Chapter 8
Chemical Industry: Servitization in Niches

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Abstract The chemical industry represents an important share of global manufacturing and all other manufacturing sectors employ products made by the chemical industry. Its strong B2B focus makes the chemical industry an interesting subject for analysis of the state-of-the-art servitization in this industry. Even more interest in the chemical industry's servitization arises from the fact that United Nations Industrial Development Organization (UNIDO) is strongly promoting the service of "chemical leasing" because of its potential to reduce the environmental impact of the use of chemicals. Thus, this paper presents a state-of-the-art analysis of servitization in chemical industry. A review of the case study literature shows that chemical management services appeal only to a sub-group of chemicals, namely specialty chemicals. As a result, commonalities and differences between certain types of specialty chemicals and their service offer implications are highlighted. We categorise the providers and customers of chemical management services and conclude by evaluating the servitization potential of the chemical industry. The empirical basis of this research comes from the literature, case studies and firm documents.

8.1 Introduction

The chemical industry represents an important share of global manufacturing turnover. In 2011, the turnover of the chemical industry was valued at 2,744 billion Euros. During this year, Asian companies were the major producers

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of chemical products (52 % of global sales), followed by European (23 %) and NAFTA-region companies (17 %). This ranking is partly reflected by the list of the largest chemical manufacturers: Germany's BASF is the largest, followed by China's largest petrochemical producer, Sinopec. US-based ExxonMobil and Dow Chemical are ranked third and fourth, respectively, and LyondellBasell Industries (NL) is in the fifth position. Finally, Saudi Arabia's SABIC, Royal Dutch Shell (GB/NL), Mitsubishi Chemical (J), DuPont (USA) and INEOS (CH) complete the top 10 (ICIS 2011). In the European Union (EU), chemical companies employed a total of approximately 1.19 million people in 2011 (Cefic 2012).

According to the European Chemical Industry Council (Cefic 2012), the chemicals industry works with three types of chemical products: base, speciality and consumer chemicals. Base chemicals (petrochemicals, polymers and basic inorganics) are produced in large volumes and sold within the chemicals industry itself or to other industries. In 2011, base chemicals represented 62.4 % of total EU chemical sales. To the group of speciality chemicals belong paints and inks, crop protection, dyes and pigments and other specialty items such as lubricants, adhesives, tanners and water treatment products (Cefic 2012; Kortman et al. 2006). Speciality chemicals are produced in small volumes. They represented 25.3 % of total EU chemical sales in 2011. Finally, consumer chemicals are sold to final consumers in the form of products such as soaps and detergents as well as perfumes and cosmetics. They represent 12.3 % of total EU chemical sales in 2011 (Cefic 2012). Whereas competition in the production of base chemicals is driven by prices, the producers of specialty chemicals compete on differentiation and customisation (Cesaroni et al. 2004).

In traditional chemical industry business models, the products mentioned above are sold by volume. It can be assumed that in these traditional models, chemical manufacturers have no strong incentives to help customers use their chemicals more efficiently. Because they earn money by selling higher volumes, inefficient use by customers will increase the sales of chemical producers (Kortman et al. 2006).

Several years ago, predominantly environmental concerns encouraged the development of innovative business models in which chemical waste is avoided. Such business models promote servitization in the chemical industry by linking the physical offers of chemicals companies with the provision of additional services to customers. Labels for these innovative business models include the following:

- Chemical product services (CPS) describe business models that shift the focus from the sale/use of chemical products to the sale/use of chemical product/service combinations that jointly fulfil the demands of customers and suppliers (Kortman et al. 2006).
- Chemical management services (CMS) are defined as business models in which a customer engages with a service provider in a strategic, long-term contract to supply and manage the customer's chemical and related services (Stoughton and Votta 2003).

- Chemical leasing is a business model in which the chemicals required for a specific service are not sold to the customer but are rather made available for use and maintained (Jakl et al. 2004).

The essence of all these concepts is that the remuneration provided to chemical manufacturers as suppliers is not entirely linked to the amount of chemicals sold. Instead, chemical suppliers are also paid for the successful delivery and management of chemicals. Thus, supplier profitability is based on better performance, not the sale of more chemical products (CSP 2009). However, the different concepts discussed in the scientific and industry literature are not congruent. Chemical leasing is often seen as a special type of management service (CSP 2009; Kortman et al. 2006). In the following, we refer to the broader concept of chemical management services and particularly note special concepts such as chemical leasing without a transfer of ownership in the presentation of the literature.

The most important reason for customers to use CMS is to generate cost savings, specifically in life-cycle-costs, because chemical providers have greater and problem-adequate know-how on how to handle chemicals (Mattes et al. 2013). Reductions in environmental waste are more of a positive side effect rather than the initial driver for these business models (Kortman et al. 2006). Kaltenegger (2006) summarises four major advantages that can be linked with cost reductions for customers that use chemical management services:

- Exclusion from liability
- Reduction in required storage space
- Reduction in amount of employed chemicals
- Reduction of health and environmental risks

Strict legal regulations exist for the handling of chemicals, especially solvents, due to their potential to be hazardous, and society is also interested in information on their handling. These legal restrictions are expressed through avenues such as the European agreement on the international transport of dangerous goods on roads (ADR) or agreements on tariffs that users have to consider (Mattes et al. 2013; Kaltenegger 2006). In addition, societal expectations create a demand for the responsible handling of chemicals, which has to be included in environmental reports for various stakeholders.

A fact that users are often unaware of is that the costs of chemical management are significantly higher than the costs of purchasing chemicals. These costs range from 1 to 10 Dollars for every Dollar spent on chemicals over their lifespan (Kaltenegger 2006). Service providers have relevant knowledge with regard to the handling of chemicals in terms of transport, storage, documentation and procurement. In addition, their expertise helps them to identify optimisation potential, such as fine-tuning chemical mixtures, and thus helps users to reduce costs. When the use of technical equipment or uncommon chemicals is required, optimisation potential is boosted through cooperation among chemical providers, manufacturers and customers. Due to the health and environmental hazards represented by chemicals such as solvents, management of the handling process constitutes a very

serious responsibility (Hammerl and Jasch 2007). Thus, handling expertise can help ensure the safety of employees and the environment by, for example, reducing emissions of Volatile Organic Compounds (VOCs) in the applications of solvents.

If customers deal with several chemical suppliers, the outsourcing of all chemical management to one orchestrating company has additional benefits. These can include reductions in redundancies related to purchasing similar products from different suppliers, the implementation of just-in-time logistic by selecting the right point of sale, simplification of Material Safety Data Sheets (MSDS), health and safety controls and, as previously outlined, lower administrative costs for purchasing and logistics because there is only one supplier instead of 6 or 7 (Kortman et al. 2006).

Within this context, the next section describes the actual diffusion of servitization in the chemical industry according to groups of chemical products (Sect. 8.2). In Sect. 8.3 different types of CMS providers and customers are characterised and Sect. 8.4 concludes with an estimation of the actual extend of CMS diffusion.

8.2 Incidence of CMS by Chemical Product Groups

The assessment and analysis of CMS incidence in the chemical industry cannot rely on official statistical data because CMS represents special types of offers that are incorporated into the total sales of manufacturers. Hence, we employ a compilation of case study data from various sources and expert commentary from the literature.

Table 8.1 presents a summary of CMS cases that were conducted between 1989 and the present and were reported in literature or on the Internet. From this compilation, it becomes obvious that both base and consumer chemicals do not play a major role in the provision of CMS. Only speciality chemicals have been reported as being included in CMS contracts.

This finding is aligned with existing expert opinions. Kortman et al. (2006) found that the base chemicals market provides limited opportunities for suppliers and customers to develop and implement chemical product services, with the exception of industrial gases and fertilisers. Bierma and Waterstraat (2000) concluded that speciality chemicals have been the driving force behind most CMS programmes. The reasons for this are the relatively high margins of such chemicals and the higher level of expertise required to optimise their use.

Hence, Sect. 8.2.1 will provide a detailed analysis of the applications of CMS for the types of speciality chemicals reported in case studies.

Table 8.1 CMS case studies reported in the literature or on the internet

CMS supplier	CMS customer	CMS chemicals	Source
Akzo Nobel Powder Coatings S.A.E. Cairo, Egypt	ABB Arab, Cairo, Egypt	Coatings	Jakl et al. (2004)
Ashland, Covington, KY, USA	Motorola Semiconductors, Austin, USA	Chemicals for semiconductor production	CSP (2013)
Betz Dearborn today GE Water: Trevose, PA, USA	GM, Truck and Bus Plant, Janesville, USA	Water treatment chemicals	CSP (2013)
Cabot Speciality Fluids Aberdeen, UK	Total E&P UK Ltd., Aberdeen, UK	Cesium formate brine	Gilbert and Downs (2010)
Castrol Industrial North America, USA	Navistar, Engine Plant, Melrose Park, USA	Machining coolants, cleaners	CSP (2013)
Castrol/BP, Liverpool, UK	Cummins, Inc., Engine Plant, Jamestown, USA	Metalworking fluid, liquid nitrogen	CSP (2013)
Castrol/BP, Liverpool, UK	Airbus UK	n. a.	Oldham et al. (2003)
Chemical Mac Oil S.A. + SUMAT, Mexico	Mexican Sugar Mills	Lubricants	Jakl et al. (2004)
Chemico Systems, Southfield/ Chesterfield, USA	Lansing School, Michigan, USA	Facility management chemicals	CSP (2013)
Dr. Badawi Chemical Work, El Ameria, Egypt	GM Egypt, Maadi, Cairo Egypt	Hydrocarbon solvents	Jakl et al. (2004)
DOW, SAFECHEM Europe, Germany	Magna Steyr Fuel Systems GmbH Austria	Solvents for metal cleaning	CSP (2013)
DuPont Canada, Canada	Ford, Oakville, Ontario assembly plant	Paint for automobiles	UNIDO (2011)

(continued)

Table 8.1 (continued)

CMS supplier	CMS customer	CMS chemicals	Source
Ecolab Serbia	Knjaz Milos, Arandelovaz, Serbia	Lubricants	Jakl et al. (2004)
Ecolab Nalco de Colombia Ltda	Ecopetrol, Bogota, Colombia	Oilfield production chemicals	CSP (2013)
ERG	Henkel ERA, Russia	Water purification chemicals	CSP (2013)
Haas TCM, USA	Claverham Manufactures Bristol, UK	Machine coolant, adhesives, paints, etc.	CSP (2013)
Haas TCM, USA	Raytheon	Management for all chemicals and gases	Claussen (n.d.)
Haas TCM, USA	Stanford Linear Accelerator Center (SLAC), USA	Cooling tower, fuel and cryogen, etc.	SLAC (2008), and Claussen (n.d.)
Haas TCM, USA	GM, Oshawa Plant, Ontario, Canada	Paint booth management chemicals	CSP (2013)
Henkel, Germany	Bambi Banat A.D. Pozarevac, Serbia	Adhesives	Jakl et al. (2004)
Interface LLC, USA	Delta Airlines, Atlanta, Georgia, USA	All chemicals needed for operating airplanes (not fuel)	Gilbert and Downs (2010)
Mardi Inc. S.A. Mexico	Cromadoro Delgado S.A. Mexico	Chemical agents for electroplating	CSP (2013)
PPG/Chemfil, Pittsburgh, Pennsylvania, USA	Chrysler Neon, Plant, Belvidere, Illinois, USA	solvents	Oldham et al. (2003)
PPG Polska	GM/Opel site in Poland	Paints used in site facilities	CSP (2013)
PPG/Chemfil, Pittsburgh, Pennsylvania, USA	Ford, Taurus Assembly Plant, Chicago, USA	Plant chemicals except paints, sealers, and lubricants	CSP (2013)
Quaker Chemical Corporation, Pennsylvania, USA	General Motors, Grand Rapids Plant USA	Lubricants, greases, adhesives, paints etc.	Jakl et al. (2004)
Tiefenbacher GmbH Ennsdorf, Austria	Mepla Alfit (today Grass), Götzis, Austria	Solvents	Jakl et al. (2004)
Zinc Misr, Cairo, Egypt	El Sewedy Electrical Company, Egypt	Zinc chloride, ammonium chloride	Jakl et al. (2004)

8.2.1 Solvents

Solvents are used in most industrial sectors to clean and degrease materials. They are used to clean metals, e.g., remove oily grease, metal scarf, dust or other impurities, as well as to dry clean garments. Solvents are also necessary in paint production to dissolve the compounds that are components of paint (Kortman et al. 2006). The production of solvents accounts for approximately 13 % of speciality chemical production and 3 % of overall chemical production (own calculation based on Cefic and Eurostat). In the following, selected case studies are presented to develop a better understanding of the particularities of CMS for solvents.

The first example of CMS for solvents involves the cooperation of Tiefenbacher and Mepla Alfit. Tiefenbacher GmbH is from Ennsdorf, Austria, was founded in 1989, and has approximately 10 employees. It is active in de-lacquering metal, plastic and wooden surfaces. For its customer, Mepla Alfit (a company resulting from a 2007 fusion with Grass into Grass GmbH, located in Höchst, Austria) which produces hinges, drawers and sliding systems, Tiefenbacher offered to provide its expertise to the internal de-lacquering process used at Mepla Alfit in the painting of different parts. The offered services included the delivery of solvents, provision of descriptions for care of the de-laquering baths, process instructions and data sheets, solvent quality analysis before and after use and waste management. The benefits of the service package included reductions in the required amount of solvents as well hazardous waste produced in the de-laquering process. The revenues for Tiefenbacher were linked to the quantity of consumed solvents (Beyer 2008).

The second example is the trilateral cooperation between SAFECHEM, Pero and Magna Steyr. SAFECHEM is a subsidiary of The Dow chemical company, with divisions in Europe and North America and approximately 20 employees (SAP 2011). SAFECHEM was founded in 1992 and provides solvent uses with services and solutions for surface cleaning in the aerospace, automotive, high precision and electronics industries, among others (Dow 2013a). SAFECHEM services over the complete life cycle of solvents, including delivery, inventory, quality monitoring and adjustment, and the recycling and remarketing of used solvents (Kortman et al. 2006). As a chemical supplier, in 2005, SAFECHEM committed to a partnership with Pero AG, a manufacturer of metal cleaning machines with approximately 170 employees headquartered in Königsbrunn, Germany (Pero 2013). In collaboration with Pero Innovative Services GmbH, located in Weiz, Austria, Pero AG founded a company to deliver cleaning services. The new company's first customer was Automobiltechnik Blau, a branch of Magna Steyer, from Weiz/Perding, Austria. In this case, Pero Innovatives Services produced a machine specialised in cleaning metal parts, was responsible for rooms and material logistics and provided the personnel for operating the machine, whereas SAFECHEM provided the adequate solvents for the customer's cleaning processes, monitored solvent quality and was responsible for waste management. The cleaning process using SAFECHEMs solvents and the operation of Pero's

cleaning machine were performed by personnel from Pero Innovative Services GmbH. The benefits to the customer from hiring a chemical service provider were savings in personnel costs because no additional expertise was needed. Furthermore, no investments needed to be made because the ownership of the machine remained with the machine builder, resulting in projectable costs for the customer and, due to the expertise of the machine builder and chemical provider, reductions in process costs. Revenues for the service provider were linked to the number of cleaned parts (Erbel 2008).

The examples presented above and experiences reported in the literature (Kortman et al. 2006) can be summarised as follows: Chemical management services for solvents play a significant role in dry cleaning, metal cleaning and paint application, e.g., as in automotive industry. The services offered in this business concept include chemical supply, quality monitoring, adjustment, removal of applied chemicals for purification and recycling. Providers of such services include companies of all sizes. As shown in the case study of Tiefenbacher GmbH, chemical management for solvents can also be a suitable business model for smaller companies. Specialisation in CMS for solvents is exemplified by the second case, in which the machine builder provides the end customer with a solution; in this case, the chemical producer acts within the solution network of the machine builder. Linking the remuneration scheme to the number of parts allows the machine builder to continue to own this product. This configuration allowed the machine builder to bring in its expertise in optimising the chemical application equipment to design the machine according to the requirements of the service concept. The technical optimisation of the machine to reduce life cycle costs made the machine so expensive that it would be impossible to sell on the market (Erbel 2008). By leasing the product and co-operating with the chemical producer, the machine builder can generate economic benefits not only for itself but also for all other network actors as well as the environment.

In addition to the primary effect of reducing the amount of employed solvents through the new business concept, further positive effects result from reduced environmental pollution and improvements in workplace conditions (Sena et al. 2008). Through the engagement of chemical service providers and remuneration schemes linked to chemical output, the cases reported in the literature demonstrate reductions in the amounts of used chemicals, resulting in lower costs for customers and positive effects for the environment. For the provider, it is reported that going downstream represents an opportunity to compensate for decreasing demand for chemicals, differentiate itself in the market and respond to legal requirements related to environmental and health protection. Through this approach, chemical producers such as SAFECHEM can provide services on their own or in co-operation with process equipment manufacturers. In addition, pure chemical service providers, such as Haas Group International (http://www.haasgroupintl.com/haas-overview.html), are important providers of solvent CMS, especially in the automotive and aerospace industries.

8.2.2 Painting/Coating

Paints are chemicals that are relevant in chemical management, especially in the car and transport equipment industry. Kortman et al. (2006) report that between 40 and 70 % of painting processes in the European automotive industry are provided within service contracts. In aeronautics, this share ranges from 30 to 45 %. For example, the production of paint accounts for approximately 12.3 % of speciality chemical production and 5.3 % of overall chemical production in Germany, the biggest chemical producer in Europe (own calculation based on VCI/Prognos 2013). In the following, selected case studies are highlighted to provide a detailed understanding of the particularities of CMS for coatings.

The first example of CMS for coatings is PPG, which was founded in 1883 and has headquarters in Pittsburgh, Pennsylvania, USA. PPG is a leader in coatings and specialty products, with more than 39,000 employees (2012) and operations in approximately 70 countries around the world. Through its 7 business segments, it serves various industries, including the automotive and aerospace industries (PPG 2013a).

PPG offers the Optima Solutions® Chemical Management programme, in which the company takes the role of a system integrator (PPG 2013b) to offer comprehensive services to its customers. PPG has sound experience in chemical management services, especially for car manufacturers. A prominent case study with PPG focused on its strategic partnership with the Ford Motor Company and its Ford Taurus Assembly Plant in Chicago Illinois. Starting in 1988, PPG was responsible for the management of most chemicals used in the plant, including solvents. As a supplier, PPG was responsible for procurement, inventory management, distribution and container management as well as quality assurance and maintenance oversight, training for VOC emissions reductions, environmental, health and safety (EHS) and chemical tests and lab analyses (Ford 2006). Although PPG (a Tier 1 supplier) and Tier 2 suppliers managed by PPG had full-time service technicians on-site, PPG was not operating the coating process with own personnel (Bierma and Waterstraat 2000). The reported benefits of chemical management services in this case were reductions in emissions, reductions in costs due to the use of fewer chemicals, higher product quality and improvements in health and safety. Revenues for PPG were linked to per-vehicle fees. This revenue scheme also served as an incentive to reduce the amount of chemicals used as well as peripheral costs. Furthermore, not linking revenues to the amount of chemicals sold encouraged PPG to work to improve usage processes (Bierma and Waterstraat 2000).

Another case study describes the cooperation between DuPont Canada and the Ford Motor Company in Oakville, Ontario, Canada, starting in 1996. DuPont was remunerated by a fixed fee according to the number of cars painted. In this case, the per-gallon cost of paint and amount of paint used were delineated in the contract and re-negotiated every quarter (GEMI 2001). An on-site technician from DuPont helped to understand the manufacturing process and identify optimisation

potential. DuPont added to its technical expertise on paint by acquiring expertise on the paint application (GEMI 2001). As a result, DuPont reduced its costs in years one through three, with the percentage of cost savings in year three being nearly half of that in the first 2 years. Ford also reduced its costs by 35–40 % through the new business model, as well as reducing its volatile organic emissions and water and wastewater emissions (GEMI 2001).

8.2.3 Lubricants

Lubricants are applied for friction minimisation or cooling in industrial production processes. Servitized offers for lubricants are reported in the automotive and metal industries, among others (Kortman et al. 2006). For example, lubricants are applied to make the operation of a conveyor smoother (UNIDO 2011). In the following, selected case studies are highlighted to provide an in-depth understanding of the particularities of CMS for lubricants.

The first example is the cooperation between Knjaz Milos and Ecolab Serbia. Kniaz Milos, founded in 1811 and having approximately 900 employees, is a producer of beverages located south of Belgrade, Serbia. Ecolab Serbia is a subsidiary of Ecolab, a world leader in professional cleaning services with headquarters in St. Paul, Minnesota, USA. Although it now has over 40,000 employees, in 2009, when the cooperation began, Ecolab had approximately 26,000 employees (Finanzen.net 2013). For chemical leasing, the type of lubricant was changed from a wet lubricant to a dry lubricant that is applied to a bottle conveyor in one production line.

Chemical leasing benefits for the customer, Knjaz Milos, include improvements in worker safety, higher process efficiency because fewer bottles fall with the use of the new lubricant and the need for smaller amounts of lubricants. The revenues for the provider, Ecolab Serbia, are linked to the working hours of the bottle conveyor. Because less lubricant is used, the service revenues within the chemical management contract include higher margins for Ecolab. As a result, both parties benefit from chemical leasing so it can be regarded as a true win-win situation. In 2011, the model was extended to two more production lines (UNIDO 2011; Ahrens 2011).

Another example is Airbus UK's 2004 decision to outsource lubrication management for its Filton production site to Castrol UK, a chemical manufacturer. Castrol performs the management of all metalworking fluids and lubricants, vibration analysis, filtration management and washer parts management. A result of this outsourcing contract is the reduction in the volume of coolants used. In addition, a decrease in the downtime of the cleaning machine was achieved as well as cost reductions in non-production-related processes (N. U. 2006). Another example is the lubricant chemical service cooperation between Fideicomiso Ingenio San Cristóbal, a sugar producer, and Chemical Mac Oil, a manufacturer of oil and greases, both located in Mexico. A Chemical Mac Oil technician is at the customer site to support and train the customer's staff. Benefits of this cooperation include higher process efficiency, reduced water and energy consumption, the

production of less waste and extensions of machine life cycles (Valerio et al. 2008). Remuneration for the chemical provider was linked to the tonnes of sugar cane that were milled at the factory (Valerio et al. 2008).

Specialisation in chemical management for lubricants is based on impact on the condition of the technical equipment and machines (Kortman et al. 2006). The outsourcing of lubricants often leads to higher lubricant consumption because the customer processes were previously performed very poorly. Adequate usage and application by chemical providers thus increases the amounts of items such as oil or grease that are used but also increases the lifespan or performance of machines.

8.2.4 Water Treatment Chemicals

Water treatment chemicals are another type of specialty chemical. Related case studies in the literature focus on wastewater purification. One case study focuses on the arrangement between General Motors and BetzDearborn, which began in 1992. BetzDeaborn (now Water and Process Technologies, a division of GE Infrastructure) (GE Power and Water 2013) acts as a Tier 1 supplier for wastewater treatment, paint detackification, power house, paint maintenance, and solvent and chemical services at the GE plant in Janesville, U.S.A. Benefits from this collaboration are reductions in employed chemicals and inventory costs, improvements in health and safety, higher quality and reductions in rework. Remuneration is based on a fixed per-vehicle fee. An additional target agreed on in the contract was the implementation of annual savings on the value of the contract (N. U. 2000).

Another example is the collaboration between Henkel-ERA, producer of industrial and household glues, soaps and detergents located in Tosno, Russia, and ERG, a service company specialised in developing wastewater purification chemicals located in St. Petersburg, Russia. To increase the level of water decontamination, Henkel-ERA established a new type of contract with the service provider in which remuneration was linked to the amount of purified water. ERG continued to own the chemicals. ERG reconstructed the wastewater processing facilities and used new technologies in this business model. Benefits from this model were cost savings of 50 %, reductions in the amounts of chemicals used, improvements in the quality of the wastewater and reductions in hazardous chemical amounts (Startsev and Schott 2008).

8.2.5 Commonalities and Differences

From the case studies on CMS for different types of speciality chemicals presented above, we learn that each speciality chemical requires particular CMS characteristics. Hence, in the following, commonalities and differences between CMS for different types of speciality chemicals are summarised.

If we first consider the commonalities, we realise that all cases include changes in revenue models. In addition to basing prices on the amounts of chemicals sold, prices of the service components are based on higher chemical application efficiency. Anttonen (2008) reports another commonality, stating that in all types of CMS, technology plays an important role in monitoring and analysing the amount of chemicals used as well as their costs. Additionally, he found that for all types of specialty chemicals, CMS offers include a portfolio of services for procurement, process management, IT services or waste management (Anttonen 2008), from which customers can choose individual services to be included in their CMS contracts.

If we focus on differences and analyse CMS for lubricants, we see that it requires technical equipment to process chemicals, such as in paint shops, or the chemicals facilitate the functioning of processes, such as cooling for machine spindles. To generate efficiency improvements through CMS, an understanding of the manufacturing processes in which lubricants are applied is necessary as well as technical knowledge in relation to the equipment. This expertise related to the exploitation of improvement potential necessitates two types of cooperation between different actors: First, cooperation between chemical suppliers and customers and second, cooperation between chemical suppliers and manufacturers of the equipment on which the lubricants are applied. Another characteristic of CMS for lubricants is that economic benefits are not necessarily derived from savings in lubricant consumption. With the introduction of CMS, the volume of consumed lubricants might even increase. The reason for this is that companies that outsource the handling of lubricants often had difficulties in performing proper maintenance (Kortman et al. 2006). Thus, by handing these tasks over to professional service providers, the amount of lubricants used could increase. However, due to proper maintenance, positive effects on the condition and performance of machinery can be realised, such as fewer machine failures and higher life expectancy (Kortman et al. 2006).

In contrast to CMS for lubricants, CMS applications for solvents have to cope with the challenge that the application of solvents for cleaning or as paint components differs according to the type of solvent, the treated surface or the application procedure (UBA 2013). Organic solvents contain volatile organic components that evaporate into the surrounding air. These components cause greater smog in the summer and are harmful because they can cause cancer (UBA 2013). Thus, solvents can be harmful to health or even poisonous and threaten air and water quality. The recycling of solvents is already a normal process; however, there are always some remaining solvents that need to be disposed of. This mostly hazardous waste needs to be disposed of in special ways that are very costly. This is only one of the unique characteristics of handling solvents. Due to the importance of using solvents, special knowledge in procurement, handling, application and disposal is required. There is also pressure from politicians in many countries to reduce the use of or even substitute halogenated solvents (Ceresana 2013) with lacquering based on water or containing no solvents at all (BASF 2004).

In Europe, for example, there are special principles affecting the application of solvents, such as 1999/EG/13, which includes reductions in VOC emissions.

CMS for coatings in the automotive industry is also unique. These services are primarily targeted towards cost reduction (Kortman et al. 2006). The CMS clients are the big automotive OEMs, which have strong bargaining power with regard to their supplier contracts. To realise cost reductions, the optimisation of the entire car body painting process has to be included in CMS projects. Hence, CMS services are targeted towards material requirements planning, material logistics, inventory control, laboratory services, paint mixing, quality control and other activities. In all these steps of the car body painting process, the experience of coating providers such as PPG, BASF or Dupont is the precondition for process improvements. Because car body painting requires supplies such as wax, PVC, phosphate, auxiliary lacquering material or solvents in addition to coating materials, the CMS contracts assign the procurement of these materials to the CMS provider. Through this second Tier, supplier management is also part of the duties of CMS providers. Miga and Benson (n. d.) characterise the relinquishing customers' need to deal with sub-suppliers (Tier 2) as the key aspect of coating CMS because these are dealt with by the CMS business partner (Tier 1). In the case of a CMS car-coating contract between PPG Poland and GM Opel Poland (Miga and Benson n.d.), the CMS supplier, PPG, had to procure 700 car-coating products from 50 tier 2 suppliers as part of its CMS responsibilities.

8.3 CMS Providers and Customers

8.3.1 CMS Providers

The case studies on CMS applications depicted above (Table 8.1) indicate that different types of companies act as CMS providers. Based on the reviewed literature, we can distinguish among 4 different groups.

First, chemical manufacturers offer CMS. Examples of this type of CMS provider include the German companies BASF and Henkel, the British companies Castrol/BP and Ecolab, and the U.S.-based companies DuPont and PPG. Some of these companies offer CMS solutions prominently on their web sites. For example, PPG has established its "Optima Solutions® Chemical Management" programme, which represents a "systems" approach through the services of a single, first-tier, on-site manager who focuses on cost reduction, safety, material management, Tier 2 management, environmental reporting requirements, problem resolution, continuous improvement and project management (PPG 2013c).

Second, chemical manufacturers have established affiliates that are focused on offering CMS. A prominent example of this type of CMS provider is SAFECHEM, which is a subsidiary of the Dow Chemical Company that provides services and solutions related to the safe and sustainable use of solvents for surface and dry

cleaning applications. With offices in Düsseldorf (Germany) and Paris (France) and a network of distributors, SAFECHEM serves over 7,500 customers around the world (DOW 2013b). SAFECHEM created its CMS trademark, Safe-Tainer™, and actively promotes this closed-loop chemical application system (DOW 2013c; Kaltenegger 2006).

Third, we identified pure service providers that offer CMS. These companies do not produce chemicals but offer full services for the handling of different chemicals in different industries. For example, Haas Group International Inc., with more than 300 employees and headquarters in West Chester, PA, U.S., is an international distributor of chemicals and provider of chemical management services. It offers a wide range of different chemicals and chemical-related-services to users in different sectors, such as aerospace and defence, manufacturing, food and beverages (Haas Group International Inc. 2011).

Fourth, manufacturers of equipment on which chemicals are applied act as CMS providers. For instance, paint shop manufacturers have the necessary knowledge for optimisation or problem solving in relation to the effective handling of coatings. An example of such a business model is the painting of truck steeple cabs for MAN Latin America (formerly VW) performed by Carese, a subsidiary of the German paint shop manufacturer Eisenmann AG. Remuneration in this case is divided into two components: Eisenmann is paid a fixed fee covering personnel expenses and another fee is paid to Eisenmann for every painted cab that passes the quality test (Koll 2010). The paint shop manufacturer acts as CMS provider that has incentives to reduce the amount of chemicals used and the cost of chemical management as well as ensuring quality.

8.3.2 CMS Customers

An analysis of CMS customers by sector indicates that the automotive industry is by far the most important source of clients. The case study reports listed in Table 8.1 name automobile manufacturers as CMS customers in 11 out of 28 cases (39 %). Electronics/electrical equipment manufacturers rank second (14 %), and the food processing industry and service sector are tied for third (11 % each).

The predominance of the automotive industry is reinforced by the CSP industry report (2009). Their results of providers' estimations of CMS market penetration in the U.S. place the automotive industry in the lead, followed by aerospace and electronics manufacturers.

The importance of the car industry as a CMS customer may be due to the broad diffusion of CMS for car coating. At the beginning of the new millennium, 40–70 % of painting processes in the automobile industry have already been servitized (Kortman et al. 2006). The prominence of the electronics and aerospace industries may result from their high consumption of specialty chemicals such as lubricants and solvents. As illustrated above, CMS for these groups of chemical

products can be found in various CMS pilot projects (CSP 2009; Kortman et al. 2006; Kaltenegger 2006).

In addition to industrial companies, public or private organisations from the service sector are also important CMS customers. Cooperation between the hospital of the city of Worms (Germany) and Schülke and Mayr, GmbH in Norderstedt (Germany), a global expert on hygiene and preservation with more than 600 employees, serves as a recent example. According to this CMS contract (DBU 2009), Schülke and Mayr does not sell disinfectants but is remunerated per disinfectant application. This new business model leads to a reduction in disinfectant consumption, especially in the cleaning area. The new model is associated with a higher level of hygiene in the cleaning of medical instruments. The cases of the Lansing School District and Stanford Linear Accelerator as CMS customers (see Table 8.1) further demonstrate the relevance of service-sector organisations as customers.

An analysis of CMS customers by size clearly indicates that until now, big multinational companies have been the most relevant clients. Out of the 28 CMS pilot cases presented in Table 8.1, 24 could be classified by size, 17 of which have more than 10,000 employees, 5 of which have between 1,000 and 10,000 employees and only 2 of which have less than 1,000 employees. This finding is aligned with the results of Mont et al. (2006) and Schröter et al. (2010). The latter study provides several reasons for the dominance of larger firms. First, the authors argue that larger firms are generally at the forefront of innovative technology or business model adoption. In addition, they conclude that the necessary volume of chemicals that economically justifies CMS is only reached in larger customer companies. Finally, they cite the bargaining power of larger companies to compel chemical providers to offer CMS contracts even if they are hesitant to agree to this business model.

Although the actual relevance of small and medium sized customer companies is limited, even this small number of CMS clients seems to be at least partly a result of governmental intervention. As UNIDO has launched a Global Chemical Leasing Programme (www.chemicalleasing.com), UNIDO member countries from developing regions with smaller companies have tried to push for the implementation of pilot cases. Both smaller CMS customer companies in Table 8.1 are part of such initiatives.

An analysis of CMS customers by region in the CMS Industry Report (2009) concludes: “It is clear that CMS is used to a much greater degree in the U.S./NAFTA-region than in other parts of the world”. Based on their 2009 survey including 15 CMS providers and 15 CMS customers, they estimated that approximately 60–65 % and 70–75 % of all CMS in use were located in the U.S. and the NAFTA-region, respectively. This inquiry finds that the predominance of the U.S. is expected to continue: 64 % of survey respondents expected growth of CMS applications in the U.S., whereas 36 % expected CMS growth in Europe and only 14 % expected growth in the Middle East and Africa. This forecast is based on the experiences of many American CMS customers that are struggling to find ways to implement CMS programmes in their overseas facilities. Factors such as

unionisation, facility operational style, perceptions of the CMS value proposition, and governmental regulations are considered to negatively affect the potential success of CMS in the overseas facilities of U.S. based multinational companies that use CMS in their home bases.

To overcome the low relevance of CMS, especially in developing countries the UNIDO Global Chemical Leasing Programme has initiated CMS pilot projects in Colombia, Egypt, Mexico, Morocco, Russia, Serbia and Sri Lanka (UNIDO 2010). Whether these activities in the mid term will influence the unbalanced distribution of CMS customers by region cannot be predicted.

8.4 Overall Relevance of CMS in the Chemical Industry and Outlook

The CMS case study reports and descriptions of CMS providers and customers presented above clearly provide evidence for the increased prominence of servitization in the chemical industry. However, the relevance of CMS remains rather marginal. Because the focus of CMS is limited to speciality chemicals, which account for 25 % of chemical production, at best only one-fourth of chemical industry sales are susceptible to changes business models from the traditional sale of chemicals to servitized business concepts.

More realistic estimations (CSP 2009) consider that approximately 55 % of speciality chemical production is for so called "direct" chemicals, which become part of end products and are not likely to be amenable to a CMS approach. The remaining 45 % have further restrictions for CMS, which leads to the assumption that an absolute maximum of 18 % of speciality chemicals, representing less than 5 % of overall chemical production, can be regarded as potentially suitable for a CMS approach.

This figure roughly corresponds with the estimation of Kortman et al. (2006). They found evidence for CMS only among chemical product groups representing a 14 % share of total chemical sales. Because not all of these product groups will adopt CMS applications, but rather one-third is expected to do so, the market potential for CMS could reach a maximum of approximately 5 % of chemical sales.

The most recent revenue figures for the CMS market indicate that the moderate market potentials introduced above are far from being reached. Based on a combination of survey responses and interviews, the CMS industry report (2009) estimated the 2009 market revenues of the CMS industry at between US Dollars 900 million to 1 billion in the U.S., 1–1.2 billion US Dollars in the NAFTA region, and 1.3–1.6 billion US Dollars worldwide. Relative to overall chemical sales around the world, these figures represented in 2009 a share of around 0.06 % of worldwide sales and a share of around 0.2 % of sales in the U.S., as well as NAFTA region (CEFIC 2011 and own calculations). Industry characteristics, such as division of labour between technology suppliers and chemical companies and

the acceptance of networks (Cesaroni et al. 2004) are ideal points of departure for new business models.

The findings presented above are aligned with statistics from the German Federal Statistics Office and the EMS survey results presented in the introduction. The most up-to-date German statistical data comparing the share of service sales in manufacturing indicate that the chemical industry is ranked at the lower end in a comparison of manufacturing sectors (Statistisches Bundesamt 2004). Whereas other industries have an average service share of overall sales of 3.8 %, the chemical industry's share is only 0.5 %. The EMS survey results confirm this ranking (see Chap. 1).

A large-scale survey of the German manufacturing industry conducted in 2009, which provides a sample of 1,484 companies, shows that at the time, 3 % of German manufacturing companies had been customers of chemical leasing (Schröter et al. 2010). Several reasons are given for this, including strict national laws concerning the handling of waste, lack of customer demand, liability risks, fear of losing know-how to the provider and the reluctance of the provider to take on all the investments. By interviewing experts from the chemical industry in Germany, Mattes et al. identified barriers that explain the low application of the chemical leasing concept in Germany. The experts named the loss of know-how, dependency on providers, internal barriers from staff and shop committees, and lack of demand from customers as issues with differing degrees of relevance (Mattes et al. 2013). Reluctance to adopt CMS is identified not only in Europe but also in Asia (CSP 2009).

Even if shares of CMS revenues for providers and the percentage of CMS customers do not actually indicate a remarkable relevance of CMS for the chemical industry as a whole, it seems to be applicable to a greater extent to several chemical product groups and regional markets.

First, in the NAFTA-region and especially in the U.S., the CMS approach has been diffused more broadly. The activities of the Chemical Strategies Partnership (www.chemicalsstrategies.org), which has been promoting CMS for more than 10 years in the U.S. and has major U.S. chemical producers as members, may have contributed to this result. UNIDO's Global Chemical Leasing Programme (www.chemicalleasing.com) is attempting to initiate a catch-up process, especially in developing countries, with pilot projects that began in 2005.

Second, CMS has gained major relevance in several market niches. In particular, the sale of paint to automotive manufacturers for the coating of cars has been replaced to a large extent by CMS contracts. Chemical manufacturers that produce coatings for the automotive industry have established this business model worldwide. We assume that most cars produced today have been coated through the application of a business model that is characterised by fixed remuneration per coated car instead of the traditional sale of coatings.

The future relevance of CMS will increase gradually. Awareness of health and environmental safety is increasing not only in developed countries but also in emerging economies, building a strong market for CMS. Emerging and developing countries will drive future demand for chemicals (Ceresana 2013). Another

relevant factor is the increasing competition for base chemicals because their production is more likely to be the starting point for chemical producers in emerging countries (VCI/Prognos 2013). Technical know-how related to specialty chemicals can be seen as an isolation mechanism. Industry studies forecast an annual growth rate of 4.5 % for the global chemical industry from 2011 to 2030 (VCI/Prognos 2013). In developed countries, higher prices resulting from diminishing amounts of resources, stricter regulations on environmental protection such as REACH and higher awareness of environmental issues and friendliness will promote the chemical management services concept (CSP 2009). However, due to the restricted feasibility of CMS applications with regard to product groups, as well as the other factors mentioned above, CMS will most likely remain a business concept of minor importance.

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