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Letter from the Editors

Challenging the impacts of climate change

In order to reply to the consequences of the climate change, agendas and initiatives have been introduced to align business strategies and activities with the natural environment. The chemical industry tries to counteract their bad reputation as a high pollution sector by voluntarily reporting on environmental indicators and initiating programs like *Responsible Care*, *SusChem* or *Chem*[3]. However, the implementation of these strategies represents a major challenge and a lot of open questions remain. When will environmentally friendly products and technologies be competitive to established ones? How can chemical companies and related industry actors accelerate the reduction of raw material use and emissions? Some insights contributing to the future orientation and organization of the chemical sector are presented in the present issue of the Journal of Business Chemistry.

The research paper of the present issue “Impacts of the REACH candidate list of substances subject to authorisation: The reputation mechanism and empirical results on behavioral adaptations of German supply chain actors” is written by Guido Grunwald and Philipp Hennig. On the basis of behavioral psychology theories, the authors develop hypotheses in order to analyze the effects of the so-called candidate list on manufacturers, users and distributors of chemicals. More precise, the authors discuss how the inclusion of chemical substances of very high concern into the authorisation list of the EU chemicals regulation affects the risk communication and reputation of supply chain actors on the basis of a survey conducted by the European Commission.

The first article of our Practitioner’s Section “On the current practice of New Business Development in the German chemical industry” by Thorsten Daubenfeld, Thorsten Bergmann, Niklas Frank and Lisa Weidenfeld provides insights into the current practice of New Business Development, including its corresponding objectives and organizational setup. Based on a survey among managers of various chemical companies and related business sectors, New Business Development appears to be a heterogeneous subject in the chemical industry. The study, for instance, outlines that structural differences of New Business Development setups are caused by firm size.

The paper by Tobias Viere *et al.* “Integrated Resource Efficiency Analysis for Reducing Climate Impacts in the Chemical Industry” describes the approach of an interdisciplinary research project to identify possibilities aiming at improving the resource efficiency of chemical production systems. The comprehensive resource efficiency analysis developed is characterized by an IT-based platform integrating various methods and tools such as material flow cost accounting to enable a simulation-based material flow network optimization. The authors highlight the importance and benefits of their approach by illustrating exemplary cases at chemical production sites.

In the article “Account Management 2.0: From Silo Thinking to Integrated Account Development”, Ralf Schmidt and Olaf Lange introduce a double loop process of account management. This new perspective on account management considers cultural-psychological factors of organizational development that have a massive impact on the success of account management. By applying the double loop process, firms specifically develop and implement customer-based strategies and, in so doing, benefit from the customer- and profit-oriented alignment of internal decision-making processes.

Please enjoy reading the second issue of the eleventh 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.

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Research Paper

Impacts of the REACH candidate list of substances subject to authorisation: The reputation mechanism and empirical results on behavioral adaptations of German supply chain actors

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The candidate list of substances subject to authorisation is an instrument provided by the EU chemicals regulation (REACH) to publicly announce and prioritize chemical substances of very high concern (SVHC) as a first step of imposing an obligation of authorisation on them, i.e. including them into the authorisation list (Annex XIV of REACH). As a consequence of inclusion into the "candidate list", a variety of obligations concerned with intensifying risk communication apply. Article producers, importers and distributors of articles have to communicate information about SVHCs contained in articles and necessary risk management measures to the recipients of the articles and provide this information to consumers on request (Art. 33 REACH). This research paper analyzes the reputational mechanism of the candidate list showing a potential to stigmatize not only the substances as such but also various actors of the supply chain associated with these substances and their brands. Drawing on behavioral psychology theories, hypotheses on the reputational impacts of the candidate list on substance manufacturers, downstream users (including formulators and manufacturers of articles) and distributors are derived. These are discussed on the basis of current empirical data surveyed by the European Commission.

1 Introduction

The safe use of chemicals, other than for chemicals used for medicines or pesticides and biocides, is normally ensured by other means than a formal and necessarily quite bureaucratic authorisation. Hence, the authorisation procedure under REACH – the EU chemicals regulation (Regulation (EC) No 1907/2006) – is intended for substances of very high concern (SVHC). Only these substances with specific intrinsic properties which are particularly hazardous to human health or the environment may be subject to authorisation under REACH. Examples for SVHCs are metals such as lead or cadmium being used in batteries, plastic softeners like DEHP e.g. used in consumer products and medical devices, chromium trioxide used for surface treatment (chrome plating) or certain solvents such as DMAC used in the production of textiles and dialysis membranes.

Substances identified as fulfilling the SVHC criteria are included in the so called "candidate list". Identified SVHCs represent the candidates which may be listed on Annex XIV – the "authorisation list". Including substances into the candidate list, inter alia, leads to further obligations of communicating risks within the supply chain and is thereby contributing to safe use. Producers, importers and distributors of articles have to communicate information about SVHCs contained in articles and necessary risk management measures to the recipients of the articles and to provide this information to consumers on request.

Inclusion in the candidate list can put pressure on suppliers to substitute SVHCs with lower risk alternatives but some SVHCs may be required to achieve certain qualities of a product and it may not always be easy to replace them with alternatives. As oftentimes cited by industry representatives, the process of publicly identifying a substance as an SVHC via its inclusion in the candidate list may threaten or even damage a company's reputation (cf. Grunwald and Hennig, 2012). This potential impact has been termed the "announcement effect" of the candidate list (cf. Heitmann and Reihlen, 2007). Here, the term reputation is broadly defined as a market-average expectation of stakeholders towards a supplier's product quality and production related conduct including product performance, consumer and environmental safety issues. Thus, a certain level of positive vs. negative reputation reflects stakeholders' (e.g. consumers') high vs. low confidence or trust into the supplier's quality and conduct (cf. Schwalbach, 2000; Büschken, 1999 and 2000; Dean, 2004; Standop, 2006).

The announcement effect could hold because sensitized (private or organizational) buyers may react negatively by attributing blame on suppliers who knowingly sold products containing SVHCs. Consequently, they form negative attitudes towards suppliers and finally may terminate business relations. As organizational customers, they may even find themselves confronted with risking their own reputation and business. In a number of cases, retailers already reacted by proactively blacklisting or banning SVHC-related products. Tchibo, one of Germany's biggest multichannel-retailers, provides a practical example for this (cf. Tchibo, 2011).

Especially for small and medium-sized companies such as formulators that rely on being able to use a specific substance, negative publicity induced by the candidate list can pose a critical threat. It should be noted that these potential negative impacts need to be viewed in the context of the benefits REACH provides (cf. European Commission, 2003; Getzner, 2013). It should also be considered that there are other REACH related costs to industry such as the cost of testing chemicals. Compared with the direct costs of complying with REACH, indirect costs such as the blacklist effect are generally more difficult to estimate and less well known.

As research on reputational effects of the candidate list is scarce or limited to anecdotal descriptions, the primary research goal of this paper is to develop a comprehensive behavioral psychological model consisting of research hypotheses capable of explaining the various reputational effects of the candidate list, thereby enabling an assessment of the potential loss of reputation and a better understanding of the blacklist effect. This includes uncovering determinants to influence any potential reputational loss, like e.g. availability of substance alternatives. Due to varying roles and dependencies of actors in affected supply chains, reputational effects may vary considerably between these actors. Therefore, an actor-specific analysis of reputation is conducted considering reputational impacts of the candidate list on manufacturers, downstream users and distributors. These hypotheses are then discussed based on current empirical data surveyed by the European Commission on behavioral adaptations within REACH supply chains. Since REACH is still relatively new and its provisions are only starting to show effects, these data reflect preliminary experience of companies with the REACH provisions.

2 REACH and the candidate list of substances subject to authorisation

The REACH Regulation first entered into force in 2007 and is built on four pillars: the Registration, Evaluation, Authorisation, and Restriction of CHemical substances. Authorisation is a risk management option for industrial chemicals that was newly introduced with REACH. It aims to assure that the risks from substances with certain particularly hazardous properties are properly controlled and that these substances are progressively replaced by suitable alternatives. REACH allows for subjecting the placing on the market and use of SVHCs to a requirement for authorisation, effectively reversing the burden of proof normally associated with restricting chemicals. Once subject to authorisation, a substance may only be placed on the market or used when it is demonstrated that the risks arising from the use are adequately controlled for (Art. 60 (2) REACH) or when the use can be justified for socioeconomic reasons and if no economically and technically viable alternatives are available (Art. 60 (4)).

Before a substance becomes subject to authorisation, it passes through a rather complex process involving multiple steps (Figure 1). First, a member state prepares a dossier identifying the substance as falling into one of the following categories based on its intrinsic properties (Art. 57):

- Substances which are carcinogenic, mutagenic or toxic to reproduction category 1A or 1B (CMR substances),
- Substances which are persistent, bioaccumulative and toxic (PBT substances) or very persistent and very bioaccumulative (vPvB substances) or
- Substances for which there is an equivalent level of concern (e.g. endocrine disruptors).

Identified SVHCs are included in the so-called candidate list. Although the candidate list itself does not entail a requirement for authorisation, it leads to a number of important obligations. Suppliers of articles must inform recipients and, on request, consumers if the article contains an SVHC in a concentration above 0.1% weight by weight (Art. 33). Producers and importers of articles must further notify the European Chemicals Agency (ECHA) of articles produced or imported which contain an SVHC in a quantity of more than 1 ton per year above the concentration limit (Art. 7 (2)). The candidate list was comprised of 151 substances as of December 2013.

All substances included in the candidate list enter a prioritization procedure for inclusion into Annex XIV of the REACH Regulation. Substances with PBT or vPvB properties, wide dispersive use and high volumes receive priority to become subject to authorisation (Art. 58 (3)). The final decision to amend Annex XIV is taken by the European Commission in accordance with the comitology process. As of April 2013, 22 substances were listed in Annex XIV (Commission Regulation (EU) No 348/2013).

In contrast to other obligations in REACH which apply mainly to manufacturers of chemicals, the candidate list and authorisation provisions directly affect numerous other enterprises in the supply chain of a given chemical. These may include suppliers/distributors of articles (which are defined as objects which are given a special shape, surface or design during production determining their function to a greater degree than does their chemical composition, like a vehicle or an electronic device) and mixtures (which are defined as a solution composed of two or more substances) and, most notably, downstream users of substances. Downstream users are defined in REACH as any natural or legal person established within the EU other than the manufacturer or the importer, who uses a substance either on its own or in a mixture in the course of his industrial or professional activities (cf. REACH Art. 3). Typical downstream users are formulators producing mixtures (e.g. detergents, paints etc.) and companies manufacturing or finishing articles.

Although the relevant supply chains and their complexity vary from substance to substance, the general structure of the supply chain as affected by the candidate list and authorisation provisions can be illustrated with the example of a color pigment (Figure 2). The pigment itself might be manufactured by a chemical producer located in the EU. It might then be used by a formulator (downstream user) to formulate paint. The finished paint (a mixture) might be supplied to a distributor who ships the product to professional end users. One can easily see that the regulation and possible ban of the substance in question (in this case, the color pigment) may not only affect the manufacturer or importer of the chemical itself but other actors in the supply chain, including downstream users, distributors and consumers/end users, who place value on the economic and technical characteristics of the substance in the production process or the end product.

The candidate list has been the subject of much debate. For manufacturers of chemicals, there is a

Figure 1 REACH process for Substances of Very High Concern (SVHC).

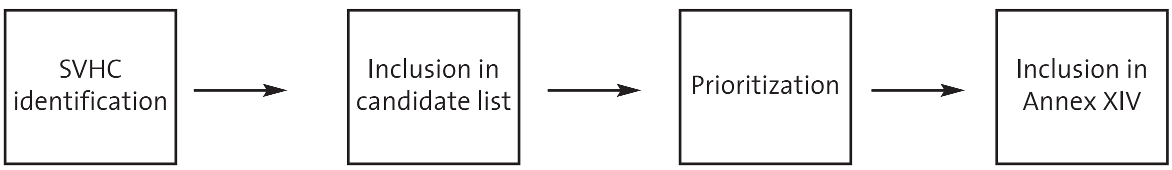
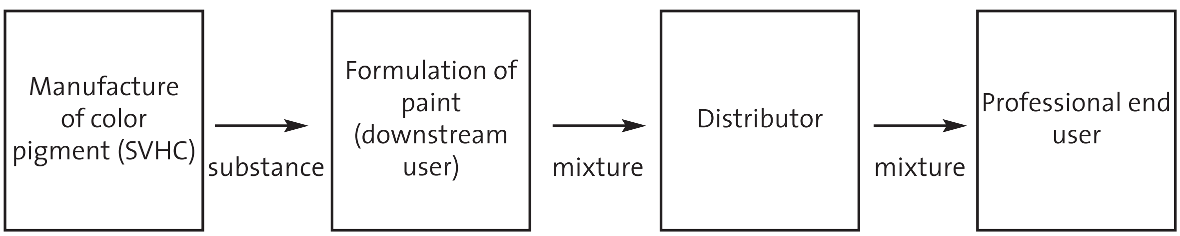


Figure 2 Example of a supply chain for a color pigment.



risk that the inclusion of one of their substances in the candidate list will lead to a loss of reputation from being associated with a serious hazard like cancer. Also, there is a risk of lower demand for the substance as a result of potential blacklisting by customers in the supply chain. For downstream users, SVHCs may play an important role in production processes in order to achieve certain functionalities. Those downstream users which cannot substitute a candidate substance with a less hazardous alternative face a risk that their activities will be disrupted if manufacturers discontinue production of the substance concerned[1] or if actors further down the supply chain, such as distributors or consumers, insist that no SVHCs be used during production or be present in the end product. In severe cases, this could amount to an existential threat to a downstream user's business.

It should be stressed that candidate substances can be legally produced and used. However, as these substances could eventually become subject to authorisation following the prioritization procedure, a successful application for authorisation may be required to use the substance in the long term. The underlying uncertainty whether candidate substances will become subject to authorisation and, if so, whether and for how long an authorisation will be granted may adversely impact companies' willingness and ability to invest in and commit to the continued supply of candidate substances or products requiring candidate substances (cf. WVM, 2012).

Because the authorisation requirement is attached to the use of chemicals and generally not to the sale or the use of the end product, one common criticism is that downstream users located in the EU are placed at a competitive disadvantage by the authorisation requirement. This is particularly relevant where SVHCs are used during the production process of articles. In principle, these processes could take place outside the EU and the finished article could be imported whereby the authorisation requirement is circumvented (cf. BDI, 2013). For downstream users in the EU, this translates to a risk that customers, i.e. the recipients of the articles, might choose to switch to suppliers outside the EU as soon as a critical substance becomes subject to authorisation or, as a precursor to this, is included in the candidate list. It should be noted though that such an export of risk by way of moving production activities to countries with lower safety standards can also lead to reputational problems for suppliers of articles.

3 Hypotheses development towards a reputational model

A behavioral analysis of reputation rests on the assumption that any significant negative or positive reputational effect on a company can be observed by changes in purchase behavior eventually accompanied by adaptations of provider (supply) behavior. The latter could be changes in product portfolio including innovations, streamlining of the product range or adapting corporate communications (cf. Grunwald and Hennig, 2012). To the extent that changes to production and sales plans of supply chain actors are unforeseen and associated with adaptation costs or lost gains, a reputational loss is detectable. Behavioral reactions towards the candidate list information to reflect, prevent or reduce any reputational loss to the firm of the supply chain actor assume the role of the dependent variable to be explained in this paper.

The candidate list contains both signals of risk as indicated by the SVHC categorization and scarcity. The latter refers to the candidate substance itself, its alternatives or related products (i.e. mixtures or articles) as the substance could become subject to authorisation. Both signals and their interrelations need to be analyzed more closely since they are subject to the processes of perception and evaluation by supply chain actors potentially evoking behavioral actions. Both users and providers of the substance or substance-related products tend to be highly involved when decoding the candidate list information as a signal of scarcity. Scarcity could take the form of users losing their product use or providers losing their market for the candidate substance and related products especially when being unable to absorb resulting losses, e.g. by offering alternatives. From the negative risk-related content contained in the candidate list information potentially threatening an organization's high priority goals (cf. Ulmer, *et al.* 2006), an increasing situational involvement of supply chain actors can generally be inferred. According to the Elaboration Likelihood Model developed by Petty and Cacioppo (1986), highly involved recipients are motivated to process factual information e.g. on risks related to a product or provider. As a result, perception of risk is expected to be higher under conditions of high than low involvement. Therefore, from the negative risk-related information contained in the candidate list, perception of risk by supply chain actors can generally be expected to increase. This is also grounded on the negativity effect (cf. Mizerski, 1982; Niemeyer, 1993; Taylor, 1991) referring to crisis signal theory, which posits that the effects of a single crisis event like the candidate listing depend on its underlying signal potential. The signal poten-

1) The direct regulatory impact of authorisation is on the use and not the production of substances but there could be indirect effects on production.

tial of a crisis event is larger the more it heralds severe future problems such as long-term consumer health risks or the risk of losing business, although the current problems may be of limited nature (cf. Jungermann and Slovic, 1993; Balderjahn and Mennicken, 1994; Alvensleben and Kafka, 1999; Grunwald and Hempelmann 2010). An alternative explanation for this effect can be derived from the availability heuristic (cf. Tversky and Kahneman, 1973) describing the tendency to make judgments, e.g. on risk, based on how easy it is to recall similar instances or how topical the risk-related information is. By including a substance on the candidate list, risk-related information is made topical which according to recency effect leads recipients to better remember the information and to receive greater weight in forming judgments as compared to information presented earlier. From this the following hypothesis derives.

H1: Listing a substance on the candidate list increases supply chain actors' perception of substance-related risk.

It should be noted at this instance that the mere fact that a substance is identified as SVHC and will be subject to further regulation can also reduce supply chain actors' perception of risk since further obligations concerned with intensifying risk communication apply. So, if actors actually perceive their rights according to Art. 33 REACH, they may intensively be willing to ask providers for clarification and, if answered promptly and competently, can reduce perceived risks. Lower levels of perceived risk in turn can lead to better evaluations of product and provider quality which generally benefits provider reputation. However, as practical experience shows, information requests can be numerous and very complex due to the high complexity of supply chains so that any fast reductions in perceived risk are less probable which is therefore corroborating hypothesis H1.

When perceiving risks, the question arises who is responsible for the existence of substance-related risks and consequently for controlling or reducing them. According to attribution theory, individuals are rational processors of information whose acts are influenced by conclusions or causal events. They attempt to find reasons for the success (e.g. a satisfactory product performance) or failure (e.g. a perceived problem and risk with the product) of use-related processes and normally categorize them according to a three-dimensional scheme (cf. Folkes *et al.*, 1987; O`Malley Jr., 1996):

The first dimension refers to location, i.e. the individual locates the cause(s) of success or failure. It asks whether the reason for a problem is more likely to be attributed to external factors such as the supplier, situation and external events or internal factors (of the user himself). The second dimension of stability focuses on the (temporal) endurance of the cause(s) of success or failure. On the one hand, if causes are stable or permanent in nature, there is a greater likelihood that similar problems will arise in future due to the fact that its cause is unchangeable. Similar problems are less likely to occur if the cause is unstable in nature. The third dimension refers to control, i.e. whether it is possible for users and/or suppliers to influence the possible causes of success or failure. Controllable causes are those over which the supplier or customer exercise a degree of influence: accordingly, it may have been possible to prevent the problem by taking certain steps like applying risk management measures. On the other hand, non-controllable causes are beyond the influence of the supplier or customer.

As the candidate list provides negative use related information, it seems plausible for users to more strongly engage in attributional activity. From an increasing attributional thinking and due to a lack of positive information e.g. from providers explaining the reasons for still using the hazardous substance, users in general may hold the provider responsible for the existence of substance-related risks. Still using the substance and not substituting it or taking measures to further reduce risks may generally be perceived as a cause of risk controllable by the provider. This is expressed in the following hypothesis.

H2: Listing a substance on the candidate list increases users' perception of provider responsibility (of substance manufacturers, downstream users or distributors) for the existence of substance-related risks.

Fueled by higher levels of involvement, both perceived degree of exposure to the candidate substance and perceived availability of alternatives, are assumed to directly impact perceived substance-related risks and provider responsibility, respectively. The impact of perceived exposure on perceived substance-related risk seems self-explanatory in that the level of exposure beyond other variables forms a key factor in risk assessment determining the level of risk. The influence is described by the following hypothesis:

H3: The higher users' perception of substance exposure, the higher is their perception of substance-related risks.

The impact of perceived availability of alternatives on perceived provider responsibility is less obvious and needs further explanation. According to attribution theory, the less (more) a provider is able to control or reduce substance-related risks, the less (more) he is held a plausible cause for the existence of the risks. For instance, a large company provider with a considerable R&D budget who could have invested much more in the past into early substitution and measures to control or reduce risks is attributed more responsibility than a smaller company provider being unable to take such measures. For the smaller provider, the cause for lacking alternatives seems to be less controllable than for the large company provider. In case alternatives are widely available on the market to both small and large company providers, recipients of this information are prone to attribute more blame on providers in general irrespective of company size as under conditions of low availability. Any defensive approach like further waiting to substitute SVHCs through alternatives is likely to be further challenged by users. From this hypothesis 4 derives.

H4: The higher supply chain actors' perception of availability of alternatives, the more providers are perceived responsible for the existence of substance-related risks.

Given that high involvement motivates recipients of the candidate list to more intensely evaluate its information content, the process of evaluation of perceived signals of risk and scarcity in forming users' attitudes towards providers of substances and related products needs to be further scrutinized. Users' attitude is assumed to be an enduring variable to reflect users' evaluations of the provider's quality and conduct (cf. Grunwald and Hennig, 2012) being influenced by situational variables like perception of substance-related risks and provider responsibility capable of evoking behavioral reactions. Consistently, according to research on negative publicity, perceptions of risk as well as perceived provider responsibility reflecting users' attributions of blame for any existence of product-related problems or risks are directly linked to the reputation construct (cf. Grunwald and Hempelmann, 2010; Standop, 2006; Tucker and Melewar, 2005; Matos and Veiga, 2004; Dean, 2004; Lyon and Cameron, 2004 and 1998; Gutteling, 2001; Dawar and Pillutla, 2000; Tadelis, 1999; Coombs, 1998; Dawar, 1998; Al-Najjar, 1995; Siomkos and Kurzbard, 1994; Siomkos and Shrivastava, 1993; Mowen, 1980).

Drawing on this stream of research, it is assumed for increases in risk perception and provider responsibility for the existence of such risks to negatively impact users' attitudes towards providers of SVHC related products in absence of any provider reaction regarding crisis management to reduce such negative perceptions. This rests on the assumption for the candidate list information to be perceived as credible and correct by users. However, it is not far from being realistic for recipients to also question the validity of the information received within their evaluative process of attitude formation. For instance, potential long-term negative effects of the chemical may be devaluated by users due to perceived forecast uncertainty of long-term impact assessments (cf. Grunwald, 2010). Besides, high individual time preference rates characteristic for myopic buying behavior may lead users to discount the negative risk-related information in light of (positive) scarcity information benefitting an altogether more positive risk and consequently better cost-benefit evaluation (cf. Hummel, 1999; Loewenstein, 1992). Since the candidate list information has an official status as being part of a legal procedure, it is assumed here that the negative influence of perceived risk and provider responsibility on attitude formation is likely to prevail as is reflected in the following two hypotheses.

H5: In absence of any provider response, the higher users' perception of risk, the more negative are their attitudes towards providers of SVHCs or related products.

H6: In absence of any provider response, the higher users' perception of provider responsibility for the existence of substance-related risks, the more negative are their attitudes towards providers of SVHCs or related products.

Drawing on attitude-behavior-hypothesis and with generally increased levels of involvement of supply chain actors as typically found on business-to-business markets and further enhanced by the candidate list, it is assumed here for users' attitudes towards the provider to influence supply chain actors' demand and supply, respectively, as long as changes in attitudes are perceivable to them. This holds true because changes in attitudes of customers can be seen as predictors of future demand to be placed on the respective supplier the attitude refers to. Thus, the subsequent attitude-behavior-hypotheses for each individual supply chain actor emerge.

H7: The more negatively end-consumers' attitudes towards the provider of the SVHC containing article are impacted by the candidate list, the lower is their demand for the article.

H8: The more negatively distributors' atti-

tudes towards the provider of the SVHC containing product (article or mixture) are impacted by the candidate list, the lower is their demand for the product.

H9: The more negatively downstream users' attitudes towards the provider of the SVHC or SVHC containing mixture are impacted by the candidate list, the lower is their demand for the substance or related mixture.

H10: The more negatively users' attitudes towards the SVHC manufacturer are impacted by the candidate list, the lower is substance manufacturer's supply of the candidate substance.

The latter may even hold under conditions of stable demand when the substance manufacturer takes precautionary measures to shielding his own reputation and avoiding negative spill-over-effects to further products from his range. As already explained, listing a substance on the candidate list shows a potential to signal both negative substance-related risks and (future) scarcity of a specific substance or the substance-related products, drawing attention to a potential substance ban concomitant with considerable lack of information on alternatives and the way the substance will finally be regulated. Therefore, besides analyzing perception and evaluation of risk drawing on negative publicity and product-harm crises research (cf. Standop and Grunwald, 2009 for a literature review), also analyzing forms and distribution of scarcity along the supply chain provides useful insights into behavioral reactions of supply chain actors (cf. Lynn and Bogert, 1996; Brock, 1968; Ditto and Jemmott, 1989; Brannon and Brock, 2001; Inman *et al.,* 1997). Since scarcity in turn is likely to depend on supply chain actors' power relative to other actors, an actor-specific analysis of reputational effects incorporating the construct of supply chain power promises in-depth insights.

Power in the supply chain represents the extent to which a company has influence on other members of the supply chain, in turn reflecting an actor's degree of dependency on other actor(s) which can take various forms such as coercive or reward (cf. French and Raven, 1959; Maloni and Benton, 1999). It is based on access to scarce resources like information (non-material) or commodities (material) or the interrelation between the two. Scarce commodities can be thought of as chemical substances technically or economically indispensable for competitively attaining product characteristics crucial to customers. Scarcity of information in the context of REACH supply chains can take the form of limited knowledge or access to information on how a substance can be used in processing a mixture or an article. Such information may be asymmetrically distributed between actors along the supply chain (cf. Grunwald and Ostendorf, 2013). Similarly, private end-consumers could perceive risk-related compared to promotional information as scarce. Both scarcity of information and commodity can limit an actor's response options and information settings relevant for decision making both varying with their relative supply chain power.

Reactions towards perceived asymmetry in supply chain power can be psychological, like cognitive reactance e.g. to be perceived by consumers when feeling inadequately informed about product risks potentially leading to consumer distrust, as well as behavioral (cf. Grunwald and Hennig, 2012; Jones and Brehm, 1970; Kroeber-Riel and Weinberg, 1996). According to balance theories such as contribution inducement theory (cf. March and Simon, 1993), equity theory (cf. Homans, 1968; Adams, 1965) or theory of cognitive dissonance (cf. Festinger, 1957), imbalances in the cognitive system like in the form of (anticipated) decreases in the balance of inducement utilities over contribution utilities (cf. Tosi, 2009), psychological reactance or deteriorating output-input-ratios will motivate deciders to reduce them in order to (re-)gain cognitive equilibrium or harmony. With regard to power imbalances in the supply chain, this can be achieved by compensating shortfalls in informational power sources through material ones and vice versa. Supply chain power is assumed to influence both psychological and behavioral reactions. While the latter seems to be self-explanatory in that material or financial disposition limits strategic choice, the former grounds on information processing to be largely dependent on the amount and quality of information available.

Market success of substance manufacturers is dependent on derived demand for the substance produced. It describes the demand placed on the substance to be dependent on the demand and changes in the price for mixtures or articles related to that substance. Assuming the candidate substance to be crucial for end product quality, in absence of suitable alternatives any credible market signal of scarcity like the candidate list information could entail (temporary) increases in prices for that substance. This is explained by users (i.e. formulators, article manufacturers and distributors) increasing their demand to build up stocks of the substance or the mixture or articles containing that substance in expectancy of scarcity given constant substance supply for the time being.

A similar effect can be observed with regard to end-consumers and distributors building up their stocks of traditional light bulbs to be phased out in the EU in favor of a new generation of energy-efficient lighting. The example may insofar be well paralleled to the case of SVHCs as alternatives such as new energy-saving light bulbs may as well possess negative properties like developing electrical smog or containing cancer causing chemicals (cf. Ward, 2011). Side-effects of alternatives may be explored less than those of the candidate substance so that the majority of the manufacturers' direct or indirect clients will be decoding the candidate list information more likely as a (positive) signal of scarcity than a (negative) signal of risk.

Resulting stable or even rising demand for the substance will nourish positive profit expectations at least temporarily causing the substance manufacturer to maintain or even increase production and supply. This general dependency of the substance manufacturer's supply from downstream users' demand and in turn downstream users' demand from the demand of distributors (e.g. retailers) as reflecting end-consumer demand for product quality relying on the candidate substance is expressed by the following hypotheses. These hypotheses also reflect demand effects which are not necessarily dependent on prior attitude formation as is likely to be the case with lowly involved actors.

H11: The higher (lower) end-consumers' demand for product quality relying on the candidate substance, the higher (lower) is distributors' demand for substance-related products.

H12: The higher (lower) distributors' demand for products related to the candidate substance, the higher (lower) is downstream users' demand for the candidate substance.

H13: The higher (lower) downstream users' demand for the candidate substance, the higher (lower) is manufacturers' supply of the candidate substance.

The analysis reveals potential determinants of the reputational loss of the respective supply chain actors resulting in the behavioral model displayed in Figure 3. As can be seen from Figure 3, direct changes in demand to the market are primarily end-consumer driven. However, behavioral reactions of actors further up in the supply chain may as well be indirectly induced by attitudinal changes as is reflected by hypotheses 8, 9 and 10 which are therefore shown dashed in Figure 3.

4 Empirical results on German supply chain actor adaptions: Methodology and discussion

While there has been much debate about the candidate list and the authorisation procedure under REACH, any evidence on the actual impact of these instruments on enterprises in the supply chain of chemicals has so far been largely anecdotal. Some empirical evidence can be derived from a study commissioned by the European Commission in preparation for the Commission's review of REACH in 2012. The study was based on a survey conducted by CSES (Centre for Strategy & Evaluation Services LLP) between June and August 2011 in which affected companies across the EU were asked to report their experiences with the operation of the REACH Regulation via an online questionnaire. The general results of the survey can be found in CSES (2012) and NKR (2012). In this section, the answers of German manufacturers of chemicals, downstream users and distributors to the survey questions focusing on the impact of the candidate list are analyzed. The sample consists of 181 manufacturers, 161 downstream users (formulators and manufacturers of articles) and 9 distributors. Here, it should be noted that some survey participants did not answer some questions so the number of respondents may not be the same for all questions. The results are discussed in the same order below.

18% of manufacturers stated that one or more of the substances they produce is included in the candidate list. The survey participants were asked what the result of the entry of a substance they produce in the candidate list for authorisation has been. The most wide-spread impact was an increase in costs for the business as a result of the information requirements triggered by the candidate list (as shown in Table 1, 61% of respondents said this occurred "sometimes", "frequently" or "always"). 55% of respondents stated that the inclusion of a substance in the candidate list led to a reduction in the demand for the substance. Hence, an impact of the candidate status on the demand of a substance is registered by manufacturers in just over half of the reported cases but apparently not in the others. The developed behavioral model may aid in explaining this ambivalent picture through the recognition that case-specific factors such as the availability of alternatives and the perception of risks may influence behavioral reactions from actors in the supply chain that determine the total demand for a substance.

When asked whether they have decided to withdraw any substance from the market as a result of REACH, 23% of manufacturers answered in the affir-

Figure 3 Behavioral model of supply chain effects of the candidate list.

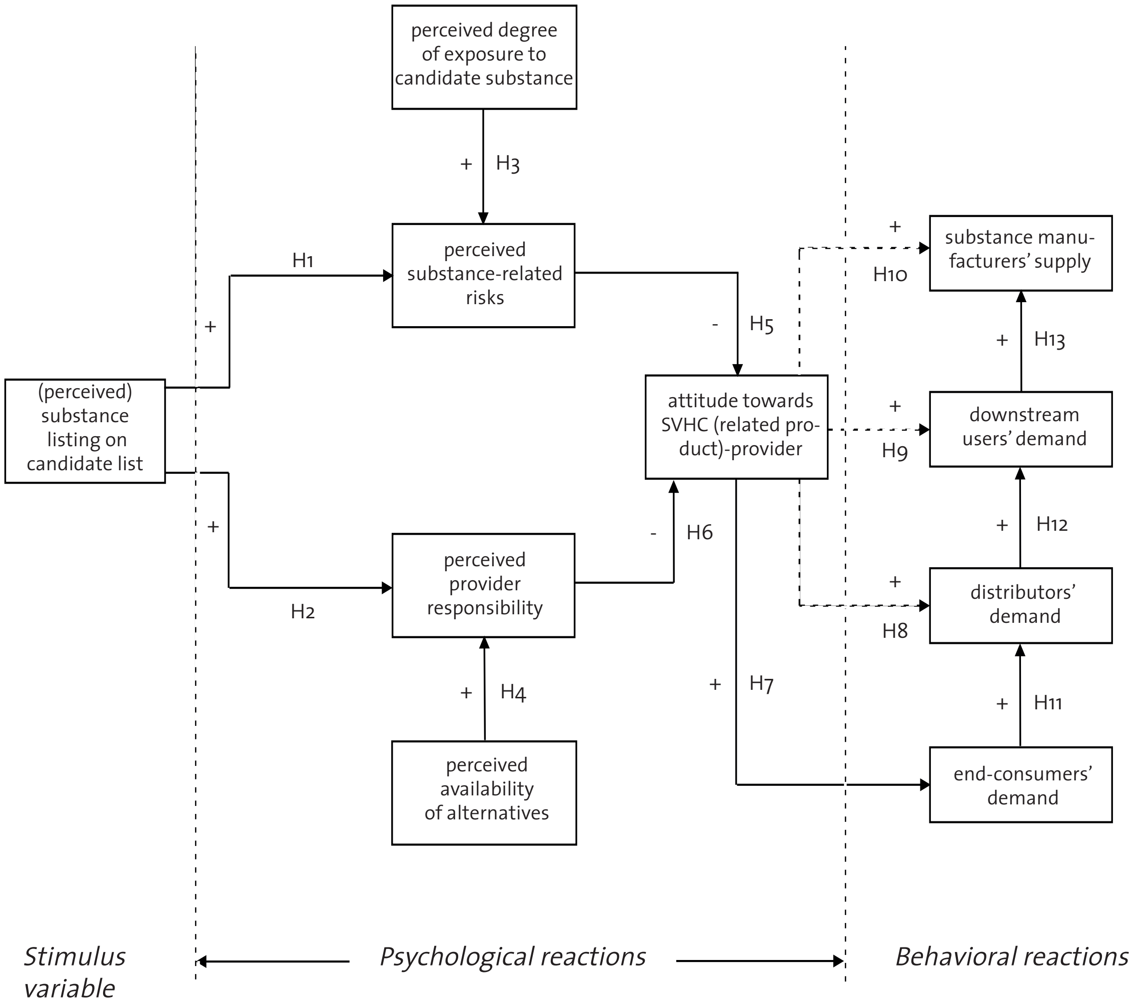


Table 1 Impact of entry of substance in candidate list from manufacturer's perspective (representative sample of 181 manufacturers of chemicals in Germany, survey conducted by CSES between June and August 2011).

Potential impact of candidate list	*Likelihood of occurrence according to respondents*					
	Don't know	Never	Seldom	Sometimes	Frequently	Always
No impact	10%	40%	15%	15%	0%	20%
Led to an increase in the costs for the business as a result of the requirement to provide informati-on to customers	19%	14%	5%	14%	14%	33%
Led to a reduction in the demand for the specific substance	10%	15%	20%	20%	5%	30%

mative and 25% declined but said that they are considering doing so in the future. However, only 22% stated the reason for the withdrawal was the inclusion of the substance in the candidate list (other possible reasons were that the substance was subject to a restriction or to a registration requirement under REACH). This calls into question whether reputational risk associated with the candidate status is the primary concern of manufacturers when deciding whether to continue marketing a substance. It should also be noted that the withdrawal of a certain substance from the market by one manufacturer does not necessarily lead to the non-availability of that substance to downstream users since there is usually more than one manufacturer or importer placing a particular substance on the market.

54% of downstream users stated that one or more of the substances used in their formulations/mixtures or in the articles they produce is included in the candidate list. Like for manufacturers, the most wide-spread result of the candidate listing was an increase in costs due to the information requirements which 80% of downstream users said happened sometimes, frequently or always, as shown in Table 2. 61% of respondents indicated that the inclusion in the candidate list led to the decision to replace the substance with a less hazardous one. This shows that the candidate list may indeed increase awareness and involvement regarding substance-related risks and prompt substitution efforts on the part of downstream users, provided that suitable alternatives exist. Suppliers removing the substance from the market (which could disrupt downstream users' activities if critical substances are no longer available) and increases in the price of the substance do not appear to be dominant impacts of the candidate list from the perspective of downstream users. The latter point is somewhat surprising since it could be expected that suppliers would adjust prices for candidate substances upwards to account for increased costs due to information requirements and possible reputational risks.

55% of downstream users stated that they have experienced the withdrawal of one or more critical substances used in the production of formulations or articles as a result of REACH and a further 22% are expecting this to happen in the future. The relatively high percentage of respondents experiencing or expecting the withdrawal of substances underlines the potentially challenging position of downstream users which are typically located at an intermediate stage of the supply chain. Consequently, they may be directly affected by behavioral reactions of both supply-side and demand-side actors to changes in attitudes towards SVHCs or SVHC-related products. When asked what has been their response to the withdrawal of critical substances, 77% of responding downstream users

Table 2 Impact of entry of substance in candidate list from downstream user's perspective (representative sample of 161 downstream users in Germany, survey conducted by CSES between June and August 2011).

Potential impact of candidate list	*Likelihood of occurrence according to respondents*					
	Don't know	Never	Seldom	Sometimes	Frequently	Always
No impact	3%	24%	17%	21%	21%	14%
Led to an increase in the costs for the business as a result of the requirement to provide information to customers	3%	7%	10%	27%	30%	23%
Led to an increase in the price of the substance(s)	21%	29%	21%	18%	0%	11%
Led to the decision of your suppliers to remove the substance from the market	6%	29%	26%	29%	6%	6%
Led to the decision to replace the substance with a less hazardous substance	3%	25%	11%	25%	25%	11%

answered that they sometimes, frequently or always switched to other substances with less hazardous properties. In contrast, only 39% switched to another supplier in the EU and 25% to another supplier outside the EU. This leads to the conclusion that if the supply of an SVHC is disrupted as a result of the supplier stopping production e.g. due to a fear of negative publicity, a downstream user would be more likely to attempt to substitute the substance with an alternative rather than to try to find another supplier for the same problematic substance.

100% of distributors participating in the survey said that the products they distribute or sell contain one or more chemical substances included in the candidate list. When asked what has been their response to the inclusion of a substance in the candidate list, 57% of distributors stated that they asked their suppliers to stop supplying products that include the substance or to ensure that none of the products supplied contain the substance. The remaining 43% had no specific response. Although the survey's sample size for distributors is too small to draw any final conclusions, it is apparent that a very high percentage of distributors have experienced that substances they sell as such or that are contained in products they sell were placed on the candidate list. The reaction of more than half of the responding distributors was to in effect blacklist those substances. As end products are usually sold to the end user or consumer through distributors, such companies often have the legal responsibility for communicating to the final customer that an article contains an SVHC. The result that a significant share of distributors (but not all) blacklisted candidate substances is consistent with the developed behavioral model in so far as there is on one hand a strong tendency for distributors to avoid the reputational risk of being associated with products containing SVHCs. On the other hand, an outright blacklisting of candidate substances may not be feasible or desirable from the distributor's point of view in all circumstances, for instance, when the end customer's involvement and degree of exposure are low and there are no suitable alternatives.

5 Conclusion

The goal of this research paper is to develop a behavioral reputational model to describe and explain potential effects of the REACH candidate list of substances subject to authorisation on supply chain actors' reputation. The candidate list is an instrument provided by the EU chemicals regulation to publicly announce and prioritize SVHCs as a first step of imposing an obligation of authorisation on them. As the candidate list comprises signals of risk and scarcity of information and commodity (i.e. a potential lack of the substance, substance-related products or alternatives), the reputational model is based on negative publicity and risk perception research considering the distribution of information and power across actors along the supply chain.

The crucial factors in determining a potential reputational loss induced by listing a substance on the candidate list appear to be the supply chain actors' involvement raising perceptions of substance-related risks and provider responsibility for the existence of such risks being influenced by perceived exposure to the candidate substance and availability of alternatives. Perceptions of risk and provider responsibility in turn are supposed to directly impact actors' attitudes towards the SVHC (or related product) provider. Attitudes towards the SVHC provider form a mediating variable hypothesized to elicit behavioral reactions (such as reducing demand, blacklisting the substance or withdrawing it from the market) with unforeseen changes in buying or supplying behavior indicating a reputational loss to the respective supply chain actor. Whereas direct changes in demand to the market according to the model appear to be primarily end-consumer driven, behavioral reactions of actors further up in the supply chain may as well be indirectly induced by attitudinal changes.

Preliminary experience of companies with the candidate list derived from a study commissioned by the European Commission is used in this paper to shed light on the empirical relevance of the reputational model developed. The results show that a significant percentage of the surveyed actors have already been directly affected by the inclusion of substances in the candidate list and this will intensify as further SVHCs are identified. The candidate status often leads to non-negligible costs for fulfilling information requirements and potentially to a decrease in demand but the severity of this perceived effect cannot be quantified with the available data. In addition to the perception of reputational risks by manufacturers and a heightened level of awareness in the supply chain, demonstrated impacts of the candidate list include substitution efforts by downstream users and blacklisting by retailers. However, in practice the occurrence of these potential impacts varies widely from case to case and differences in substances' properties, uses and supply chains likely play a key role in this, as suggested by the developed behavioral model.

Further empirical evidence is needed to empirically test the reputational model derived. These data could be gathered by stakeholder consultations using questionnaire designs incorporating the constructs used in the model to enable micro-analyses. Companies may use the model to derive suitable strategies of corporate social responsibility (CSR), e.g. communicative responses, to manage negative publicity induced by the candidate list and to shield or rebuild reputation by considering e.g. perceptions of substance exposure and availability of alternatives as strategic target variables in shaping attitudes.

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Practitioner's Section

Integrated Resource Efficiency Analysis for Reducing Climate Impacts in the Chemical Industry

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Reducing greenhouse gas emissions of the material-intensive chemical industry requires an integrated analysis and optimization of the complex production systems including raw material and energy use, resulting costs and environmental and climate impacts. To meet this challenge, the research project InReff (Integrated Resource Efficiency Analysis for Reducing Climate Impacts in the Chemical Industry) has been established. It aims at the development of an IT-supported modeling and evaluation framework which is able to comprehensively address issues of resource efficiency and climate change within the chemical industry, e.g. the minimization of material and energy intensity and consequently greenhouse gas emissions, without compromising on production performance. The paper presents background information on resource efficiency and the research project, an ideal-typical decision model for resource efficiency analysis, the conceptual approach for an IT-based integration platform as well as the case study design at the industrial project partners' sites. These first results are linked to future activities and further research questions are highlighted in the concluding section.

1 Introduction – Resource Efficiency in Chemical Industries

Mitigation of climate change is an inevitable challenge for manufacturing industries. Numerous efforts are made in reducing climate impacts caused by greenhouse gases. Isolated approaches to reduce greenhouse gases - for instance by increasing energy efficiency - are useful starting points but fail to explore the full potential of more holistic approaches. The latter require practice-oriented integrative methods which combine aspects and concepts of process and chemical engineering, environmental life cycle assessment, managerial accounting and operations research. Such integrated approaches are still rare. One reason is a lack of adequate instruments for systematic consideration of the various environmental and climate impact categories in process engineering and design. Especially small and medium sized companies require support to keep track of possible climate protection and resource efficiency measures.

"Resource" is a rather broad term with a range of different meanings, including for instance manpower (human resources), time, finance, raw materials or operating supplies. The term resource efficiency, though, is mostly used in the context of natural resources and sustainable development: "Resource efficiency means using the Earth's limited resources in a sustainable manner while minimizing impacts on the environment. It allows us to create more with less and to deliver greater value with less input" (European Commission, 2013). This particular understanding of resource efficiency has been appointed as one of the seven flagship initiatives under the European Commission's 2020 strategy (European Commission, 2011).

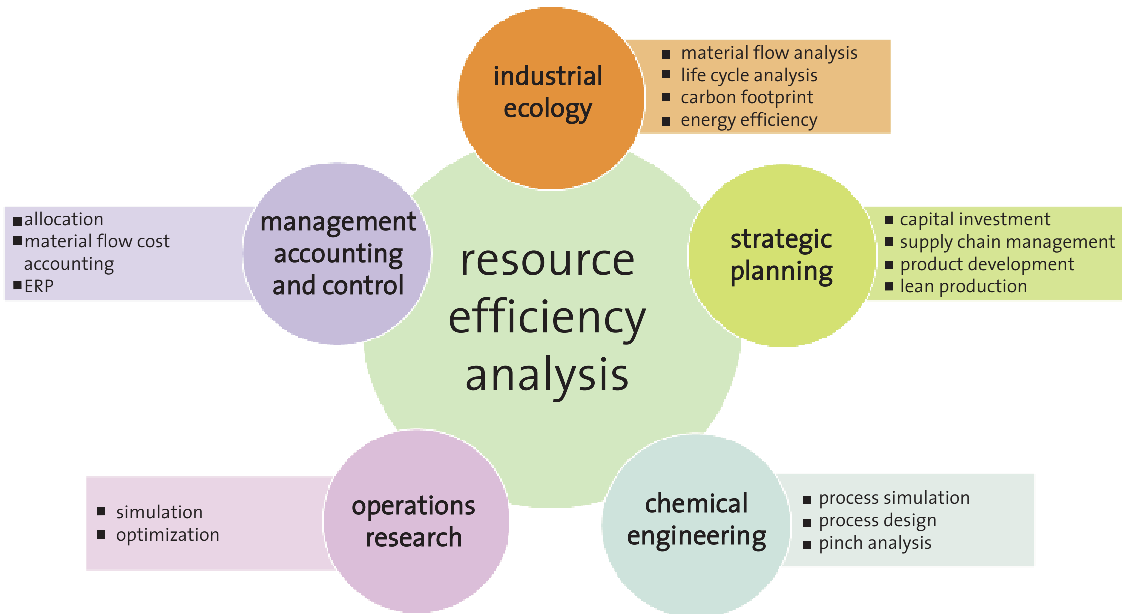
Looking at single topics within resource efficiency, like energy efficiency, there are already numerous guidelines or supporting programs available. In contrast, guidelines on integrated approaches for resource efficiency analysis are still rare or under development. The Association of German Engineers (VDI), for instance, currently develops standards and general guidelines on resource efficiency analysis to pursue the reduction of resource input and emissions and to increase resource productivity (VDI ZRE, 2013). A study mandated by the European Commission identified financial and information barriers, lack or insufficiency of knowledge on resource efficiency approaches in particular, as main obstacles for the application of resource efficiency analysis (Rademaekers *et al.*, 2011).

Achieving resource efficiency not only requires integration of methods and tools from different disciplines, but also the inclusion of supply chain actors. Limiting resource efficiency analysis to single processes or production units is unlikely to fully explore reduction, recycling and symbiosis potentials within large industrial production networks. Within eco-industrial parks and highly integrated production networks, waste flows and heat losses from one company become valuable inputs for other businesses (Herczeg *et al.*, 2013). Hence, integrated resource efficiency analysis incorporates a holistic, system-wide perspective.

To meet these challenges, an interdisciplinary research project on *Integrated Resource Efficiency Analysis for Reducing Climate Impacts in the Chemical Industry* (InReff) has been designed and is partly funded by the German Federal Ministry of Education and Research (BMBF).

From an overall perspective this interdisciplinary research project aims at developing an IT-supported modeling and evaluation platform which is able to comprehensively address issues of resource efficiency and climate change within the chemical industry. Enhancement and integration of available concepts and methods, software prototyping, case study research, and knowledge transfer are essential parts of the project and conducted in close collaboration of one software solution provider, three industry partners, two universities and a wider range of associated organizations and experts. Well

Figure 1 Complexity range of integrated resource efficiency analysis.



established methods for process development and design, flow sheet simulation, heat integration, material flow analysis, material flow cost accounting and environmental assessments, including carbon footprinting and life cycle assessment, need to be combined in a coherent approach and supported by an IT-based environment for integrated resource efficiency analysis. The variety of potentially relevant methods and tools is presented in Figure 1.

This paper explores the project's conceptual approach on resource efficiency analysis (chapter 2), elaborates the concept for an IT-based framework for integrating relevant tools and methods (chapter 3), introduces the industrial case study design (chapter 4) and concludes by explaining the project's knowledge transfer conception and future research activities (chapter 5).

2 Conceptual Approach - Integrated Resource Efficiency Analysis

Based on a dialogue of chemical and process engineers, decision makers from industries and consultancy as well as academics in the field of chemical engineering and industrial ecology, an ideal-typical model for performing an integrated resource efficiency analysis has been developed. The dialogue took place on project workshops and included practitioners and academics from organizations outside the project. Figure 2 depicts the ideal-typical model including tools identified as highly relevant.

The model follows basic decision making model notations and thereby provides a sequence of steps that pursue continuous resource efficiency increase. Starting with basic considerations on the goals to be achieved and the relevant system boundaries (1), an energy and material flow analysis of the chosen system is performed (2). This analysis provides the basis for initial computation and assessment of key performance indicators and targets that quantify and benchmark the overall objectives (3). In some cases a basic energy and material flow analysis will reveal resource efficiency improvement potentials immediately (4a, 7, 8). Applying constant iteration to adapt target and system boundary (5, 4b), the model can be expanded and refined in order to find efficiency enhancing measures (6a-c). The refinement happens either within the energy and material flow model (6a) or integrates further tools like flow sheet simulation, heat integration analysis (6b) or carbon footprinting (6c). If multiple improvement potentials are identified, priorities need to be defined (8). Here, integrated optimization routines are beneficial to support the decision (9). The implementation of measures and control of its achievement (10, 11) either determines the analysis or initializes a new improvement circle (1).

Material and energy flow analysis is a key component of the ideal-typical model and serves as the backbone for any process evaluation and optimization. Material and energy flow analysis accounts for material and energy inputs and outputs of processes, production units, chemical plants or even whole production networks and their interrelationships. This can be achieved by empirical input/output data (measurements and data records for batches or time periods) and provides a basis for several follow-up resource efficiency methods and their integration:

- *Environmental life cycle assessment methods*, in particular product and corporate carbon footprints (see ISO 14040, 2006; PAS 2050, 2011; GHG Protocol, 2011) to enable the inclusion of environmental impacts and objectives within and beyond company borders into resource efficiency decision making. For initial assessments, standardized life cycle inventory databases such as ecoinvent (Ecoinvent, 2013) provide average datasets for purchased materials, auxiliaries and energy supply. Chemical engineers can use life cycle assessment methods to compute the whole life cycle impacts of product specification modifications or alternative process technologies. Thereby, environmental and resource efficiency aspects become part of product and process design decisions.

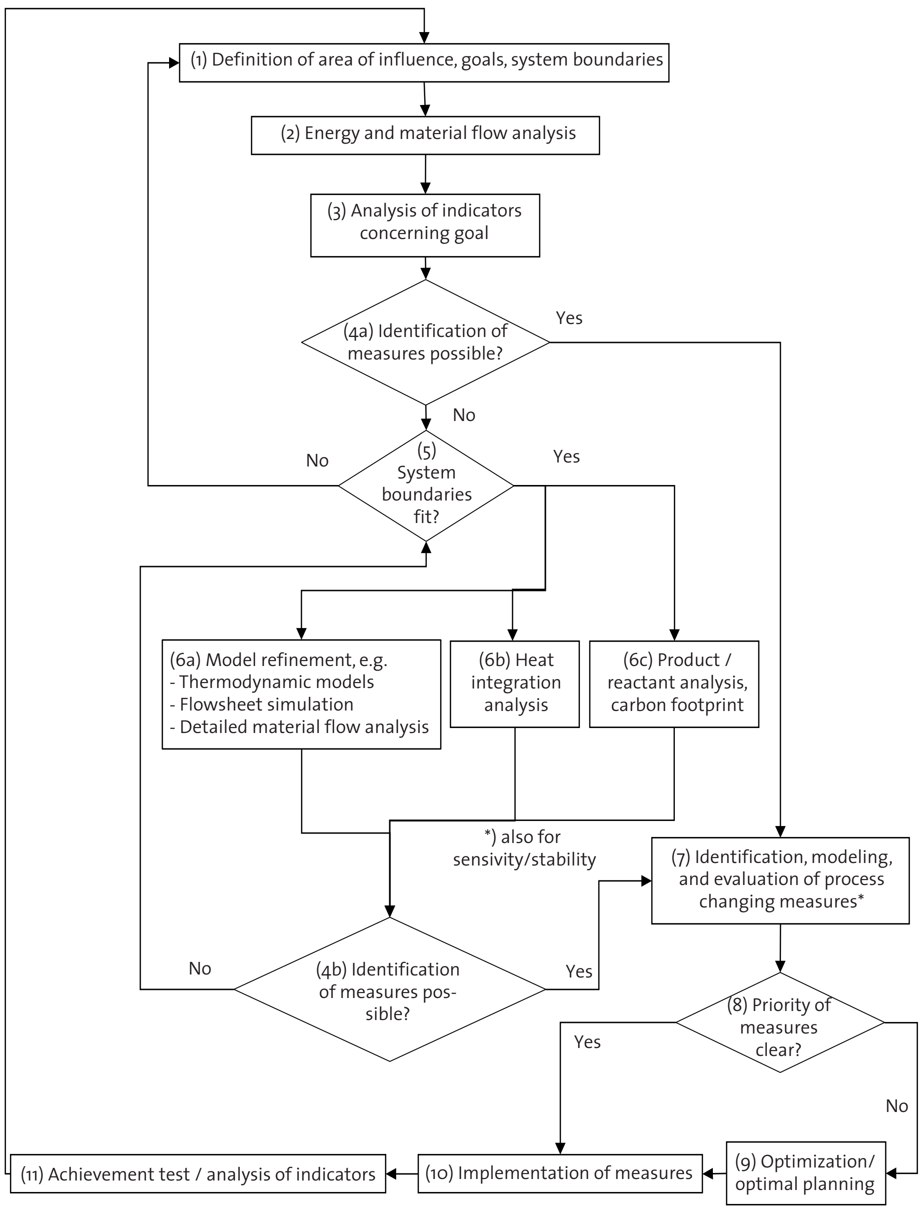
- *Computer Aided Process Engineering (CAPE)*, including flow sheet simulation, is a common working environment in process development and engineering (Beßling *et al.*, 1997; Braunschweig & Gani, 2002). Thermodynamic calculations result in consistent mass and energy balances which allow for proceeding steps like unit operation and equipment design, cost estimations or set-up of the process measuring and control strategy. One important point for the integration of CAPE tools is an easy to handle and generally accepted interface for data transfer to other resource efficiency applications. Furthermore, CAPE supports the integration of explanatory models into resource efficiency analysis, i.e. the definition of causalities and assessment of thermodynamic consequences of planned resource efficiency measures.

- Methods of *heat integration* for optimizing the interplay of heat sources and heat sinks in a production system. Data on warm and cold flows are collected and added to composite curves.

These curves can be analyzed regarding the potential of internal heat integration and the requirement for external heat supply. One well-known method for heat integration is the pinch point method (cp. e.g. Linnhoff & Hindmarsch, 1983). Heat generation and cooling processes require large amounts of energy. Energy efficiency increases by means of heat integration reduce climate impacts and fossil fuel demands of chemical industries.

- *Material flow cost accounting (MFCA)* according to ISO 14051 (2011) makes use of material and energy flow analysis and aims at increasing resource efficiency by analyzing the particular cost of material loss and resource inefficiencies respectively. Chemical industry waste streams bear purchasing costs of lost material, processing and energy costs up to the point of loss and arguably even depreciation costs for used equipment and facilities. MFCA computes these lost values and hence provides figures on the potential gain that can be achieved by fur-

Figure 2 Ideal-typical model of integrated resource efficiency analysis (starting at top).



ther reducing waste streams and material losses.

- *Resource-efficiency oriented allocation methods* to treat multi-output processes adequately. By-products and multi-product processes are very common in chemical industries. Allocation methods have huge impacts on the results of ecological and economic product assessments and might lead to "subsidizations" of resource inefficient products and by-products if material and energy demands are not considered properly. Hence, resource efficiency analysis requires a thorough evaluation of existing allocation methods accompanied by new approaches such as game theory based allocation (Hougaard, 2009).

- The before mentioned methods are applied to derive ideas and measures for resource efficiency improvements. These options have to be evaluated within the given methods and against pre-defined indicators. Finally, *simulation-based optimization of material flow networks* can be applied to find optimal parameter settings for resource efficient production and products. Implementation and control of derived measures conclude the resource efficiency analysis and provide the starting point for continuous resource efficiency improvement at the same time.

Implementation and control of derived measures conclude the resource efficiency analysis and provide the starting point for continuous resource efficiency improvement at the same time.

3 IT-based Framework

Software and IT support is an essential part of any type of analysis within this large array of relevant methods and tools related to resource efficiency, while its heterogeneity implies that an 'one fits all' software solution is neither feasible nor efficient. Hence, a clever combination and integration of formerly isolated software tools and methods is more promising. The overarching objective of the InReff project is the development of an IT-supported modeling and evaluation framework in order to receive decision-supporting information for increasing resource efficiency in a holistic but feasible manner.

The framework facilitates resource efficiency analysis as described in the previous chapter and provides the foundation for mapping the actual material, energy and cost flows, checking optimization potentials and giving a visual overview on the effect of potential measures. The development of this framework includes selection of a suitable device, design of easy to handle interfaces for linking the relevant methods and tools, identification and integration of the required functionality for modeling, evaluation and optimization as well as specification of the navigation structure for user guidance.

At current stage, the framework interlinks software solutions for thermodynamic flow sheet simulation, software solutions for material and energy flow analysis including environmental and cost assessment, and algorithms for optimization.

3.1 Flow Sheet Simulation And Material Flow Network Interface

Material flow networks (MFN) and flow sheet simulation (FSS) are two complementary modeling techniques that serve different purposes in resource efficiency-directed analyses. As indicated in the workflow in Figure 2, MFN as the more abstract modeling technique is well-suited for the coarse-grained modeling of larger-scale processes up to the size of whole facilities. In contrast, FSS allow for physically valid modeling with regard to several substance properties and thermodynamic relations, typically stored in large accompanying substance databases.

An integration of MFN and FSS seems beneficial for several reasons: Firstly, an initial MFN can be set up with comparatively little effort in an early modeling phase; compensating missing data with broad estimations and simplistic (e.g. linear) relations to describe material and energy flow. This model can later be refined by replacing certain elements (i.e. transitions in the MFN) with data obtained from detailed FSS. Secondly, a MFN can serve as a link between different FSS sub-models. Due to the detailed modeling level, the simulation of large flow sheets is often computationally expensive and not guaranteed to converge. This situation might be improved by mapping only the most relevant processes to FSS and establishing linear input-/output-relations between these processes in an intermediary MFN. Thirdly, material flow analysis (MFA) tools like Umberto (cp. ifu Hamburg GmbH, 2014) allow to apply economic and ecological performance indicators to the calculated flows and to display the results using Sankey diagrams (Möller *et al.,* 2001; for Sankey diagrams cp. Schmidt, 2008; the relevance of MFN for efficiency increase in complex chemical production networks is discussed in Viere *et al.*, 2010). An integration of MFN and FSS enables the use of these analysis techniques on result data obtained from FSS as well.

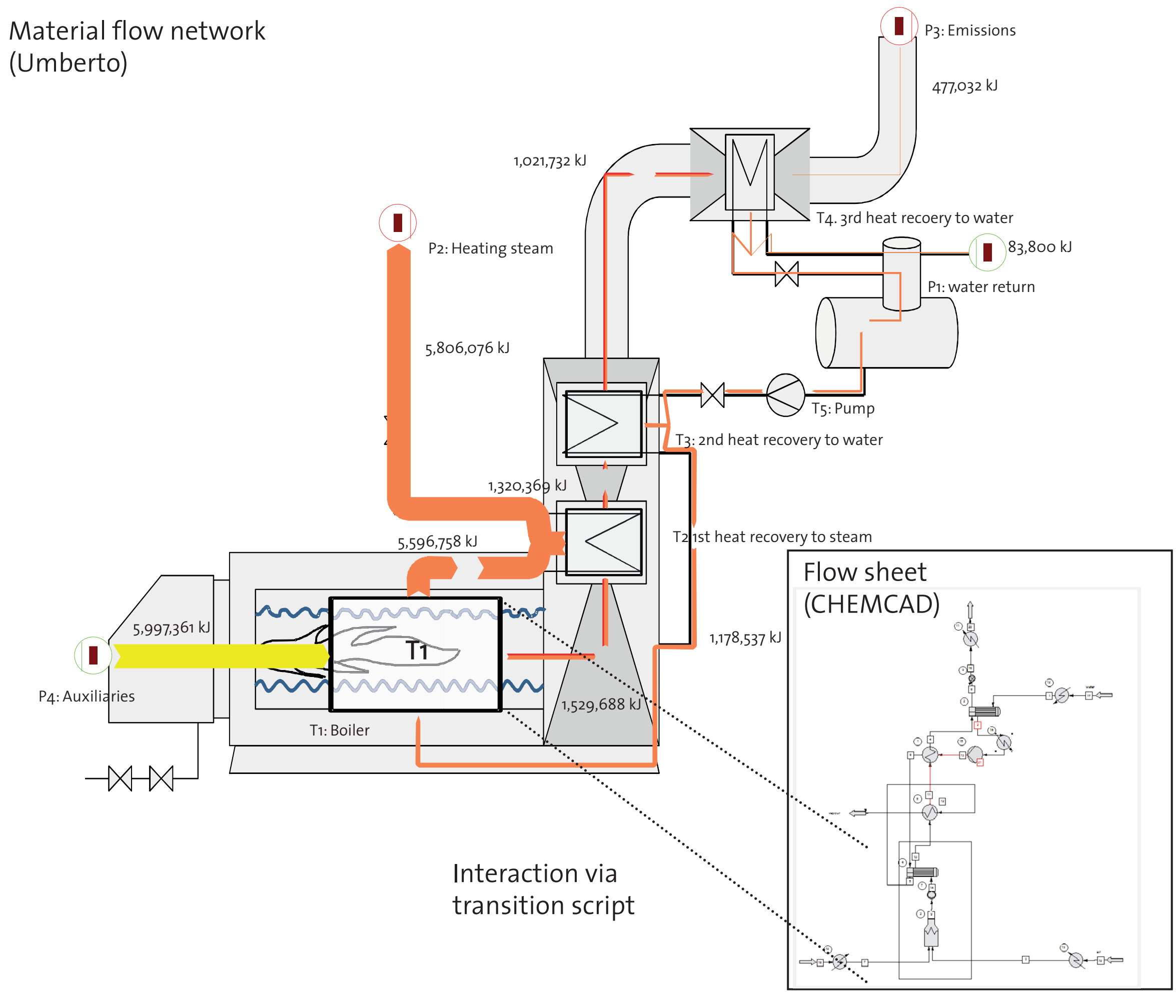
As part of the IT-based framework, a prototypical interface between two exemplary tools for MFA (Umberto) and FSS (CHEMCAD, cp. Chemstations 2014) has been developed. The joint calculation is controlled by Umberto in a so-called master/slave fashion: A transition in the MFN can encapsulate a CHEMCAD model and initiate its simulation by calling CHEMCAD's COM (Component Object Mode, see e.g. Box, 1998) interface with the scripting language Python (cp. Python, 2014). Data between MFN and FSS is exchanged via a pragmatic spreadsheet-based interface, currently built upon Microsoft Excel. The use of spreadsheets enables a transparent and traceable data exchange between both process models. Furthermore, it allows for straightforward data conversion (e.g. from flow rates calculated by the FSS to larger time periods balanced in the MFN) and for predefined template spreadsheets that support users with the coupling of MFN and FSS models.

Prototypes with different degrees of automation concerning data exchange and simulation control have been implemented at example models based on real processes from the InReff partners Sachtleben Chemie GmbH and H.C. Starck GmbH. Figure 3 depicts a first model of a steam generator where the transition T1 in the MFN is refined by a flow sheet in CHEMCAD (for a detailed elaboration of the prototypical interfaces cp. Denz *et al.*, 2014).

3.2 Simulation-Based Material Flow Network Optimization

Simulation-based optimization is an optimization approach for simulation models (Fu *et al.*, 2005). A simulation model is a model of a real system in which model variables are varied to analyze the system (Shannon, 1975). Model variables utilized for optimization are called decision variables. Simulation-based material flow network optimization aims at finding values of the decision variables

Figure 3 Integrated modeling with MFN and FSS at the example of steam generation (adopted from Denz *et al.*, 2014, Fig 4).



that minimize or maximize the objective of the objective function of the optimization problem. The objective might be the minimization of the production costs or CO_2 emissions per product unit or the maximization of the benefit per product unit. Decision variables are defined within the material flow network and they have a strong impact on the objective of the optimization. Decision variables can be either technical or chemical parameters such as yield, temperature, and pipe diameter or material and energy flows.

To support simulation-based optimization within MFN and in combination with FSS, an interface prototype has been developed that steers the optimization process. The prototype applies optimization algorithms to MFN and the underlying FSS (for a detailed description cp. Zschieschang *et al.* 2014). At current stage it uses a commercial solver (OptQuest, see Laguna, 2011), that provides multiple search algorithms suitable for simulation-based optimization. Search algorithms explore the solution space for the optimal set of decision variables. The prototype will be enhanced to include further search algorithms and to identify best possible algorithms in terms of accuracy and computational effort depending on specific optimization problems.

4 Industrial Case Studies

To constantly evaluate the practical relevance of conceptual developments and prototypes, case studies are being conducted throughout the project. These case studies comprise the analysis of barium sulfate production at Sachtleben Chemie GmbH (Duisburg, Germany), tungsten manufacturing from scraps at H.C. Starck GmbH (Goslar, Germany), and aqueous alkyd resin production at Worlée-Chemie GmbH (Lauenburg, Germany). In the following, the case study design and first case study results are presented.

4.1 Barium Sulftate Production

Sachtleben Chemie with its production sites in Germany and Finland develops and produces white pigments and functional additives for customers in a wide range of sectors all over the world. For more than 130 years, Sachtleben has been one of the leading manufacturers of high-quality white pigments and excels with its expertise and quality.

One of these functional additives is barium sulfate whose production line in Duisburg (Germany) is to be analyzed in terms of resource efficiency. During the production, caulk stone is deoxidized in rotary kilns to barium sulfide and afterwards precipitated with sodium sulfate to high-purity barium sulfate. This barium sulfate is dried, milled and packed in the post-treatment.

Initial analysis has identified several resource efficiency potentials that are currently under detailed investigation. These include energy saving potentials, e.g. by exhaust gas recirculation, substitution and variation of raw materials (petrol coke vs. natural gas), e.g. by process optimization, and an optimized and material flow based cost allocation rule for the production network using simulation-based optimization and the FSS-MFN interface (see 3.1 and 3.2).

The InReff case study at Sachtleben Chemie GmbH in Duisburg has so far revealed several improvement potentials at various points within barium sulfate production. These include for instance process engineering measures like optimizing fuel usage by heat integration at the day ring dryer. It also comprises business measures, such as an optimized cost allocation for multiple incurred in a process step and end-products. This improved cost allocation builds on the material flow models developed within the InReff project.

4.2 Tungsten Manufacturing

H.C. Starck GmbH is a world-wide operating company with over 2800 employees. At its major production site in Goslar (Germany), the company is established as an operator for production processes of hard-metal powder.

A batch production line is considered as the benchmark process. It includes the smelting of feed materials (ores, power or length metal scraps), followed by roasting and dissolving as well as purification process steps. Additionally, extraction and crystallization steps are necessary to separate the value components. Different products can be generated subsequently by operating beneficiation processes like calcinations, reduction and carburizing.

Characteristics of the production line are deviating feed material qualities combined with resource scarcity, high process temperatures and spatial separation of the different process stages at production site. Therefore, large potentials for improvement, especially in regard to resource and energy consumption, are expected. For this reason a systematic identification and quantification of potentials combined with climate protection measures is needed. Expected results of this resource efficiency measure are decreasing carbon dioxide emissions and energy consumptions per unit of intermediate products.

For the InReff project, a top-down approach has been used to gather all available material and energy flows of the process. Initially, no consistent mass and energy balances for the different process stages were available. In a first step, data gaps had to be filled by using databases, measurement data, and assumptions. Based on the derived consistent material flow model of the tungsten line (including energy demand and material losses) first saving potentials have been identified. For the most relevant process stages detailed models have been generated with tools like ChemCAD and Excel.

For the smelting step, mass and energy balances of the ovens have been compiled in Excel. Based on the results high energy demands and losses were identified. Operation at the particular site requires recycling streams that are mechanically processed and then retreated in the furnace process. Through better process control and adjustment of process parameters, a complete avoidance of such inefficient recycling streams appears to be feasible. At present, various thermochemical modeling studies are carried out to improve process control. Furthermore, so-called empty trips are analyzed in detail. During such empty trips, caking and unreacted material need to be treated without any production of valuable intermediates. H.C. Starck is currently optimizing its oven to further reduce or even fully avoid empty trips. Expected benefits are energy savings, simplified process design and possibly even capacity increase.

4.3 Aqueous Alkyd Resin

Worleé-Chemie GmbH is a medium-sized manufacturer of high-value additives, binders, and resins for the production of colors and varnishes (Worlée, 2013). The major production site of the long-established company is located at Lauenburg, close to Hamburg. During the last decade, Worlée has been engaged in several environmental protection activities including a commitment to and several awards achieved in the *Responsible Care* initiative of the German Federation of the Chemical Industry (VCI, 2014). Furthermore, Worlée is member of 'Climate Protection Enterprises' (Klimaschutz-Unternehmen e.V.), an association of German companies committed to voluntarily achieve measurable and ambitious targets in respect to climate-protection and energy efficiency.

Several measures have already been taken to improve the company's production line in the past; including heat insulation and recovery, use of renewable energies and primary products, coupling of thermal oil supplies, and flue gas cleaning by means of thermal post-incineration. For process analysis, pinch methods as well as material and energy flow analysis and visualization have already been applied using a proprietary software tool.

Thus, the main research question pursued in the case study is: If and how the workflow and tools of integrated resource efficiency analysis enable further improvements in a setting where several measures have already been implemented and relevant methods are already known. The modeling focuses on a production line for Aqueous Alkyd Resin in the first place. A material flow model of the main process and auxiliary processes like the thermal post-incineration has been set up and is currently refined with respect to process specification and data collection. This model will be the basis for further analysis steps that will include the application of LCA methods, material flow cost accounting (MFCA), alternative allocation methods, and optimization with the aid of algebraic reformulation of the MFN. Due to the early modeling stage, results for this study are not available yet.

5 Conclusion and Outlook

This paper has presented the conceptual approach as well as first results of research on Integrated Resource Efficiency Analysis for Reducing Climate Impacts in the Chemical Industry (InReff). Within the project, an ideal-typical model for resource efficiency analysis as well as prototype features for an IT-based modeling and evaluation framework have been developed, including the integration of material flow networks and flow sheet simulation as well as simulation-based optimization of both, ecological and economic performance targets. Next necessary steps comprise the feasibility and practicability enhancements of these prototypes and integration of further requirements, heat integration in particular. Industrial case studies at three different companies have been introduced and are used for evaluation and enhancement of the IT-based framework and prototypes.

Furthermore, the case studies as well as several workshops within the project including non-project participants from chemical industries and academia, foster knowledge transfer. In near future, project results and developments will be discussed with and disseminated to various actors in chemical industries including small and medium-sized enterprises (SME). As part of such knowledge transfer, a training concept on integrated resource efficiency thinking is to be developed and expected to meet requirements of multinational chemical companies and SME alike. This requires a flexible approach to software application allowing large enterprises to integrate their in-house solutions while enabling small companies to execute a resource efficiency analysis within reasonable time and effort by using less sophisticated software solutions.

Current results and conceptual developments support the authors' expectations that an integrated resource efficiency analysis is feasible and beneficial for chemical industries. Further work is required to substantiate this impression, to provide further case study evidence and practical guidance to chemical industries, and to initialize continuous resource efficiency analysis in chemical companies of all sizes.

6 Acknowledgements

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Practitioner's Section

Account Management 2.0: From Silo Thinking to Integrated Account Development

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Account management in combination with the successful, strategy-driven development of customers constitutes the nucleus of Marketing & Sales Excellence.

This article introduces the Double Loop Process of account management. This process utilizes cultural-psychological factors of organizational development which have a massive impact on whether account management succeeds or fails. Nonetheless, these factors too often remain outside the scope of consciousness, and therefore, they cannot be controlled. Through the Double Loop Process, customer-based strategies are developed and profitably implemented by integrating all required internal functions and expertise in a collaborative and productive way.

Thereby, the Double Loop Process sustainably contributes to the customer- and profit-oriented alignment of internal decision-making processes within a given corporate culture. It improves cross-functional collaboration, instead of letting silo thinking, departmental egoisms, management from the "ivory tower," or the reference to "lack of time" and "exhaustion" jeopardize account-related profit potentials.

1 Account Management in Marketing & Sales Excellence

The importance of account management is directly correlated with the concentration within a customer base. In other words, effective account management is increasingly critical as the success of a business becomes more and more dependent on the relationship to individual accounts. This concentration process has been an observable trend within the chemical and life science industry for many years.

In this context according to Diller *et al.* (2005), account management comprises the management of a supplier's communication and interaction processes with potential or existing customers in order to generate or foster customer relationships all along the customer life cycle.

In addition to the planning, organization, leading and controlling of the sales staff, account management also includes the topics of customer acquisition, fostering customer relationships, customer retention, as well as complaint management and winning back dissatisfied customers. Furthermore, account management includes the termination of customer relationships and the process management, as well as sales organization and the controlling of customer management (see Diller *et al.*). This kind of definition for account management clearly emphasizes the sales aspects of account management and therefore the sales excellence component.

In contrast to this sales-driven definition of account management, there are other definitions which look upon account management more as a special form of marketing organization, in which very important customers receive special and preferred treatment as key accounts. At these defined key accounts, it is crucial to accurately target the marketing instruments. In this context, the assignment of the sales staff with their specific decision-making power is regarded as one of the marketing instruments, which is and should be directed by marketing (see Kirchgeorg, 2014).

The different definitions of account management already reveal a separation process between marketing and sales, which must be overcome in order to sustainably develop and profitably strengthen customer management. This separation process is the result of an increasing acceleration of day-to-day business leading to "burn-outs," "time bottlenecks," or lack of "concentration." In the end, the acceleration causes avoidance of real, personal collaboration in favor of alleged effort savings (see e.g. Virilio, 2008; Goleman, 2013, and Rosa, 2005).

Instead of swinging back and forth from a marketing perspective to a sales perspective and thereby from the organization towards the customer and back, the Double Loop Process of account management reveals how customer interaction processes can be managed cross-functionally and cross-departmentally beyond silo thinking. Thereby the Double Loop Process takes into account research findings showing that similar competences – but different orientations of marketing and sales (product vs. customer and long term vs. short term orientation) – obviously have a positive effect on their cooperation and market performance (see Homburg and Jensen, 2007).

The Double Loop Process considers account management to be a comprehensive, reconciled marketing **and** sales process, which is attuned to a company's or a company division's strategy. It ranges from structuring and segmenting customers, through their acquisition, fostering, and retention, all the way to the winning back of lost customers and account-related controlling processes. In doing so, the Double Loop Account Management concerns marketing excellence, as well as sales excellence, or better yet – the marketing and sales excellence, also involving all other functions that are necessary for the profitable optimization of collaboration with customers.

Due to the advanced customer concentration, the significance of such an integrated account and key account management is generally fairly high in the chemical and life science industry: In some markets, it's not uncommon to see a single customer contribute more than 30% of a supplier's business and to see 80% of sales to be made with only 12 customers, who only account for 3% of the entire customer base.[1]

In these markets, it seems reasonable to give serious consideration to how to secure and sustainably extend business with the most important customers. Customer-focused strategies, account plans, or account development plans (in the following ADPs), often referred to as customer concepts (see e.g. Schmitz, 2006), or key account strategies serve this purpose. In literature (and in practice), these account-focused strategies or ADPs are considered to be a critical success factor for key account management (see e.g. Ryals and McDonald, 2008).

There are numerous examples (see. e.g. Sirsi, 2005) and guides (see. e.g. Ryals and McDonald, 2008) for the content of ADPs. Usually the ADP covers the analysis of a customer in its market and competitive environment and derives an account strategy based on this analysis. The strategy is then to be converted to an account-related action plan. At the same time, the ADP creates the basis for controlling the performance of the business with a particular account (see e.g. Küng *et al.,* 2002).

The development and implementation of ADPs is usually considered to be a linear process. Initially, the account managers are being prepared for their assignments, including the development of account plans by more or less theoretical trainings. In the ideal case, the top management, as well as other function owners who are relevant to the key account managers' success, is involved (see e.g. Cheverton, 2012).

Despite all training efforts, the creation of ADPs remains a rather unpopular task for sales. ADPs are considered to be another administrative exercise, which lowers sales efficiency and distracts from the actual sales job, aside from visit reports and sales planning. Sales' objections to ADPs are manifold and originate from different sources and interests (see e.g. Cheverton, 2012).

After the unpopular creation of the ADP, the (key) account manager is responsible for its implementation. Even though in many cases, especially in the case of global key accounts, cross-functional teams are involved in the implementation process (see e.g. Zupancic and Senn, 2000), in practice and in many how-to manuals, the impression arises that the (key) account manager is more or less on his own during implementation (see e.g. Jones, 1997).

Developing difficulties concerning internal interfaces and the ADP implementation are either underestimated or not even recognized by both the top management and the other company divisions. Only marketing and sales seem to be aware of the difficulties (see Harms *et al.,* 2011), albeit from different perspectives.

Therefore, it is no surprise that the lack of awareness of interface problems results in optimization processes being driven by individual corporate functions. For instance, Sales excellence programs are initiated without sufficiently accounting for marketing's role. In these environments, ADP-programs often focus on the creation of the ADP-document within the sales department, instead of reaching the full potential of implementation at and with the most relevant interfaces.

On the other hand, marketing excellence programs optimize without taking sales into account. Likewise, there are books on marketing excellence, which have 15-page long glossaries that do not even

1) These ratios originate from an industry praxis in the fine chemical business and are not too exceptional for many chemical markets.

mention sales or selling (see e.g. Burkitt and Zealley, 2006). Here ADPs are seen more as tool for controlling sales activities. Marketing can back down to a strategic and more theoretical view on the customers and ADPs, instead of really meeting the challenge of implementation barriers and hindrances. Instead, this is left to sales people, who conversely regard the strategic analysis and handling of customers as too theoretical.

In the following paragraph, the integrated approach for "Account Management 2.0" will be introduced, which replaces such silo thinking with a cross-functional and implementation-driven view of customer management and ADPs. In doing so, both sales and marketing excellence are sustainably supported by involving all relevant interfaces within the organization.

2 Account Management 2.0: The "Double Loop Process" of Account Management

2.1 Customer Portfolio Management and Customer Segmentation

The basis of Account Management 2.0 is the question of which customers should be handled in what way and with which effort and intensity. This question must be answered by marketing and sales working in close collaboration and by applying various well-established concepts and methods available (see e.g. Homburg *et al.,* 2012):

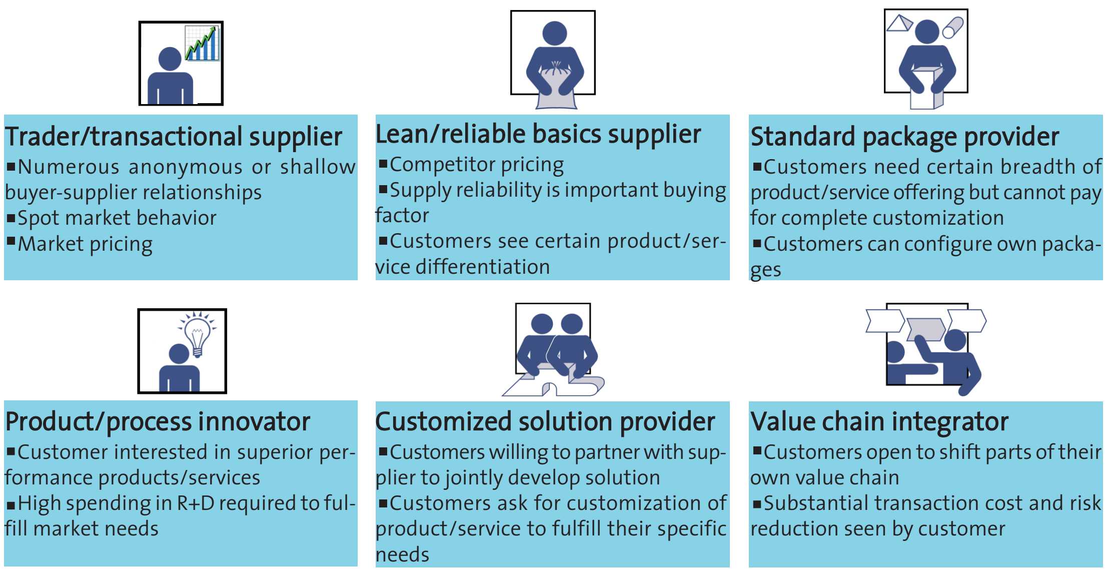
- **ABC-Analyses** refer to the customer concentration in relation to different possible variables, like e.g. sales volume, net sales, contribution margin, or profit potentials of individual customers. They conclude which contribution to business is or can be achieved with which portion of customers and thereby mainly support the prioritization of customers and the controlling of customer-related resource allocation.

- **Customer portfolio analyses** examine the attractiveness of customers and one's own competitive position in order to derive normative strategies for the resource allocation across customers.

- **Customer segmentations** define homogenous customer clusters in order to structure the different go-to-market approaches and to make them more effective and more efficient. In the chemical industry, geographical, industry- and respectively product application-based segmentations still prevail, although need-based segmentations are increasingly applied (see e.g. Goudappel, 2013; and Lach and Hasse, 2013.).

The application of these methods then leads to the determination of a customer's status (e.g. as a global key account, A-, B- or C-account, regional key account, regional account, etc.) and to different go-to-market models, which indicate which customer segments (especially need-based ones) should be approached in what form and with what level of intensity. In the chemical industry, the question arising above all others is which product and serv-

Figure 1 Customer Interaction Model in the chemical industry using the example of BASF SE (see Lach and Haase, 2013).



ice qualities should be offered to which segments and through which sales channels at what price level. Here, customer interaction models, as displayed in Figure 1, are increasingly applied.

For example, as a trader/transactional supplier you will not offer technical services or customer-specific products to your customers. Also personal sales and customer visits will be limited for the commodity products you are offering. The focus is for lean and cost efficient processes to remain competitive.

In contrast, as a product/process innovator, you will, for example, offer specific services and engage in customer-specific development projects to develop and sell your specialty products with value pricing and value selling processes.

So customer interaction models define the marketing-mix, the backend business processes and your organizational set-up of a supplier, based on the requirements established in relevant markets.

And together with the methods, mentioned before, they create the basis for the future customer management processes, which should be defined in the ADPs.

Vice versa, the insights gained in the course of ADP processing have influence on the aforementioned methods and their outcome. For example, an adjusted view of customer potentials may have an influence on the customer attractiveness and may promote a former regional account to a key account position. Or a customer's assignment to a need-based segment changes due to the insights gained during the account development processes.

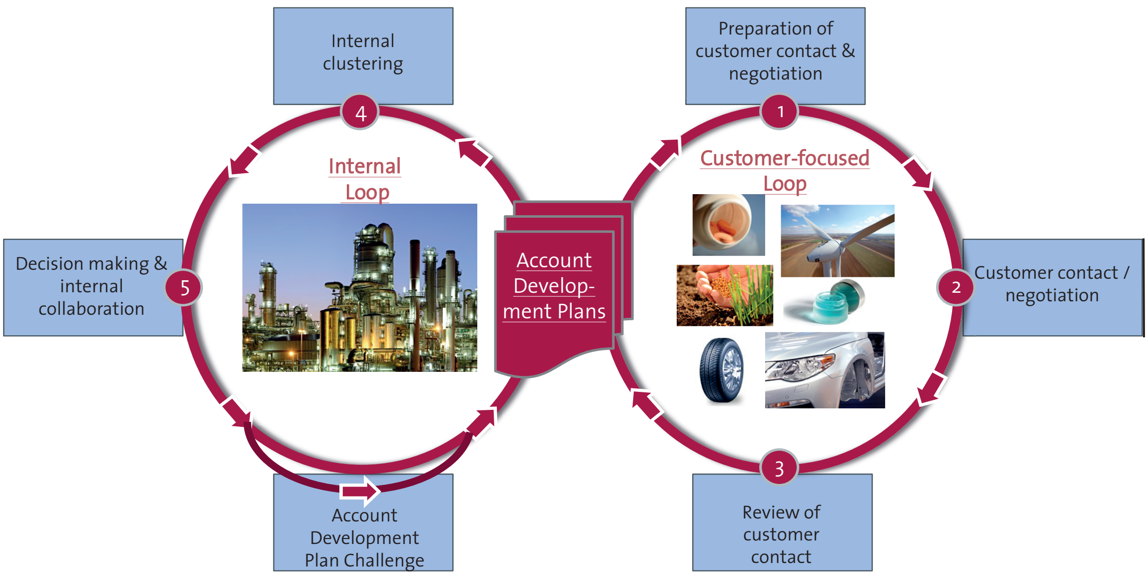
Accordingly, customer portfolio management, customer segmentation (including corresponding go-to-market models), and account planning are interdependent.

The tasks connected to these methods can neither be exclusively assigned to sales excellence, nor to marketing excellence. In fact, both sides and additional functions are required in order to achieve true marketing and sales excellence, while referring back to clearly defined roles and responsibilities, of course. Thereby, one of marketing's central roles is to define the methodological setting concerning portfolio analysis, segmentation methods, and go-to-market models, whereas sales is more responsible for the customer-focused planning and implementation processes including the loading of the aforementioned methods with relevant information. This is where the Double Loop Process comes into play, which will be explained in the following paragraph. The process incorporates the different perspectives into one comprehensive account management process, integrating and coordinating all relevant functions and perspectives necessary to develop and implement true marketing and sales excellence. In the Double Loop Process, the ADPs take a central but strongly implementation-oriented position.

2.2 The Double Loop Process at a Glance

At the end of the day, there are basically two answers to the core question – When can the appli-

Figure 2 The Double Loop Process of Account Management.



cation of ADPs, as a central element of account management, be regarded as a success?

First, the ADPs are only really worth the effort if they support the sustainably profitable implementation of the account strategies and account-related measures. The needle eye of customer contact and of customer negotiations has to be passed successfully.

And second, this will only be possible if the ADPs support and improve the account-related internal decision-making processes in terms of effectiveness and efficiency.

This correlation is shown in Figure 2, which provides an overview of the Double Loop Process with its elements and features, which will be explained in the following section:

The aspect of customer-related ADP implementation highlights **the right hand** loop of the process. In this **customer-focused loop**, the objective is to be successful in the interaction with the customer and to come to the right strategic conclusions from the customer contact.

This customer-focused loop includes topics, such as:

- the preparation of negotiations, including the available tools and methods,
- the successful implementation of negotiations and customer contacts, as well as
- the consequential strategy-related post processing of the customer contact.

So, the ADP has to be designed in such a way that it supports these topics significantly better than without having ADPs in place. For example, the ADP should include conclusions about the customer's decision-making processes and buying center in order to ease the preparation of negotiations. In addition, insights and conclusions gained and achieved during customer contacts should be summarized in the ADP. If necessary, the customer strategy should be modified based on these findings.

The second aspect of internal implementation focuses **on the left and internal loop**. It refers to the cross-functional decision-making process, the internal implementation of customer-related measures, the internal knowledge transfer and the coordination within the organization. Furthermore, the identification and solution of cross-account topics is part of this loop.

For this purpose, it's helpful, for example, to support customer-related investment decisions or resource allocations by quantifying the profit potentials, which are expected to be involved with the investment. For instance, how many resources it will take to carry out a collaborative innovation project with a customer should be determined, as well as how much additional profit may be expected due to that project.

The internal investment decisions are often trend-setting for the future collaboration with a customer and shall therefore be represented and summarized in the ADP, including their consequences for the customer strategy.

Instead of a static focus on the ADP-document, in Account Management 2.0 the **ADP** becomes **a dynamic pivotal point for the customer management process**: the results of the interactions with the account are included in the ADP which can therefore be used for the internal preparation of decision-making. After having passed through the internal loop, the ADP summarizes the internal decisions and their strategic consequences for the future collaboration with the customer, which once again builds the basis for the preparation of future interactions with the customer.

Inevitably, the ADP becomes a living document, as the Double Loop Process is continuously conducted, again and again.

In the following section, the Double Loop Process's elements will be described in greater detail.

2.3 The Elements of the Right, Customer-Related Loop

The right loop of the Double Loop Process takes care of the integrated and cross-functional preparation, implementation and post-processing of negotiations or important customer meetings.

The following elements can support the **preparation of negotiations** which should, depending on the relevance of the negotiation, be implemented more or less intensively and in a cross-functional way:

- **Goal Matching:** Goal Matching includes the clear internal determination of negotiation objectives, the analysis of potential negotiation objectives of the opposite party, and the identification of positive overlapping and cooperation potentials, as well as remaining conflicting targets. This goal matching sets the ground for the later design of the negotiation choreography. Furthermore, it inhibits any reflex of seeing the customer as an enemy, who - based on the mechanisms of separation - per definition cannot provide a win-win scenario.
- **Agenda Setting:** The Agenda Setting includes a conscious psychological and strategic determination of negotiation topics and their sequence.

Hereby, the course of the negotiation and / or the customer meeting is essentially determined. In the course of the agenda's determination and design matching with the customer, the balance of power between both parties, both acting in their respective corporate culture, becomes apparent. The agenda setting also takes into account the primarily unconscious factors of an encounter between two negotiating parties, which are highly relevant from a corporate culture perspective.
For example, actively influencing an agenda that has been suggested by a big key account is e.g. a good opportunity to get back to eye level with the customer, even before the actual negotiation begins. In contrast, if taking appropriate influence on the agenda does not succeed, one is already pushed to a defensive position and has to resort to more suitable tactics.

- **Power Mapping & Customer Decision Processes:** A power mapping analyzes and visualizes the quality of the previously established relationships to a customer's buying center members, the internal relationships between a customer's influencers and decision makers, and the influence spheres or communicational gateways of competitors. This implies a thorough analysis of the customer's decision-making process. This clarifies who should be handled in which order and in what form in order to gain as much influence in the customer's decision-making process as possible. These analyses should therefore also be included in the ADPs.

- **Personal Psychological Mapping:** The psychological mapping includes the analysis of sales-relevant personality factors within the team and the corresponding assessment of the negotiation partners from the opposite party in order to shape negotiations and communication in a way that increases the probability of success. By analyzing the perceptual and decision-making preferences of the persons involved in the negotiation, the Myers-Briggs Type Indicator (MBTI®) can notably support these processes. (for the MBTI® see e.g. Bents and Blank, 2010.)

- **Value Arguments:** At the core of the negotiation and its preparation are the value arguments which, in terms of sequence and formulation, must be applied according to the negotiation objectives, the personality of the negotiation partners and the negotiation situation as such. In negotiations for specialty products and applications, the product's benefits are at the forefront. They e.g. lead to cost savings for the customer within his manufacturing process, a higher production output, higher quality products, more security, a higher sustainability, or image advantages. For commodity businesses or commoditized business, it's more a question of service-oriented and supply chain-related elements of differentiation, leading to savings in terms of time, personnel, and / or costs, a higher process stability, or generally less stress and risks for the customer.

- **Information Needs:** During the course of the preparation of a negotiation, the information that should be attained from the customer during the negotiation needs to be clarified in order to optimize one's own price determination or increase one's own market and competitor intelligence.

- **Negotiation Choreography, including roles, strategy and tactics:** The negotiation choreography describes how negotiations should be lead. This includes the determination of negotiation roles within the team and suitable negotiation tactics. Thereby, it's determined which negotiation arguments and tactics should be utilized in which way and by whom. The choreography finally describes the rhythm to which you want to "dance" and negotiate with the different corporate cultures involved in the negotiation.

- Depending on the responsible employees' experience and demand, **negotiation trainings and negotiation simulations** can support the rehearsal and practice of the negotiation choreography.

After closing the negotiation, the Double Loop Process heads into the **post-processing phase**. In addition to reflecting the outcome with colleagues, writing visit reports and feeding CRM systems (see e.g. Albers and Krafft, 2013), here the focus should be on systematically checking the negotiation results actually achieved against the negotiation strategy and objectives. Additionally, the need for adjusting the account strategy, ideas for account-related measures and resource requirements become apparent and should finally be summarized in an update of the ADP.

2.4 The Elements of the Left, Internal Loop

The major objective of the Double Loop Process's left loop is the cross-functional alignment and implementation of account-related activities in a way that supports a sustainable profit optimization as much as possible.

Based on the insights gained during the customer interactions, the account manager's task is to spot resource requirements and ideas for account-related measures and improvements in a way that allows an efficient internal decision-making process and a profitable implementation.

On the one hand, he has to ensure the implementation of agreed upon measures and terms within his own responsibility and decision authorities. In case he encounters insurmountable resistance at the internal interfaces, e.g. with supply chain management, the R&D department or the technical service, he must escalate the conflict through the hierarchy and thereby bring it to a head. It is imperative to overcome the divisional boundaries for the sake of the successful and profitable collaboration with the customer.

Furthermore, the (key) account manager should identify and address responsible internal decision makers for those topics that exceed his own responsibility and decision authority. If he's been given the green light for his topics, he should actively pursue the implementation in order to support a customer-minded and efficient implementation process. In contrast, in case he does not come through with his initiative and suggestion, there still remains the possibility to escalate through the organization's hierarchy.

As easy and obvious this way may sound, it can become a real burden in practice. Blurry roles and responsibilities, narrow decision-making authorities (even on management levels), hidden conflicts between different departments, personal conflicts, non-matching incentive-systems and target agreements, and other priorities in the supporting divisions do not make the job any easier.

In this connection, the challenges are so manifold and organization-specific that universal statements can barely be made. In many cases, the Double Loop Process creates the foundation for a comprehensive organizational development project. This may e.g. be the case, when it becomes apparent that roles & responsibilities are not defined clearly and / or are not put into practice, or when the Double Loop Process reveals that certain interfaces and / or processes do not work properly. Consequently, the Double Loop Process can lead to insight into the necessity for more comprehensive organizational development diagnostics. The organizational development diagnostics then allow for identifying and treating the roadblocks which prevent an integrated account management, overcoming departmental and functional separation processes. For this purpose, the organizational diagnostics may refer to the principles of a morphologic impact analysis (see Salber, 1995).

Despite the common implementation topics mentioned above, a central element of the left, internal loop is the so-called "**ADP-Challenge**": The ADP-Challenge can be compared to a pit-stop, during which the most important account-related developments will be systematically and comprehensively analyzed together by the top management and the relevant decision makers.

The ADP-Challenge has the following functions:

- Exchange about the ADPs of different accounts and their insights, ideas, proposed strategies and measures,
- Exchange about topics, trends and market observations that go beyond the individual account perspective,
- Decision about important account-related and cross-account investments,
- Strategic guidance for future management of the account(s),
- Identification of and decisions about cross-account measures,
- Coupling of account-related investments with the budgeting process,
- Critical assessment and improvement of the quality of ADPs,
- Challenge and sustainable development of account managers and account management teams, as well as
- Contribution to the organizational development towards an integrated and sustainable profit-driven development of accounts and markets.

The way in which the ADP-Challenge is implemented significantly depends on the size, complexity and regional structure of the sales organization.

Nevertheless, all the ADP-Challenges should have the following factors in common:

- Design as a fixed ritual in the business calendar,
- Involvement of the top management,
- Involvement of the executives and decision makers of the relevant functions (e.g. marketing, sales, R&D, business development, supply chain / production),

- Interactive course of action,
- Scheduled in a way that the ADP-Challenge's results can be included in the budgeting process,
- The obligation for everyone involved to prepare for the ADP-Challenge, and
- A neutral and result-oriented facilitation, at least during the introduction of the ADP-Challenge.

The implementation of the ADP-Challenge will increase the customer and market orientation of the budgeting process and thereby improve it significantly. A well-implemented ADP-Challenge will replace meaningless Excel tables with well-grounded and coordinated budget figures, which refer much more to a systematically aligned planning of customer- and market-related investments, price levels, quantities, sales, costs, and contribution margins.

The following paragraph elucidates how differently the ADP-Challenge and the Double Loop Process can turn out, depending on the organizational structure and the business under consideration.

2.5 Implementation of the Double Loop Process in Different Businesses

There is no universal pattern for the course of the Double Loop Process and the ADP-Challenge. Even the introduction of the Double Loop Process as such may occur very differently.

In some cases, it is appropriate to start with the right loop and prepare the account managers and negotiation teams by conducting negotiation trainings and workshops for strategically important negotiations. After that, the account managers and cross-functional teams can be guided through the Double Loop Process with systematic coaching.

In other cases, it may be appropriate to start with the left loop of the Double Loop Process before getting to the first ADP-Challenge. In this case, the ADP-Challenge, which marks the starting point of the left loop, would initially be conducted without pre-designed ADPs. Instead, the account managers will give a presentation on selected topics without any guidance or restrictions in terms of templates and formats. The form of their presentations will than provide important input for the later design of the APDs. The second ADP-Challenge will then refer to ADP-formats, contents and templates defined in the meantime.

In a third case, the definition of ADP-contents and templates and the subsequent roll-out to the account managers and account management teams can mark the start of the Double Loop Process.

In the optimal case, the implementation of the Double Loop Process will be preceded by an organizational development diagnostic in order to attune the implementation process to the specific corporate culture and situation. This will also reveal how the ADP challenge should be designed in the very specific case.

In a **global key account organization**, the main challenge of the Double Loop Process's implementation is the coordination of the global and regional views on account management. Here, the ADP-Challenge turns into a global event, which comes along with corresponding traveling and coordination expenses. The number of key accounts to be considered is usually limited in a way that enables the ADP-Challenge to be conducted over the course of one or two days, given there aren't any problems. In the case of a two-day ADP-Challenge, which covers 10 key accounts, there would be, for example, up to one hour left for each account.

In the case of a lower customer concentration with a global and broadly diversified customer structure, one has to face completely different challenges.

For example, if there are only 5 or 6 global key accounts in a sales organization, but 900 important regional customers and 150 account managers who need to be considered, the Double Loop Process and the ADP-Challenge have to be regionalized in order to avoid a major event with up to 200 employees. An event of this size could not be handled properly in terms of content. Only for the global key accounts, the aforementioned scenario can be applied.

Here it is beneficial to additionally deal with the 900 regional customers in a two-phase approach:

- In a first phase, the topics that need to be dealt with by the regional sales organization or subsidiary are processed in regional ADP-Challenges under the guidance of the corresponding area managers or regional sales heads.
- In addition, the topics that cannot be processed or solved within the regions and e.g. require a high amount of central resources will be dealt with in a central ADP-Challenge. This second step of a supra-regional ADP-Challenge will deal with those insights and requirements gathered during the different regional ADP-Challenges that need to be solved within the headquarters. Both the regional sales executives and the supra-regional decision makers will be involved in this second phase.

In particular, the fact that the regional ADP-

Challenges usually have to deal with a more fragmented customer base and a high number of accounts often leads to the necessity of modifying the classic course of the ADP-Challenge. It is e.g. not feasible to work through 30 presentations and discussions for all the regional accounts in a linear process. In this case, more innovative workshop concepts must be applied to support the control of attention and concentration of the participants. For example, a combination of self-studies, prepared webinars and fair concepts could be utilized for the presentation and discussion of the ADP contents for a high number of accounts.

It becomes obvious that the Double Loop Process's and the ADP-Challenge's basic principles stay intact in both application examples. In either case, the implementation must be attuned to the specifics of the organization, its culture and the customer portfolio. There is no universal solution.

2.6 Contents of the ADP

As the ADP becomes part of a dynamic, comprehensive and integrated process during the course of the Double Loop Process instead of an unpopular, mandatory document moldering on servers or in drawers, it's just as important to address the ADP's actual contents.

The integration into such a Double Loop Process affects the ADP's content, which, in its details, turns out to be highly specific to company, business and culture.

The **contents of the ADP** usually follow a similar basic structure with the following elements:

- Executive or Management Summary
- The situation of the customer
- Our business with the customer and existing business potentials
- Our strategy
- Measures, milestones and required resources

The weighing and arrangement of the aforementioned building blocks are highly business dependent and company specific. For example, in commoditized businesses, the focus shifts to supply chain topics, while in innovative specialty businesses, the technical and development-related questions, as well as customer projects, are of higher importance. This should be reflected accordingly within the ADP structure.

Furthermore, the **content and length of the ADP** should accommodate the customer's importance. It is therefore recommended to shape the ADPs with different levels of detail and scopes for different customer segments.

A further question that needs to be answered over the course of the ADP creation is: at what point can the contents of an ADP be standardized using **templates** and with which **software** shall the ADPs be created (e.g. Excel, Powerpoint, Word)? While templates simplify the reading and processing of different ADPs, they significantly restrict the account manager's room to maneuver and make it harder for him to convey his customer story. For that reason, a careful and well-dosed application of templates is recommended, which often speaks against a mainly Excel-based implementation of ADPs. At the same time PowerPoint offers the advantage over Word, in that the ADP's contents can easily be used for presentation purposes without further adaptation (e.g. in the course of the ADP-Challenge).

In each case, it makes sense to choose a strongly result- and profit-oriented ADP design to support the left loop of the Double Loop Process. This means that business potentials at an account, objectives, etc. should be expressed in terms of contribution margins. This poses a challenge to a lot of account managers, for which they should be prepared accordingly.

Important topics for the right loop are e.g. decision-making processes, our relationship to the customer's decision makers and their personality profiles. They can e.g. be addressed in the section, dealing with our business with the customer.

In any case, the Double Loop Process transforms the usage of ADPs and the subsequently enhanced decision-making process into an integrated and cross-functional process.

3 Conclusion

The Double Loop Process of account management, as presented here, leads to a fundamentally changed perspective on account management and the creation and implementation of ADPs. The ADP becomes part of a comprehensive customer management and decision-making process, which supports the systematic preparation, implementation and post-processing of customer negotiations. Additionally, it systemizes and improves the internal cross-functional coordination and decision-making concerning account-related strategic topics.

The firm embedding of the ADP-Challenge within the organization offers the opportunity of an annual, systemized strategic debate about account-related questions and decisions. It aligns the account-related strategies involving all relevant functions and creates strategic clarity for the affected account managers and account management teams. The coordination of the ADP-Challenge with the budgeting process in terms of timing, organization and content leads to strategically well-founded, agreed-upon, more customer- and market-related budget figures.

The entry to the Double Loop Process, its course of action, and the form of the ADP-Challenge are highly dependent on the individual case. Nevertheless the basic principles, which have been briefly outlined with the help of different examples, remain the same.

The introduction of such a Double Loop Process does not require witchcraft, but demands and fosters discipline, organization and effort from everyone involved - from account managers to decision makers at important interfaces, right up to the top management.

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Practitioner's Section

On the current practice of New Business Development in the German chemical industry

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The results of a survey on the practice of new business development conducted in 17 chemical industry companies and related business sectors, such as service providers, are presented in this article. The objectives and organizational setup of New Business Development were found to be exceptionally heterogeneous and to cover a broad spectrum. The differentiation between New Business Development and Innovation Management was also not consistent between the companies. All the companies underlined the importance of technical and scientific know-how for new business development staff, but also emphasized the relevance of interdisciplinary competencies at the interface between natural science and business. Small companies follow a rather opportunistic New Business Development approach without dedicated organizational structures. Larger companies, on the other hand, employ a Stage-Gate process and largely derive their ideas from megatrends. Differences between small and larger companies are discussed in the article at hand.

1 Introduction

Chemical companies are currently facing ever-increasing competitive pressure in their market environment. Some of the drivers for this increasing competitive pressure are the globalization of value chains (CHEMonitor, 2014), the shorter product life cycles (Roland Berger, 2014), as well as with the faster commoditization of products, and shareholder's expectations of publicly listed companies. As a reaction to this competitive pressure, we observed that in the last decade many companies have established dedicated functional or organizational units that are responsible for "New Business Development" (NBD). Compared to the more "traditional" units responsible for R&D and innovation management, NBD is not only responsible for new product development within the existing market environment of the company, but also deals with the development of (new) business activities along the whole value chain (concerning e.g., marketing, service, customer access, business model) (BASF, 2014; Clariant, 2014; CABB AG, 2014; Freudenberg, 2014; von Delft *et al.*, 2013; Böcking *et al.*, 2013). While there is no clear definition of New Business Development in the scientific literature, most authors so far seem to agree that NBD focuses on development of business activities outside the existing boundaries of a company (Karol *et al.*, 2002a; Klumpp/Koppers, 2009). Karol *et al.* relate New Business Development for a company with "growth opportunities [that] lie outside both their current product/technology base and those markets/customers they currently serve" (Karol *et al.*, 2002). Klumpp and Koppers emphasize that "Business development [...] aims at a change in the current portfolio and can be seen as an innovation in regards to technologies or business models" (Klumpp/Koppers, 2009). In the context of this article we propose the following working definition "New Business Development is the process of identification, evaluation and establishment of new business areas of a company".

In order to get an impression of the current practice of New Business Development in the chemical industry, we conducted expert interviews with 17 companies of the chemical industry and their related areas (such as, e.g., service providers). We hypothesized that differences exist in the practice of New Business Development in the companies, and that there should be major differences between small and larger companies. New Business Development in the Chemical Industry has already been addressed in the scientific literature (Karol *et al.* 2002a; Karol *et al.* 2002b). However, to our knowledge there is no investigation or discussion of the differences in New Business Development in the Chemical Industry between smaller and larger companies in the scientific literature so far.

A further aspect to be examined in the survey were the competencies required for staff working in New Business Development. In this context it is interesting to note that as early as 1975, Cooper analyzed that it was not technical issues which led to failure of new product development, but rather shortcomings in "close to the markets activities" such as a poor market analysis, a lack of marketing effort or an inadequate compilation of a business plan (Cooper, 1975). One possible reason for this finding is the fundamentally different cultures of natural scientists (representing the technical competencies required for R&D) and economists (representing the market-near competencies required for e.g. marketing).

Another challenge for staff in New Business Development is the increasing interdisciplinarity in chemistry, as can be seen by analyzing the interdisciplinarity of Nobel prizes in chemistry from 1901 to 2013 (Figure 1).

2 Methods

We interviewed 19 experts from 17 companies of the chemical industry and related areas (e.g., service providers) about the topic New Business Development. The experts were managers of the units New Business Development (10 interviewees), innovation management (4), CEOs (3) and marketing manager (2).

The companies in the survey cover a broad range of company size as well as business activities and target markets (Table 1). This breadth was chosen in order to investigate the practice of New Business Development as a function of company size and business focus.

New Business Development activities can be generally classified using the Ansoff matrix (Ansoff, 1965) (Figure 2). Although this matrix is commonly focused on products, the underlying logic is transferable to other areas (such as services or business models).
All interviewees responded to a standardized questionnaire that contained open and closed questions on the following topics:

- Definition of New Business Development and differentiation from Innovation Management (two open questions in order to capture the breadth of the topic within the company).

- Objectives of New Business Development (open discussion and quantitative rating of the relative importance of the four quadrants of the Ansoff matrix).

- Organization of New Business Development

Figure 1 Interdisciplinarity of Nobel prizes in chemistry, 1901-2013. Each point represents a Nobel prize. The nearer a point is located towards an edge, the higher the importance of the respective field.

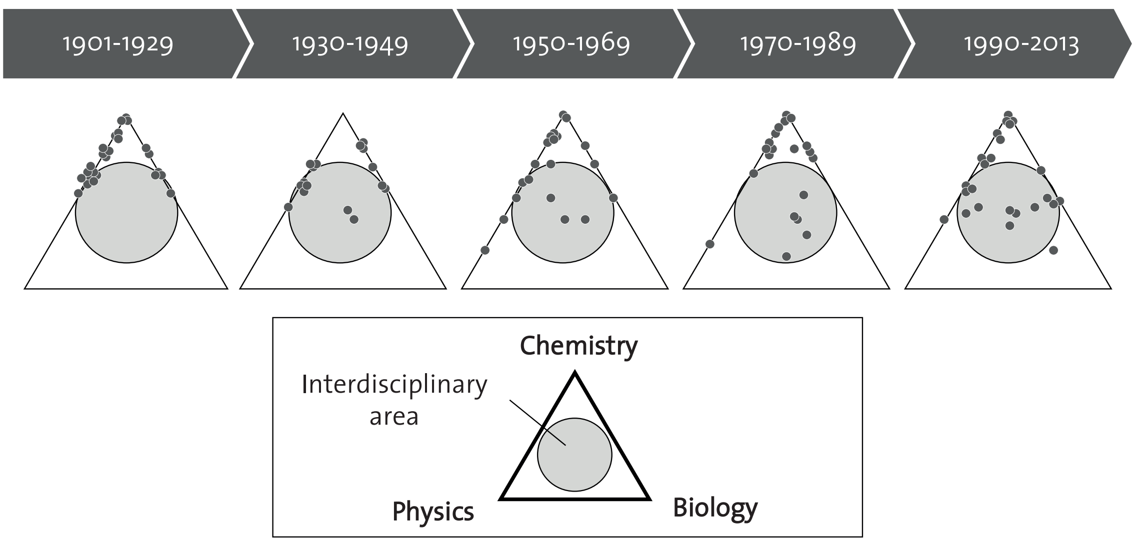
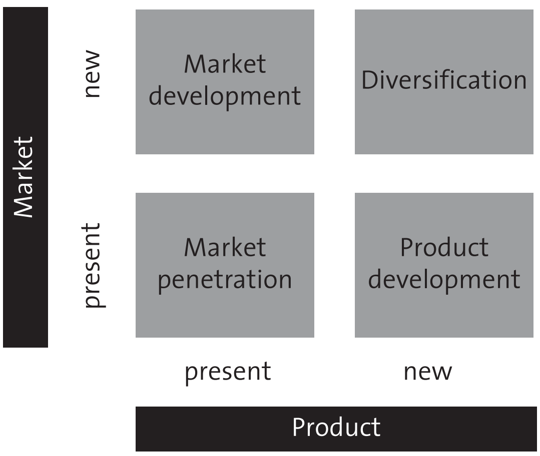


Table 1 Anonymized overview of companies that participated in the survey (SME: Small and Medium Enterprise; LSE: Large-Scale Enterprise; "Number" represents the quantity of companies of the respective type in the survey).

Company type and size	Number	Focus of business activities
Specialized SME (less than 1,000 employees)	5	Service provider in the composite material industry
		Service provider for the pharmaceutical industry (film coating)
		Manufacturer of pharmaceuticals and textile chemicals
		Electroplating of plastics for the automotive industry
		Manufacturer of PVA and PVB for different end applications
Focused LSE (more than 1,000 employees)	4	Manufacturer of MCA for different end applications
		Manufacturer of high performance polymers for different end applications
		Service provider with focus on laboratory analytics
		Manufacturer of silicones for different end applications
Diversified LSE (more than 1,000 employees)	8	Manufacturer of a broad range of polymers for various end applications
		Precious metals and inorganic materials for high-end technological application
		Diversified manufacturer of specialty chemicals for different end applications
		Manufacturer of fine chemicals for industrial applications
		Manufacturer of specialty chemicals for feed applications
		Manufacturer for goods for various industrial end applications
		Manufacturer of pharmaceuticals and a broad range of fine and specialty chemicals
		Large-scale manufacturer of base, fine and specialty chemicals for end applications

Figure 2 Ansoff matrix for classification of New Business Development objectives of interviewed companies.



(open question about the organizational setup, with focus on the hierarchical level on which NBD is executed in the company).

- Professional competence of staff (open and closed question in order to investigate the importance of technical competencies versus economic competencies).

- New Business Development process, origin of ideas and typical project duration (open questions).

The questions and the results are discussed in detail in the following section. All interviews were conducted either by phone or personally.

3 Results and Discussion

3.1 Objective and organization of New Business Development

All interviewees were asked to assess the individual fields of the Ansoff matrix according to their relative importance for their company. The results of this question are displayed in Figure 3.

Interestingly, all companies seem to have different prioritizations in the focus of New Business Development. This can be seen from the fact that all companies assessed the four quadrants of the Ansoff matrix differently. In the light of this result, it is less surprising that there is no single definition of New Business Development in the literature.

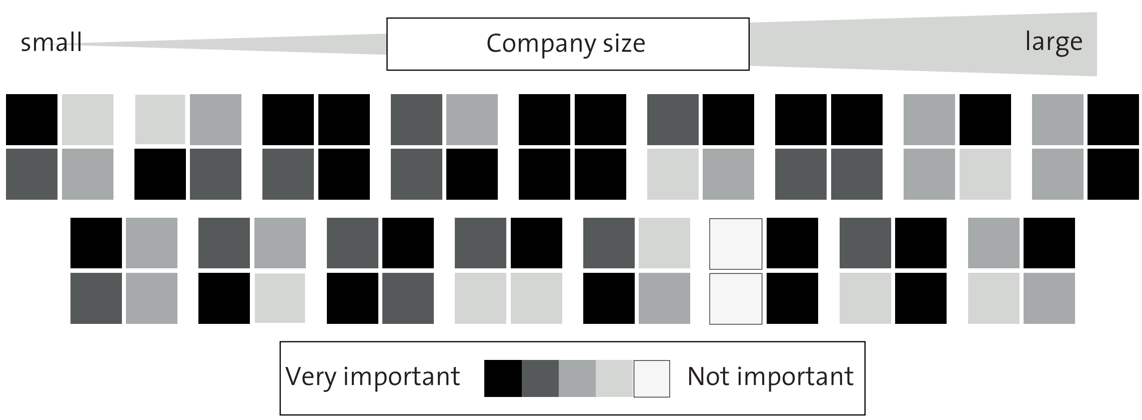
Furthermore, it can be seen in Figure 3 that diversification (development of new products for new markets) seems to become more important with increasing company size (the further one goes from left to right in Figure 3, the more often interviewees ranked the upper right quadrant of the matrix with “very important”). This result can be explained by the fact that the time-consuming and expensive development of new products and innovation constitutes an integral part of the competitive strategy of larger companies. They also have sufficient resources to fund the development of these new products, which is usually difficult to realize for small companies due to budget restraints.

Smaller companies, on the other hand, rather seem to focus on market penetration and – to a lesser extent – market development. This result is somewhat surprising, as market development also requires a large amount of resources. However, all the companies surveyed seem to hold their own definition of what “market development” specifically means. Smaller companies often defined “market development” in terms of “expanding into other geographical regions”, whereas larger companies also included “opening up of a previously unserved customer segment” (like, e.g., using PTFE [polytetrafluoroethlyene] for non-stick coating in frying pans – beyond traditional B2B market segments), which usually requires more resources.

However, beyond possible ambiguities as to the definition of the four quadrants of the Ansoff matrix, we think the survey results reflect first and foremost the broad diversity of different market segments and competitive environments which are characteristic for the chemical industry.

The organizational setup of New Business Development in the companies surveyed is also quite different. Some of the most frequently mentioned

Figure 3 Objectives of New Business Development as a function of company size. Every company is represented by a 2x2 square corresponding to the four quadrants of the Ansoff matrix in Figure 2.



forms of organization are displayed in Figure 4. In addition, some companies reported that they do not have a dedicated NBD unit. This concerns mainly smaller companies where NBD is carried out directly by the CEO without a separate organizational unit.

For those companies that have a dedicated NBD unit, three different forms of organization can be distinguished, according to the hierarchical level where New Business Development is located. Firstly, there can be a central NBD unit for the whole company (Figure 4, left hand side) with a direct report to the top management of the entire company (for some small companies, NBD is actually executed by the CEO himself). Secondly, the NBD unit can be an individual organizational unit within one of the business units (Figure 4, middle). And thirdly, some companies reported forms of organ-

Figure 4 New Business Development forms of Organization in the surveyed companies.

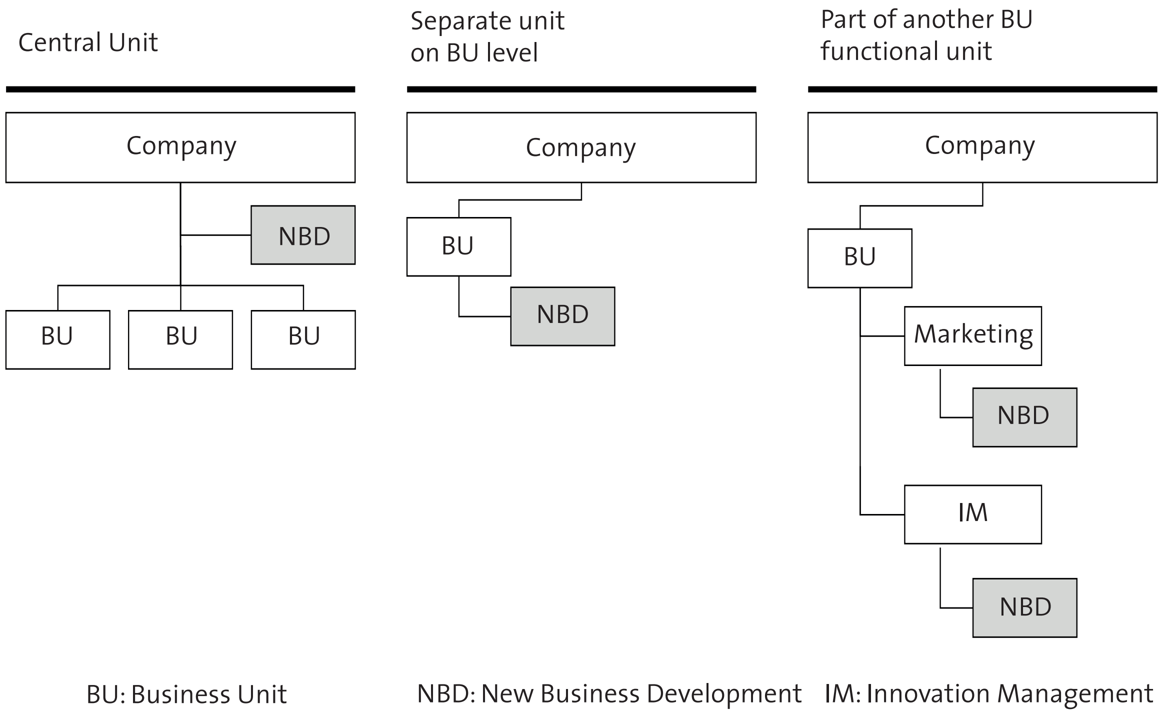
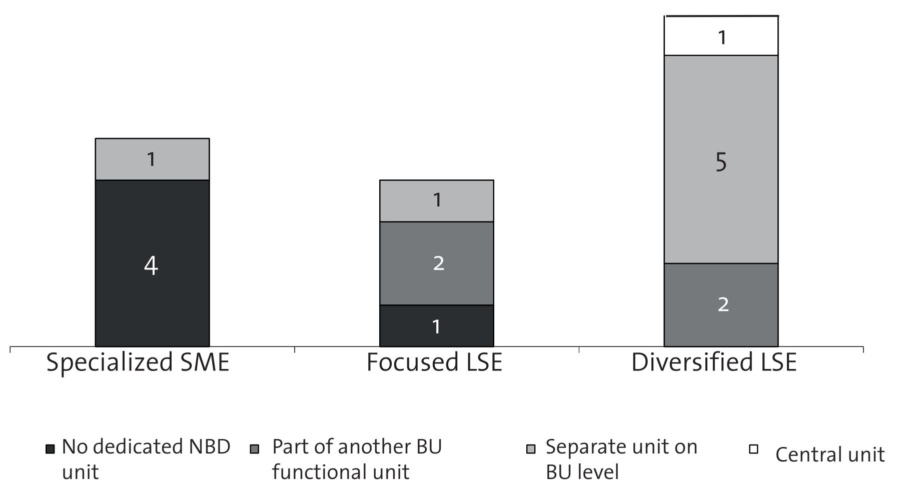


Figure 5 New Business Development forms of organization as a function of company type and size.



ization where the NBD function is part of another functional unit within the business unit, such as marketing or innovation management (Figure 4, right hand side).

These different forms of organization differ between smaller and larger companies (Figure 5). In focused SME, there is usually no dedicated NBD organizational unit (given the usual narrow market focus of these companies, NBD is often conducted on CEO level or as an additional task within other functional units), whereas larger companies usually execute NBD in a dedicated unit. Most diversified LSE in the survey reported to have a dedicated NBD unit within each business unit (due to the often specialized market focus of individual business units). In focused LSE, the organizational setup seems to depend on the market. One company with focus on one specific niche segment does not employ a dedicated NBD unit. Another company with focus on two individual niche products organizes its NBD in individual units on BU level (due to required technical knowledge in each individual end market). And two companies that focus on a larger variety of end markets employ NBD units as part of other BU functional units in other "market-near" activities (either marketing or application engineering).

From Figure 5 it could be inferred that the importance of more centralized organizational units seems to increase as a function of company size and diversity. Indeed, there is some anecdotal evidence from the survey that larger companies seem to further strengthen their activities in these long-term topics with dedicated organizational units that are positioned at a company level (not on BU level). These centralized units are responsible for strategic NBD portfolio management of the entire company. However, it is not possible to generalize this finding. For example, one diversified LSE reported that the existing centralized NBD unit was recently restructured into several NBD units in each business unit, due to different competitive and technological dynamics in the end markets served by the individual business units.

We think that it is also important to distinguish New Business Development from organizational functions that focus on long-term future trends (time horizon > 10 years) like the "Corporate Foresight" unit at Evonik (Evonik, 2014).

In this context, it is further important to note that the differentiation between New Business Development and Innovation Management is seen quite differently between different companies. The answers of the survey participants cover a broad spectrum, as can be illustrated by the following examples:

- "Innovation Management is a tool of New Business Development."
- "Innovation Management is the development of new products and processes. New Business Development is rather located at the customer interface."
- "Innovation Management rather focuses on existing products and processes."
- "There is no distinction between New Business Development and Innovation Management."

The large differences in the objectives of New Business Development and the differentiation towards Innovation Management probably reflect the broad spectrum of different markets in which the companies are active. Given that these markets differ with respect to many parameters (e.g., competitive dynamics, success factors, product life cycle duration) it is not surprising that a large variety of New Business Development models is established in the chemical industry. The differentiation between New Business Development and Innovation Management is also not unequivocal in the literature. However, it seems that the practice of Innovation Management is rather associated with product and process development within the existing business (Hauschildt/Salomo 2007), whereas New Business Development seems to focus on development of business opportunities outside the existing business, i.e. the upper right corner of the Ansoff matrix (Karol *et al.* 2002a).

3.2 Professional background of New Business Development staff

As already described above, New Business Development is a function with many interfaces within the company and outside the company (Figure 6). This requires staff with a broad set of skills, particularly communication skills as well as willingness and ability to learn.

In this context it is interesting to note that the majority of employees in New Business Development in the companies interviewed have a background either in chemistry / natural sciences or engineering (Figure 7). Most companies reported that a pure economics background would not be sufficient for successfully working in NBD, as might be underlined by the following exemplary quote:

"*We have tried once to employ a pure economist in New Business Development. Unfortunately, this was not successful as he lacked the technical background in chemistry and natural sciences.*"

However, most companies emphasized the importance of combining both technical expertise (chemistry) and economic know-how. It is therefore not surprising to find graduates with a PhD and further training in economics (e.g., Master of Business Administration, MBA). In addition, students who followed other interdisciplinary study courses at the interface of natural sciences and economics were also mentioned to hold the competencies required for New Business Development.

Furthermore, it seems that an academic degree is necessary in order to successfully work in New Business Development. One could hypothesize that this reflects the requirements of competencies like communication skills and abstract thinking which are mainly practised during an academic study course. Nevertheless, 15 percent of NBD employees the companies interviewed have followed vocational training and have no academic degree. They are mainly employed in smaller and medium-sized companies with flat hierarchies. In these cases, it was mainly the practical experience that represents a core competency of these employees for New Business Development.

Figure 6 Illustrative display of some internal and external interfaces of New Business Development.

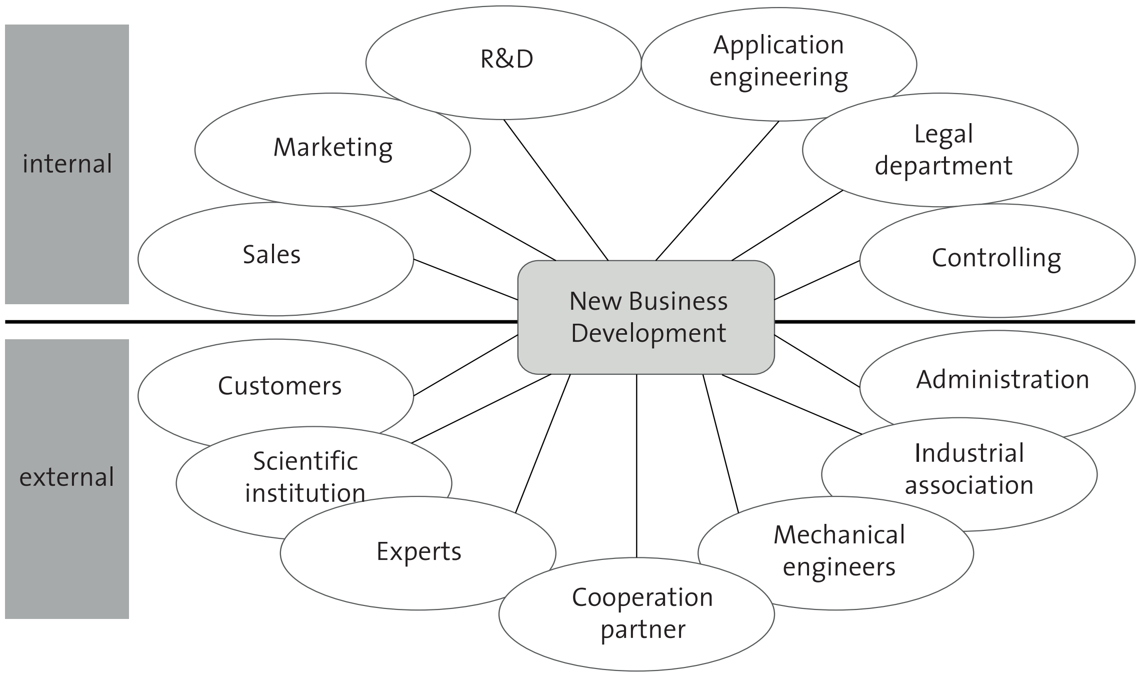
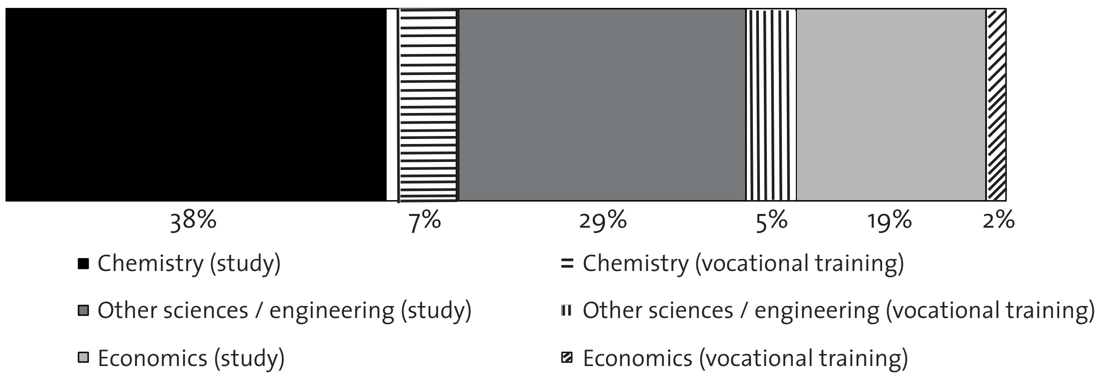


Figure 7 Professional background of New Business Development staff according to answers of survey participants (n=17).



The practical experience of NBD staff was also mentioned at larger companies. Besides the professional expertise (through vocational or academic training), customer and market know-how, combined with an established industry network (in order to quickly identify the experts for specific subjects related with an NBD idea) are critical success factors for employees in New Business Development.

3.3 New Business Development process

The companies in the survey with more than 500 employees apply a Stage-Gate process (Cooper, 2001) for management of their NBD projects. This process is usually adapted to the specific requirements of the company. One example of such an adapted process is DuPonts "business initiative process" (BIP) that has been described in the literature (Karol *et al.* 2002a; Karol *et al.* 2002b).

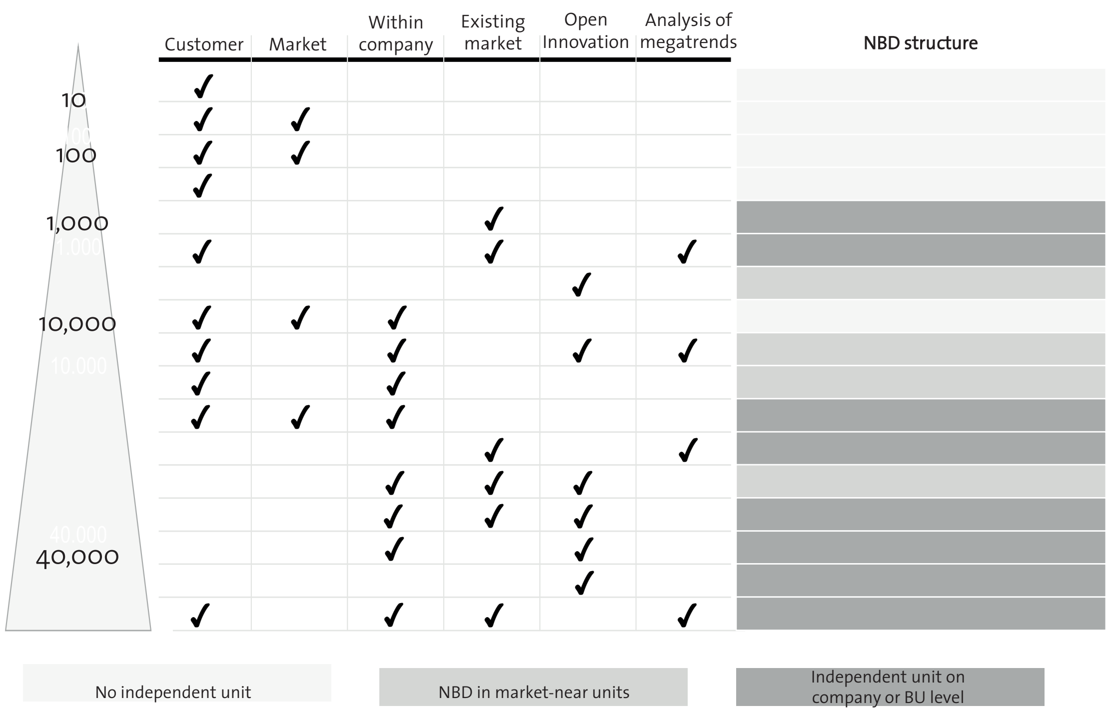
Companies with less than 500 employees do not usually follow an established and defined process and pursue a rather opportunistic approach towards New Business Development. A specific type of such a "pragmatic" approach has been described in the literature (Schlesinger *et al.* 2012).

The most important sources of ideas for New Business Development are given in Figure 8. Most companies derive their ideas from different sources. However, it can be seen that smaller companies seem to prefer their immediate customers as origins of ideas. Larger companies, on the other hand, derive their NBD ideas more out of long-term considerations (such as, e.g., out of megatrends). One possibility of deriving specific ideas for New Business Development would be the application of systematic patent analysis and mapping tools, as described in the literature (Seymour, 2008).

It can also be seen in Figure 8 that it is the larger companies that established a dedicated New Business Development unit as an independent functional organization with specific processes. This result emphasises once more that smaller companies seem to pursue a rather opportunistic approach towards New Business Development without such dedicated functional units.

Differences between smaller and larger companies can also be identified with respect to the duration of New Business Development projects (Figure 9). Whereas companies with up to 1,000 employees seem to favour short-term projects of 1-2 year duration, larger companies also execute

Figure 8 Origin of ideas for New Business Development and structure of NBD as a function of company size.



projects with a duration of typically up to 10 years (in one case even up to 15 years).

This result is also not surprising, given that larger companies (as discussed before) are more capable of pursuing these long-term projects due to sufficient resources and capital. Smaller companies seem to focus on short-term, customer-driven projects centered on application development. Product development is followed to some extent in smaller companies, but, due to time and resource restraints, is not the common objective of NBD. And technology development, which requires an even larger amount of time and resources, is only pursued to a significant extent at larger companies.

4 Conclusion

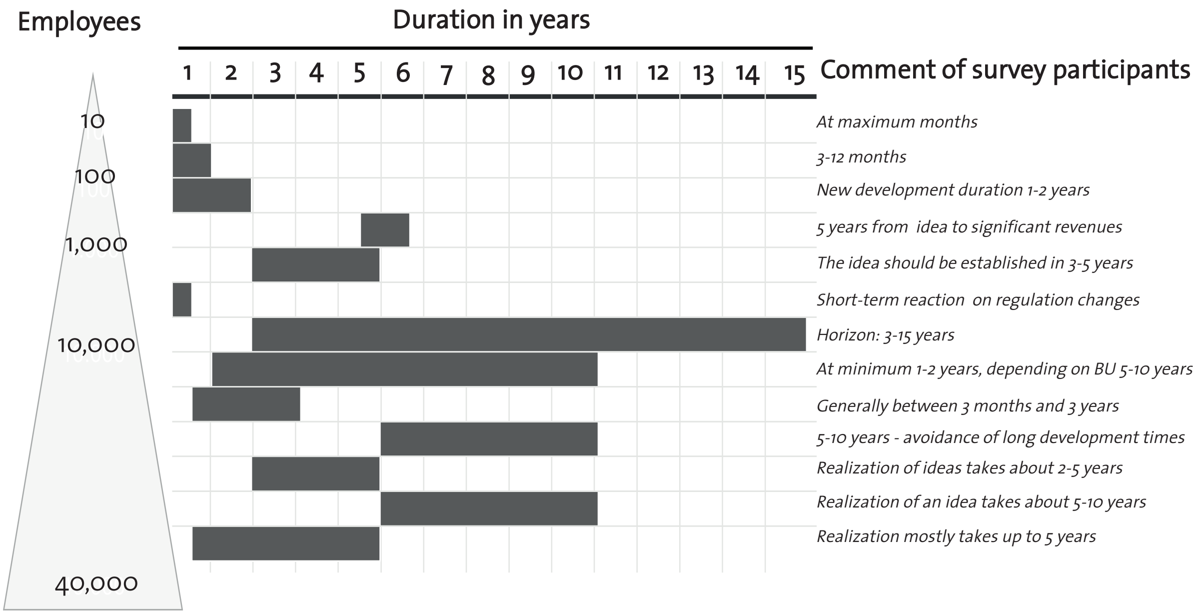
In the work at hand, several aspects of New Business Development in the chemical industry and related areas are investigated. In this context, differences depending on company size were analyzed.

New Business Development represents a heterogeneous subject in the chemical industry as different definitions, objectives, organizational structures and processes exist in practice. Smaller companies do not usually have dedicated NBD units, both due to resource restraints, and usually to narrow market focus. For larger companies (>1,000 employees) the structure of the NBD organization seems to depend on the diversity of end markets served. With increasing company size and diversity of the product portfolio, a dedicated NBD organizational unit seems to become more important. However, given the rather small sample size and the differences of end markets addressed by the companies (Table 1), we cannot conclude to which extent the individual market segment influences the setup of NBD in the chemical industry. We would encourage further research in this field with a larger sample size in order to better understand this topic.

With respect to the competencies required it is important to note the relevance of technical know-how. Of particular importance are also competencies at the interface of different disciplines (such as chemistry and economics), which can be obtained through additional academic training in economics (such as an MBA) or in an interdisciplinary study course.

Smaller companies pursue a pragmatic and somewhat opportunistic approach towards New Business Development, which can be inferred from the fact that the end customer is often the major origin of ideas and that there is no dedicated process for execution of NBD projects. Larger companies,

Figure 9 Duration of NBD projects.



on the other hand, focus more on long-term projects (as derived from megatrends, for example) and usually follow a Stage-Gate process for execution of NBD projects.

However, the results presented in this work should be taken with caution, as the total number of companies that participated in the survey was quite low (n=17). Therefore, the results cannot be seen as statistically significant, but should rather be interpreted as a trend study. It is therefore quite possible that the specific situation in an individual company is considerably different from the results outlined in this article.

What is the implication of these results for management of chemical companies and service providers such as consulting companies? In our view, these results can be of use in two major dimensions.

Firstly, this study may sensitize decision makers in the chemical industry for the topic New Business Development. We currently seem to face the situation where it is not only the large chemical companies that implemented a dedicated unit, but that also small and medium-sized companies are beginning to enter the field of New Business Development. So each company should carefully ask itself to which extent this topic is already addressed within the current organization – and investigate the necessity of creating a dedicated New Business Development unit in order to stimulate long-term sustainable growth and competitiveness. In this context, it seems important for us to note that all companies have identified NBD as a prerequisite for establishing long-term competitive advantage in the industry and market environment.

Secondly, the results may help managers responsible for New Business development to benchmark their own practice compared to other companies displayed in this work with respect to the various areas of objectives, organizational setup, processes or competencies required. This may help to heighten the activities of each individual company and to ensure that the application of New Business Development will further evolve in the chemical industry.

Therefore, although New Business Development itself can still be seen as an emerging topic within the chemical industry, some structural characteristics and differences already become visible in the market place. It will be important and interesting to follow the development of these models in upcoming years in order to see which of these models will continue to prosper and whether there will be approaches towards New Business Development that may not prevail. In any case, it will hardly be possible for decision makers in the chemical industry to circumvent this topic for their company.

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