the Journal of Business Chemistry intends to become the leading journal for decision makers in the chemical and pharmaceutical industry.

Publisher

The Journal of Business Chemistry (ISSN 1613-9623) is jointly published by the Institute of Business Administration at the Department of Chemistry and Pharmacy (University of Münster) and the Center for Industry and Sustainability (Provadis School of International Management and Technology). It is published every four months as an open access journal.

Subscription

Online-Subscription is possible at:
subscription@businesschemistry.org.
The articles are available for download free of charge at www.businesschemistry.org.

Abstracting and Indexing

The Journal of Business Chemistry is covered by the following abstracting and indexing services:
- EBSCO Publishing
- Hamburg Institute of International Economics
- German National Library of Economics
- Chemical Business NewsBase (CBNB) by Elsevier Engineering Information, Inc.

Contents

ISSN 1613-9623

Vol.14, Iss.1, February 2017 [Journal of Business Chemistry]

Letter from the Editors

Shaping the environment for innovation

When talking about innovation, the environment in which scientists and corporations operate is a crucial factor. Innovations are often generated in strong ecosystems with complementary resources. The increasing interest of companies in topics such as, for example, opening up corporate culture to external impulses, exchanging with suppliers and/or customers, or assessing employee competency to promote innovation are all part of the effort to increase the capacity of the chemical industry to innovate. Chemical companies are actively using changes in their environment to stay competitive and prepare for future challenges. In the literature there is also evidence that innovation performance is affected by the establishment of employee development programs or the exploitation of emerging synergies.

The article "Novel approaches in professional education to foster innovation in the chemical industry" by Dorit Lehr and Christoph Auch, introduces Climate KIC's Certified Professional Program, which was founded by the European Institute of Innovation and Technology (EIT) and focuses on defining an innovation competency framework. The relevant competencies include five working areas: Addressing challenges, creativity, envisioning & planning, leading innovation and flexibility & learning. They highlight how important it is for companies in the chemical industry to not only think in terms of "molecule" innovation, but to search for innovation in overall encompassing systems (e.g. health, nutrition, mobility) and thereby reconfigure the field of inquiry for innovation. Consequently they argue that successful professional education activities should be challenge-based, action oriented as well as crossing disciplinary boundaries.

The article "The future of German chemical sites: Potential pathways and organizational readiness – Introduction to a study design" written by Clara Hiemer and Carsten Suntrop presents a research design, that aims to identify the status quo and the future development of chemical sites. By starting with a common definition and presenting the everyday challenges of chemical sites resulting from the different stakeholder groups involved, the scope of the study is set. In the following chapters the authors describe the two-step approach of the study, combining quantitative and qualitative data collection to assess the current internal performance of chemical sites as well as developing hypotheses of future challenges.

Finally, the commentary "Successful Management of chemical sites: A challenge for management theory and practice" by Jürgen Vormann, the CEO of Infraserv GmbH & Co. Höchst KG, offers additional insights into the management of chemical sites. By highlighting the reorganization of chemical sites and the application of various business models, he also emphasizes the importance for further in-depth research. The author advocates a cooperative approach to analyzing the business models of chemical sites with researchers, practitioners and industry associations playing complementary roles.

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

Ruth Herrmann (Executive Editor)

Bernd Winters (Executive Editor)

Practitioner's Section

Novel approaches in professional education to foster innovation in the chemical industry

Dorit Lehr* and Christoph Auch**

* Center for Industry and Sustainability at the Provadis School of International Management and Technology, Industriepark Höchst, Gebäude B835, 65926 Frankfurt am Main, Dorit.Lehr@provadis-hochschule.de

** Professional Educational Lead Europe at Climate-KIC, Industriepark Höchst, Gebäude B835, 65926 Frankfurt am Main, Christoph.Auch@climate-kic.org, www.climate-kic.org

Fostering innovation in the chemical industry demands a new approach to the competencies required by employees. To succeed in innovation processes, competencies are needed that transcend the mere scientific knowledge in chemistry: skills are needed to work in teams in a transdisciplinary manner in order to generate new ideas. Moreover, these skills will enable employees to exploit innovations that exist at the interface with other disciplines and industries. However, how can such competencies be trained and fostered? This article addresses competencies that are crucial to cross-industry and interdisciplinary innovation processes. Furthermore, it outlines principles for developing competencies through professional educational activities and provides both practical examples and domains for further research.

1 The chemical industry and the need for cross industry innovation

Observers have remarked that the chemical industry and chemical science is presently in a phase of transition: For decades, discoveries in chemistry inspired both the industrial world as well as academia. However, since the 1990s, there has been a focus on process improvement in the chemical industry and relatively few fundamentally new products have been introduced to the market. Today, innovations are more likely to originate instead from related fields such as biotechnology or partnerships with other disciplines (Whitesides, 2015; Chandler, 2005, p. 35).

According to an expert survey, the long-term success of a company is dependent, among other factors, on its ability to anticipate new (mega-)trends and explore opportunities early in the process through innovation (Utikal and Leker, 2015). The current paradigm in the chemical industry is, however, focusing on running the existing business effectively. It is about exploiting the opportunities which are provided in the current state of doing business rather than exploring new opportunities. Gathering these "low hanging fruits" will likely result in improvements to the system and increased earnings in the short run – though these small steps may not suffice in order to succeed in the long-term. Whitesides (2015) argues instead that chemistry must undergo a radical shift away from studying "atoms, molecules, and reactions" to dealing with complex systems that involve molecules, in any form – in material science, biology, geology or indeed city management. Research in the field of chemistry should therefore reframe its focus and work on systems in an integrated manner together with other disciplines. Innovations in chemistry should go hand in hand with innovations in other disciplines and should thereby focus more on societal problems. Exemplary new research questions may address such questions as "How does the brain think?" or "Water, and its unique role in life and society" (Whitesides, 2015). Research and innovation in chemistry thereby requires a completely new perspective.

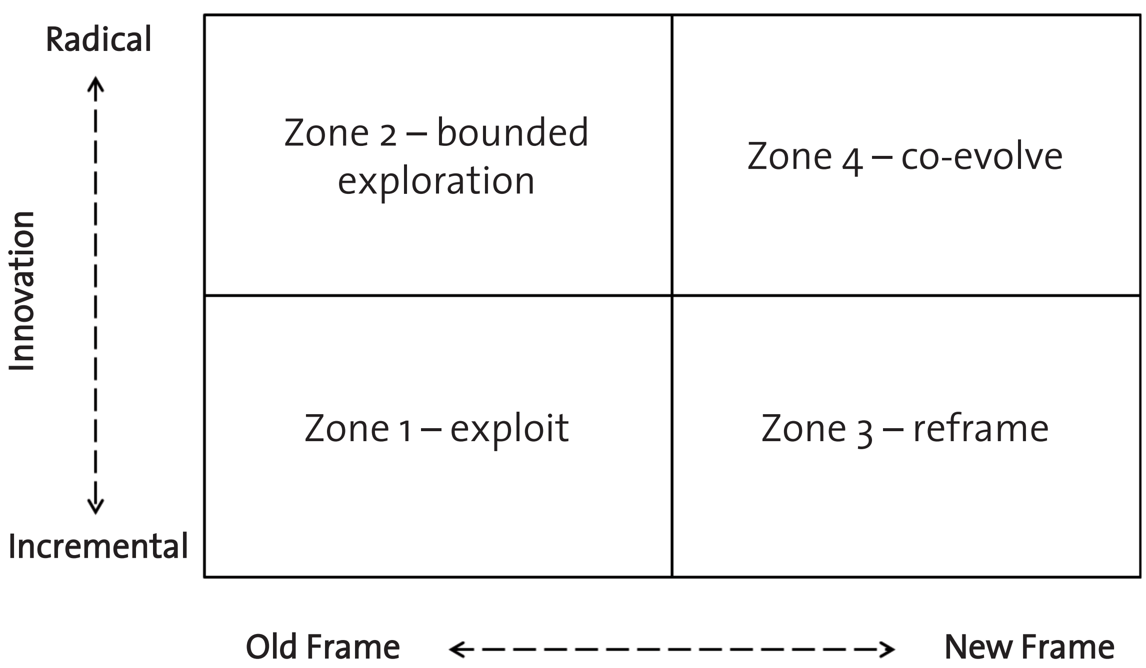
Following this line of argumentation, companies and higher education institutions should re-evaluate whether their existing framework of developing innovation is adequate. Innovation is thereby defined as a process through which a new product, service, process, position, policy or paradigm is obtained from the generation of new ideas which provide solutions to problems and needs (Matthews and Brueggemann, 2015). Evidently, processes of innovation involve many iterations and cycles between the phases of preparation, ideation, modelling and implementation. This implies that innovation does not necessarily follow a linear approach but rather adopts a trial and error pattern. The outcomes of innovation may manifest in different ways and may become disruptive to existing systems. (Bessant and Tidd, 2011) Therefore, giving room to innovation often implies abandoning existing routines and procedures in favor of new ways of operating that support creativity, flexibility and the ability to fail (Henderson and Clark, 1990; Ancona, Backman and Isaacs, 2015). But what exactly is meant by "give room to innovation"? How does innovation occur and how can innovation be fostered?

As Figure 1 shows, there are different strategies that can be employed to investigate innovation: from exploiting the current business model with incremental innovation within the existing framework, to radical innovation in a completely new system, which is related to doing something fundamentally different and working on the "edge of chaos" (Tidd and Bessant, 2013). Depending on the need for innovation and the aspiration, different routes can be taken to foster innovation.

Innovation can therefore take place in a stable and shared framework within which adaptive and incremental development takes place (Zone 1). In this zone, it is associated with refining tools and methods for its operations. Innovation can also be more radical: it involves exploring new territory, pushing the frontiers of what is known and deploying different search techniques for doing so – but this still takes place within an established framework (Zone 2). In practice this would, for example, involve research and development investments with high risk but significant opportunities. In contrast, innovation can also concern changes in the way the business architecture functions and less concerned about pushing technological frontiers with radical innovation (Zone 3). It is about exploring alternative options, introducing new elements, experimentation and open-ended enquiry. Innovations can also emerge as the product of a process of coevolution. In this space, many different elements are involved and each affects the other. Working in this zone makes considerable demands on the organizational structure as well as the people involved – it requires abandoning existing routines in favor of creativity and flexibility but also ambiguity and the ability to fail (Tidd and Bessant, 2013).

Innovation in the chemical industry has so far merely focused on exploration and exploitation of innovation in a given framework. Exploring new opportunities in the chemical industry as illustrat-

Figure 1 A map of innovation search space, adapted from: Tidd and Bessant (2013), p. 286



ed by Whitesides (2015) will likely require more radical shifts in the way innovation is framed. The ambition is therefore not only to create new products but also to shape new ecosystems, expanding the scope and playing field of chemistry (Ommen and Kuiper, 2017). There are ongoing initial attempts to reframe existing routines. The Clariant innovation center, for example, is an attempt to open up the company's innovation process to different stakeholders – from academia and other related branches – to introduce new ideas and think outside of the silos (Kottmann, 2016).

2 Competencies for cross-industry innovation

Optimizing the ongoing business – while at the same time creating the opportunities for innovation - is the central challenge in the chemical industry in the future (Utikal and Woth, 2017). Versatile and resilient organizations, with employees mastering the challenges of adapting to trends as well as shaping them, are key to securing business success in the long term.

Much of the literature on managing innovation focuses on an adequate organizational structure to foster innovation, but innovative organizations imply more than a structure: they constitute an integrated set of components that work together to create and reinforce the kind of environment which enables innovation to flourish (Tidd and Bessant, 2013). Individuals play a key role and we argue that education is an important pillar to prepare and coach individuals to help guide the innovation process.

Competencies promoting innovation – such as creativity and transdisciplinary communication – do not usually form part of formal education (European Commission, 2016). Competencies have often been assumed to be a given and the focus in education was rather to train students to become experts in a certain field. This particularly holds true in the case of chemistry, where the prevailing idea is that a successful employee needs to understand the discipline in depth (Utikal, 2015). However, being solely an expert may no longer suffice in order to fulfill the requirements of the future job market (Economist, 2017). In view of the need of the chemical industry to transform and foster new innovation, the question regarding how to use scientific knowledge is becoming increasingly important. This requires competencies which transgress pure knowledge but require multidisciplinary perspectives. Innovation experts are not only experts in a given area, but also in the processes of designing and implementing changes. Their success comes from their ability to see new connections and opportunities and from envisioning new realities (Bezarra, 2005). These descriptions already demonstrate the need for certain competencies in order to drive innovation. Individual competencies are thereby defined by Matthews and Brueggemann (2015, p.10) as "the combination of learnable behaviors that encompass attitudes (wanting to do), skills (how to do), knowledge (what to do), practical experiences (proven learning), and natural talents of a person in order to effectively accomplish an explicit goal within a specific context." These generic competencies can be further specified by describing competencies which are in particular relevant to promote innovation. We therefore have to first understand how the innovation process itself is organized. In essence, the process is described by Tidd and Bessant (2013) in these four steps:

1) Search - how can we find opportunities for innovation?
2) Select - what are we going to do - and why?
3) Implement – how are we going to make it happen?
4) Capture – how are we going to get the benefits from it?

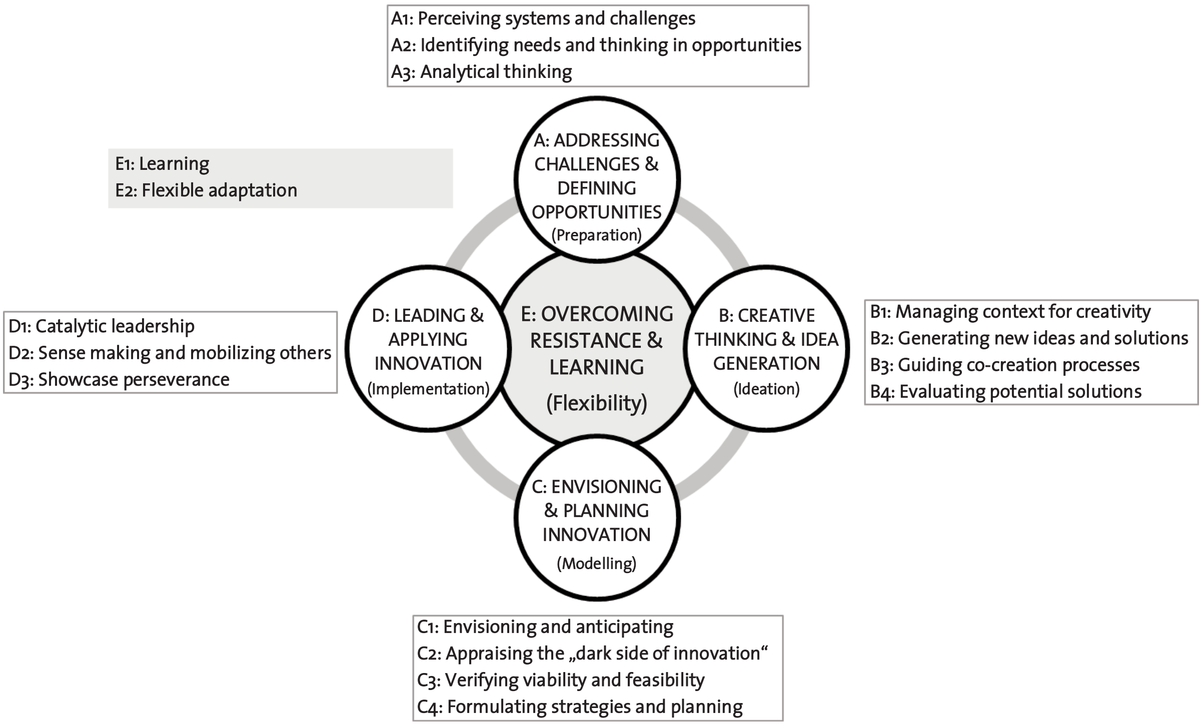
A European education project – Climate KIC's Certified Professional Program, funded by the European Institute of Innovation and Technology (EIT) - has used these four stages as an orientation to further define their competency framework in order to promote innovation. The development of the competency framework thereby followed a rigid process: based on a literature review, bottom-up research, and taking into account the Universal Competency Framework (CEB Talent Assessment, 2013) as well as general expert feedback, a first draft of the framework has been developed. The first framework was then evaluated again by experts and feedback was integrated into a second draft which has been applied in a practical test with around 50 candidates and assessors.

At the core of the framework are five working areas which are key to promoting innovation: Addressing Challenges, Creativity, Envisioning & Planning, Leading Innovation, Flexibility & Learning[1] (see figure 2). All working areas are underpinned by certain core competencies - competencies that may also be useful for employees in the chemical industry in view of the need to foster innovation.

Addressing Challenges requires recognizing that existing solutions do not always lead to the best possible results. The need to de- or reframe given

[1] See www.certifiedprofessional.eu for the general framework and further details

Figure 2 Climate KIC's Certified Professional Competency Framework for Innovation



solutions, and to constantly search for improvement, is fundamental to developing new innovations. Applying systems thinking, recognizing patterns, and thinking in options aids in identifying problems. In-depth analysis leads to a thorough understanding of the roots of these problems and allows the drawing of hypotheses. Whiteside (2015), in his article, for example, has thoroughly analyzed the chemical industry and reached the conclusion that the chemical industry is concluding an era of exceptional growth. Opportunities still appear but are broader in scope and greater in complexity. He identifies new core problems that focus on whole systems, overcoming the old paradigm in chemistry of focusing research solely on molecules. This analysis can then serve to guide further innovation in the chemical industry.

Creativity is per definition key to innovation processes and idea generation can be seen as one of the core segments of the innovation process. It is important to mention that creativity can be an individual or a group task with regard to co-generation. Consequently, the context (environment) plays an important role as it may hamper or support creativity. In fact, innovation is regularly an insightful and co-creative process. This underlines the importance of incubation as well as sharing and discussing ideas. Evaluating and synthesizing potential alternatives helps to identify which idea to expand upon.

In view of the high relevance of patents, innovation has usually been forced to take place in a closed setting. However there are initial examples now, in which the structure for innovation is opening up: for example Clariant has developed an Open Innovation Initiative jointly with the University of St. Gallen and Stanford University, with the objective of actively and strategically integrating external knowledge into the company. External partners, start-ups or universities are invited to contribute ideas and solutions to "Open Innovation" focus fields. This often results in the development of project-related, long-term partnerships. In return, Clariant offers partners access to financing opportunities, marketing, infrastructure and practical know-how (Kottmann, 2016).

Envisioning & Planning: In order to elevate an idea to the status of an innovation, it requires strategic vision and planning. In this respect, a reasonably elaborated idea about the future and an anticipation of the future impact of innovations are essential. Constantly questioning the nature of the demand and the added value of the innovation is crucial at this step. This includes an evaluation of viability- and feasibility issues as well as the anticipation of unintended negative side-effects of the innovation. Moreover, a strategic action plan with prioritized action steps assists in the implementation of the innovation.

Leading Innovation: As soon as an innovation attracts a certain level of attention from others, leadership qualities become an essential characteristic of an innovator. This means that resources (human, time, money, material, etc.) need to be secured and used in a strategic manner. At the same time, a trustworthy, people-oriented, inclusive working environment needs to be provided. Potential allies need to be mobilized to engage and take action and potential opponent forces need to be countered with perseverance or convinced of the advantages of the intended innovation. Companies often have a very well elaborated set of process descriptions for innovation. These mainly focus on innovations in the established fields presented in figure 1: Zone 1: exploit and Zone 2: bounded radical. However, in a company that intends to leave the established framing of the innovation field (e.g. a chemical company intending to provide broader solutions to a customer problem), employees have to handle a higher level of uncertainty and ambiguity, as information from other fields and industries have to be integrated into the established innovation processes and tools. In this situation, mobilizing support within the company and beyond is a challenging task.

Flexibility & Learning: Throughout all working areas of innovation, flexibility and the ability to continue learning are central. The innovator must learn from his/her experiences, success, and failure as well as from those of others (vicarious learning). The chemical industry often acts on the vagaries of a global market. The growth market of today can be the crisis market of tomorrow – as the example of Brazil has shown. Thus, companies in the chemical specialty sector need to re-act to global changes with increasing flexibility and speed (Kottmann, 2016). This also holds true for the individual employees who need to have the ability to share their learning with others and introduce relevant changes quickly to top management. This is especially difficult if chemical companies pursue innovation in a more radical way and reframe their existing business model, engaging in a co-evolutionary innovation process (see figure 1). They then need to integrate information from different sectors and cannot rely on the existing routines and networks in evaluating new information.

The competencies described above are often developed informally - through life and work experience. Professional education (education for practitioners with an academic background) can also play a vital role in preparing employees for their tasks and increasing employees' competencies to broaden the perspective for creating successful innovations (Utikal and Woth, 2017).

3 Professional education approaches to enhance innovation competencies

Actively striving to enhance innovation competencies requires new thinking on pedagogic approaches and a departure from the paradigm of knowledge driven education. Competencies arise not simply through transferring knowledge using a certain method. Competencies are much more closely related to the learner's inner process: the context of learning and the people with whom and from whom learning takes place. As a result, at the center of the learning process is the learner's selfhood and the development of his or her personality.

The following guiding principles are considered as being effective in developing suitable professional education programs focusing on the development of competencies.

A. **Challenge based learning:** Professional educational programs need to be demand driven. The basis for defining professional education offers are therefore innovation challenges and barriers faced and perceived by practitioners. A gap analysis between competencies requires facing the respective challenges and existing competencies of the workforce and management in a given context is the foundation for defining specific learning objectives of educational activities. The challenge is then frequently focused on a broader, more complex system which can be analyzed from multiple angles.

B. **Action / application orientation:** Participants should not only absorb knowledge, but also apply new knowledge, tools and methods to real existing problems, challenges and endeavors. The learning takes place through analyzing a situation, identifying one's own strategies and engaging in a dialogue with others about working hypotheses. It is also about allowing detours that include the counterpart's thinking, and jointly arriving at answers that are not rigidly determined in advance. A reflection phase after the exercises enables a critical evaluation of the problem solving process. Including challenges in training often creates a sense of urgency, passion and ownership, which also ensures a successful transfer of the learning to the workspace.

C. **Interdisciplinary approach:** Innovations are often created at the interface of disciplines. However to be able to really work in an interdisciplinary manner, it is important to set a base for cooperation and communication: so that participants value that other people make different observations, that another way of thinking makes sense, that there are more possibilities than were previously registered. Difficulties in forming an interdisciplinary team have to be mentioned in advance of the program, as well as providing rules for handling conflicts.

D. **Modular approach, allowing contextualization:** The central question is: how do the competencies arise? What are the needs? What are the objectives? People have different levels of competencies and it is important to adapt the training content to the respective expectations of the participant.

E. **Personalized learning:** Learning formats ensure that people can shape continuous learning under their own motivation and direction. Competency based learning becomes a much more personal experience and in the design of the training formats, it has to be carefully evaluated regarding how much personal presentation and explanation, self-disclosure, trying things out, making mistakes, feedback etc. are necessary in order to initiate, practice and develop the desired competences to a genuinely sustainable degree.

F. **Renewing the role of the trainer / coach:** In a learning community, the trainer makes participants aware of their active role and then guides the collective generation of knowledge across participants so that a collaborative learning experience evolves. The trainer also helps participants in reflecting about their own learning situation and the learning challenges. Depending on the focus of the training, additionally a lecturer/content driven trainer acts as an expert in their field and provides input in the training.

G. **Make use of the knowledge triangle between education, research institutions and business:** Active cooperation between the three partners serves to create a stimulating atmosphere for innovation: education provides skills and competencies for research and innovations, research generating new knowledge for education and innovation creation, and business ensuring knowledge on market developments for education and business opportunities regarding new research.

These principles have being taken up by Climate-KIC and Provadis School of International Management and Technology AG activities in professional education. The activities aim to foster innovation relating to a low carbon and climate resilient development. The applied formats are new approaches to learning and explicitly focus on the enhancement of competencies for innovation and transformation. To ensure the success of the courses, participants are briefed beforehand about the pedagogic concept and the new learning setting. Furthermore, during the program, trainers need to announce the objective and design of upcoming learning and team challenges carefully in order to guarantee that participants can handle them in a productive manner. All formats have been applied to professional education activities with participants from the chemical industry.

The **Pioneers into Practice Program**[2] for example allows climate change professionals to work in a different work placement for four to six weeks. Thereby the participant is tested in the application of their expertise in a new working environment and concurrently receives insights from a different branch. By solving a real climate challenge in the temporary work placement institution, the participant has to work in a transdisciplinary manner. The exchange also fosters the connection between research, education and business as it is intended to place participants from research to business and vice versa. Before and during the placement the participants receive bespoke mentoring and support on transition thinking and system innovation in the area of climate change adaptation and mitigation. This program has been applied in the chemical industry as well: Here, an energy advisor has been working in the manufacture of varnishes. The participant could use his knowledge and skills to develop an energy registry in which, on the one hand, the total consumption of electricity, gas and heating oil of the manufacturer is recorded and on the other hand the energy used in the various business sectors, e.g. in the production, for the illumination or for the cooling of compressors calculated. The program thus allowed the participants to thoroughly assess a certain system of working – addressing challenges which hinder an efficient use of energy. Within four weeks of collaboration, many suggestions for improvement have been developed, which in future can significantly reduce

[2] For further information: pioneers.climate-kic.org

energy consumption in the company. New ideas from the energy advisor as well as intensive collaboration helped to identify low-hanging fruits for energy efficiency – but it also tackled more structural problems and technically challenging issues, such as the cooling of the compressors. To ensure that the ideas are also being implemented, the energy advisor also had to develop a clear vision and translate this into a detailed action plan with prioritized actions.

The **Exchange** program is also an example which puts the action and challenge based learning into focus: Participants are involved for 18 months in their respective enterprise working on a real challenge. The project "Sustainability in the Chemical Industry", for example, supported companies in the calculation of their Carbon Footprint as well as in the implementation of a climate strategy. Eleven companies, most of them SMEs, participated in the program. All companies calculated their footprint and were challenged to transform the results into entrepreneurial decision processes and to develop a climate strategy. Participants received professional mentoring through workshops and coaching to support them on their journey. Through this project, participants could apply and further enhance their competencies in promoting and implementing a certain innovation: They identified company-specific barriers that needed to be overcome to create climate friendly products and processes. Creating company internal alliances, gaining support for one's own ideas and initiating change processes have been relevant competencies that have been trained in the program.

Professional Education Training Courses on the other hand are very condensed courses, lasting for 1 to 8 days. These courses support ideation and promotion of innovations tackling the challenges of climate change. The training courses combine thematic focus areas with action based learning modules and participants work in transdisciplinary groups on case studies. Learning from peers is thereby of increasing importance. In the courses, realistic examples are applied allowing participants to use their competencies to solve the exercises, which will also help participants in their everyday contexts on the job.

The formats have been developed based on five years of experience in which the aforementioned formats have been co-created and tested with partners. More than 1000 participants from more than ten European countries joined the different formats. All courses have undergone a thorough evaluation using standardized questionnaires and open feedback sessions. The evaluation was created from the perspective of trainers/lecturers, program managers (responsible for the planning and organization of the courses) and participants. Participants particularly appreciated the action based and peer to peer learning approach as well as the experience of working in an interdisciplinary manner in teams. These principles led to an active involvement in the learning process and participants took pride in the results achieved. Trainers positively mentioned the creativity that became apparent after groups were formed and operating properly. Program managers see the challenge driven design as very rewarding, as the program reflects a "real life challenge". For them, a major challenge lies in adequately contextualizing the program. To make sure that participants fully engage in the program, the challenge needs to be linked to participants' background and professional experiences, but it has to be framed in a way that forces participants leave their established way of thinking.

The outlined examples of European professional education activities highlight current approaches to developing participants' innovation and cooperation skills. In view of the need for the chemical industry to promote cross-industry innovation, the outlined pedagogic concept is considered to be a complementary activity to the established formal education system focusing on knowledge in a single discipline. This challenges experts in one field and discipline to work in new ways and to work in a more transdisciplinary fashion.

4. Outlook and fields for further research

Broadening the competency development of the chemical industry seems necessary if innovations are increasingly tackled on a system level rather than a product and process level. The ability to identify and analyze systems is a prerequisite for identifying promising fields concerning innovation. However, to successfully transform the inventions into innovations, not only knowledge, but also skills and a proactive attitude are needed. Learning approaches that explicitly aim at knowledge development in addition to skills and attitude development are still comparatively new.

Based on the examples outlined we see the following topics as important for further research:

Effectiveness and efficiency of professional education activities:

Measuring the effectiveness of a professional educational activity is an important challenge in itself. Asking participants about their satisfaction level after the course and after a four week time span, is one of the pragmatic approaches to evaluating effectiveness. Nevertheless, competencies are not rapidly acquired, making it difficult to quantify and visualize the impact of the educational formats. Sometimes the outcome of the programs becomes apparent for the individual only in the long-term by having a better awareness of the embeddedness of individual innovation activities in a broader system and within a company's and industry's history. With regard to the efficiency of the professional education programs, the right balance between in-class and online training for adequate competency development is an ongoing issue. For higher education institutions, it will be a continuous learning process to identify the most suitable concepts and formats by which to enhance competencies.

Certification of competencies:

Europe's business world still attributes considerable importance to formal education and university degrees in its hiring and career development approaches. This may be an effective manner at times when there is little or no change. Nowadays, however, employees work longer than ever before (around 40 years if they start their professional career at the age of 23) and they do so in a dynamic environment, e.g. due to the digitalization. In this context, it is important to maintain a system for identifying and measuring competencies that are relevant to the current and future success of companies (Cedefop, 2015)

Climate-KIC, in cooperation with Provadis School of International Management and Technology AG, is tackling the challenge of defining and measuring competencies and thus aims at recognizing talent, which has so far not been captured by formal degrees (Certified Professional Program). The program assesses, in the field of transition management, innovation management and entrepreneurship, existing competencies of candidates based on their experience.

In our view, making the relevant competencies transparent is the first step in developing and managing competencies more effectively. To make this approach more powerful we encourage and further promote the discourse on developing a competency framework for innovation. A continuous discussion regarding how to integrate this standard on the job market is also necessary.

Linking professional education activities to a transparent competency framework will increase the value of professional education activities. Employees will better understand which competency they need to develop and how to do so. Employers will be able to evaluate the added value of an individual professional education measure if this measure is related the standard competency framework. Thus, finding consensus regarding relevant competencies to promote innovation will further reveal the value of professional education and facilitate in helping to professionalize lifelong learning in Europe.

References

Ancona, D., Backman, E., Isaacs, K. (2015): Two Roads to Green, in: Henderson, R., Gulati, R., Tushman, M. (ed.), *Leading Sustainable Change. An Organizational Perspective*, Oxford University Press, Oxford, pp. 225-249.

Bessant, J., Tidd, J. (2011): *Innovation and Entrepreneurship*, 2nd ed., Wiley.

Bezarra, C. (2005): Building Innovation Competencies, in: *Proceedings of the Canadian Design Engineering Network (CDEN) Conference*, Kananaskis, Alberta, July 18-20, 2005.

CEB Talent Assessment (2013): *The Universal Competency Framework*, available at https://www.cebglobal.com/content/dam/cebglobal/us/EN/talent-management/talent-assessment/pdfs/Universal-competency-framework-white-paper.pdf, accessed 13 February 2017.

Cedefop (2015): *European guidelines for validating non-formal and informal learning*, Luxemburg.

Chandler, A. D. (2005): *Shaping the Industrial Century. The remarkable story of the evolution of the modern chemical and pharmaceutical industries*, Harvard University Press, Cambridge.

Economist (2017): Learning and earning, in: *Special Report Lifelong Education*, 12 January 2017, pp. 5-7.

European Commission (2016): *New Skills Agenda - Working together to strengthen human capital, employability and competitiveness*, available at http://ec.europa.eu/social/BlobServlet?docId=15621&langId=en, accessed 13 February 2017.

Henderson, R. M., Clark, K. (1990): Architectual Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms, *Administrative Science Quarterly,* (35), pp. 9-30.

Kottmann, H. (2016): Interview on "Managing growth and profitability in the chemical industry", in *Journal of Business Chemistry*, **13** (3), pp. 99-101.

Matthews, C., Brueggemann, R. (2015): *Innovation and Entrepreneurship: A Competency Framework*, Routlege, New York.

Ommen, F. v., Kuiper, C. (2017): Openness and managing the innovation family, in: *Perspectives* (4), pp. 30-33.

Tidd, J., Bessant, J. (2013): *Managing Innovation: Integrating Technological, Market and Organizational Change*, 5th ed., Wiley.

Utikal, H. (2015): Personalarbeit wird bunter, in: *Provadis School of International Management and Technology (ed.) Von den Megatrends zum Geschäftserfolg Was bedeuten Megatrends für das Management in der chemischen und pharmazeutischen Industrie in Deutschland*, pp. 24.

Utikal, H., Leker, J. (2015): Die Studie: Von den Megatrends zum Geschäftserfolg, in: *Provadis School of International Management and Technology (ed.) Von den Megatrends zum Geschäftserfolg - Was bedeuten Megatrends für das Management in der chemischen und pharmazeutischen Industrie in Deutschland*, pp. 5-7.

Utikal, H., Woth, J. (2017): Raus aus dem Silo, in: *Perspectives* (4), pp. 8-10.

Whitesides, G. M. (2015): Reinventing Chemistry, *Angewandte Chemie International Edition* (54), pp. 3196-3209.

Practitioner's Section

The future of German chemical sites: Potential pathways and organizational readiness

Introduction of a study design

Clara Hiemer* and Carsten Suntrop*

* CMC² GmbH, 50996 Köln, Germany, info@cmc-quadrat.de

Chemical sites are an integral part of the chemical industry in Germany. Therefore, it is obvious that the development from diversified to more specialized chemical companies will also lead to rising challenges for the chemical siting sector. Furthermore, chemical sites need to react to changes in the environment of chemical companies, such as the relocation of supply chains or intensifying EU regulations. As changes in the chemical industry require the adaptation of chemical sites, this article presents a study design to assess the status quo and the future challenges chemical sites will need to confront.

1 Introduction

The chemical industry is one of the most important sectors and it has a long tradition in Germany. But since the 1990s the structure of the chemical industry has changed considerably. About 20 years ago, the market was dominated by a few big diversified companies. Today, most of the companies are more specialized and smaller in terms of sales and employees. In 2006 about 93 % of chemical companies were small and medium-sized enterprises and this trend continues. Often those smaller chemical companies arose as units branching off from diversified companies in order to concentrate on core processes. A consequence of the concentration on core processes is the increasing outsourcing of infrastructure services and other site services to subsidiaries or external service providers. The multiplicity of interests at the chemical site and its many interfaces must be considered (Wildemann, 2016, Wildemann, 2009), and is presented in more detail in chapter 2.1.

Today, the chemical industry in Europe and especially in Germany faces many different challenges. The relocation of supply chains to regions with cheaper costs for raw materials, the increasing investments in regions with higher economic growth and the mounting regulations for the chemical industry in the EU are just some examples of challenges faced by the chemical industry (Vormann, 2016). Nevertheless, the chemical industry in Germany has one decisive competitive advantage in comparison to other regions: chemical sites. Using common supply and disposal structures, as well as purchasing resources and intermediates in the composite structure of chemical sites, generates synergies for the chemical companies located at the site. This offers a significant competitive advantage to chemical companies. Small, medium-sized and big chemical companies can focus on their core competencies, while the site and infrastructure services are offered by specialized service providers (Wildemann, 2016; Wildemann, 2013). Due to the changes of the structure of the chemical industry, chemical sites also changed profoundly over the past 15 years. They evolved from internal organization of the site to professionalized service providers. Today, they are a branch of industry in their own right and specialized operators and managers of chemical sites have become critical to the success of the industry as a whole. Chemical sites nowadays have separate conferences and working groups at VCI specifically for their own branch of industry.

Besides the challenges faced by the chemical industry, the chemical sites industry has its own challenges and threats, such as being an innovative and customer-oriented service company with core competencies in management of change and complexity. Different business models and the transfer of business models to other chemical sites are just some of the challenges chemical sites are currently facing (Suntrop, 2016).

Following this introduction, section 2 provides a definition of chemical sites, taking different perspectives into account. The difference between traditional industrial parks and chemical sites is presented, as well as site services and the future trends of the industry of chemical sites. Section 3 gives an overview of the study as well as the research focus: chemical sites. Also, the research design is presented in detail. For the assessment of the future development of chemical sites in section 4, five hypotheses are developed, which are based on key driving forces affecting chemical sites. In addition, twelve internal performance dimensions are presented, addressing different facets of chemical sites. Furthermore, the cost structure of chemical sites is differentiated. The three aspects, hypothesis, internal performance and site service costs, are the basis for the questionnaire design. A future outlook from the study results and the benefits arising for different stakeholder groups is given in section 5.

2 Chemical sites at a glance

2.1 Different perspectives on chemical sites

Since chemical sites bring together different stakeholder groups it is essential to describe the perspectives in more detail. In general, five perspectives need to be considered: Market of chemical sites, operators, customers, site managers and owners.

Figure 1 shows the different perspectives and their respective interests, requirements as well as their strategic challenges.

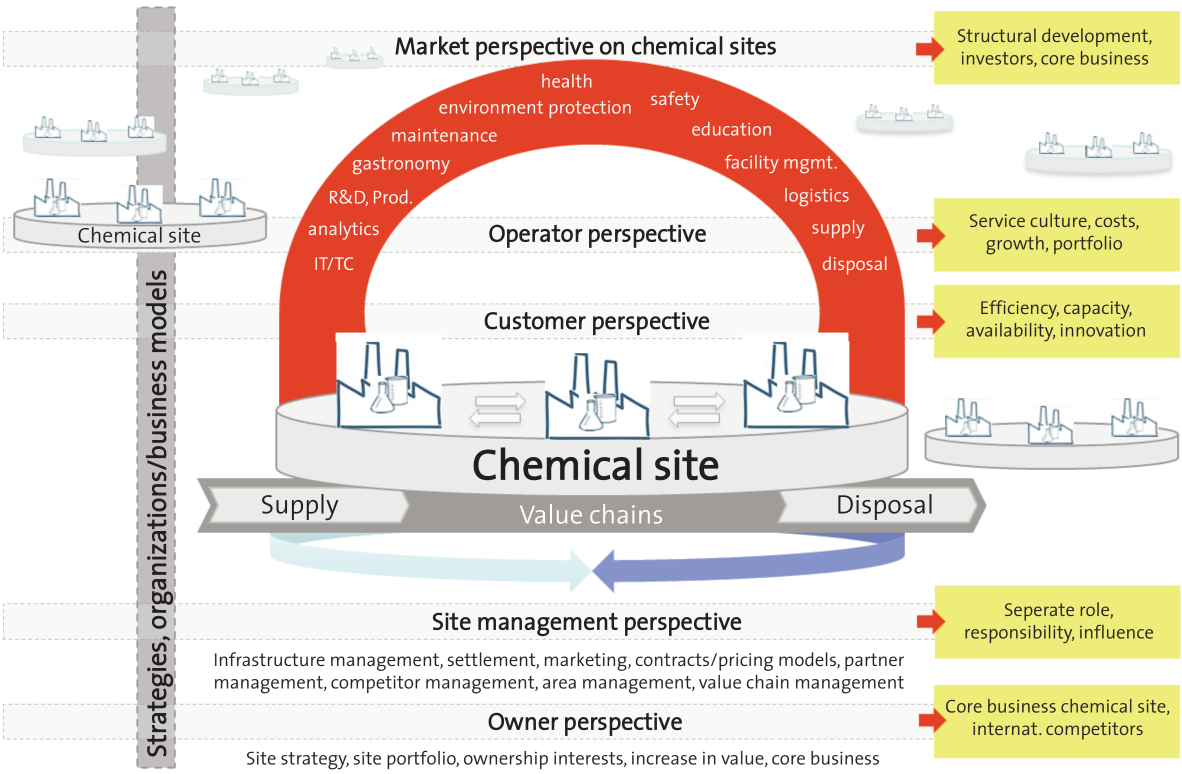
The market perspective on chemical sites as a whole focuses especially on structural development and the attraction of investors.

The customers, meaning the chemical companies at the site, buy the site services. They want to safeguard their management, marketing, research and production tasks as well as their inbound and outbound supply chains. They therefore deal with important matters of efficiency, capacity, availability and innovation.

The operator of the chemical site offers diverse site services (see figure 2 for examples). This is why establishing a service culture, having a clear service portfolio as well as low costs to guarantee an attractive price level are essential issues for the operator. In addition, the operator is interested in stability and the growth of his service business.

The manager of the chemical site bears the responsibility for the attractiveness and competitiveness of the chemical site. He has various tasks:

Figure 1 Different perspectives of chemical sites, adapted from: Suntrop (2016), p. 14



infrastructure management, settlement, marketing, contract and pricing models, partner management, competitor management, area management and value chain management.

The owner of the chemical park is responsible for the site strategy, site portfolio, ownership interests and increase in value – so he is interested in high capacity utilization and in the international competitiveness of the site (Suntrop, 2016).

Due to interlinkages between these different perspectives, many ideal types and visionary organizational structures as well as business models may arise. Chemical sites are applying a diverse set of business models to satisfy respective stakeholder groups. Considering the need for the integration of these different perspectives, chemical sites must develop systematic tools and measures to fulfil the multiple requirements of their stakeholders (Suntrop, 2016).

2.2 Definition of chemical sites

In order to consolidate the perspectives introduced above, a comprehensive definition of chemical sites is presented. Therefore, a chemical site is primarily defined according to the following criteria:

- A chemical site is a geographical cluster of legally independent chemical suppliers and chemical/industrial consumers (chemical industry in the following value-added stages: petro, basic, specialty and agro chemicals).
- At chemical sites, hazardous and non-hazardous substances are produced, researched and marketed from predominantly limited-access locations.
- Multiple services such as the supply of media, disposal of waste and wastewater, maintenance, logistics, basic infrastructure, facility management, health-, safety-, environmental- and quality-management, safety, analytics, education, social services and administration ensure the effective and efficient processing of supply chains located at the chemical site.
- The manager of the chemical site controls the high and sustainable market attractiveness of the site.
- Due to the effective and efficient processing of supply chains the owner of the chemical site can secure the capital employed for infrastructure and areas of the chemical site in the long run.
- All this happens according to each individual history of development at each chemical site (owner, products, contaminated waste, location, network) (Suntrop, 2016).

2.3 The difference between traditional industrial parks and chemical sites

The main difference between traditional industrial parks and chemical sites is that chemical sites are connected at all levels. The companies that are located on the chemical site make it a functional and logistic entity. There are synergies and network effects that are a unique feature of chemical sites (Grigat, 2016).

The formation of chemical sites has been a real success model for Germany as a business location. Nevertheless, professionalization of services, strict segregation of the core business and the strategic orientation of the different chemical sites indicate potential for improvement in the future. Small chemical sites in particular have only just started to work with external companies and open up to the competitive environment. They lag behind in developing themselves into professional and competitive sites (Wildemann, 2016).

2.4 Site services – a market alongside chemical sites

A service industry has arisen around chemical and industrial sites. This industry is a multimillion dollar market in a major state of flux. Figure 2 shows the main areas of service offered to companies.

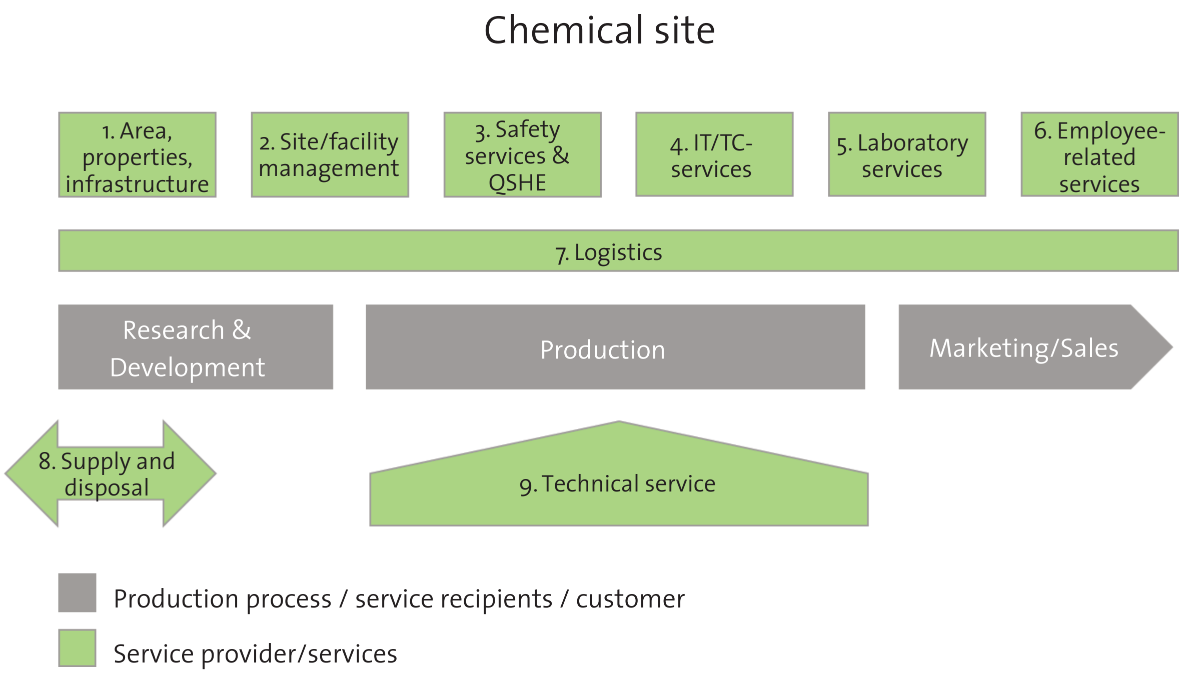
Site services are diverse. Everything that does not directly contribute to the production of intermediate or end products can be classed as (industrial site) services. Because of the wide range of site services, services are clustered into nine categories (please also see figure 2):

1. letting and leasing of area, properties and infrastructure,
2. services concerning site / facility management,
3. safety services and QSHE (quality, safety, health, environment),
4. IT and TC (telecommunication) services,
5. laboratory services,
6. employee-related services,
7. logistical services,
8. supply and disposal services and
9. technical services.

Only the letting and leasing of area, properties and infrastructure, most supply and disposal services, and some safety services are so-called site-dependent services. Fundamentally, all other services can be offered site-independently.

Since service providers at chemical sites are competing with other companies in this growing market it is vitally important to apply the right business models.

Figure 2 Categories of services in chemical parks, adapted from: Fröhling and Schnell (2016), p. 94



From diversified full-line suppliers to highly specialized industrial service providers and from providers that are not mobile to ones that are – everything can be found.

Some service providers are still bound to their customers due to their ownership structure.

One current trend is the backward integration of the service organizations into the companies, e.g. Dow, Evonik and Lanxess (Fröhling and Schnell, 2016).

Different levers can be used to optimize site services: Strategic reviews regarding the in- or outsourcing of services, active management of demand and an optimized management of the overall process, which develops from an isolated view to a broad perspective. Optimization of site services can lead to cost reduction and an improvement of the competitive situation (Hofmann and Michel, 2016).

What should be pursued in addition to this is a fully automated, digital chemical site that has highly integrated energy and material cycles and good transport connections.

2.5 The chemical industry is changing

Specialization, staggered supply chains, multiregional global competition, turnaround in energy policy – these are just a few examples that drive changes in the chemical industry. Due to a lack of natural resources in Germany and Europe only a specialization of technical and highly valuable products make the decisive difference. The high-performance infrastructure of chemical sites offers a good prerequisite for enabling innovative chemical products and processes to be successful in the world market. However, the industry has to help shape these changes that begin at the grassroots (Mathies, 2016).

Therefore, the following section presents a study design which aims to outline a picture of the future of the market of chemical sites; which requirements chemical sites have to meet in the future and how their actual performance can be measured today.

3 Study design

3.1 Overview of the study

Our study focuses on the industry of chemical sites located in Germany. As such, the market of chemical sites is surveyed with the intention of creating transparency and supporting the future development of the industry and the market players in responding to upcoming challenges. As a starting point for the study, chemical sites are described in more detail. Secondly, the future of chemical sites is described, and thirdly, the performance of chemical sites is analyzed by applying 12 identified performance indicators. Analysis of the study results will provide the additional benefits of enabling identification of points where there is need for action, possible action strategies, and market potential.

The study aims to answer the following research questions:

1 What is the future development of the industry of chemical sites?
2 What requirements will chemical sites have to meet in the future?
3 What is the degree of fulfillment of those requirements today?
4 What is the overall performance of chemical sites?
5 What are the challenges faced by the market of chemical sites?

3.2 The research focus: chemical sites

As already mentioned, this study focuses upon chemical sites. In the following, the research object is further characterized to set a clear scope for our study:

- Region: Germany
- Industry: Sites that focus on the chemical and processing industry.
- Site structure: Multi-user sites are the object of the study, where several legally independent companies are located on each site. So, different manufacturing companies use the infrastructure jointly. It might be possible to transfer the operation of the site to one institutional unit.
- Operator of the chemical site: The provider for at least one operator service (e.g. supply) is organizationally defined.
- Manager of the chemical site: Management responsibility for site development and business is identified according to all stakeholders.

3.3 Presentation of the research design

The first step of the study is the collection and consolidation of information about the participating chemical sites. In general, the information is differentiated according to three dimensions comprising a set of criteria.

The first dimension "Site" mainly focuses on information about the site itself by collecting predominant facts like the area in which the site is operating, the number of customers and employees or the generated revenue.

The second dimension "Site operations" is more focused on the services provided at the site. Therefore, in particular qualitative information about, for example, the supply, waste and facility management, technical services, as well as the chemical services, are analyzed.

The third dimension "Site management" explains the competitive and sustainable development of the chemical site in more detail by collecting, for example, information about the settling of new customers.

A detailed overview of the research criteria is also shown in table 1.

The second step of the study aims to conduct quantitative and qualitative data collection from different site stakeholders. The starting point is the identification of driving forces and requirements affecting chemical sites and their future development. This information forms the basis to develop appropriate hypotheses on relevant topics, which are the focus of the data collection. Furthermore, twelve performance indicators are used to assess the internal performance of the organization (see the following section 4).

Basically, the study is conducted in a two-step approach (see figure 3). First, managing directors of chemical companies at the site, managing directors of chemical site service providers, heads of site development and site management, project developers of chemical sites, heads of business development at the site, shareholders of the site and external experts will be asked to participate in an online survey. The results will show the perspective of the participants on the future development as well as potential requirements. Furthermore, the developed hypotheses can be verified or falsified. In the online survey, the participants will also assess the internal performance of the sites by answering questions on the twelve performance indicators (see figure 4).

Second, in-depth interviews will be conducted with some of the participants to receive more qualitative statements and deep-dive insights about the upcoming challenges of the future. In this way, the results from the first step can be verified and they can also be researched in more detail.

4. Hypotheses development

4.1 Driving forces for future development

The general definition of the chemical site as well as the different stakeholder groups were presented in section 2. The identification of driving forces is partly based on this definition and also on current global trends in the chemical industry. In

Table 1 Three dimensions to describe chemical sites

1 Site	Area Location Permission Number and quality of customers Employees Revenue Responsibility [Owner]
2 Site operation	Provider of infrastructure service (supply, waste and facility management, technical services, safety, logistics, chemical services) Responsibility [Operator of the chemical park]
3 Site management	Development of site (infrastructure, group) Settling of new customers Provider of basic services (safety) Provider of basic chemical products Responsibility [Manager of the chemical park]

total, six driving forces are presented and the influence on chemical sites is explained in more detail.

Internationalization
Global chemical production has an average growth of 3.4 % in the forecasting horizon from 2015/16 till 2030. But 60 % of the total growth applies to China, while the average growth of German chemical production is only 1.5 % (VCI, 2016). The internationalization of chemical companies is therefore still of great importance. Chemical companies can benefit from higher growth rates abroad.

Nowadays, most German chemical companies are already operating on a global level and the trend to exploit markets in emerging countries is still ongoing. Therefore, internationalization is one factor that could potentially affect the future development of chemical sites.

Competitive environment
The literature on the chemical industry assumes that between 2015 and 2035 the growth of the European industry will lag far behind in comparison to the growth of the global chemical industry (Schulz et al., 2012; Keller et al., 2015). On the one hand this emphasizes that the competition will increase and on the other hand it gives a first indication of the necessity for chemical sites to adapt to those changes.

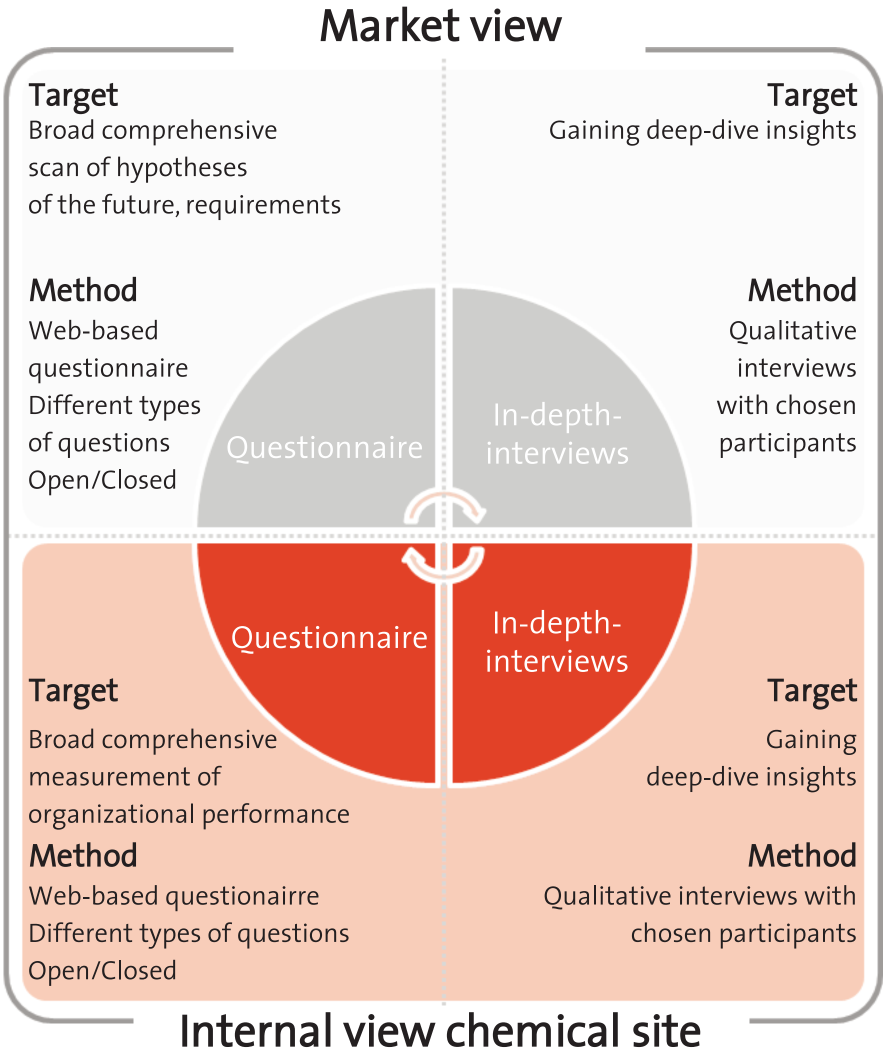
The cost structure is still one decisive factor influencing a consumers' decision. Therefore, chemical companies need to realign their efficiency management by using so far unused capacities.

Customer demands
Considering the current trends in the chemical industry, service providers at chemical sites are facing various challenges. The digitalization of chemical sites, for example, challenges the service providers to implement new services to meet the changing demands. The cost needs to be controlled at the same time as the product portfolio is extended.

Ownership
The owner of a chemical site is not necessarily the service provider. There are different options to organize the ownership. First, the biggest user is the sole owner of the site (e.g. Chempark, Industriepark Walsrode, Heraeus, Evonik Marl/Wolfgang). Second, there are several producers operating at the site, and they have shared ownership (e.g. Höchst, Gendorf, Knapsack, Wiesbaden, Chemipark Leuna). Third, the chemical site is assigned to an external investor (e.g. ThyssenKrupp-Xervon at Köln-Merkenich, Münchsmünster) (Pruys, 2011). The leadership as well as the structure of the sites vary slightly according to the ownership of the chemical site.

Innovation capability
One aspect important for the attraction of customers to chemical sites is the interdisciplinary and

Figure 3 Data collection to receive information about the market development and the internal organizational performance of the chemical sites



innovative environment. Chemical sites provide companies with different specializations the opportunity to establish various forms of cooperation (VCI., 2013; Leker and Golembiewski, 2015). As such, corporations can increase their innovation performance by conducting research across industries and disciplines.

4.2 Hypotheses

The previous two sections presented and set the foundation on which the following five hypotheses are built:

Hypothesis 1:
As production sites of chemical companies have partly relocated to Asian countries and overall internationalization continues, the management of chemical sites must consider the opportunity of offering services abroad. Thus, the service providers of chemical sites will need to expand their businesses globally to stay competitive in the changing environment, to exploit emerging markets and to benefit from international growth. As such, the set-up of the strategy and the structure of chemical sites are decisive for their future development.

Hypothesis 2:
The cost and efficiency pressures on service providers at chemical sites will steadily increase. Therefore, there is a need to create more cost transparency throughout the industry of chemical sites and work on progressive cost reduction. This means that chemical sites need to analyze their cost structure and adjust it to stay competitive.

Hypothesis 3:
The competition between chemical sites for attracting new industrial settlements will increase. Hence, chemical sites have to align their business models so that they have a consistent focus.

Hypothesis 4:
The ownership of the chemical site will have an effect on the strategy pursued and therefore on future development. Being simultaneously both producer (user/ customer) and owner of a chemical site is an interrelated doubling of roles. This impedes the entrepreneurial responsibility and the business alignment of chemical sites.

A clear positioning as an internal service center would often be more consistent if the core business of the owner remains producing chemistry. On the other hand, the operation of the site could be the core competence of the owner, with the development of the site and the increase of its value being the main aims. The positioning of the owner therefore needs to be clearly aligned.

Hypothesis 5:
The innovation culture of chemical sites will have a decisive impact on the attraction of stakeholder groups (e.g. customers and investors). Thus, chemical sites need to set a clear strategic focus, for example by also attracting downstream industries. They have to ease research efforts across different industries and disciplines.

4.3 Internal performance

Measuring the internal performance and creating transparency of site service costs will make it possible to assess how competitive and future-oriented chemical sites already are.

4.3.1 Performance dimensions

To measure the internal performance of an organization, the tool presented in figure 4 is used. This tool represents a systemic and constructivist view of organizations, meaning that organizations are seen from different perspectives. It is shaped by change management and strategy management concepts as well as by practical experiences. This tool can also be used for discussions about cooperation and acquisitions or as a guide for company expansion and restructuration. It consists of twelve indicators.

The twelve performance indicators are shown in figure 4. Furthermore, the indicators are assigned to four subordinate topics: Enabling future, Creating value, Learning and renewing, Interacting socially. The presented dimensions ensure the performance of an organization in the long-term and are therefore important for the future development of chemical sites. The performance indicators are measured in percentages. A performance indicator that is valued at 100 % works perfectly, while a performance indicator that is valued at 0 % is very poor. All indicators are measured in the same unit so that the total performance can be calculated.

The performance indicators show the fields in which the chemical site is already well-positioned and the fields in which actions are required in order to meet previously identified future challenges.

The first dimension Enabling future comprises the performance indicators: Strategy, Leadership and Structure. By assessing the status quo of those three indicators the participants draw a picture of the current capability of the organization to be future-proof.

The second dimension Creating value mainly focuses on: Finance, Processes and Customers. When assessed by the participants, those indicators reveal how well the organization creates value and meet the needs of its customers.

The third dimension Learning and renewing assesses the performance in the fields: Innovation, Creation and Learning. These indicators evaluate the capabilities of the organization to adapt to its environment, to develop and to renew itself.

The fourth dimension Interacting socially deals with the different levels of social relationships as well as working conditions within the organization: Team, Employees and Culture. These indicators focus on communication and individual development (Muhler and Suntrop, 2016).

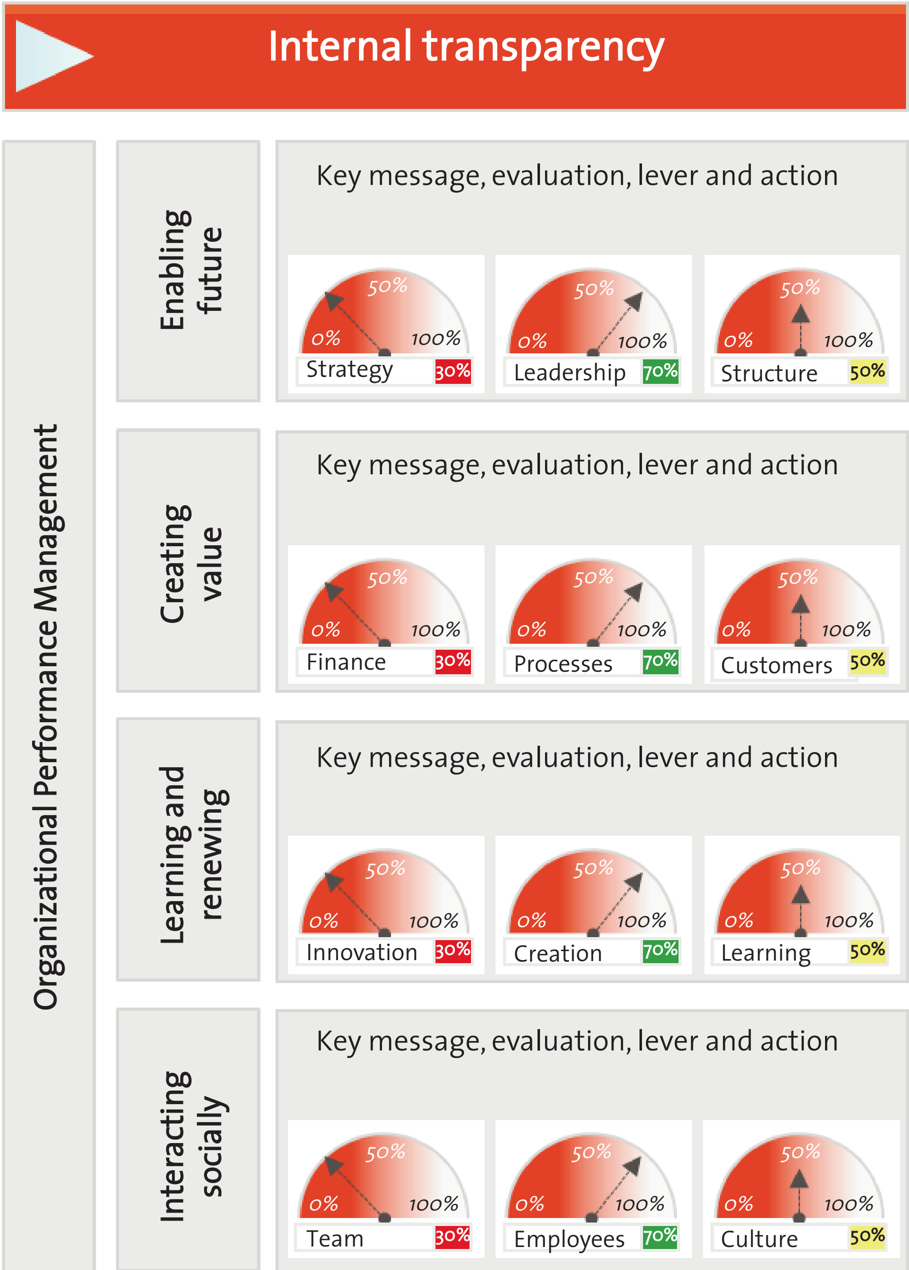
4.3.2 Transparency of site service costs

Another and additional claim of the study is a comparison of site service costs at different chemical sites. This is to increase the transparency of the cost structure at each chemical site and to give sites the opportunity to see how competitive they are when they compare their cost structure with other sites. To keep current customers and to attract new ones it is crucial to know whether the service costs are more or less expensive than at other sites.

Figure 5 shows the cost share of site services from the point of view of the customer.

In figure 5 site services are divided into supply services, e.g. energy and steam supply; disposal services; safety/ site services, e.g. works fire brigade; technical services; logistical services; and other services. As part of the data collection, the absolute costs of all these services at different chemical sites in Germany should be identified. In this way each chemical site gains an insight into its cost structure.

Figure 4 Overview of the performance dimensions, adapted from: Suntrop (2016), p. 30



Because the size of chemical sites varies a lot and therefore the service costs will vary, a relative figure to enable comparison of service costs at different sites is also needed. Therefore, the different service costs will be set for example in relation to full time employees and to the size of the chemical site. If the relative costs of several chemical sites are received, it will be possible to compare different chemical sites in terms of their service costs. That information can be used by the sites to evaluate their own competitiveness.

5. Future outlook towards the study results

The intended outcome of the study is on the one hand to assess the status quo and on the other hand to assess the future development of chemical sites. The results of the survey will create deep-

Figure 5 Cost share of site services, adapted from: Suntrop (2016), p. 22

Supply services	Disposal services	Safety/Site services	Technical services	Logistical services	Other services
Electricity Process Steam Process and Drinking Water Industrial Gases	Environmental Management Waste Water Waste Treatment and Removal	Basic Infrastructure Facility Mgmt. Site Security Safety incl. Fire Prevention & Fire Protection General Site Management	Electrical and Mechanical Maintenance and Repair Technical Warehouse Engineering Contractor Management	Transport Storage Supply and logistics planning Production logistics	Analytics IT Canteen Medical Training Purchasing Quality
Share of Site Service Cost					
60-80 %	10-15 %	5-8 %	5-8 %	5-8 %	1-3 %

er insights and greater transparency of the market of chemical sites. Therefore, the participants of the study will receive the results and may use them for benchmarking purposes in the sector. The benefits arising from this will be to provide a showcase of the state of the sector, evidence of the need for action, the development of action strategies as well as the assessment of the market potential.

For sure, the quality of the study as well as the resulting statements will depend on the quantity of participating sites and the quantity of individuals employed at the chemical sites respectively. This is a crucial factor in attaining a more or less complete picture of the chemical sites market. Also, the assumptions concerning future development will be analyzed by aggregating them to receive a comprehensive overview which will challenge chemical sites to confront the requirements of the future. In addition, the study will identify the gap between the present performance and future requirements.

One limitation of the study will be the transfer of the individual results. As the questionnaire assesses the internal performance of each individual chemical site, the results can hardly be transferred to other chemical sites or markets in other countries without considering specific environmental conditions. The statements from the individual sites will need to be consolidated in order to represent the average performance of the market within which the sites can be compared.

Considering the different stakeholder groups of chemical sites as stated at the beginning of the article (please see section 2), the benefits can be expanded upon as follows:

The operator of the chemical site obtains transparency of the competitive environment of sites, a comparison of business models and strategic directions, a categorization of the development process and content for his business strategy.

The manager of the chemical site obtains a comparison of business models in terms of site management, as well as concepts for cooperation and differentiation models. The owner of the chemical site may benefit from the insight into transparent market development and may thus develop useful strategies regarding investments and courses of action.

For consultancies, the study offers market information for strategic and organizational projects of site operators and managers in the chemical industry.

The study may also provide a basis for innovative models in the industry of infrastructure providers within universities.

The study should be repeated in a continuous manner in order to assess performance improvements as well as the adaptation of chemical sites to future challenges. Furthermore, it is important for chemical sites to assess whether future prognoses have changed after a certain period of time, so that they can audit their strategic orientation and applied business models accordingly.

References

Fröhling, B., Schnell, M. (2016): Industriedienstleistungen im Umfeld der Chemie- und Industrieparks, in: Suntrop, C. (ed.), *Chemiestandorte – Markt, Herausforderungen und Geschäftsmodelle, WILEY-VCH Verlag*, Weinheim, pp. 83 - 115.

Grigat, E. (2016): Erhöhung der Attraktivität eines Chemiestandortverbundes am Beispiel von CHEMPARK – Verbundstrukturen von Chemiestandorten – Bedeutung und Entwicklungsperspektiven, in: Suntrop, C. (ed.), *Chemiestandorte – Markt, Herausforderungen und Geschäftsmodelle*, WILEY-VCH Verlag, Weinheim, pp. 141 - 153.

Hofmann, C., Michel, C. (2016): Standortdienstleistungen in der chemischen Industrie als Wettbewerbsfaktor, in: Suntrop, C. (ed.), *Chemiestandorte – Markt, Herausforderungen und Geschäftsmodelle*, WILEY-VCH Verlag, Weinheim, pp. 179 - 191.

Keller, A., Belderok, A., Douma, E., Kühner, S. (2015): *CHEMICALS 2035 – GEARING UP FOR GROWTH*, Roland Berger Strategy Consultants, Munich.

Leker, J., Golembiewski, B. (2015): *Disziplinübergreifende Innovationen in der chemischen Industrie, in: Von den Megatrends zum Geschäftserfolg*, eine Studie in Kooperation von: VCI Verband der Chemischen Industrie, Westfälische Wilhelms-Universität Münster, Provadis Hochschule, PwC Strategy&, pp.23 - 24.

Mathies, C. (2016): Chemiekomplexe in ihrer historischen Entwicklung und Trends in der Entwicklung von Chemiestandorten, in: Suntrop, C. (ed.), *Chemiestandorte – Markt, Herausforderungen und Geschäftsmodelle*, WILEY-VCH Verlag, Weinheim, pp.61 - 82.

Muhler, B., Suntrop, C. (2016): *Workshop Unternehmensentwicklung – in sechs Schritten zur leistungsfähigen Organisation*, Schäffer Poeschel Verlag, Stuttgart.

VCI. (2016): *Die deutsche chemische Industrie 2030 - Update 2015/2016, VCI-Prognos-Studie*, available at https://www.vci.de/services/publikationen/broschueren-faltblaetter/vci-prognos-studie-die-deutsche-chemische-industrie-2030-update-2015-2016.jsp, accessed 12 February 2017.

VCI. (2013): *Die deutsche chemische Industrie 2030, VCI-Prognos-Studie*, available at https://www.vci.de/services/publikationen/broschueren-faltblaetter/detailseite-12-21.jsp, accessed 12 February 2017.

Pruys, O. (2011): *Evolution der Chemieparks*, available at http://www.chemanager-online.com/themen/industriestandorte/evolution-der-chemieparks, accessed 06 January 2017.

Schulz, O., Forrest, R., Rings, T., von Hoyningen-Huene, J. (2012): *Chemical Industry Vision 2030: A European perspective*, AT Kearney.

Suntrop, C. (2016): Chemiestandortperspektiven und –strategien, in: C. Suntrop (ed.), *Chemiestandorte – Markt, Herausforderungen und Geschäftsmodelle*, WILEY-VCH Verlag, Weinheim, pp.3 - 31 .

VCI (2017): *Welcome to the homepage of the German chemical parks*, available at http://www.chemicalparks.com/Seiten/default.aspx, accessed 07 February 2017.

Vormann, J. (2016): Vorwort, in: Suntrop, C. (ed.), *Chemiestandorte – Markt, Herausforderungen und Geschäftsmodelle*, WILEY-VCH Verlag, Weinheim, pp.XV - XVI.

Wildemann, H. (2016): Das Chemieparkkonzept – Ein Modell mit Zukunft, in: Suntrop, C. (ed.), *Chemiestandorte – Markt, Herausforderungen und Geschäftsmodelle*, WILEY-VCH Verlag, Weinheim, pp.35 – 59.

Wildemann, H. (2013): *Chemieparks – Organisationsstrukturen, Geschäftsmodelle und Erfolgsfaktoren*, TCW-Verlag, München.

Wildemann, H. (2009): *Die Zukunft des Chemiestandorts Deutschland*, TCW-Verlag, München.

Commentary

Successful management of chemical sites: A challenge for management theory and practice

Comments on the article: "The future of German chemical sites: Potential pathways and organizational readiness." by Clara Hiemer and Carsten Suntrop

Jürgen Vormann*

* Infraserv GmbH & Co. Höchst KG, 65926 Frankfurt am Main, www.infraserv.com

The question of how to organize and manage chemical sites is as old as the Chemical industry itself. It gained new importance approximately 25 years ago when the British Imperial Chemical Industries (ICI) finalized its corporate transformation process in the early 1990s. Part of this reorganization included a new organizational structure and a new business model for chemical production sites. The German Hoechst AG followed swiftly in the mid 1990s with a new corporate structure that was subsequently copied by quite a few of its German and international competitors. In both of these cases, new answers had been found concerning how to organize and develop the chemical sites of multinational players: Legally separated site service companies were created under the roof of a corporate holding company, providing infrastructure services to a number of independent operational tenants at various sites. Some of these operational tenants belonged to the same corporate structure, some of them were third parties. The underlying rationale behind this new structure was to bring a "market orientation" into the management of production sites, to make information on site- and management performance more transparent, to significantly increase flexibility so as to adjust business portfolios and to reduce operational costs. In the case of Hoechst AG, the hollowed-out site service companies also became the owners not only of the infrastructure assets (e.g. the waste management facilities, the energy production facilities), but also of the land upon which their respective sites were based. Even though these restructurings received a lot of public attention, in general the vast majority of chemical companies have retained the established structure of integrated chemical site infrastructure and services to this day.

These developments already hint at the fact that there is no one single model for organizing and steering chemical sites successfully. Analyzing the benefits of alternative organizational and business models for chemical sites, coming up with root-cause relations and formulating hypotheses about the developments of chemical sites over time are therefore important tasks for a practice-oriented management theory in the context of the chemical industry. Managers of the approximately 60 industrial parks in Germany (see German trade and invest description), as well the site operators of the hundreds of different production plants in Germany, are continuously looking for the best solution for fulfilling safety, security, quality, costs, environmental and flexibility requirements by optimizing their chemical sites and site management. They stand to benefit from scientific insights on successful site management approaches and are also potential research partners.

Pathways within the chemical industry in general are an interesting scientific topic from a historical, technical and economical point of view. Chandler (2005) has done valuable work in analyzing the business models of chemical companies over time (Chandler, A. D. (2005): Shaping the Industrial Century. The remarkable story of the evolution of the modern chemical and pharmaceutical industries. Harvard University Press. Cambridge). A comparable work analyzing management approaches of chemical sites is still missing. In their article, "The future of German Chemical Sites: Potential pathways and organizational readiness", Clara Hiemer and Carsten Suntrop present a study design with which to assess the status quo and the future challenges chemical sites might need to confront. They define a chemical site as “a geographical cluster of legally independent chemical suppliers/industrial consumers”. The article provides a brief introduction to the topic by describing potential pathways of the global chemical industry, highlighting potential development paths for the management of chemical sites and outlining some of the internal prerequisites chemical site managers need to fulfil in order to prepare for future challenges.

The authors select a “multi-faceted” definition of chemical sites and consider the perspectives of different stakeholder groups. This approach sheds light on the role of stakeholders and the influences they have.

In their research design they distinguish between a market view (What are the external driving forces shaping the chemical industry and having an impact on successful chemical site management?) and an internal view of chemical sites (To what degree is a chemical site ready to take on the identified challenges?).The authors propose a multi-method approach to analyzing the strategic developments in the site management of the chemical industry: First, they intend to collect and consolidate information about participating chemical sites. Second, they intend to conduct quantitative and qualitative data collection from different stakeholders. Through an online-survey they intend to ask participants about their opinion on different potential developments for the chemical industry and their implications for chemical sites. Face to face interviews are planned with selected participants.

From a management perspective it is highly interesting to gain an in-depth understanding of the rationale behind the different business models implemented at chemical sites. A transparent overview of chemical sites in Germany could be a first step in an effort to obtain an overview of competing business models and their growth potential over time. Hiemer and Suntrop propose a large-scale online survey and selected interviews to analyze strategic developments in site management of the chemical industry. Whilst these data sources may provide interesting insights, I would propose adjusting and complementing the approach by having dedicated in-depth case studies and historical studies. These additional methods would help to identify development patterns over time and allow an explicit outline of the underlying root-cause assumptions that lead to management decisions. The insights derived from this approach could serve as a reliable basis for practitioners in formulating their own assumptions about the future development of the chemical industry, the requirements successful chemical sites need to fulfil in the future as well as guidelines for each action. The results would have to respect and take into consideration the highly distinct perspectives held by investors, site operators and -owners or managers.

With regard to the “internal readiness” of chemical sites to pursue successful site management strategies, Hiemer and Suntrop propose an in-depth analysis of the cost structure of chemical sites. They intend to gather this information through the aforementioned online survey, but also by conducting additional personal interviews. Instead I would propose the gathering of information by way of an independent and professional service provider in cooperation with the “Fachvereinigung Chemieparks” of the German Chemical Manufacturers Association (VCI). The Fachvereinigung is currently discussing a state-of-the-art benchmarking study to identify and share the relevant information within a group of panel-participants on an anonymized basis in a longitudinal study. In my experience, reliable cost information is not easily gathered in large-scale online surveys. In contrast, in a community with a common interest – such as the Fachvereinigung– the probability of gathering high quality information would in all likelihood be higher as the participant companies would have a higher level of commitment to the study (which they commissioned themselves) in comparison with an online survey. In general, the results from benchmarking chemical sites in Germany could support site operators or managers in their day-to-day business by strengthening their competitive position and increasing their attractiveness for chemical companies.

A scientific analysis of the structural changes of chemical sites over the past decades alongside the general development of the chemical industry might also consider the following questions:

- Which criteria drive regional investment decisions in the chemical industry – and how are these criteria changing over time? What makes them change?
- What are the implications of changing regional investment decisions with regards to the required infrastructure in terms of size, location, service portfolio, ownership structure, etc. for existing sites and new sites?
- Which criteria determine make-or-buy decisions in the chemical industry – in particular with regard to infrastructure and infrastructure related services?
- Which considerations are needed to properly evaluate competing management models for chemical site managers/operators (organizational rules vs. market mechanism)?

- Who is the "rightful" owner of the infrastructure of a chemical site – and why?
- Is there a useful lifespan of chemical sites – and how is it determined?

The questions above represent an additional set of topics which also need to be considered when addressing possible future pathways of chemical sites. Answers to these questions might help managers of chemical sites (operators, investors) to identify future areas of interest or suitable pathways for chemical sites. In order to address these questions appropriately, a broad coalition of actors is needed: Companies need to share their own reflections on successful chemical site management. Researchers need to apply a broad range of quantitative and qualitative research methods – ranging from historical case studies, to expert interviews and large-scale surveys. And industry associations need to create a supportive environment for open discussion of research approaches and findings. From my point of view, finding answers to these questions is well worth the effort.

References

Chandler, A. D. (2005): *Shaping the Industrial Century. The remarkable story of the evolution of the modern chemical and pharmaceutical industries*, Harvard University Press, Cambridge.

Submission guidelines

Manuscripts may be submitted for consideration as research papers, papers for the practitioner's section or as commentaries.

All submitted manuscripts should contain original research not previously published and not under consideration for publication elsewhere. Papers may come from any country but must be written in American English.

Initial Submission

Authors are required to submit manuscripts via e-mail (submit@businesschemistry.org). Please prepare the text in Microsoft Word or rtf-format. When submitting a manuscript, please include the following information:

- Information about the authors (affiliation, postal address, e-mail address)
- Tables and graphics separately in jpg-format (high quality), Microsoft Excel or Powerpoint.

Additionally, please stick to the formal requirements presented below, especially concerning citations and graphics. Manuscripts disregarding the guidelines may be returned for revision prior to any reviewing activity.

Organization of the manuscript

Manuscripts can be arranged in the following order:

- Title, author(s), and complete name(s) of institution(s), corresponding author's e-mail address
- Abstract
- Introduction
- Methods
- Results
- Discussion
- References

These guidelines are, however, flexible, especially for case studies. To structure your manuscript, please try to restrict yourself to a maximum of three levels of headlines.

References and footnotes

The authors are fully responsible for the accuracy of the references. Citations in the text contain only authors' names and date of publication [e.g. (Leker, 2001), (Bröring and Leker, 2006) or (Bröring et al., 2006) when three or more authors]. Full references have to be included at the end of the paper in alphabetical order. For more information on the reference style, please visit www.businesschemistry.org.

Tables and figures

Tables must have titles and sufficient empirical detail in a legend immediately following the title to be understandable without reference to the text. Each column in a table must have a heading, and abbreviations, when necessary, should be defined in the legend. Please number the tables. Figures should have titles and explanatory legends containing sufficient detail to make the figure easily understood. Appropriately sized numbers, letters, and symbols should be used. The abscissa and ordinate should be clearly labeled with appropriately sized type.

Revision

Revise text in Microsoft Word. Revise graphics at publication quality resolution. You may submit the revised manuscript as a single Microsoft Word document. Please send the revised manuscript via e-mail to the Editor who contacted you. You will need:

- Your submission number
- A cover letter with information for the Executive Editor and responses to raised concerns
- The revised manuscript.

Publication

The Executive Editor responsible for your submission might ask you to change the format of your files in order to publish it. If the manuscript does not fulfill the formal requirements, the paper might be denied publication.

Comments

More information can be found on www.businesschemistry.org. If you have any further questions or comments you are welcome to contact us at contact@businesschemistry.org.

Thank you for your contribution!

ISSN 1613-9623

Journal of Business Chemistry | www.businesschemistry.org | ISSN 1613-9623