EPCA

THE EUROPEAN PETROCHEMICAL ASSOCIATION

Sustainable Chemical Supply and Logistics Chains

THE PATH FORWARD

REPORT 2013

with participation of cefic

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EPCA wishes to thank the member companies for the illustrations put at its disposal.

Note on Competition Law

EPCA is committed to strict competition law compliance. This is both to ensure that every EPCA activity complies with the law, and to avoid all misunderstanding about such activities.

This commitment was fully respected by the three working groups that originated this 2013 Report on Sustainable Chemical Supply and Logistics Chains.

More than 30 EPCA member company representatives received an open invitation to join one of the three working groups initiated by EPCA. Invitees were selected for their interest in previous EPCA supply chain and logistics workshops, think tanks, seminars or meetings. Each working group was tasked with studying how to increase sustainability ("people, planet, profit") in chemical supply and logistics chains from different viewpoints:

- How to cope with complexity and uncertainty in supply chains
- How more openness and transparency as well as cooperation can support the development of sustainable and efficient supply and logistics chains
- How to use technology as an enabler of sustainable supply chains

Participants were invited to share with their working groups examples of "best practice" coming both from their own companies and from other industries. Coming from different backgrounds, participants provided the following viewpoints: producers and shippers of chemicals, logistics service providers, consulting companies and academics specializing in supply chain management and logistics. They were cautioned to share only information that was either already in the public domain or for which their company or information supplier could assure *nihil obstat* (no hindrance) to competition law compliance.

To provide validation for the report contents, academics and consultants with proven supply chain and logistics expertise were asked to join the working groups. To ensure competition law compliance throughout the report generation process, these members assisted in the working group discussions by:

- Collecting data deemed to be "sensitive"
- Collecting data on a one-to-one basis from participants
- Ensuring neutral reporting of interview outputs

Each working group met six times in the course of 2012 and 2013 during which participants were always reminded of competition compliance rules. All meetings had a specific agenda and minutes were issued and filed. In the working group that explored the potential for more openness and collaboration to deliver more efficient and sustainable supply chains, all participants were informed and reminded of the need for caution regarding horizontal cooperation agreements. Although these may have the potential to infringe competition law, they can also produce pro-competitive effects as described in the updated European Commission guidelines on horizontal cooperation regulations (see EU Official Journal C11 of 14 January 2011). These guidelines address primarily horizontal cooperation agreements like R&D, production, purchasing, commercialization, standardization and exchange of information. They allow for assessing whether an agreement has an anti-competitive object or an actual or potential restrictive effect on competition, which is not allowed. However, if this agreement produces pro-competitive effects that outweigh its restrictive effects on competition, it may be considered as conforming to the guidelines. Pro-competitive effects consist of enabling efficiency gains which could not be reached without the indispensable restrictions on competition under the relevant horizontal agreement, provided customers receive a fair share of these efficiency gains and that the parties to the agreement remain competitors for a substantial part of the products or services they offer. The burden of proof of compliance with the guidelines remains with the parties to the relevant agreements. In this pro-competitive context, EPCA stressed that any and all benefits from possible cooperation must be shared between all business partners in the value chain.

The same approach applied both to the meetings of the steering group supervising the progress made by the working groups and to the meetings of the editorial board, which merged the three working group reports into one report including a specific sustainability section.

The composition of the working groups, steering groups and editorial board can be found in the acknowledgement section of this report.

The purpose of this EPCA supply and logistics chain report is in no way intended to be a "shopping list" or set of recommendations for the industry. Rather, it aims to identify significant efficiency improvements, innovative approaches and sustainability gains that can be achieved through simplifying or better managing complexity and uncertainty, the use of new or improved use of existing technologies and more openness as well as pro-competitive collaboration in supply and logistics chains.

While designed to identify some pro-competitive benefits that could potentially result from specific steps and practices, the report's work was always carried out in the abstract. Therefore, it is up to each reader to decide individually upon his or her own best business strategy.

I. Executive summary

Today, supply chain managers across the global chemical industry, while operating in a very difficult economic environment, need to respond to important sustainability challenges in the supply chain. Chemical production is shifting faster than expected from Europe to Asia, while shale gas is attracting new investments in North America. These factors are realigning global supply and demand balances, altering the volume and direction of material flows, and significantly increasing supply chain complexity and uncertainty.

Mindful of today's wide-ranging changes, EPCA, with the participation of Cefic, initiated a project to explore opportunities to respond to these major supply chain challenges. Combining expertise from the industry, academia and consulting companies, the study examines supply chains in the chemicals and other sectors. By making extensive use of case studies, this report aims to showcase good practices and demonstrate how they contribute to more sustainable logistics and supply chains.

The report focuses on four major areas:

(1) Managing complex and uncertain supply chains in a global context (Chapter 3)

The report recommends addressing complexity and uncertainty in chemical supply and logistics chains. As such, it identifies key drivers and maps supply chains for several chemical products, reflecting various degrees of complexity and uncertainty. The case studies highlight possible ways to cope with uncertainty (requiring strategic business engagements) or complexity (requiring functional expertise). The chemical industry, like other leading industries, is applying in this context demand-driven supply chains, product standardization, collaboration, decoupling downstream, differentiation and segmentation.

(2) Pro-competitive collaboration as a route to more efficient and sustainable supply chains (Chapter 4)

While the technology and concepts all appear to be available, there still seems to be reluctance or inability amongst supply chain business partners to collaborate more effectively, often manifested in an unwillingness or inability to share data and information. The report highlights the growing need for pro-competitive collaboration (both horizontal and vertical), while respecting competition rules, to secure efficiency and sustainability in logistics chains. Drivers include rising energy prices, environmental requirements, infrastructure issues and the skills gap. The report shows that partnerships can help to significantly improve supply- and logistics chain sustainability, e.g. delivering significant cost savings, lowering CO_2 emissions or raising the quality of service for customers. The report highlights the critical success factors of both vertical and horizontal collaboration which includes clarity about the business case, visionary thinking and leadership. A methodology and checklist for pro-competitive horizontal collaboration are proposed.

(3) Technology as an enabler of sustainable supply chains (Chapter 5)

The report categorizes technology applications by reference to their relationship with assets or supply chain processes and whether these applications have been initiated by producers or service providers. The majority of the applications were initiated by service providers and were process-related. For reaching sustainability goals, economic benefits were the most important driver whereas "planet" and "people" effects reached a similar, but slightly lower level than "profit". In addition, the report highlights cutting edge and future technology breakthroughs that could radically transform supply chains. The internet of things, the cloud, social media, customization technology (3D printing) and nano-technology are put at the forefront with a timeframe for implementation. To be successful in these fields, the industry has to look beyond the numbers, as the business case may not be evident today. This requires leadership and vision.

(4) The three elements of sustainability ("people, planet, profit") of all case studies produced in this report are examined in more detail in Chapter 6.

Whilst the vast majority of cases produced in this report show "profit" benefit, more than half thereof also have a positive effect on "planet" and nearly half on "people". This "people" effect addresses change management as well as the need for constant training and development of individuals to reach the skills required for collaborative approaches and the application of new technologies, as well as improvement of safety and security. Collaboration and technology as enablers to manage or mitigate uncertainty and complexity as well as to reach sustainability goals prove to be equally important. A quarter of collaboration cases include authorities (regional, national, local).

In conclusion, this report demonstrates the crucial importance of greater responsiveness and resilience, increased innovation in processes and technology, and enhanced collaboration in making supply chains more efficient and sustainable. It identifies pathways for sustainable chemical supply chains in an increasingly complex and uncertain business environment inclusive of the implementation of the 10 Global Compact Principles (see www.unglobalcompact.org).

2. Introduction

2.1. Background

EPCA's strategic goals include but are not limited to ensuring a quality platform to meet, communicate, exchange information, and transfer learning. EPCA encourages open debate, bringing new, horizon widening and thought provoking ideas that challenge "business as usual" approaches. EPCA promotes the long-term sustainable development of the petrochemical business community and contributes to the improvement of the public image of the chemical industry. EPCA's mission statement integrates these key strategic goals, adding that the association will initiate, facilitate and promote ideas and projects of interest to the long-term sustainable development of the petrochemical industry, its partners and service providers.

In the scope of establishing forward looking working groups, a strategic review identified a number of key changes in supply chain and logistics in recent years, including:

- Supply chains have become increasingly global as customers have developed a global footprint, and this multinational dimension challenges "one size fits all" standardization approaches
- The global financial crisis has put even more pressure on costs and demands to remain competitive, whilst energy and transportation costs continue to increase
- Geo-political instability, insecurity through piracy and terrorism, and demand volatility all impact supply chains, and require companies to increase flexibility and agility in their supply chains
- The environmental impact of supply chain activities is being scrutinized, and increased legislation is likely, which will inevitably lead to higher costs. Companies will need to consider the impact on emissions, energy usage, and water as part of their overall sustainability goals
- Other global trends, including shifts in centers of production, urbanization, and ageing populations, will demand a supply chain response
- Changes in technology, including IT, social media, and instant communication are creating new rules of engagement

As a consequence, the following three working groups have been established:

- Managing supply chain complexity and uncertainty
- Making chemical supply chains more efficient and sustainable through pro-competitive collaboration
- Technology as an enabler for sustainable chemical supply chains

Cefic participated in some of the working group discussions, in particular the working group on pro-competitive collaboration.

This report represents the consolidated output of the deliberations of the working groups, which had a mixed composition of representatives from producers, service providers, academic institutions and consultants. Participation was through open invitation.

2.2. EPCA Study

2.2.1 Objective

The objective of this study is part of EPCA's continuing effort, as a service to its members, to present innovative, breakthrough ideas that challenge "business as usual" practices. EPCA is constantly exploring ways of making chemical supply chains more efficient for the benefit of all stakeholders, and this is witnessed by a series of publications, think tank reports, and workshops since 2000.

The study recognizes the supply chain challenges that the chemical industry will be facing in the next two decades. It addresses the impact of uncertainty and complexity, collaboration, and developing technologies, and also offers ideas on how the industry might exploit these opportunities to improve supply chain and logistics sustainability ("people, planet, profit") while also driving out operational waste.

For many years, EPCA has encouraged the building of trust and partnerships between producers and service providers, in order to optimize supply chains for both economic and environmental impact reasons (always ensuring strict compliance with competition law). EPCA recognizes that collaborative initiatives will always be the prerogative of individual companies, and believes it is now time to bring into focus the opportunities for improving sustainability, as well as the challenges that will be faced from policy intervention and increasing regulation over the next 20-30 years.

Finally, the objective was to present the results in a well structured written report that will assist decision-makers in fully understanding the challenges and opportunities, inspire initiatives, and provide both conceptual ideas as well as case study evidence of what is possible.

2.2.2 Scope

The scope of the study includes identifying new factors in areas impacting the supply chain, the challenges these present, and available, effective mitigation solutions. The study considers these developments in terms of "people, planet, profit", with a focus on initiatives encouraging pro-competitive efficiency and collaboration.

The study includes all areas associated with physical inbound and outbound flows, storage, and information flows, and all modes of transport. The manufacturing process is out of the scope. Both commodity and specialty products are included.

The geographical scope is global, although with a focus on intra-European and inter-regional supply chains, flows in and out of Europe, plus some relevant flows such as the Middle East to Asia. Internal supply chains in countries such as Brazil and China are excluded.

In technology, both IT and non-IT elements are considered. This includes the use of technology in asset design and process improvement, with both chemical and non-chemical applications. The impact of technology on the human element is considered.

2.2.3 Approach

The study used the previously successful "steering group and working group" approach to examine three areas of focus. The working groups brought together recognized experts from the chemical industry and their logistics service providers, as well as representatives of academic institutions and selected consultancy firms, meeting on a regular basis through the course of 2012, and early 2013. Participants in the steering group and each working group are listed in Acknowledgements in Chapter 10.

Each working group illustrated and reinforced its respective report with short case studies from the chemical sector and other industries. In order to create a homogenous survey, the three areas of study were merged into one report with an additional specific chapter on sustainability.

3. Managing supply chain complexity and uncertainty

In this EPCA study, which was supported by the Vlerick Business School, significant benefits to economic performance, customer service, energy consumption, and carbon emissions have been identified. Supply chain leaders in the chemical industry and their logistics service providers may wish to benefit from the experience of complexity and uncertainty in different supply chains.

3.1. Introduction

Chemical supply chains are global, and often complex and uncertain. This section of the report addresses the challenges that are making chemical supply chains increasingly difficult to manage, and also offers a way to categorize typical supply chains by complexity and uncertainty.

In today's economically volatile and uncertain world, supply chains are influenced by a wide range of factors, including:

- Increasing customer service demands regardless of geography or degree of difficulty
- Globalization, GDP growth outside "the West"
- Movements to less well established markets with less well developed infrastructure and administrative processes
- Volatility in economic climate
- Fluctuations in fuel cost
- Less control and more hand-offs due to specialization and multi-subcontracting
- Changing manufacturing footprint between raw material supply and demand
- Demand for more sustainable solutions driven by customer and/or regulatory pressure
- Mergers and acquisitions across the supply chain
- Increasing number of specialties
- Hazardous goods, commercial regulations and global trade management

3.2. Objective

The objective is to help member companies manage complex supply chains and cope with increased uncertainty.

Drivers of complexity and uncertainty are identified, and good practice case studies in the chemical industry are discussed. These case studies suggest options for managing and controlling complexity and uncertainty, and for simplifying and streamlining supply chains. Learning that can improve sustainability in the supply chain is also identified. Key features of supply chain good practice from other industries are also examined and compared with mitigation examples from the chemical sector. Most of these best practice examples come from Gartner's Supply Chain Top 25 list, and have been complemented with case studies from the whisky and apparel industries.

3.3. Managing complexity and uncertainty

This section identifies the main causes of complexity and uncertainty. Segmenting typical chemical supply chains, it then examines case studies to explore how companies have improved their supply chain efficiency, resilience and sustainability.

3.3.1 Causes of complexity and uncertainty

Supply chain *complexity* is primarily driven by four factors: the nature of its products; market requirements; physical process characteristics; and administrative, financial and information flow characteristics.

Uncertainty in the supply chain can be grouped into four categories of risk and volatility, which relate to supply, demand, process and control systems, and operating environment. Some examples of factors driving complexity and uncertainty are listed in the table below.

Table 1a	Table 1b
Drivers of complexity	**Drivers of uncertainty**
Product characteristics » hazardous products » temperature sensitive product mix	Supply (upstream) » supply fluctuation e.g. feedstock availability, quality variability » price fluctuation of raw material » short-term opportunistic trading behavior
Market requirements » high service standards » sophisticated customer requirements » geographical scope	Demand (downstream) » demand fluctuation » market price fluctuation » demand trading activity
Process characteristics – physical flows » theft and security concerns » number of modal changes » number of hand-offs » number of subcontractors	Process and control » changing tariffs and duties » tendering » asset reliability issues
Process characteristics – administrative and financial flows » documentation requirements » customs regulations and sanctions » payment terms incl. Letters of Credit » fraud	Environment » natural disasters (e.g. earthquake, flood, tsunami, volcanic eruption) » political instability » social instability (e.g. strikes) » competitive behavior » weather and seasonality

Tables 1a & 1b – Drivers of complexity and uncertainty

3.3.2 Mapping supply chains in the Complexity/Uncertainty grid

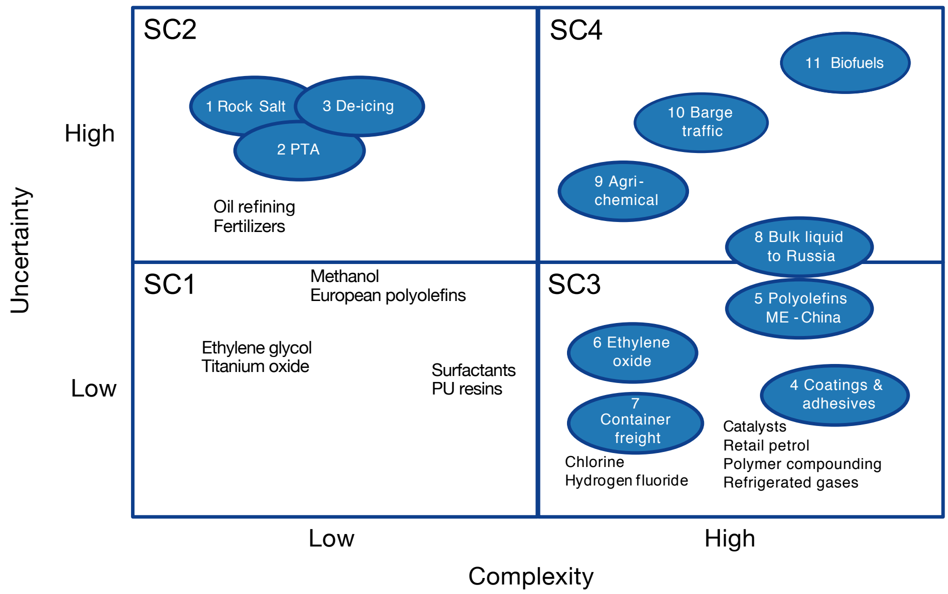
To illustrate the variability of complexity and uncertainty faced by the industry, the supply chains of 25 chemical products have been assessed and scored against the drivers described in Tables 1a and 1b.

From Figure 1 below, a set of 11 cases (in blue), that were either in the public domain or the release of which raised no issue under competition law, was selected and is described in the following sections of this report. The cases illustrate good supply chain practices for managing or reducing complexity and uncertainty.

Figure 1 - Mapping supply chain complexity and uncertainty

Quadrant SC1 lists some supply chains with a low degree of complexity and uncertainty. As a consequence, these supply chains offer few insights for managing or reducing complexity or uncertainty. Improving efficiency is key in such chains. They include products such as methanol, titanium oxide, ethylene glycol, polymers, surfactants and PU resins, which typically include large volume global or trans-European movements in bulk ships, containers and road/rail tanks.

Quadrants SC2, SC3 and SC4 list products with supply chains that are either complex and/or uncertain. Good practice cases related to these quadrants are considered in more detail in Sections 3.4.1 to 3.4.3. below.



3.4. Analysis of Good Practice Case Studies

3.4.1 Supply chains with Low Complexity and High Uncertainty

Supply chains in Quadrant SC2 are characterized by a high degree of uncertainty. Therefore, the main goal for these chains is to either mitigate or reduce uncertainty. This report considers the cases of three product supply chains in this quadrant: rock salt, PTA and de-icing fluids.

Rock salt demand is uncertain due to fluctuating weather conditions. Customers in the Netherlands and the producers have acted to improve this position through centralized control of strategic stocks, collaboration and asset sharing between local areas, and enhanced long-term and local short-term forecasting.

In Europe, PTA is mainly sold to the seasonal soft drinks PET bottle market and, to a lesser extent, to the Asian textile market, where demand is volatile. Demand and price variation is managed through flexible plant output and inventory. A combination of fixed base silo capacity and variable outsourced container park operations allows stock to be flexed at minimum cost.

For de-icing fluids, uncertainty in European demand and the rapid response requirement for airplane de-icing have been managed through a flexible, intermodal supply chain, with Vendor Managed Inventory (VMI) and extensive communication to and across a small number of Logistics Service Providers (LSPs).

Other examples of high uncertainty are found in oil refining, where price volatility results from variable demand for crude oil and fuel and political instability, and in the fertilizer industry, which is affected by seasonality, the weather and the threat of "dumping".

CASE STUDY I

GETTING A GRIP WITH SALT

The supply chain of rock salt

Introduction

The demand for rock salt, used on roads in the Netherlands during winter times, is very seasonal and difficult to forecast. Product is mainly sourced from outside Europe and supplied in bulk with a long lead time. It is a basic and relatively simple supply chain with strategic storage locations and regional depots for local use. There are a limited number of suppliers and the main salt customers are the national road association and local municipalities. Demand is mostly on a spot basis as the municipalities are usually not willing to commit to any contracts. This, in combination with the seasonality of demand, generates considerable uncertainty.

Opportunity

The main challenge is to find the optimal balance between inventory cost and service. In case of cold weather, actions need to be preventative and taken quickly. Lack of stock during a harsh winter can have a big impact (accidents etc.) and involves the whole community. In addition, demand can be unpredictable as the municipalities are all locally organized and have their own specific ordering policies. Coordinated planning and effective mitigation strategies are vital to avoid shortages.

The Solution

The obvious mitigation strategy is to better manage uncertainty by increasing inventory levels. In recent years, problems with icy roads and sharp price increases during periods of shortage have made extra stockholding more acceptable. The cost of stock-out outweighs the additional inventory cost for this relatively low value product with its basic storage requirements.

The Dutch government has also set up its own strategic storage (National Rock Salt Bank) in order to become more independent from the commercial market. In addition, quick-source substitutes like sea-sand are promoted.

Uncertainty has also been reduced by improving demand predictability: long-term weather forecasting helps to determine optimal inventory levels and the need to source additional national supply, while short-term local weather data helps in scheduling local supply.

Finally, municipalities are prompted to cooperate. Emergency protocols and priorities have been developed on the basis of central planning. For example, main roads are prioritized over small local roads. Cooperation is also required in the use of the spreading equipment and multi-skilled personnel are available to optimize the available capacities.

Despite increased stock levels and supply chain improvements, shortages may still happen. To ensure smooth operations, communication between distributors, the government and the local community is of high importance.

The Value

Given the long rock salt supply chain, past winter shortages have been costly and have also had a big impact on society. Mitigation against uncertainty increases the sustainability of this supply chain. Since accurate weather forecasting remains difficult, rock salt supply chain uncertainty will persist. Therefore, collaboration and communication remain key areas for attention.

CASE STUDY 2

BOTTLING SEASONALITY

The supply chain of PTA

Introduction

The PTA supply chain has a low degree of complexity. PTA is a basic chemical, primarily produced in a single grade, and mainly shipped in bulk containers. In recent years, extensive PTA production capacity has been added. To be economic, plant capacity is usually above 600 000-700 000mt/year.

Fluctuations in demand and supply are major causes of *uncertainty*. PTA is the main ingredient for making PET, which is predominantly used in plastic beverage bottles. Seasonality sees PET demand peak during the summer. As PTA and PET plants are often integrated, a good stock of PTA is needed to cover for any plant outages.

Throughout 2012, significant crude oil price fluctuations and an increase in Asian demand drove up prices for paraxylene, the main raw material for PTA. However, surplus PTA capacity made it almost impossible to pass upstream costs onto downstream PET customers.

In response, PTA producers have built up inventory and cut production. However, because storage capacity at PTA plants is limited, alternative solutions are needed.

Opportunity

In general, PTA plants either run at 100 % capacity or are idled. Technology enables different production rates, but levels below 100 % are not efficient. Consequently, PTA plants run flat out during spring, summer and early autumn, and are then regularly turned off and on.

Inventory stored at plants is usually low (up to 5 days only). PTA is more difficult to store in silos than most other dry bulk petrochemicals as it compacts, meaning that both vibration and nitrogen are required for storage. An additional storage cost element is the silo structure, which must accommodate product weight.

The Solution

It is clear that when basing the required silo storage capacity on maximum inventory levels, producers face very high capex investment. One producer decided to base its storage capacity on the minimum inventory level and make use of a mixed silo/container storage solution. An on-site terminal was built, including a container yard. Today, most PTA is stored in bulk 30ft containers, achieving an excellent payload of up to 32mt.

The Value

Outsourcing the on-site terminal to a third party logistics service provider has given this PTA producer the opportunity to increase efficiencies and to concentrate on its core business. Extensive investment could be avoided, thereby freeing up cash and turning fixed costs into variable costs. The customer only pays a daily rate for the storage capacity needed. Finally, by storing additional stock in the final delivery mode (30ft), cleaning and distribution can be avoided.

CASE STUDY 3

BREAKING THE ICE

The supply chain of de-icing fluid

Introduction

Demand fluctuations are the major cause of *uncertainty* in the supply chain of anti- and de-icing fluids. Demand for this product is highly seasonal, with peak demand from September to January. Demand unpredictability is driven by the weather and the quality of customer planning.

However, the level of *complexity* is relatively low with few process steps, a narrow product mix and a stable group of customers.

Opportunity

Most demand is at airports in mainland Europe, with 80 % of the volume sold in tankers, and the balance in drums and Intermediate Bulk Containers (IBCs).

Service and lead times are critical for customers, as in many cases customer storage capacity is limited. Supply chains can also be long, as in the case of deliveries from the UK to Russia and Finland.

There are four main logistics service providers (LSPs) employed, and intermodal traffic is extensively used in Europe. An additional factor is that air side access to airports is usually limited to approved carriers and drivers only.

The Solution

Demand uncertainty is mitigated by creating a flexible intermodal supply chain. Local strategic stocks of tank containers are established at eight depots, and VMI is in place at several customer sites. Concentrated material is diluted locally into ready-to-use product. Demand forecasting continues to be based on historical demand, customer plans, and weather forecasts. There is daily communication with customers and LSPs about intervention and planning updates. Early order notification and demand forecasts are shared with the LSPs.

Service Level Agreements (SLAs) are in place with both customers and LSPs, and special attention is paid to understanding transit time details.

Country-specific LSPs are supported by a single European operator employing tank trucks.

The Value

The most important benefit is the enhanced customer service level. This has been achieved through reduced lead times, optimal stock levels and improved communication/information.

In addition, improved planning, flexible production, intermodal storage solutions and SLAs have helped to improve customer service levels whilst limiting the effect on costs.

3.4.2 Supply chains with High Complexity and Low Uncertainty

Supply chains in Quadrant SC3 are characterized by a high degree of complexity. The main challenge here is to develop capabilities to cope with complexity or, alternatively, to be creative in simplifying the chain. Four cases from this quadrant are reviewed: European coatings and adhesives; global container freight; polymers from the Middle East to China; and ethylene oxide.

For the European coatings example, complexity stems from multiple products, suppliers and locations combined with a lack of a central overview, and different service standards and packaging. Sophisticated optimization simplified the network, changed the manufacturing footprint and generated improved service.

Breaking with tradition, polyolefins are now moved from the Middle East in bulk containers and packed in China in order to simplify and gain benefits with regard to lower inventory, reduced number of movements, improved carbon footprint and shorter customer order times. Documentation complexity, planning processes, cultural differences, visibility and internal network movements in China and the Middle East are managed by using one prime LSP.

By managing all aspects of complexity arising from the movement of a highly hazardous product a producer is able to safely transport ethylene oxide by road. Control features include specialized equipment, training material and programs, driver testing and vetting, hazard and operability (HAZOP) studies and emergency response (see Chapter 6, Section 6.1).

Global container shipping has been controlled through a single forwarder coupled with tracking and improved process management.

Other examples of high complexity but low uncertainty not covered by a case study are: retail petrol (multi-pot delivery, self loading and discharge, routing needs, short lead times, hazardous); catalysts (reverse logistics, traceable containers); polymer compounding (product range); refrigerated gases / temperature sensitive chemicals (special equipment and controls); high-hazard chemicals (chlorine and hydrogen fluoride).

CASE STUDY 4

BRUSHING UP THE NETWORK

The supply chain of coatings and adhesives

Introduction

The company is a major European multinational coatings and adhesives manufacturer. In a very competitive market place, the company manufactures and supplies specialty products to a range of industries in various geographies with different service standards and packaging requirements. The transportation and storage costs, including working capital, are a major component of the total cost of supply.

The company had a rather *complex* supply chain. It used a number of different manufacturing technologies across several production sites, each having their own set of capabilities. Traditionally each site took responsibility for freight procurement and local stock control within an overall working capital objective. Products were usually delivered direct to the customer from the manufacturing site warehouse. Many individual products had been developed at each site for regional clients and were distributed across Europe to new customers.

Opportunity

To gain from the benefits of scale while still providing high service standards and accessing local logistics service provision, the company wanted to redesign its manufacturing and distribution network. Some changes in manufacturing footprint were possible where the technology was common but formulations differed. In some specific regions, market share was under threat as local producers were offering very high service standards, so there was a need for some local warehousing.

The cost/benefit of local rather than central warehousing had to be considered in order to balance the revenue and margin growth from additional sales against the additional storage and handling costs. This provided an opportunity to redistribute transport activities between LSPs.

The Solution

The scale and complexity of the challenge required a number of simplifications and assumptions to be made. Twelve months of historical data were consolidated into one network optimization tool. Data segmentation enabled a scenario modeling approach to identify both global cost optima, such as adapting the manufacturing footprint, and local service optima, such as the size and location of a distribution warehouse. This led to a network of focused and specialized manufacturing sites, producing coatings that were then shipped directly to customers or via local distribution hubs that could react swiftly to market needs.

A more centralized approach to freight procurement led to a retendering process by region while still enabling the value of local LSPs to be captured.

The Value

Pan-European optimization has reduced complexity in the manufacturing and distribution network. The revised manufacturing footprint and product rationalization have improved efficiency. Local optimization of distribution has raised service standards and sustained market penetration in some regions, and enabled planned sales growth in others. Tendering of freight activities has substantially cut transport costs and fostered a near 10 % reduction in carbon emissions.

CASE STUDY 5

MERGING TRIPLE CULTURES

The supply chain of polyolefins from the Middle East to China

Introduction

Following a plant expansion, large volumes of polyolefins are exported from the Middle East (ME) to China. Customer lead times in China need to be as short as those in Europe despite the length of the chain.

Some *uncertainty* results from an extended supply chain and from regional regulations in China.

Complexity is generated through minimum bulk stock in the chain, multinodal supply chain planning, local customs and tariffs, free trade requirements and local road infrastructure. Different cultures regarding safety and the length and volume of the supply chain (bulk and packed road at both ends, warehousing, packing, ro-ro shipping, container shipping) add to the complexity.

Opportunity

This is the first major bulk supply chain where the bagging is done in China. Traditionally, polyolefins were bagged at production and shipped to China for customer collection at a warehouse. To save cost and minimize the carbon footprint the new supply chain solution involves loading bulk into 20ft and 40ft containers at production followed by multimodal shipping to China. Upon arrival in China, product is immediately packed into 25kg and 1mt bags and delivered to the customer, so no bulk storage is needed. This change has required detailed planning. The supply chain design meets the customer pull, economic cost and low carbon requirements.

The Solution

One major logistics provider, working closely with the producer, manages the full supply chain through to customer delivery in China.
Collaborative forecasting and planning by the solution provider and the producer ensures continuous flow from the Middle East production facility to packed stock in China with a 12 % increase in the load factor and minimum intermediate stock.
A close liaison with Chinese regulators ensures minimum delay and best economics associated with customs and local authority requirements.
Western safety standards have been applied across the whole supply chain using an advanced packing facility, an intensive Chinese distribution network and operator training programs.

The Value

These solutions make a long and complex supply chain effective. Large bulk shipments are packed locally, which puts the decoupling point between push and pull close to the customer. Operations are safe and economical with minimum stock, short delivery time, reduced carbon footprint and minimum interruption to supply. The supply chain can be easily scaled up to meet expected growth requirements.

In sustainability terms, these efficiencies – including not having to return pallets to the Middle East – have reduced emissions by around 15 %.

CASE STUDY 6

PROTECTING THE CHEMISTRY SET

The supply chain of ethylene oxide

Introduction

Ethylene oxide is moved by road in the UK and other European countries. It is highly hazardous: a gas at 11 degrees centigrade, flammable and highly reactive. Exposure to humans must be prevented.

There is little *uncertainty* associated with the supply chain other than the threat to ban movement by road.

The supply chain *complexity* does not originate from conventional issues such as sourcing, planning, stock keeping units (SKUs), distance, or multimodal. It results from ethylene oxide's hazardous properties, which entail special controls as the product leaves the factory gates and enters the public domain. During plant shutdowns, it must be sourced from other European companies.

Opportunity

The supply chain has been specifically designed to minimize the risk of accident or injury, and to reassure regulators and the public that road transportation is safe.

The Solution

Specialized, dedicated equipment is used. Instead of conventional gas road tanks, pressurized Isotanks are deployed. These have extra strength to contain the product in the event of an accident. Specialized couplings are also used.

Detailed HAZOP studies have been undertaken, including route planning, population density analysis, mode comparisons and general scenario analysis techniques.

Specific driver training and retraining is in place and involves classroom, video and pass or fail examinations. Driver identity passes are used to ensure only qualified drivers can enter loading and off-loading facilities.

A single dedicated logistics provider with a long-term contract makes deliveries, which creates a collaborative relationship.

A trained and dedicated emergency response team is in place to deal with any incidents.

The Value

Ethylene oxide has been moved by road for many decades without loss of containment. This enables downstream manufacture of solvents, antifreeze, textiles, detergents, cosmetics, adhesives, polymers, polyurethanes, pharmaceuticals and other derivatives at non-integrated locations.

CASE STUDY 7

BOXING CLEVER

The supply chain of global container freight

Introduction

DSM sourced and managed its marine carrier contracts on a global basis. However, individual business groups handled their respective transport operations, documentation and order booking. Consequently, the supply chain had a fairly high degree of *complexity*.

Opportunity

Information from carriers and forwarders was contained within many systems, complicating ease of access and analysis. There was no standard reporting structure, which meant comparative carrier performance evaluation was not always possible. Also, dealing with multiple forwarders and carriers absorbed valuable management time and resulted in the urgent need for standardization and data transparency.

The Solution

DSM decided to implement global sea freight standards and, working with the logistics staff in each of the Business groups, initiated a company-wide sourcing project to develop these standards. The primary goals of the initiative were transparency, process optimization, improved supplier quality, and greater cost efficiencies. Potential suppliers were invited to participate in a Request For Quotation (RFQ) process and challenged to provide innovative solutions to meet defined goals.

BDP International was awarded the global transportation management business, including freight forwarding, import brokerage, documentation, invoicing, and some ocean transportation.

Even with a global business presence, it was apparent that every implementation has local content, and therefore any supplier had to be able to replicate the global footprint.

Technology was also a key success factor in providing the necessary transparency for global shipment visibility. This was achieved through Electronic Data Interchange (EDI) connectivity and BDP's technology and metrics architecture, allowing for tracking entire shipments, seeing shipped volumes, and assessing individual carrier performance.

The Value

By mapping all the work processes and standard operating procedures (SOP), efficiencies are being achieved throughout the global supply chain.

Improved planning results in greater use of lower-cost logistics solutions and delivers cash savings to businesses.

By using combined volumes purchasing power, freight contracts are improved.

Other benefits include invoice checking, reduced transport management costs through simplified supplier relationships, improved control of detention and demurrage obtained from supply chain transparency, and carrier lead time visibility helping to improve delivery reliability and customer service.

3.4.3 Supply chains with High Complexity and High Uncertainty

Quadrant SC4 is probably the most challenging: supply chains within it are complex and uncertain. Case reviews from this quadrant include the global supply chains for agrichemicals and biofuels, and with bulk liquid supply to Russia. The barge traffic system is also included, as an example of multiplayer collaboration at one point in the supply chains.

Through using rail rather than short sea transport, and standardizing equipment, procedures and operator training, it is now possible to offer customers in Russia the same bulk delivery service offered in Western Europe. Uncertainty, caused by weather and port congestion, and complexity, due to a less developed network, have largely been overcome.

In the agrichemicals case, decoupling push from pull, using robust Sales & Operational Planning (S&OP) processes and product segmentation in combination with a global supply chain improvement program, have delivered lower inventories, reduced costs and carbon footprint, while also improving seasonality and volatility management.

Each year, slot planning of 10 000 container barges, which on average called at eight Antwerp terminals per voyage, was both complex and uncertain. Each barge operator now requests a slot time through a web-based portal system. Through collaborative planning involving the port, the terminal and the barge operators, significant efficiency improvements are achieved.

The biofuels supply chain contends with many complications, including uncertain supply alternatives, government interventions, regulatory issues, environmental constraints, carbon credits, traceability, price fluctuation, seasonality, weather and more. Flexibility in plant production and raw material purchase together with government cooperation, environmental management, upstream integration and local positioning are the mitigation methods.

CASE STUDY 8

TO RUSSIA WITH BULK

The supply chain of bulk liquids from Western Europe to Russia

Introduction

Intermodal transportation from Western Europe into Russia either by short sea or by rail faces many challenges. Differences in rail gauge, difficulties in winter when entering the port of St Petersburg and some bureaucratic issues can create delays in the supply chain.
In general, short sea transportation via the port of St Petersburg is effective. However, the port and its road network can get very congested. Winter weather can freeze the port entrance, disrupting the supply chain. Beyond St Petersburg the road network is not well developed and distances to the main chemical industry centers are long. Some bureaucratic delays, such as customs clearance and paperwork, can also add to the *complexity* and *uncertainty* of supply chain management.

Opportunity

Uncertainty from combining sea and road transport can be mitigated by switching to rail in Russia. However, rail gauge and long lead time issues remain, and slow customs clearance at the Moscow rail terminal can cause major delays.

The Solution

The focus on rail and road, in combination with an investment program for standardizing equipment and procedures all over Europe, has brought major improvements to the supply chain.

At Bertschi, standardized equipment that was already in use in Western Europe has now also been introduced in Russia. Bertschi has trained its Russian drivers in its European training center to master the standards. A cleaning station has been built for tank containers to enable reloading in certain areas.

The Value

Standardization drives out complexity and helps to improve performance in terms of cost, safety and service. Extensive driver training, for example, has substantially improved safety and sustainability performance. Through central planning, resources can now be optimally allocated, which improves reliability, customer service, efficiency and environmental impact.

It is now possible to offer customers in Russia the same service as Western European customers.

CASE STUDY 9

SEEDING DESIGN SOLUTIONS

The global agrichemical supply chain

Introduction

The company is a major producer of agricultural chemicals. Global agrichemical supply chains are *complex*. Between the raw material supply and the delivery to the farmer, multiple hand-offs take place, including intermediate production steps, active ingredient (AI) production, formulation, filling and packaging, and intermediate stocking points. Upstream supply chain requirements are significantly different from those at the demand side. The business is highly *uncertain* because of its seasonality and volatility, leading to low forecast accuracy. For example, demand is influenced by the weather, and subsidies influence planting programs. The lead time from raw material ordering through to sale of finished product can be 12 months or more, and the ability to react to changing demand for AI during a season is limited.

Opportunity

There was a basic disconnect in the supply chain: AI supply was managed globally, while formulation, filling, and packaging were managed locally. There was no clearly identified decoupling point between supply and demand: inventory dispersed across many silos; high finished goods inventories in the countries to buffer against limited supply flexibility; and a global operating model based on harmonized processes.

A new model was required, which recognized the supply chain drivers (market reality, business strategy focusing on core products and key brands, and service levels) while meeting the corporate objectives of reducing inventories, offering greater supply flexibility and optimizing production cost.

The Solution

A phased supply chain performance improvement project was developed, spanning several years. Short-term initiatives covered portfolio optimization, improved sales forecast accuracy, elimination of some slow movers, and a revision of supply chain metrics. The model was designed to decouple Push and Pull by using global AI warehouses positioned in the regions and introducing a regional supply chain organization to manage demand. In addition, the work process for both Push (AI production) and Pull (formulation and filling) along the whole chain was optimized, based on a robust S&OP process, product segmentation, improved long-term and short-term forecasting and a Key Performance Indicator- (KPI) driven service level agreement.

The Value

Inventory reduction targets were achieved. Project success was dependent on top management sponsorship, regional management support, applying best-in-class supply chain thinking, and process and systems integration.

This company reduced both complexity and uncertainty. Better forecasting and planning have reduced the impact of market uncertainty on the chain. Segmentation and decoupling reduce the complexity and "split" the chain into sections. There is a focus on efficiencies and economy of scale in the upstream part of the chain; downstream the focus is on market responsiveness and flexibility. In combination, this leads to a more robust and resilient supply chain.

CASE STUDY 10

HARBORING EFFICIENCY

Antwerp barge scheme

Introduction

The Port of Antwerp handles about 10 000 container barges each year. The average container barge calls at eight terminals in the port on a single voyage. These terminals are widely dispersed within the port and located on different banks of the river Scheldt. This can require vessels to pass through locks between terminals. Loading quays are shared with sea going vessels. Slot planning for barges can therefore be *complex and challenging* in a port the size of Antwerp.

Opportunity

Before the introduction of the Barge Traffic System (BTS) by the Antwerp Port Authority, every barge operator had to contact each terminal operator individually via e-mail or phone. There was no coordination between different terminal operators. Especially for container barges that call on multiple terminals in one voyage, this resulted in a lot of re-planning of loading and unloading activities, poor communication, inefficient management of sailing schedules, inefficient utilization of quays, etc.

The Solution

BTS is a free web-based application that enables barge operators to request a time slot at the terminal. The system visualizes the available terminal capacity for barge handling, the real-time number of requested barge moves and conflicting slot requests, thus encouraging the barge operators to draw up a feasible sailing schedule in the port. This planning information is collected on Day 1. On Day 2, BTS provides the requests to the terminal operators who draw up a terminal plan, taking into account aspects such as sailing time between the terminals, and handling time for the container moves. BTS then checks for conflicts between the handling schedules of the different terminal operators. If conflicts occur, the system will ask the relevant terminal operator to resolve the conflict. Around noon, BTS confirms the slots with the barge operators.

On Day 3, the plan is executed and adjusted as the barges are handled. The terminal operators register all operational data in BTS (actual time of arrival and departure, start and end of operations, number of containers handled). By combining this data with real-time information on lock schedules and barge positions, adequate follow-up of barge handling in the port is achieved.

In the first stage, BTS only functions for container terminal and barge operators. As the system only works optimally when generally used in the port, it became mandatory for the barge sector. In a later stage, the system will also become available to tanker operators and liquid bulk terminals.

The Value

BTS, a unique communication platform for the container barge sector, captures the complexity of the port activities, and enables terminal operators to manage it jointly.
It increases competitiveness in the port of Antwerp: BTS makes the chain more reliable, reducing uncertainty for both barge and terminal operators. It lets terminal operators make better use of their equipment and people. Barge operators can minimize waiting times, which cuts lead times for container inland navigation in the port and also lowers emissions. BTS is a good example of how collaborative planning leads to operational excellence, through improvements in efficiency and reliability.

CASE STUDY II

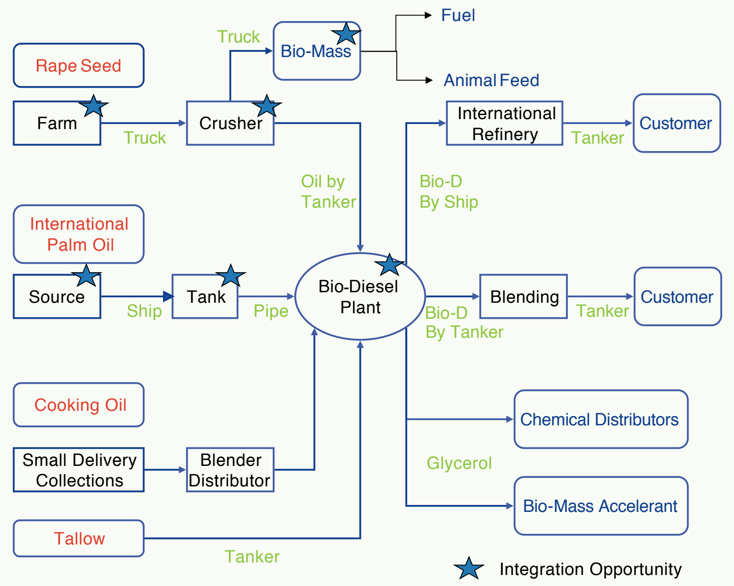
FUELLING FLEXIBLE SOLUTIONS

The biofuels (biodiesel and bioethanol) supply chain

Introduction

Biodiesel and bioethanol supply chains have similar characteristics, one being derived from natural oils and the other from crops such as sugar cane and corn. A typical biodiesel supply chain is shown below, and reflects the general complexity found across petrochemical supply chains.

Biodiesel supply chain



The supply chain involves many different stakeholders, which makes it complex to manage. In addition, this chain is subject to many sources of uncertainty in supply and demand, in the process, and in the environment.

Opportunity

Raw materials are high-volume commodity rapeseed, palm oil, soya or tallow and cooking oil. Supply of these raw materials is impacted by many factors, so companies must be flexible and try to ensure timely access to products. For example: rapeseed is higher priced and needs to be locally sourced; soya from Argentina is affected by national government desires to add downstream production; vegetable oil prices are influenced by China's huge but fluctuating demand; cooking oil is best priced but must be collected and cleaned by blenders; and crop yields are driven by the weather and global events.

Regulations also affect the supply chain. These include: import or export tariffs; complicated classification further affected by "splash and dash"; certification systems; and the percentage quota of biofuels to be added to fossil fuels.

Environmental issues include carbon credits, deforestation, animal habitat, transparency and the need to supplement fossil fuels.

Prices swing according to demand, crude oil prices, government regulations, low temperatures (cold flow plugging), by-product markets and the supply factors mentioned above.

The Solution

To secure raw materials, to benefit from economies of scale, and to manage the impact of regulations and tariffs on performance, large companies have focused on vertical integration, which includes plantations, feedstock trading, and involvement in crushing, biomass, and the glycerol market.

To mitigate regulatory uncertainty, a strong governmental interface and in-depth knowledge of technical, political and social implications are required.

Small companies compete through a combination of locating close to rapeseed areas (large companies are often located at the ports to aid imports and exports), using cheap cooking oil source material (now extensively used by big companies), taking space on large palm oil ships, working with traders and adjusting production up and down (sometimes full shutdown) in line with the available margins.

Waste and cooking oil blenders and distributors are new entrants in the industry, collecting small quantities, storing, cleaning, and bulk delivering to the producers.

The Value

Successful biodiesel manufacturers are those who become fully integrated across the supply chain. Ownership of the supply chain reduces the uncertainty, and provides the overview that is needed to master the complexity of the chain. Small manufacturers adopt a strategy of adaptability and flexibility, moving from niche to niche as the market develops.

Other mitigating actions include government cooperation, adjusting tariffs and building in flexibility with regard to the raw material sourcing, production volumes, physical distribution and location.

Throughout the supply chain, biodiesel producers must ensure credibility through full traceability, ensuring animal habitats are not destroyed and lowering the carbon footprint through local production and shipment in large vessels.

3.5. Results

3.5.1 Lessons learned from the 11 petrochemical cases

Table 3 lists the issues faced and supply chain practices demonstrated in 11 petrochemical cases, the impact of these practices on the complexity and uncertainty in the supply chain, as well as the competitive performance improvements and benefits that have been obtained.

It is an impressive list of practices, some of which are found in several cases:

- Standardization of products and processes
- Outsourcing of logistics
- Centralization vs. localization of distribution
- Forecasting and planning
- Collaboration with supply chain partners, including ports/regional, national and local authorities
- Shifting the decoupling point which allows late differentiation in the supply chain
- Training

Practices identified in the 11 cases offer different examples of how supply chain complexity and uncertainty can be managed. Some aim simply to cope with and manage the complexity and/or the uncertainty. However, most go beyond the acceptance of complexity and uncertainty, and explore their root causes. Refer to Table 2 on page 31 for an overview of the 11 petrochemical cases, and 2 further cases from other industries.

Supply chain practices discussed in these cases offer multiple benefits. Improvements in efficiency and cost can be found in the majority of the cases, and significantly these improvements are often associated with an improvement in customer service and delivery reliability. They also highlight the way that supply chains have been made more responsive, flexible and resilient. Most cases also demonstrate practices that have increased supply chain sustainability, indicating that concern for people and planet has become a key focus area. However, there is also evidence that sustainability benefits are often an associated result of efforts to improve cost and efficiency (profit). Chapter 6 of this report explores the concept of sustainability including “planet” and “people”.

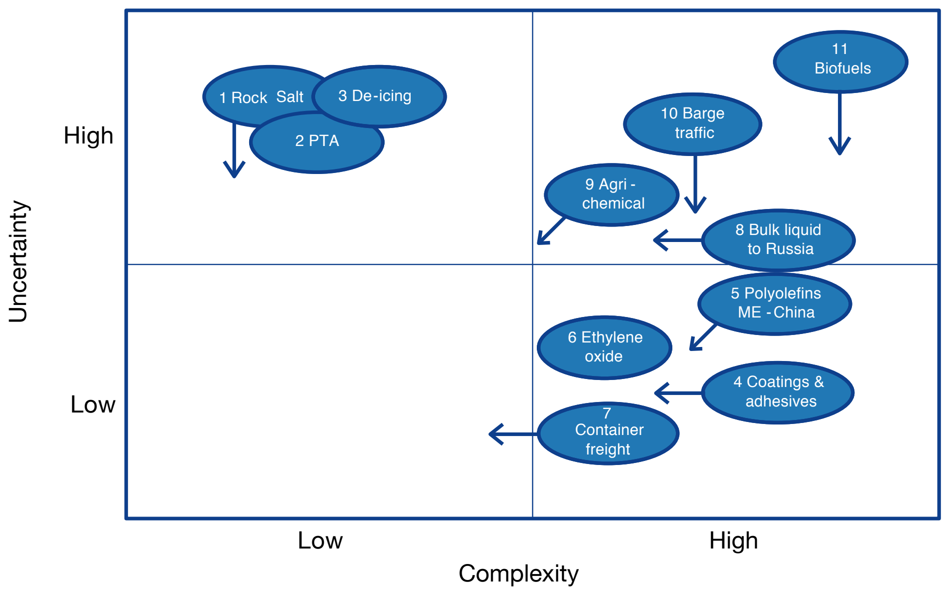
Three cases recognize the importance of training and the development of supply chain expertise in order to effectively manage complexity and uncertainty, and to apply best practices.

Several cases exploit collaborative practices to reduce both complexity and uncertainty, and all of them enjoy benefits in efficiency, service, and sustainability. Collaboration in the supply chain takes place in multiple ways, and collaborative planning, forecasting and replenishment have become a common practice. Chapter 4 of this report looks at collaborative practices in the petrochemical industry in more detail.

Two cases illustrate the innovative use of information technology to reduce complexity and uncertainty and Chapter 5 addresses the issue of technology in detail, and illustrates the application of technology with a wide range of case studies.

Figure 2 - Impact on complexity and uncertainty in the petrochemical cases

The arrows show the issue addressed in the comparative Table 2 on page 31



3.5.2 Lessons learned from other industries

Having reviewed some supply chain practices in the chemical industry, the report now looks at potential lessons to learn from other industries. An interesting benchmark is offered by the Gartner Supply Chain Top 25, an annual ranking of companies considered leaders in supply chain management. Whereas no chemical companies appear in this ranking, a number of the customers of the chemical industry are present (e.g. P&G, Johnson & Johnson and Unilever). The absence of chemical companies should not be considered bad news. All ranking systems tend to have their strengths and weaknesses, and in this case the weightings of the Gartner study (e.g. return on assets) tend to favor asset-light companies with strong consumer brands (e.g. Apple, Coca-Cola) that are diametrically opposed to the petrochemical industry segment (high barrier of entry, capital-intensive, focused on plant optimization and high-volume commodity production).

An analysis of the supply chain practices of companies in Gartner's Top 25 for the years 2010, 2011 and 2012 shows all leaders focused on building a demand-driven supply chain. They are innovative and have become solution (rather than product) providers. Agility and resilience are key areas of attention, and are achieved through collaboration with customers and suppliers. Operational excellence leads to cost reductions and efficiency improvement. Supply chain planning and supply chain talent development are critical capabilities. Some companies have developed and introduced excellent systems for managing the complexity of their chain (e.g. sophisticated supply chain planning systems), while others have focused on reducing the complexity (e.g. by segmenting the supply chain to serve product/market segments differently). Based on this analysis, many of these best practices are also well established in the chemical industry, as is shown in the supply chain practices column in Table 2 on page 31.

Some of the best practices Gartner identifies are well illustrated in two examples from the apparel and the whisky industries. Although these industries are very different from petrochemicals, they offer some interesting insights for this sector. The cases illustrate supply chains characterized by a high degree of complexity and uncertainty, countered by practices such as supply chain segmentation, product rationalization, postponement strategies, outsourcing and collaboration with supply chain partners.

CASE STUDY 12

THAT'S THE SPIRIT!

Scotch whisky's global supply chain

Introduction

Scottish whiskies – known collectively as "Scotch"– generate a £4.3 billion market. 100 % of the production is in Scotland, and 90 % is exported to 200 markets (35 % EU and 65 % rest of the world by revenue). The Scotch supply chain presents challenges related to uncertainty and complexity. *Uncertainty* exists due to the ageing process, which relies on long-term demand forecasts, and the extreme range of demand volatility, which is low for mass-market products but high for luxury products. *Complexity* stems from the heavily regulated global market, the scarcity of sustainable sources of cask wood and the constraints in sourcing cereal feedstock locally.

Opportunity

The supply costs and inventory requirements are high, and margins are volatile as price adjustments compensate for the time lag (ageing process) between supply and demand.

The Solution

The company decided to harmonize stock keeping units (SKUs) by reducing the number of products (what is the right number of age, size, quality, and special edition variants for each brand?) and to control the number of bottle sizes, special editions, packaging and labeling.

Moreover, the company adopted a postponement strategy in its supply chain. It decided to postpone packaging, particularly of luxury products requiring special packaging materials (rare woods, precious metals, etc.), to label the bottles in local warehouses, and, where possible, to use local bottling plants.

Supply chain service was differentiated by customer and by product segment. For example, luxury products sold to small, undemanding customers were centralized in a single warehouse, and delivered with long lead times. Mass-market products sold to large and demanding customers were stored in local "spoke" warehouses and could be delivered within a day.

The Value

These solutions help drive down cost and reduce inventory while improving service for customers who need it. The SKU harmonization enables better demand management, which lowers inventory requirements, and helps to avoid losses from poor demand forecasting. The postponement strategy reduces inventory and presents significant opportunities to reduce logistics cost. Differentiation allows better service for demanding and important customers without over-serving others. This has significant top line benefits, and reduces the overall cost-to-serve.

CASE STUDY 13

FASHIONING PARALLEL LINES

The apparel supply chain

Introduction

The supply chain for apparel is highly differentiated, ranging from predictable demand for basic products to constant innovation and unpredictable demand for fashion items. The sales channels are either to stores or direct to customers (online and catalogue sales) and are affected by seasonality, the peaks being Christmas and summer. Manufacturing is in South East Asia with stocking points at the factories, distribution centers, local storage facilities and stores. For one apparel manufacturer, product returns represent 5 % of store volumes and 25 % of direct customer sales.

Uncertainty exists due to the unpredictability of demand for fashion products and the large number of SKUs including color and size.

Complexity is generated through the need for fast speed to market in the fashion segment, in parallel running "fashion" and "basic" as well as "stores" and "direct to customers".

Opportunity

High losses occur due to the mark down of unsold products. Trade-offs must be made between service levels (stock-outs) and inventory. There is a high cost of inventory in the fashion segment due to the limited shelf life.

The Solution

One apparel company outsourced its supply chain to two wholly-owned subsidiaries with internal service level agreements: one took charge of manufacturing and sourcing of raw materials; the other provided logistics, and took responsibility for sourcing packaging materials used at the warehouses and point of sales materials.

The company also invested in selected key capabilities. It developed collaborative forecasting and planning with direct transmission of Point Of Sale (POS) data (for example, to adjust for errors in the forecasts of sizes). The company also segmented its supply chain into "Basic" (mostly sea transport and large quantities) and "Fashion" (mostly air transport and small quantities), and learned how to run them in parallel. Distribution Centers (DCs) for stores and "direct to customers" were separated due to order quantity differences. Finally, sourcing of non-apparel fashion items was entrusted to highly capable suppliers with no minimum quantities and short lead times.

This required significant investments in IT for the transmission of POS data, and advanced ERP configuration to manage parallel supply chains.

The Value

These solutions helped to improve responsiveness in the "Fashion" supply chain, key to building the brand and top line, while maintaining competitive costs along the "Basic" supply chain. The project had a positive impact on the margin, and service was tailored to expectations.

Overview of supply chain practices in 11 cases from the petrochemical industry and 2 cases from other industries in this chapter

#	CASE STUDY	ISSUE ADDRESSED	SUPPLY CHAIN PRACTICES	BENEFITS
LOW COMPLEXITY-HIGH UNCERTAINTY				
1	Rock Salt	Managing and reducing uncertainty	Increased stock levels Improved forecasting, central planning Collaboration	Delivery reliability Sustainability (people)
2	PTA	Managing uncertainty	Increased stock levels Outsourcing of logistics Collaboration	Efficiency/cost
3	De-icing fluid	Managing uncertainty	Outsourcing of production Localized distribution centers Centralization and outsourcing of logistics Collaboration	Service/delivery reliability/customer Responsiveness/ flexibility
HIGH COMPLEXITY-LOW UNCERTAINTY				
4	Coatings and adhesives	Reducing complexity	Product portfolio rationalization Specialized plants Localized distribution centers Centralization and outsourcing of logistics Collaboration	Efficiency/cost Responsiveness/ flexibility/customer Sustainability (planet)
5	Polyolefins from Middle East to China	Reducing complexity and uncertainty	Decoupling point (push vs. pull) Outsourcing of logistics Improved forecasting, central planning Collaboration with authorities Training	Efficiency/cost Service/delivery reliability/customer Sustainability (planet)
6	Ethylene oxide	Managing complexity	Innovation (specialized equipment) Outsourcing of logistics Collaboration Training	Sustainability (people & planet)
7	Global container freight	Reducing complexity	Standardization and outsourcing of logistics Collaboration Improved planning Performance management Innovation (information technology)	Efficiency/cost Service/delivery reliability/customer

#	CASE STUDY	ISSUE ADDRESSED	SUPPLY CHAIN PRACTICES	BENEFITS
HIGH COMPLEXITY-HIGH UNCERTAINTY				
8	Bulk liquids from Western Europe to Russia	Reducing complexity	Standardization of logistics Training	Efficiency/cost Service/delivery reliability/customer Resilience Sustainability (planet)
9	Agrichemicals	Reducing complexity and uncertainty	Supply chain segmentation Improved forecasting and S&OP Product portfolio rationalization Decoupling point (push vs. pull) Distribution network (central vs. local) Performance management	Efficiency/cost Responsiveness/ flexibility/customer Resilience
10	Barge traffic	Managing complexity Reducing uncertainty	Collaborative planning Innovation (information technology)	Service/delivery reliability/customer Efficiency/cost Sustainability (people & planet)
11	Biofuels	Managing complexity Reducing uncertainty	Vertical integration Flexible sourcing and production Collaboration	Flexibility Sustainability (planet)
LESSONS LEARNED FROM OTHER INDUSTRIES				
12	Scotch whisky	Reducing complexity and uncertainty	Reduce product mix and harmonize SKUs Implement postponement Customer & product segmentation	Efficiency/cost Improve service/ customer Lower inventory
13	Apparel industry	Reducing uncertainty of demand Reducing complexity of various channels	Outsourced supply chain and logistics Collaborative forecasting & planning Segmentation of supply chains IT and ERP configuration	Efficiency/cost Improve responsiveness Customer

Table 2 – Supply chain practices for 13 cases studied in Chapter 3

3.5.3 Conclusions

In the past, significant improvements in chemical supply chain performance have been identified and achieved through the application of well established approaches to optimization, such as product flow analysis, spend-maps, network analysis, and cost-to-serve work process improvement.

A useful addition to this toolbox is the approach used in this report to focus on addressing "complexity and uncertainty". The case studies illustrating the application of this methodology are evidence of what can be achieved in bottom-line gains coupled with environmental and social improvement.

It should be noted that this approach requires strategic business engagement when considering the implications of uncertainty, and supply chain functional expertise to mitigate the effects of complexity. This broad-based approach is necessary to ensure that benefits accrue across the economic, environmental, and social components of the business. It should also be understood that a level of supply chain maturity will be required if these benefits are to significantly impact the organization and the bottom line. A comparison of the list of practices taken from the 11 petrochemical cases with the 2 case studies in the other industries leads to some interesting conclusions. It is striking that most of the practices encountered in the other industries are also applied in the chemical industry. The evidence suggests the chemical industry can be compared with other leading industries and companies assessed by external benchmark organizations such as Gartner ([1]). Some practices apply broadly, irrespective of the dynamics and characteristics of the industry.

Many companies have been building a demand-driven supply chain, shifting the decoupling point and adopting postponement strategies. Supply chain segmentation is finding its way into the petrochemical industry to improve customer service and to reduce the complexity of the chain. Operational excellence is improving efficiency. Along with the economic and sustainability improvements, collaboration with customers and suppliers is identified as an important factor in many of the good practice examples.

Because of the nature of the chemical industry, the recruitment and retention of highly skilled, trained and quality specialists coupled with enlightened leadership are essential for delivering these improvements.

([1]) Gartner Supply Chain Top 25 report for 2010, 2011 and 2012.

4. Making chemical supply chains more efficient and sustainable through pro-competitive collaboration

Significant cost, service and CO_2 emission benefits are demonstrated by successful examples of pro-competitive supply chain collaboration in this chemical industry study by EPCA, Cefic and A.T. Kearney. If looked at also in conjunction with the increasing future supply chain challenge, these examples should encourage the chemical industry, its logistics service providers, and its customers to embed the lessons learned in their day-to-day operations and pursue more pro-competitive collaboration opportunities, subject to full compliance with competition laws.

4.1. Introduction

EPCA and Cefic have been addressing supply chain improvement themes in the chemical industry for many years. While the technology and concepts all appear to be available, there still seems to be reluctance or inability amongst supply chain business partners to collaborate more effectively, often manifested in an unwillingness or inability to share data and information. However, not all information sharing is anti-competitive. Indeed, certain information sharing can be pro-competitive and may, indeed, serve a pro-competitive objective, such as to create more efficiencies in the supply chain to the ultimate benefit of all stakeholders involved, the environment and the consumer. Therefore pro-competitive collaboration in supply chain and logistics has been identified as a critical success factor that requires further research and development.

4.2. Objective

The objective of the work undertaken in this regard was to evaluate the business case for pro-competitive collaboration, identify best practices, examine specific chemical supply chain challenges, and make tangible suggestions to help our industry become even better at fulfilling our customer needs in a sustainable manner.

This report looks at collaboration in both inbound and outbound transport logistics, and at warehousing and other related services. Evaluation of the business case for pro-competitive collaboration takes account of desk research and in-depth interviews with industry experts, carried out in 2012 and 2013. Examples included describe collaboration in the chemical industry and across industries.

In general, two types of pro-competitive collaboration are common in chemical supply chains. Most common is vertical collaboration, where a chemical shipper and a logistics service provider work together, or where a shipper seeks closer integration with its customers. Horizontal collaboration, where either two or more shippers work together, or two or more logistics service providers work together, appears to be less common. Also possible, but less common, is integrated collaboration, between multiple shippers and multiple logistics service providers.

Evidence gathered through this study confirms that companies proactively and systematically engaging in different types of collaboration benefit significantly from their efforts (see Table 3 on page 47).

Figure 3 - Routes to pro-competitive collaboration benefits

15-20 % cost reduction potential and other benefits through pro-competitive collaboration

Successful collaborations in this study show ***15-20 % cost reduction*** *potential. This figure is confirmed by the numerous interviews conducted to develop this report and explore the various cases. Often those cost savings directly lead to* ***lower CO_2 emissions****, partly because less empty space and fewer kilometers are involved, and partly because of mode shifts. Lead time reduction by higher delivery frequencies can reduce the cash conversion cycle and enables* ***working capital reduction****. Accordingly collaboration can often also lead to* ***service level improvements for customers****. Collaborative standardization initiatives can drive* ***health & safety*** *levels across the industry.*

This study found three routes to collaboration benefits:

Vertical collaboration benefits	• In this case the shipper and logistics service provider, or different chemical shippers and their customers or suppliers collaborate • Such partners can jointly optimize their supply chain and logistics processes, e.g. through decoupling of loading and driving which cuts waiting times, or by sharing planning and order information in advance to optimize logistics resources scheduling
Horizontal collaboration benefits	• In this case shippers or logistics service providers collaborate amongst themselves • Shippers can drive collaborative outsourcing, enabling carriers to optimize transportation routes or allow for return loads • Logistics service providers can share their networks to improve fleet asset utilization and availability for customers
Integrated collaboration benefits	• In this case multiple shippers, multiple logistics service providers and multiple customers collaborate • A community of companies from both sides, and potentially even cross-industry, can promote joint interests, e.g. building a joint distribution platform or driving industry standardization

In the chemical industry, vertical collaborations are the most common. The contact between shipper and carrier is well established and opportunities to generate value for both sides are actively pursued. Horizontal collaborations happen less often, since there are legal limitations that make some stakeholders shy away from further exploring opportunities.

The initial research conducted for this study found some good working examples of pro-competitive and legal collaboration in the chemical industry. However, there is room for further improvement. Therefore interviews with industry experts were conducted to identify examples of best practice in supply chain collaboration. Those interviewed, more than 40 in all, were primarily senior executives in chemicals and transportation companies. In addition, 20 case examples of collaboration within the chemical and other industries were analyzed to identify good practices resulting from companies collaborating. Five of these cases are described in detail at the end of this chapter and referenced – some more than once.

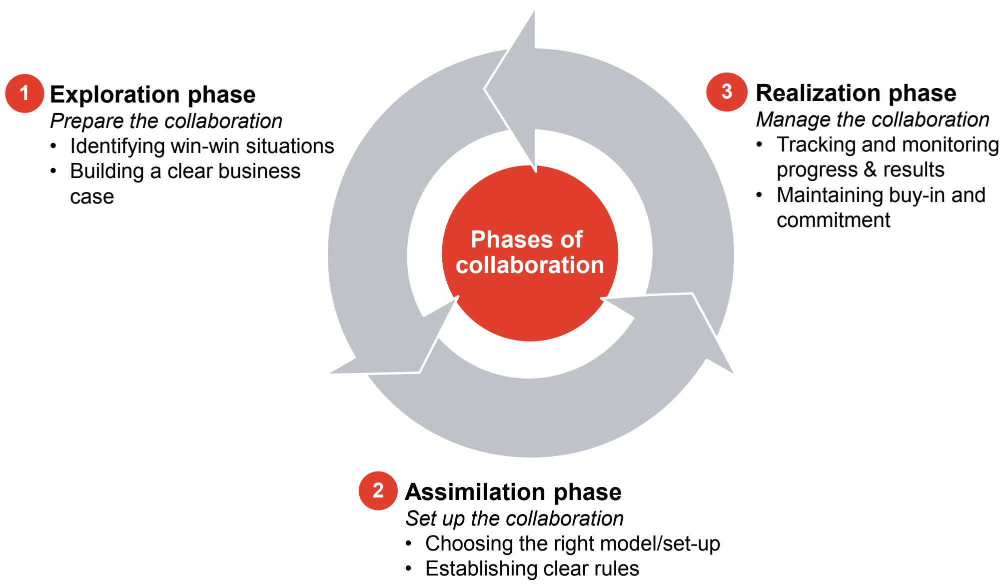
4.3. A three-phase pro-competitive collaboration approach with clear requirements

This report has adopted A.T. Kearney's framework for analyzing pro-competitive collaboration. The interviews and case analysis conducted by A.T. Kearney looked at the establishment of successful collaborations in three phases, each with specific requirements (see Figure 4). Findings in the report are also supported by the recently published position paper "CO3 Characteristics of Collaborative Business Models" for which a working group headed by Heriot-Watt University experts analyzed the characteristics of successful collaborations in other industries.

In the first phase – **Exploration** – a foundation for collaboration is established by identifying achievable win-win opportunities and defining the business case. In phase two, **Assimilation**, collaboration is established by developing an appropriate set-up, and by jointly agreeing the rules of engagement. Finally, in the **Realization phase**, the collaboration is executed with tracking, monitoring and continuous change management to secure sustainable success. In addition, any collaboration requires continuous review, refinement and exploration of new ideas.

Figure 4 - Three-phase model of successful supply chain collaboration

Successful pro-competitive collaboration follows three phases



The following sections examine each collaboration phase in detail, illustrated by examples of good practices within the chemical industry and beyond. The key lessons can be summarized as follows:

- Pro-competitive collaboration requires an active, structured and continuous search for collaboration opportunities, the vision to see the benefits, and the ability to inspire others to engage. It requires an overall openness and the willingness to clearly define a systematic framework that fosters and supports collaboration
- Once identified, the opportunity needs to be laid down in a commonly accepted business case with benefits, cost and investments transparent to and fairly shared between all partners
- There is no single best pro-competitive collaboration model; however, mutual trust and clear rules of engagement are common success factors of all positive collaborations
- Partners have to ensure that the performance of the pro-competitive collaboration is constantly measured, and issues are openly discussed and jointly resolved to sustain the commitment of all participants

In order to provide some hands-on support for future collaborators, Section 8.1 of the Appendix provides a checklist for successful collaboration practices.

4.3.1 Exploration phase – preparing the collaboration

Creating win-win situations ensures that all the partners are visibly better off collaborating. Win-win scenarios come in many forms.

> *The collaboration between Mars, the consumer goods company, and both its logistics service provider and retail customers increases efficiency and reduces CO_2 emissions for all partners. Steps taken in this case include shared warehousing, synchronized loading and discharge time windows, shared road transport and combined deliveries to retailers to increase the full truck load (Case Study 14).*

Sometimes collaboration requires an outside trigger.

> *One win-win scenario stemmed from the massive landslide that blocked the Gotthard tunnel in 2012 for about one month and limited transit capacity. "It is fascinating how suddenly logistics providers offered free capacities to each other – somehow this does not work during normal times," says one senior supply chain manager of a chemical company.*

Identifying suitable collaboration partners is not trivial. While many companies carry out structured searches for suppliers as part of their supplier management programs, similar searches for partners are less common. For example many vertical collaboration opportunities could be identified if regular dialogues on this topic were established with customers on one hand and suppliers on the other. An open eye for opportunities definitely should be fostered across the entire organization.

> *One of the companies in our research found a partner through the attentiveness of one of its logistics managers, who saw raw material supply coming in from a customer company using the same containers as were used to make deliveries to that customer. He contacted the company and they agreed to bundle the bi-directional loads (Case Study 15).*

> *Consumer goods company Mars used a different approach to partner identification. By establishing a collaboration brand named "Green Order", it created enough awareness amongst its customers to make them participate in a horizontal cooperation effort (Case Study 14).*

Looking for something new and innovative in supply chain collaboration means fostering idea generation. Over the years, supply chain management has gained significance in the chemical industry, leading many companies to establish central supply chain functions. These functions should be closely involved in discussions with logistics companies to spark new opportunities.

Procter & Gamble, for example, have established specific positions for supply chain innovation, which are staffed with creative entrepreneurial seniors. These people are carved out of the daily supply chain operations in order to focus on identifying novel solutions.

The logistics procurement approach of the chemical industry has also gradually been changing. It has come a long way from a transport lane approach, sourcing transport services from A to B. Today, people in this function are determined to add value to chemical supply chains. They are looking to obtain transport and logistics services from providers capable of integrating supply chains and linking consignors and consignees of chemical goods in a more sustainable way. They also want LSPs to have greater focus on supply chain costs, reliability and robustness. This makes logistics procurement specialists ideal facilitators between LSPs and chemical shippers, ensuring that logistics operations integrate seamlessly with chemical supply chains.

In the case of a chemical company and its chemical customer, the purchasing department of the customer accepted paying more for incoming goods because outbound costs could be reduced. This collaboration was made possible by getting all the affected departments to recognize the corporate net benefits (Case Study 15).

Chemical shippers can also foster collaboration by taking supportive steps such as synchronizing the start and end dates of contracts, to enable bundling across business units and ultimately with other chemical companies.

Most critical to the success of collaboration is a **change of mindset**: adding value to the chemical supply chains requires a willingness to share information that enables business partners to better manage their resources. For example, long-term strategic business relationships, where all parties involved are committed to continuously improving the efficiency and effectiveness of their operations, make LSPs better able to meet customer needs and increase supply chain sustainability.

One chemical company interviewed provides for example monthly shipping forecasts to its carriers; the operational and transactional level of detail in these forecasts is made possible by a dedicated technical interface. The investment required to set up an interface of this kind is only worthwhile if a long-term relationship is envisaged.

Instead of investing in its own IT system, DSM Engineering Plastics has completely outsourced the handling of transportation – including IT – to logistics firm IDS. The success of this arrangement comes down to deep trust in a long-term relationship (Case Study 16).

At the start of any collaboration, and within the limits of what is allowed under competition laws, the partners need to agree a mechanism for sharing the benefits. A range of methods to define the mechanism is available, but the key to success is agreeing on one that satisfies all the partners.

In the case of UCB and Baxter, the neutral facilitator TRI-VIZOR developed a benefit-sharing mechanism based on the Shapley method. This is a gain-share concept from cooperative game theory, which calculates a unique allocation of benefits to all the players in a game according to their input and importance to the overall outcome (Case Study 17).

A consumer goods company and a heavy goods shipper agreed on an even split of both the cost reductions achievable by having fewer trucks on one transportation lane, and the additional handling costs incurred in bringing the partners' goods together.

Building a clear business case is an absolute prerequisite for successful collaboration. Without one, none of the partners can be motivated by "what's in it for them", nor is it sufficiently clear what objectives are to be pursued and as such any collaboration is lacking both direction and an appropriate business incentive. Research showed that, in many cases of attempted collaboration, the business case was not sufficiently clear or not well communicated from the beginning.

A common and major obstacle to building a business case is a lack of good data. Reasons can include differing data structures across different business units, regions and individual sites, or insufficient reliability of data quality.

To address this challenge, one chemical company interviewed said it started to establish globally standardized data structures including harmonized definitions of key performance indicator (KPI) calculations across its businesses and regions. As a result, any volume, cost or timing information needed for business calculations is centrally available.

Sharing data between competing chemicals or logistics companies may have competition law implications. In such cases, a neutral facilitator can be the ideal party to ensure that no commercially sensitive information is disclosed to competing parties, competition is maintained, and therefore no competition law is infringed. At the same time, the neutral facilitator of such collaboration – such as a 4PL (fourth party logistics service provider) – has full visibility of the supply chains in scope and is therefore best positioned to quantify the associated value and to provide inputs for associated business case calculation.

When pharmaceutical companies UCB and Baxter decided to try "carpooling" on routes to Eastern Europe, logistics company TRI-VIZOR provided a legal framework to guarantee antitrust compliance. The framework ensures that community information is fully transparent while company-specific information is kept confidential (Case Study 17).

To prepare for collaboration, there needs to be full transparency on the likely benefits, costs and investments for all the participants. Practices such as "price overstatement" (to ensure room for concession in negotiations or conceal benefits) may be tempting where there is mistrust, but they are not an appropriate start for a successful collaboration.

Establishing an accurate business case is often difficult. However, it is crucial not to wait too long, and to find the right time to get started. Successful examples of collaboration show that getting started with small pilot steps and then validating initial benefits can be a very pragmatic way to prevent endless analysis. For example, starting collaboration with only two partners could avoid complicated structures and provides the transparency needed to confirm the expected business case.

4.3.2 Assimilation phase – setting up the pro-competitive collaboration

Choosing the right model or set-up requires clarity about each partner's role in the collaboration, and agreement on the infrastructure required.

> *In a vertical collaboration, logistics firm Bertschi has taken on the role of lead logistics provider (LLP) to a chemical company. Services include supply chain design and the management of contracts, transport, finance and IT, as well as shipment tracking (Case Study 18).*

Starting with a pilot project (where collaboration is limited to part of the business at first) with low complexity can often be beneficial. Such a project is easier to implement, quicker to decide on and less risky for the participants than a full-blown engagement. A successful pilot can also build conviction that the partners are compatible, and that extending the collaboration is the right way forward.

> *In the vertical collaboration between a chemical company and its customer, the companies' decision to tender jointly for transportation led to cost reductions of around 25-30% and enhanced sustainability (Case Study 16).*

Data sharing is often a crucial requirement for successful collaborations, as it is the basis for better supply chain planning and ultimately optimization. In vertical supply chain collaboration, not involving competitors, information sharing is a far more common practice. The challenges come when competing companies engage in horizontal collaboration, where companies must be willing and able to share supply chain information without infringing competition laws. Companies engaging in such collaboration must be confident that everyone gains without losing competitive advantage, and that collaboration yields benefits that far exceed the levels of supply chain and logistics performance that each company can realize alone – that is, without collaboration.

> *For the DSM Engineering Plastics-IDS collaboration, IDS's information and communications technology (ICT) platform 'infodis' links the producer's order system to its carriers' transport management system (Case Study 16).*

> *For UCB and Baxter, TRI-VIZOR provided a Cloud-based collaborative ICT control tower and a seamless and transparent process for ordering and freight payment (Case Study 17).*

> *Bertschi has made major investments in hardware and software capacity to enable it to operate as lead logistics provider for its chemical company partner (Case Study 18).*

> *In another case of vertical cooperation between a haulier and a chemical shipper, the haulier invested in its IT systems so that the shipper is now able to provide it with monthly forecasts of transportation requirements for the next two months. Both parties benefit significantly in terms of improved forecasting and greater operational efficiency. Neither would be reaping these benefits if deep mutual trust had not already existed between them.*

Investment in physical infrastructure may also be needed to support collaboration.

Before the consumer goods company and the heavy goods shipper – aiming for two-way truck-sharing on a single transportation lane – were able to work effectively, they had to set up a new system to handle the transport boxes.

For pro-competitive horizontal collaboration, involving a neutral mediator can facilitate both initial and ongoing success – not least, by eliminating adverse behavior in any of the participants. The function of mediator can be taken on by a 'real' fourth party logistics provider, or some other neutral player – as, for example, in the case of TRI-VIZOR, which acted as neutral coordinator to consolidate and coordinate flows from the two pharmaceutical shippers to Eastern Europe (Case Study 17).

Establishment of clear rules avoids misunderstanding and, thereby, conflicts. It is essentially also the basis for building trust, as collaborations with clear understandings of each party's roles and responsibilities result in smooth supply chain operations. It also confirms to everyone at the outset of collaboration the benefits envisaged.

A set of rules needs to be agreed, defining the information that will be shared between the partners, and the frequency of sharing. It is important to clarify the legal framework for and constraints to information sharing to ensure competition law requirements are met.

In contrast to UCB and Baxter's collaboration mentioned above, where TRI-VIZOR provides the legal framework, there are also examples of pro-competitive horizontal collaboration where each of the shippers continues to have separately negotiated contracts with the logistics service provider. This approach avoids the necessity of setting up a complex new framework.

Another aspect requiring attention is to define how special events are handled. Such events might include conflicts that could arise around gain-sharing or related to the potential addition of another collaboration partner who could add further value but whose entry might shift the balance in a logistics network. With such events, the main issue is not what exactly will be done but how decisions will be taken to ensure fair conflict resolution: i.e. which persons or forums will come together and who has which decision-making powers.

Monitoring is needed for non-conformant behaviors so that they can be avoided. An example might be higher-than-agreed frequency of order changes. In such cases the partners must agree on acceptable deviation and compensation methods.

Pro-competitive collaboration set-ups must work in the volatile world of the partners' business environments. Therefore it is critical, according to a manager of one successful collaboration initiative, that "rules must be pragmatic and allow for adaptation to changing environments."

4.3.3 Realization phase – managing the collaboration

Tracking and monitoring progress and results is vital to success because any pro-competitive collaboration is inherently unstable. The agreed KPIs should constantly prove the benefits of the arrangement in practice. Measuring performance against the defined business case helps to keep all the partners on board.

For Mars and its customers, dashboards and scenarios help to give key decision-makers transparency on CO_2 emissions and cost savings (Case Study 14).

Where the partners have regular review meetings at management level, the collaboration is much more likely to stay on an even keel, with adjustments made as necessary. Other collaborations in our study have involved annual strategic meetings to review implementation progress.

Even where a business case is calculated at the outset, the partners do not always check regularly that the benefits of the collaboration are being delivered.

> *In one case that was analyzed for this study, with €20 million of savings projected from the collaboration, no quantified tracking at all is carried out as long as all three of the shippers participating feel confident they are benefiting adequately.*

Maintaining buy-in and commitment from top management is essential to ensure that all the stakeholders give their full and sustained commitment to the collaboration.

Typically, large companies have a range of stakeholders that need to be convinced of the necessity and advantages of collaboration. These stakeholders can include supply chain units, and central and decentralized logistics entities, as well as purchasing departments. Their acceptance of any collaboration is vital, so that it not only works well, but also is constantly improved.

Improvement comes from reviewing and adjusting processes and exploring new ideas for the collaboration. Top management needs to be aware of any KPI deviations, or any objectives in jeopardy, so that the necessary adjustments are made in good time. But KPIs alone will not give the full picture.

In pro-competitive horizontal collaboration especially, a change in mindset is often required before stakeholders engage properly in the new arrangement. Alongside the quantitative KPIs, attitudes need to be monitored regularly, as they are powerful early indicators of likely success or failure. Some companies establish a form of 360 degree feedback process on the collaboration counterparts; this allows tracking and structured discussion of areas that could be improved.

Personal chemistry between collaborating parties also has a strong influence and should not be underestimated. The right people with the right mindsets are needed at key positions in the collaboration set-up and management. Their understanding of the purpose and benefits of collaboration, and their ability to communicate these, can make or break their colleagues' and cooperation partners' readiness to support and promote collaboration.

4.4. Pro-competitive Collaboration Case Studies

CASE STUDY 14
Branding a collaboration boosts success

Consumer goods firm Mars has demonstrated how creating a distinct brand for a collaborative initiative can lead to lower cost, better service towards the retail customers and lower CO_2 emissions.

Mars wanted to establish horizontal collaboration with its retail customers in order to measure and reduce CO_2 emissions. Implementing this required a shared conviction that everyone involved – within Mars, its customers and its logistics service provider – would benefit from the initiative.

Creating a brand for the collaboration was second nature for a company like Mars. The "Green Order" brand led to good visibility of the initiative and also helped identify potential partners.

Manufacturers and logistics providers were given the tools to synchronize time windows, share road transport and increase fill. Full truck loads were increased by combining deliveries to retailers. Dashboards and scenarios enabled key decision-makers to get CO_2 emissions visible and under management.

Everyone benefited. Mars increased its transport efficiency; the logistics service provider achieved more efficient truck utilization. Among the retailers, service levels and customer satisfaction rose: they could be confident of a 24-hour delivery service for (combined) full truck loads and 48-hour delivery service for less than full truck loads. Meanwhile, the more efficient logistics organization meant that society as well as Mars and its collaboration partners benefited from reduced CO_2 emissions.

CASE STUDY 15
Joint tendering cuts transport costs

A chemical company and its chemical customer recognized that their respective production and re-packing facilities were located very close together. The chemical company decided to change to intermodal transportation, so that it could use the same transportation provider as the customer. The two companies tendered jointly for a single transportation contract that would cover both facilities. As a result they achieved savings of 25-30 %, while the transportation company gained the benefit of full loads and returns.

At the heart of this collaboration is a "Drop and Swap" system. The transportation company drops a container and picks up another one according to a joint schedule. On-site staff unload a container only when it fits the schedule. To make this work, permits had to be set up to store containers with chemicals in them on the parking space on both sites, and creation of a buffer had to be accepted.

A key success factor was having the right volume and frequency of transport to ensure a good flow balance. But crucial to the venture was building buy-in from all the people involved on both sides. In particular, the customer's purchasing department perceived it was paying more for inbound logistics, while the shipper's outbound transportation was costing less. All the departments affected needed to be aware of and agree with the overall objectives and benefits of the collaboration; the shipper shared its cost reductions with its customer.

CASE STUDY 16

Outsourcing logistics operation improves efficiency

Faced with having to upgrade its internal systems to improve logistics efficiency, DSM Engineering Plastics (DEP) decided to outsource the transport management for all its packaged goods – 18 000 shipments per year – to logistics provider IDS. Through IDS's information & communication platform 'infodis', DEP's enterprise resource planning system is linked to the transport management systems of a number of carriers, ensuring DEP orders go directly to the carriers.

With IDS in operational control, DEP was able to not only reduce its own logistics personnel but also improve customer satisfaction. Customer complaints were reduced to five per thousand shipments.

A precondition for the success of the collaboration was the strong trust already existing between DEP and IDS. Outsourcing to IDS gave DEP a quick and efficient alternative to the time-consuming and expensive upgrade of its own systems that would have been required.

(*Source:* www.businesslogistics.com [2012])

CASE STUDY 17

Third party facilitated horizontal collaboration cuts costs and CO_2 and improves service levels

By engaging TRI-VIZOR as an impartial third party facilitator for their pilot truck-sharing initiative, on a trade lane to Romania, pharmaceutical companies UCB and Baxter achieved net cost savings of more than 10 % and CO_2 savings of 28 %, as well as improved service levels.

TRI-VIZOR's role centered on coordinating and bundling materials. This included providing a means for setting up and managing communities, mechanisms for gain-sharing between the two partners, and a transparent seamless process for orders and freight payment. TRI-VIZOR also established an adequate legal framework with multilateral contracts, to ensure anti-trust compliance: full transparency of information was given to all the partners on common areas while company-specific information remained confidential.

A key factor in the success of the pilot was accurate identification of matching truck companies and freight flows. The facilitator also provided vital support in setting up the detailed process, legal framework and operations, and access to a Cloud-based collaborative ICT control tower.

CASE STUDY 18

"Lead logistics provider" concept enables more transport with less CO_2

When stresses began to show in a chemical company's supply chain, the company turned to one of its logistics service providers, Bertschi, for solutions.

Bertschi took on the role of "lead logistics provider" with responsibility for redesigning the supply chain, and managing contracts, transport, finance and IT, as well as shipment tracking. To engage in this, Bertschi invested around €10 million in equipment and infrastructure – mainly at the chemical company's sites – and software to enable it to operate within the chemical company's IT system. The infrastructure investments aimed at allowing a higher share of rail transport, whereas the software investments were the basis for Bertschi managing contracts and transport and tracking shipments for the chemical company. As a result of the new concept, the number of service providers in the supply chain was reduced from seven to four – the lead provider and three partner transportation companies.

Following implementation of the "lead logistics provider" concept, rail transport of the chemical company increased by 48 % and road transport fell by 24 %. Annual CO_2 emissions were reduced by 2 200 tons. Overall costs were also cut, through reductions in fixed costs and continuous productivity improvement. At the same time, customer service improved, with better delivery performance and optimized containerization giving the supply chain greater flexibility. The sustainability of the entire supply chain is growing, thanks to a greater amount of intermodal transport and better control systems enabling improvements in security.

The "lead logistics provider" concept has worked well because the chemical company and Bertschi agreed on a clear business case for change. Revenue losses at the service provider have been outweighed by cost reductions due to efficiencies. Annual strategic meetings of the two companies help to ensure that implementation progress continues to be monitored and driven forward.

4.5. Conclusions

Interviews with more than 40 senior executives from chemical producers and the logistics industry confirmed that there is a strong commitment and desire to pursue the potential benefits of pro-competitive collaboration. As can be seen from the case study examples, which are summarized below in Table 3, there are many benefits accruing from vertical pro-competitive collaboration. However, because of the sensitivity, examples of horizontal pro-competitive collaboration are still rare. The good practice collaboration examples, based on trust and transparency, have generated significant economic benefits, including productivity improvements, cost savings, and improvements in asset utilization. On the environmental front there is evidence of reduced carbon emissions, and associated reductions in energy usage. There have also been customer service enhancements through improved delivery reliability.

As referenced above, there remains an intrinsic concern with respect to sharing information with competitors, and this was reflected in the discussions during the preparation of this part of the report. This is the main reason why there are limited examples of horizontal pro-competitive collaboration and why it is difficult to establish an overall business case and value proposition. Nevertheless, recent signals from Brussels indicate that there is increasing recognition of the need for collaboration if the objectives of the European Commission Roadmap are to be achieved (see Chapter 6, Section 6.2).

In addition, it is likely that changing sources of energy and feedstock supply, geo-political and economic instability, climate change, and gaps in skills (if not in equipment or infrastructure) will sooner, rather than later, provide a compelling case for the chemical industry to reconsider its stance towards pro-competitive collaboration. The industry will have to integrate collaborative approaches into both vertical and horizontal supply chains, wherever they are operating, in order to exploit the intrinsic value potential. In the circumstances the industry is therefore encouraged to explore the methodology and checklist contained in Section 8.1 of the Appendix.

Overview of the 5 case studies presented in Chapter 4

#	CASE STUDY	ISSUE ADDRESSED	SUPPLY CHAIN PRACTICES	BENEFITS
I4	Mars, customers, and LSPs' brand collaboration	Establishing trust and conviction for collaboration Shared benefits	Horizontal collaboration between retail customers Establish shared conviction through branding Share tools for collaboration between manufacturers and LSPs	Efficiency/cost Improved truck utilization Higher delivery reliability for retail customers Sustainability – Lower CO_2 emissions (planet)
I5	Chemical producer and customer conduct joint tendering	Transportation cost reductions Gain-sharing Balance of flows	Joint tendering of single transport contract to cover facilities of producer and customer Drop and swap Build buy-in from all parties/ collaboration	25-30 % transportation cost saving
I6	DSM Engineering Plastics (DEP) and IDS – outsourcing logistics operation	Efficiency improvement	Outsourcing of transport Linkage of DEP's resource planning system to transport management system of multiple carriers Collaboration based on trust	Reduction of logistics personnel Improved customer satisfaction Quick and efficient alternative to upgrading own systems
I7	UCB, Baxter and TRI-VIZOR – third party facilitated horizontal collaboration	Costs, CO_2 and service	Truck-sharing on specific trade lanes Accurate identification of matching truck companies and freight flows Detailed processes, legal framework and operations Cloud-based collaborative ICT tower	Efficiency/cost – Net cost savings of 10 % Sustainability – CO_2 savings of 28 % and reduced energy use (planet) Improved service level/ customer
I8	Bertschi and chemical producer – LLP concept	More transport productivity, less CO_2	Adoption of "lead logistics provider" Management of contracts, transport, finance, IT and shipment tracking by LLP Collaboration to agree case for change Strategic review between producer and LLP to manage implementation progress	Efficiency/cost Modal shift – 48 % increase in rail transport, 24 % reduction in road Sustainability – CO_2 emissions reduced (planet) Service level improvement/customer

Table 3 – Comparative table for pro-competitive collaboration case studies in Chapter 4

5. Technology as an enabler of sustainable chemical supply chains

The use of technology in the chemical industry is well established in internal, basic transactional processes driving efficiency and productivity improvements, these are illustrated through a variety of case studies explored by EPCA in and supported by Möbius Consulting and Ghent University. However, the speed of new technology developments and external policy pressures may require the industry to accelerate technology adoption in order to remain competitive. A selection of these new developments and the associated opportunities are reviewed in more detail.

5.1. Introduction

Technology has played a significant role as an enabler of change and progress in supply chain management over the past several decades. Examples include: data warehouses based on ERP platforms; using IT to manage large-scale transport tenders; automated order and dispatch tools; advanced forecasting and S&OP tools; tracking and tracing; network modeling; and control towers/dashboards. These and other innovations have improved efficiency and productivity. Other technologies – including modal switch, payload improvement, package design, emission control, and engine design – have improved efficiency and sustainability.

At the human level, technology in the form of personal electronic safety equipment and alert devices has contributed to a safer and cleaner work environment.

Although the focus is often on emerging technologies, the benefits of legacy technologies – as shown above – are still being exploited. The chemical industry is perceived to be more conservative in terms of employing leading edge supply chain technology (probably best described as an "early observer" rather than an "early adopter"), and seeks to capture enhanced value from process improvement and exploiting established technology.

This reinforces the initial observation that technology is more an enabler of change, rather than a driving force for change. There are few cases where technology has been the instigator of change in chemical supply chains.

There is usually a compelling need to improve efficiency and effectiveness, either to remain competitive or to achieve competitive advantage, and technology provides the tool to enable that improvement and/or achieve best practice.

Chapter 3 makes reference to the Gartner Supply Chain Top 25 as a benchmark of supply chain best practices in other industries. The analysis of these companies concludes that many are focusing on building demand-driven supply chains and using innovative approaches, including enabling technology, to become solution providers. The areas of innovative supply chain application include cost focused improvement, specialized packaging, integration of product design and supply chain, and technology platforms for new product growth.

In this respect it will be seen from the case studies in this chapter that the chemical industry is effectively exploiting well established supply chain technologies, even though it may not be an early adopter of leading edge developments. Although some technology can be relatively easily introduced, it should be noted that in an asset-heavy context, the logical option for the chemical industry is to focus on process improvements, and on safety and security.

This report also addresses the implications of the European Commission White Paper 2011, and the EU Strategic Transport Technology Plan on sustainable chemical supply chains, which are covered in Sections 5.7 and 6.2 of the report.

5.2. Objectives

The objective is to consider technological developments in all areas associated with physical inbound, outbound and storage activities, as well as order-to-cash processes. The aim is to identify applications that can significantly benefit chemical supply chains, and deliver new ideas and developments in supply chain technology to EPCA members.

Several areas are identified where technology is being applied for competitive advantage and to improve customer service performance. These include both IT and non-IT related applications, such as the use of technology in data based planning processes to identify decoupling points between Push and Pull, Availability to Promise solutions, and to visualize complex network optimization. The use of technology in hardware applications is also recognized.

There are many well established IT related applications including Sales and Operations Planning (S&OP) end-to-end planning tools that improve product availability and enable rapid response to customer demand. Portals for order processing and transport booking are also well established (e.g. Elemica). On the other hand, electronic cargo monitoring, using for example Radio Frequency Identification (RFID), Global Positioning System (GPS) and Electronic Product Code (EPC) technology, and meshed networking, has significant potential for the chemical industry. In this context the report also considers the importance of standards and the role of Global Standards 1 (GS1) in designing and managing a global system of supply chain standards.

Non-IT technology applications are largely focused on improved asset and equipment utilization, and productivity improvements. The report showcases a number of examples where technology is being applied to improve payloads, safety performance, and modal switch, with innovations being driven by both producers and third party logistics companies (3PLs).

A basic principle is to have a broad focus encompassing new technology, the practical aspects of implementation, technology value propositions, and technology as an enabler for sustainable solutions (benefitting "people, planet, and profit"). It is recognized that IT receives the most attention – but it would be wrong to exclude other technologies. Areas where technology can be used to maximum benefit are perceived to be in improving asset utilization (e.g. self-loading, Transport Management Systems [TMS]) and enhancing visibility, communication, and information sharing. It is also recognized that in certain cases, technology (in the traditional sense) may not be the solution. In some cases, re-engineering the work process may offer solutions, making new technology superfluous.

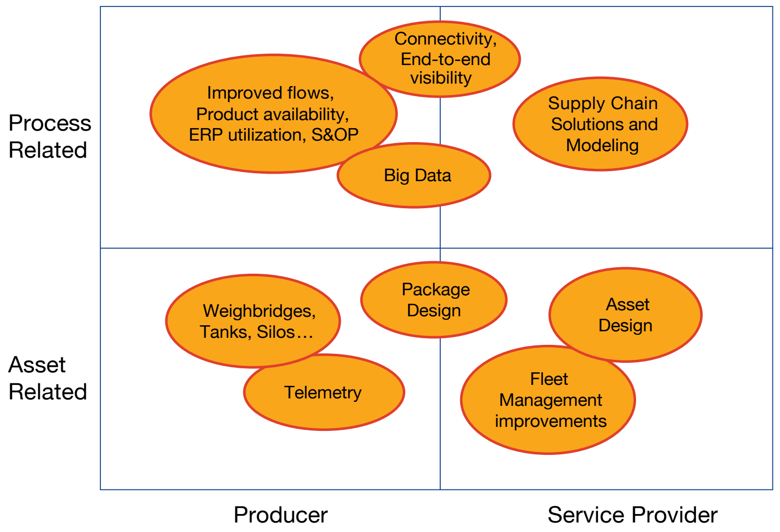
5.3. Technology Application

For the purposes of this report, technological innovations in chemical supply chains have been classified in two dimensions:

- Innovations linked to individual, tangible assets, versus innovations more associated with work processes
- Innovations driven by 3PLs and other service providers, and those introduced by shippers and producers

Using these two dimensions it is possible to plot generic technology innovations in the following 4-square matrix.

Figure 5 - Technology application matrix referencing processes, assets and users (producers/service providers)



The following section considers each of the quadrants in more detail, illustrated with selected case studies:

5.3.1 Producer / asset related (physical, data, and human assets)

Producers have traditionally applied technology solutions to their site logistics assets, for example using telemetry for remote inventory monitoring on tanks and silos, and connectivity between weighbridges and loading gantries with ERP systems and dispatch operations.

Tracking of transport units (containers, trailers) in real time can bring supply chain optimization benefits, including asset management/optimization, customer service improvement, transport information reliability, cargo protection, automatic data capture and exchange with third parties. Stakeholders are shippers, their customers, forwarders, insurance companies, regulatory bodies, etc. The essence of the business case is that savings in transport costs and reduced losses in the commercial value of the load must outweigh the costs of the enabling technology. So far, many applications of this technology are within refrigerated transport and transport of high-value cargoes.

However, there are also examples of producers using technology solutions (in this case RFID) to track & trace the physical movement of hazardous products. The Dow Chemical Company was an early user of a radio frequency-based auto-ID system using sensors, satellite communications and GPS to track the location and status of 650 railcars in North America transporting chemicals posing a toxic inhalation hazard (TIH) (Case Study 19). Currently the Central German chemical cluster is actively pursuing a project (ChemLog) that will enable the tracking and tracing of cargo units in multimodal supply chains into Eastern Europe (Case Study 21). Tracking and Tracing of hazardous products, and the ChemLog study are illustrated in more detail in case studies included in this section of the report.

Recent high-profile incidents (e.g. the disaster in the Gulf of Mexico which took the lives of 11 oil platform workers, or the Texas City Refinery explosion which killed 15 workers in 2005), growing regulatory pressures, and declining costs of technology are encouraging companies to consider investments in technology that can track and locate as well as monitor the location of human assets in exposed or hazardous environments. More details can be found in the Real-Time Location Systems (RTLS) for Personnel in Case Study 20.

However, the successful implementation of RFID connectivity and of wider end-to-end applications that make supply chains more efficient, is dependent on **standards implementation**. Standards are the foundation for clear, understandable exchanges between companies (e.g. for tracking purposes in the event of an accident or to evaluate existing alternative logistic options in an increasingly global economy), and for keeping costs under control. For the past 30 years, GS1 (a neutral, not-for-profit organization) has been designing and implementing global standards for use in the supply chain. These standards ensure effective exchanges between companies, facilitating interoperability, and bring together

companies representing all parts of the supply chain. **By agreeing to standards (through an organization like GS1) technology is actually enabling both vertical and horizontal pro-competitive collaboration.**

Although originally created by manufacturers and retailers to improve the efficiency of the distribution of food and consumer goods to supermarkets, GS1 standards are today used by millions of companies in sectors such as healthcare, transportation and logistics, aeronautics, defense, chemicals, and high tech.

GS1 barcodes are the most well known and universally recognizable part of the GS1 system of standards. However, they are now being enhanced by the smaller GS1 DataBar, which can contain far more information. RFID is complex and multifaceted, and therefore RFID tags use GS1's EPCglobal® standards and enable companies to manage shipments, inventories and assets across geographies, boundaries and sectors. They also enable traceability, quality assurance, and accurate inventory control.

For example, Gerry Webber, the clothing company, implemented the GS1 Electronic Product Code and RFID to optimize their logistics procedures and retail processes, and to introduce a novel form of retail security. The normal manufacturer's care label was developed into a textile EPC/RFID tag incorporating functionality for anti-theft, care instructions, and the EPC. Security equipment placed at store entrances could be eliminated, and goods receipt and inventory management in stores was simplified.

CASE STUDY 19

Radio frequency identification (RFID) technology – track & trace (T&T)

Introduction

The ability to manage hazardous material packages during storage and transportation is of critical importance. The capabilities and potential benefits of this technology have been demonstrated in the US using the ARG-US RFID technology developed by the Argonne National Laboratory.

Opportunity

The Argonne National Laboratory, Illinois has developed an RFID technology for the management of nuclear and radioactive material packages during storage and transportation. This development included hardware design (e.g. sensors and batteries), application software development, and secured database and web server development.

The Solution (Technology Application)

In 2009, Argonne conducted a 300-mile demonstration of the transportation application that successfully combined RFID item monitoring features and commercial satellite vehicle-tracking equipment from Qualcomm. A subsequent 2010 test on a Los Alamos National Laboratory truck demonstrated that minimal modification was necessary to install the ARG-US RFID equipment. An acceptance road test in late 2010 integrated ARG-US RFID technology and DOE TRANSCOM by using Qualcomm satellite gear in vehicles, tracked and traced two separate vehicles, and showed that the tracking, monitoring, and communicating of radioactive material shipments was possible across the country.

Device and systems development and implementation projects are continuing. Activities include new sensor capabilities (e.g. radiation and gas sensors) for the RFID tags, designing RFID tags for new packages, improving reader functionality, improving RFID security, and adding RFID door seals. Other efforts include expanding the applications to international security and safeguards of nuclear materials, as well as other hazardous materials and valued assets in storage and truck/rail transportation.

The Value

An RFID system can offer enhanced safety, security and materials accountability, reduced need for manned surveillance, real-time access to status and event history data, including continuous environmental condition monitoring, and overall cost effectiveness.

Clearly the successful tracking of radioactive materials has direct relevance for the chemical industry. For example, Dow Chemical is using RFID technology to track across North America several hundred railcars used for transporting toxic inhalation hazard (TIH) products.

CASE STUDY 20

PINPOINTING PEOPLE

Enhancing Worker Safety with Real-Time Personnel Location Systems

Introduction

Traditional safety approaches, such as personal protective equipment (PPE) or behavioral safety methodologies, have all been effective, but may have reached a plateau in moving manufacturers towards their goal of the "zero-incident workplace". Real-time location awareness systems may produce the radical improvement in safety that manufacturers are seeking.

Opportunity

When the "unthinkable" happens, one way to give workers the best chance of survival is to know where they are. Wireless personnel location awareness systems designed to improve worker safety are now gaining more serious attention from multinational corporations.

Workers sometimes raise concerns that tracking technologies represent an invasion of privacy. However, the technology can mean the difference between life and death, because it can provide rescue personnel the exact location of missing workers, and prevent sending rescuers into dangerous areas to search where no workers are present.

The systems can also be used for access control, providing automatic notification or alarms when people enter dangerous or restricted areas without proper permits or authorization.

The Solution (Technology Application)

Sometimes called real-time location systems (RTLS) these technologies rely on active RFID tag responders worn by workers, contractors and visitors. The location of these people can be determined in real time, thanks to the RF sensors mounted within the plant that receive signals from the tags.

For outdoor locations covering large areas beyond pre-assigned zones, Global Positioning System (GPS) satellite technology can also be used, with location accuracy to within 50ft. Dow Chemical uses GPS technology to help ensure the safety of remote workers along 4 000 miles of Gulf Coast pipeline.

Some location awareness systems are designed to track people's movement between zones, with tags being read as employees pass doors and other choke points. In an emergency these systems can count and locate thousands of people in real time as they assemble at evacuation points and muster areas, enabling timely identification of workers accounted for, or still missing.

The Value

The investment required for personnel location systems depends on the scope of coverage and the technology deployed, but the cost is clearly a big factor in holding back wider application. However, Statoil, which is an early adopter of the technology in its offshore locations with more than 3 000 tags in use, has identified business benefits through productivity improvements. Compared with Statoil's previous manual mustering system, the RTLS has significantly reduced the time required to carry out prescribed exercises, and allows personnel to return to work more quickly.

CASE STUDY 21

FOLLOWING MULTIMODAL MOVEMENTS

ChemLog – Tracking and Tracing (T&T) of chemical transport in multimodal traffic

Introduction

The Central German chemical cluster "Chemie / Kunststoffe" has successfully established itself in recent years. It has given special attention to improving chemical logistics in Central Germany as well as improving connectivity with the growing markets in Central and Eastern Europe, and has coordinated these efforts with the Verband Chemischen Industrie (VCI), Cefic, and EPCA.

The goal of the "ChemLog Tracking and Tracing" project is to raise the transparency and sustainability of the transport chains to support a modal shift from road to multimodal.

Opportunity

With more than 90 % of chemical products sold in Eastern Europe transported by road, the industry is exploring ways to realize safer and more efficient means of transport by encouraging a modal shift from road to multimodal wherever possible.

The current T&T environment is characterized by a plethora of different technical solutions adapted to the needs of individual companies. This fragmentation is a barrier to larger common systems, which can also support emergency response management systems (see Chapter 6, Section 6.1).

The T&T of road transport is well developed and offers a lot of information through the connection of the hardware to the truck, and additional communication with the driver. However, in the absence of a driver accompanying the shipment, the multimodal transport of chemicals requires certain information during the physical transportation chain, which will necessitate the application of technology. In a multimodal environment, this information flow is broken when the goods are moved to rail transport because there is only limited information on the full train, meaning single containers cannot always be traced, and information on all containers is not available on a single system or platform. The combination of different modes of transport and the lack of a common T&T system for the whole transport chain is a significant hurdle in the efficient organization of intermodal transport.

The ChemLog Track & Trace project will identify the specific requirements, processes and organization, and pilot defined opportunities to sufficiently track cross-border multimodal traffic, specifically to East European markets.

The Solution (Technology Application)

The project is still continuing, and therefore no final solution is in place. However, verification of the Saxony-Anhalt initiative in the context of the Galileo project has ensured that infrastructure and resources are in place, and that the Fraunhofer IFF in Magdeburg (the only German research institute addressing logistics and safety) is a participant.

The Value

The ChemLog project expects to deliver the following benefits:

- Increased sustainability of end-to-end supply chains, especially in the context of safety and security
- Reduced emissions through the modal switch from road to intermodal
- Improved logistics efficiency through improved organization and consolidation of traffic, and collaboration with LSPs
- Emergency management systems and organizations to improve emergency response
- Improved access to the growth markets of Central and Eastern Europe

5.3.2 Producer / process related improvements

Process related technology in chemical supply chains has been used in planning applications, such as S&OP, sourcing and scheduling optimizers, and linear programming for refining and cracker optimization for many years. Today producers are increasingly using CRM systems to support front-end order-to-cash processes and improve customer service, and technology solutions to handle large volumes of data in freight tendering processes. EDI applications are also being used to enhance connectivity between shippers and 3PLs.

The use of data (and this is increasingly becoming Big Data) is an essential enabler of process improvement, and producers have leveraged their ERP systems and invested heavily in data warehouses which feed supply chain KPIs and other reporting systems, as well as supply chain network modeling and design systems. Apart from the mass of transactional data collected through ERP systems and stored in data warehouses, other sources of data include: sensors used to track material and personnel; posts to social media sites and corporate websites; digital pictures and videos; purchase transaction records; email messages and data files on corporate servers; and cell phone GPS signals. These are all adding to this data tsunami. IBM estimates that 90% of the data in the world today has been created in the past two years (see www-01.ibm.com/software/data/bigdata/).

Chemical companies, like most enterprises, are amassing terabytes of data of all types in structured and unstructured formats. For time-sensitive processes this data needs to be scrutinized and analyzed quickly, assuming of course that business leaders can trust the information in the first place. Establishing trust in Big Data is a challenge in itself as the variety and number of sources grow.

"Big Data is more than simply a matter of size; it is an opportunity to find insights in new and emerging types of data and content, to make your business more agile, and to answer questions that were previously considered beyond your reach." IBM

However, in order to obtain those insights, achieve the promised business agility, and answer those questions, a data plan needs to be developed *before* investing heavily in technologies providing advanced analytics. The opportunities for the chemical industry to exploit Big Data using relational databases (although more established in the retail industry) are illustrated in Case Study 24 taken from the McKinsey Report on US healthcare.

Basic work process re-engineering will often, by itself, deliver significant productivity improvements without requiring any additional technology investment. Alternatively, process improvements can drive enhanced exploitation of existing technology (e.g. in-place ERP systems and S&OP tools). The SABIC Adaptive Dynamic Sourcing project (Case Study 22) is an example of developing a work process that leverages in-place systems (SAP, APO, S&OP, Transport Requirements Planning, Loading Monitor, and Carrier Portal) to secure competitively priced transport and drive improved customer service.

More extensive process improvements addressing fundamental network redesign and scenario development, including physical location of inventory, sourcing decisions and alternative product routing, may require more sophisticated technology tools employing network modeling and optimizers, and Dashboard / Control Tower technology. This is often the case when a major capacity expansion requires a re-balancing of supply and demand, revised sourcing, and new routes to market. This is illustrated in Case Study 23 on the Lucite / Mitsubishi Rayon Company MMA expansion.

CASE STUDY 22

SECURING TRANSPORT CAPACITY

SABIC's adaptive dynamic sourcing (ADS)

Introduction

The ADS project was launched to secure transport capacity at all times in a volatile petrochemical market. Taking the current and future threats into account (e.g. growing congestion, driver shortage, reduced driving time, digital tachograph, CO_2 reduction) the risk of non-supply to the customer due to the lack of transport capacity is seen as a major risk.

Opportunity / Business Case

The aims of the innovative Adaptive Dynamic Sourcing process are as follows:

- Guarantee transport capacity for the volume of European orders expected in the future
- Proactively inform hauliers about expected transport requirements, considering that 80 % of the order stream should take place in an "uninterrupted" manner via S2S connectivity (i.e. without manual intervention)
- No expansion of the workforce in the supply chain division

The Solution (Technology Application)

The contractually agreed volumes in the annual transport tender (RFQ) are based on anticipated volumes from the SABIC Sales and Operations Planning (S&OP, in SAP APO). In addition to production, S&OP is also used to plan transport requirements. The S&OP data is combined with the planned loading site and the method of transport. Accumulating the information provides a forecast of all the routes, which is then used in the strategic and tactical tendering process.

Each month, the Transport Requirements Planning is developed once the new S&OP has been established. The contractually agreed transport volumes are compared with the adjusted plan for the next 2 to 3 months. Contracts for any additional unplanned volumes and newly created routes are entered into by way of additional tendering procedures.

Every day, each carrier is provided with a loading monitor that has been created on the basis of the actual order register. This system-based loading monitor lists the actual customer orders, and gives details of the expected shipments (shipment forecast) for the next 1 to 2 weeks. The monitor is published on the SABIC carrier portal. In contrast to the S&OP, which is completed on the basis of expected volumes, the loading monitor is filled out with actual orders, and is therefore more accurate. The carrier guarantees a contractually agreed volume (this is the flexibility necessary to guarantee the "secure supply").

Shipments which are still "pending" after the three steps listed above are processed on the carrier portal using SABIC's own e-bidding tool. Each contracted carrier can use the portal to enter their own preferences, for example different loading sites and destination countries. If a shipment matching the preference profile entered by the haulier arrives on the tool, the haulier will automatically receive an email alert so that it can submit a bid.

The Value

By transferring from a reactive to proactive collaborative process, transport is secured against competitive prices. A dynamic (proactive) approach to transportation sourcing also ensures greater delivery reliability for customers. There is a potential environmental benefit if fleet optimization can reduce empty running.

CASE STUDY 23

END-TO-END ENHANCEMENT

Computer modeling and dashboards to optimize a global supply chain

Introduction

Following the approval of a multi-million dollar investment in additional MMA production capacity from the Middle East, scheduled for start-up in 2015, Lucite wished to take the opportunity to evaluate alternative shipping routes and parcel sizes, time charter vessels, alternative bulk storage locations, variable production capacities and optimized location sourcing using computerized software modeling techniques.

Opportunity

For example, the Agility approach uses computer modeling for supply chain optimization of the combined production volumes from 13 global manufacturing locations operated by Lucite and Mitsubishi Rayon Company Ltd (MRC). The scope includes individual fixed and variable costs, utilizing bulk shipping routes and parcel size, including ISO tanks.

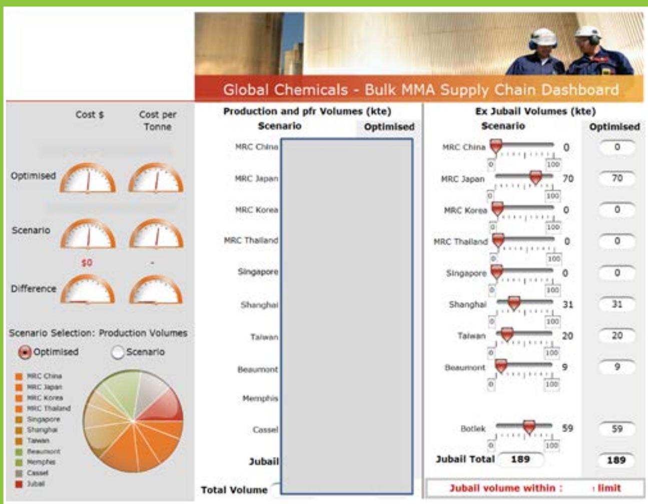
An essential part of modeling is to understand the local operational or economic issues (for example tax free zones) and to have full cooperation / understanding from all parties when developing scenarios, which includes the following components:

- Variable production costs and volumes
- Optimized customer to plant production based on entire supply chain cost
- Alternative shipping routes and parcel sizes
- European ISO tank consideration
- Forecast customer demand and production capacities
- Middle East production consideration given to the inventory impact on stock holding while product was at sea (in transit)

The Solution (Technology Application)

The solution is based on the development of a bulk shipping and manufacturing sourcing optimization model to evaluate alternative logistics strategies, for forecast customer demand volumes, by flexing production costs, alternative shipping lane availability, bulk parcel size variance and optimized customer to manufacturing plant allocation.

In addition to evaluating various production scenarios, Lucite uses interactive dashboards to assess production sourcing costs during scheduled plant shutdowns, and to compare their shipping rates with those of the market and mid-size chemical companies.



The Value

The strategic design model and dashboards allow global sourcing and optimum end-to-end supply chains for the business, covering all the components in the Business Case above, simplifying strategic and operational decisions and, in particular, generating significant competitive advantage.

CASE STUDY 24

BIG DATA

An information revolution in US healthcare: McKinsey & Company March 2013

Introduction

Over the last decade pharmaceutical companies have been amassing years of R&D data into medical databases, while insurance companies and providers have been digitizing their patient records. At the same time the US Federal Government and other public stakeholders have been releasing data from clinical trials and patient information covered under public insurance programs, and recent advances in relational database technology have made it easier to collect and analyze information from a variety of sources.

Opportunity / Business Case

Healthcare expenses represent more than 17% of US GDP. To discourage abuse of the system many health insurance companies are shifting from a "fee-for-service" compensation model (which rewards physicians for treatment volume), to risk-sharing arrangements based on results. Pharmaceutical companies are also being reimbursed on the basis of a drug's ability to improve patient health. There is a move towards evidence-based medicine that systematically reviews clinical data as a basis for treatment decisions – i.e. aggregating individual data sets into big data algorithms. Although the healthcare industry has lagged behind sectors such as retail and banking in the use of big data for patient confidentiality reasons, McKinsey believes it could soon catch up.

The Solution (Technology Application)

Traditional healthcare tools for capturing value (primarily based on contracting and negotiating leverage) do not always take complete advantage of big data, and like most value levers, they focus on reducing cost rather than improving patient outcomes (value). Stakeholders will benefit when there is a holistic patient-centered (customer) approach to value, focusing equally on spending and results. The McKinsey model includes five integrated "pathways", which evolve and create feedback loops as new data becomes available:

- Right living. Patients encouraged to play an active role in their health by making the right choices about diet, exercise, etc. (Work Process Improvement)
- Right care. Patients must receive the most timely, appropriate treatment available. (Prioritized Solutions)
- Right provider. Any professionals who treat patients must have strong performance records, with the skill sets and abilities capable of achieving the best outcomes. (Supplier Performance and Selection)
- Right value. Payers (Insurance Companies) and Providers should continually look for ways to improve value e.g. provider reimbursement tied to patient outcomes. (Continuous Improvement)
- Right innovation. Stakeholders must be constantly alert to new opportunities to improve healthcare delivery. (Breakthrough)

Effective Big Data technology (relational databases) will detect a change in one pathway, and drive changes in another, since they are all inter-dependent.

The Value

Some healthcare leaders have already captured value based on this model. Kaiser Permanente has implemented a new computer system (HealthConnect) to ensure data exchange across all medical facilities and promote the use of electronic health records: result – around $1 billion in savings from reduced office visits and lab tests.

Astra Zeneca has established a partnership with WellPoint's data and analytics subsidiary, Healthcore, to conduct real-world studies to determine the most effective treatments for chronic illnesses, and to drive R&D investment decisions.

5.3.3 Service providers / asset related

Since the chemical industry has largely outsourced its physical logistics requirements, Third Party Logistics companies (3PLs) are providing the assets (trucks, barges, railcars, warehouses, tanks, skilled staff, etc.) to handle the physical transportation of chemical products. 3PLs are under constant pressure to reduce costs and improve asset utilization and productivity, and therefore there is a concentration of technology developments in the Service Provider/Asset quadrant.

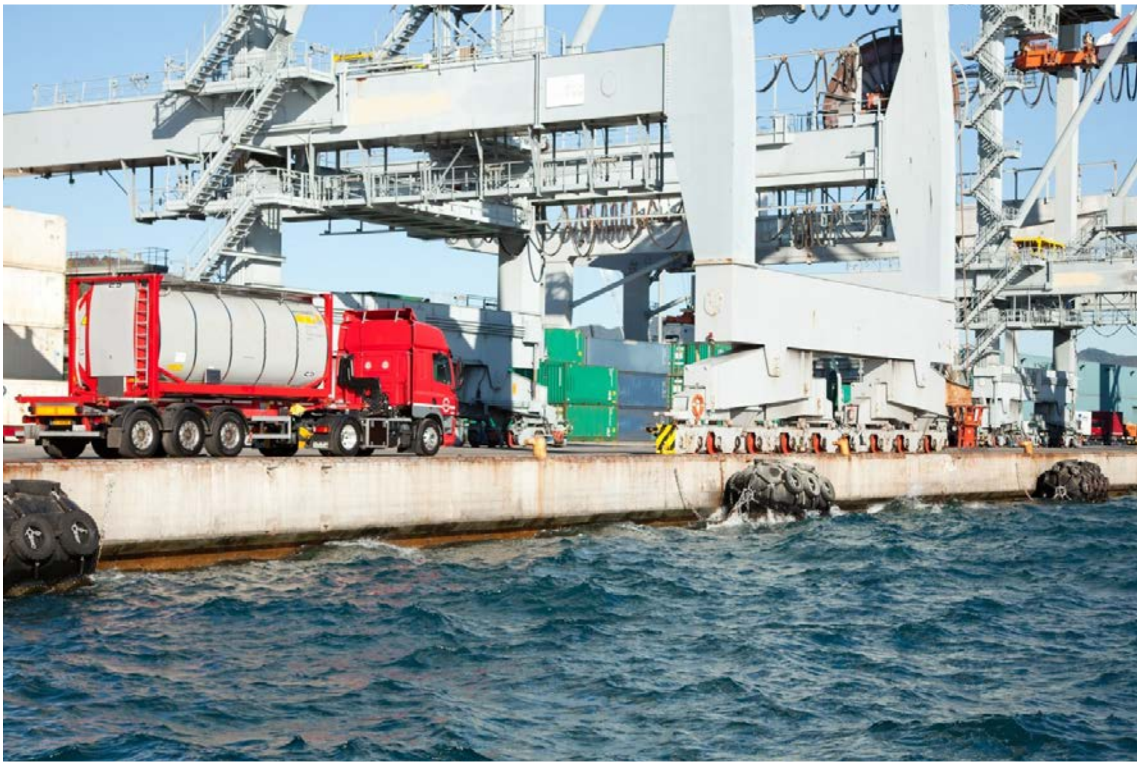
These solutions are employed to optimize the use of existing assets, as well as applying engineering technology in the development of new innovative solutions. In some cases these developments are managed in conjunction with a producer, such as in the Samskip / DSM Case Study 25, which has achieved a real breakthrough in materials for construction and re-design of the conventional steel container. Chemical producers have also been influential in the design of material handling and safety equipment such as pumps, filters, and hose connections.

Policy initiatives, consistent with the EU White Paper on improving sustainable mobility through enhanced infrastructure and asset utilization, and reduced emissions, also play a role in this quadrant, although the impact to date has been limited.

For example, a European Commission-funded research project (SARTRE – Safe Road Trains for the Environment) aims to develop strategies and technologies to allow vehicle platoons to operate on normal public highways. This is envisaged to deliver significant environmental, safety, and comfort benefits. The scheme is based on a lead vehicle and driver taking responsibility for the platoon, with the following vehicles operating in a semi-autonomous control mode using cameras and radar to monitor the leading truck, and mimicking all the accelerating, braking, and turning actions.

In 2012 a Volvo truck led a platoon of vehicles including trucks and cars on a public highway near Barcelona, covering a distance of 200km in one day. The distance between each vehicle was six meters, the speed 85kph. Considerable further development will be necessary, from both a technical and commercial perspective, if this is to become viable, but it serves to demonstrate the degree of visionary leadership which is being applied in this field.

There is also research into the use of hybrid engine technology in commercial vehicles, especially for city center and urban deliveries. Although stabilized technology for light vehicles, there are still major challenges for incorporating hybrid technology in heavy goods vehicles (HGV). Manufacturers are developing field test vehicles to be used in urban and suburban areas with gross weights of 12, 19, and 26mt. The French Environment and Energy Management Agency (ADEME), working in cooperation with Norbert Dentressangle and HGV manufacturers, has been conducting comparative studies, but the commercial results and benefits so far have been less than compelling.



Further investment will be necessary in battery technology, driver behavior and driving style has to be adjusted, and there will be some operational constraints on where and when these vehicles can be employed (e.g. standardized "milk-runs" and staying close to maximum payload). The impact of the "internalization of external costs" on the economic model also needs to be understood.

More details on the EU's policy initiatives can be found in Section 5.7 and 6.2.

In contrast to policy interventions, which traditionally have been unsuccessful, entrepreneurial developments and innovations with a demonstrated value proposition enjoy higher rates of success. The EU's Innovation in Surface Transport Processes (InnoSuTrans) project has been studying a number of different initiatives e.g. Eurovignette, Cabotage, Rail Traffic Manager System, Reefer Containerization, Y-shaped hull support system, Air Lubrication, European Intermodal Loading Unit, and Short Sea shipping. In almost all cases, policy intervention has failed to gain any traction, whereas commercial innovation such as reefer containerization and the Y-shaped hull (see Case Study 26) are considered to have been a success.

As in the Producer/Process quadrant, some developments may be solely dependent on a collaborative process improvement approach including a number of stakeholders, with relatively limited recourse to systems and tools. The success of the project (see Case Study 27) on delivering grocery products into central Paris by barge on the River Seine was dependent both on a redesign of the assets (containers and barge), and on the human factor (change management and stakeholder engagement), which ensured that all participants were aware that success required their collaboration and abandonment of some entrenched positions. The message for the chemical industry is that things are happening closer to the customer that may eventually have an impact on B2B supply chains. Inner city night-time delivery trials have also taken place in Dublin and Barcelona under the EU's Sixth Framework Programme for Sustainable Surface Transport.

CASE STUDY 25

MORE FOR LESS

Composite multimodal freight container – saving weight and increasing payload

Introduction

Samskip and DSM jointly developed a lightweight composite, more durable, 45ft high Cube Pallet Wide Dry Freight Container for the European multimodal market.

The new container is 20 % lighter than its steel counterparts.

Weight reduction is achieved by using composite panels to replace the commonly used corrugated steel.

In June 2011, Lloyd's certified the first pallet-width prototype. It was successfully real-life field-tested for over one year by Samskip.

Opportunity

Transform the European 45ft multimodal container and the 13.6m trailer to achieve lighter weight and more durable solutions.

This new composite container could bring operators average daily benefits of €2.39 at an additional cost of less than €1.00 per day.

A lighter, more durable, 45ft container enhances competitive advantage in the 45ft container market and takes cargo off roads and onto more environmentally friendly transport solutions such as rail, barge and vessels, or a combination.

The Solution (Technology Application)

Development of a steel frame container using walls made with proprietary and patented composite panels, glues and building techniques to ensure a cost efficient container in terms of raw material and serial production.

The Value

The lower tare weight in combination with an aerodynamic design leads to significant fuel savings during transport when compared to a steel container with the same load. Conversely, when used in transport modes where weight limitations apply, like rail and road, the lower container weight can enable a payload increase for heavy commodities.

The container will either carry more cargo weight or carry the same cargo weight while using less energy.

Composite walls, unlike steel, insulate cargo from outside temperature.

Flat walls – unlike corrugated – make loading and unloading easier.

Direct and indirect repair costs will be lower and there will be less cargo damage.

Composite walls last longer than steel, will not corrode and are easy to clean.

Impact corners will protect the container roof against damage during handling.

CASE STUDY 26

SHIP SHAPE

Rhine barges: Y-shaped hull support system and dual-fuel

Introduction

The Y-shaped hull support system is considered to have been a successful technology innovation, improving vessel safety beyond the conventional double hull, and allowing improved economics through greater tank size. More recently the first chemical tanker has been built using the Y-shaped hull and designed to run on LNG and diesel.

Opportunity

Shippers were seeking to move larger volumes (9 000m^3) on the Rhine, but were restricted by the maximum cargo tank size of 380m^3 set by the Central Commission of Navigation on the Rhine (CCNR). This would mean 24 tanks with all the associated piping and pumps, so economically not viable. The first collision-resistant Y-shaped hull was introduced in 2002 by Chemgas (designed to carry ammonia and propane). Deen Shipping developed the prototype MTS Apollo with 12 cargo tanks each of 760m^3 in 2008. Today there are 24 vessels operating with the Y-shaped hull.

The concept is based on the simple expedient of incorporating a Y-shaped support web structure (a type of honeycomb) on the inside of the hull. The structure is designed and constructed in such a way that its deformation absorbs the force of the colliding object to produce optimal resistance through a complex system of bending, buckling, and stretching. The hull is better able to avoid the skin being pierced or torn open, preventing spills or gas leakage.

The CCNR-permitted tank size can be increased from 380m^3 to 1 000m^3 if it can demonstrate similar hull strength between a reference vessel and one with a Y-shaped hull. A reference vessel is a regular tank barge with cargo tank size of 380m^3 and a conventional energy absorbance in case of a collision. The design of a Y-shaped hull tanker has to be compared with this reference vessel. If the risk of cargo outflow remains the same between this 1 000m^3 Y-shaped hull tanker and the reference vessel then the CCNR will approve the vessel.

The Solution

Using this technology, Deen Shipping introduced the MTS Argonon in December 2011, which is reportedly also the first new-built tanker to run on liquefied natural gas (LNG). The 6100dwt chemical tanker ship runs on dual-fuel (LNG/diesel in the ratio of 80:20) which significantly reduces CO_2 and NOx emissions, and cuts particulates to almost zero.

The Value

Because the Y-shaped hull design is deemed to be safer and more acceptable to regulatory bodies, the concept offers the opportunity to fit fewer but larger tanks. For a conventional tank barge, the number of tanks can be reduced from six to four, meaning less pumping facilities and better use of available cargo space. Building costs are only marginally more expensive but offer more structural stability and safety. The collision-resistant structure results in a lighter ship, and therefore a larger deadweight, increased payload, and reduced energy consumption.

In addition to the environmental benefits (reduced emissions from the use of LNG as a fuel), the dual-fuel solution contributes considerable operational savings as LNG is cheaper than diesel.

(*Source:* Ship Technology, The Motorship, Deen Shipping)

CASE STUDY 27

WATER WORKS

Barging products into Paris city center

Introduction

Delivering grocery products into central Paris via barges on the River Seine ceased 200 years ago. However, faced with the challenge of providing customers with "the best service, while minimizing the impact of activities on local residents (noise, CO_2, congestion)", the concept has recently been reintroduced by the French retailer Franprix.

Opportunity

On-the-shelf availability of products is one of the key supply-chain drivers of the retail supply-chain, but growing consumer/citizen environmental awareness and community requirements for a cleaner environment create a need for new solutions for deliveries to stores, especially in high-street residential areas. As a market leader in the Paris area with 800 shops, a responsible corporate citizen, and sensitive to potential future regulation, Franprix sought a new delivery-to-store system that would be cleaner, safer and have less impact on residents, whilst maintaining existing service levels and cost structure.

The Solution (Technology Application)

The multimodal solution developed and managed by Norbert Dentressangle combines road and river transport. From the Franprix grocery warehouse in Chennevière-sur-Marne (South-East of Paris), the goods are transported by road to the port of Bonneuil-sur-Marne (8km). They are then loaded onto a barge before making the overnight crossing (20km) on the River Seine to central Paris' port de la Bourdonnais (Eiffel Tower). The containers are loaded onto trucks, which deliver the goods to the 100 Franprix stores in Paris city center.

The demands of the physical and logical chain have driven genuine innovation, including a change in the approach of information sharing from the traditional warehouse to road carrier link to a new visibility created between stores (re-order), warehouse (differentiated preparation), initial road carrier, barge carrier and final road carrier.

Two sizes of special containers (24ft and 27ft) had to be developed. The design of the containers also included provisions to conform to noise reduction certification requirements.

Finally, enhancements and even major investments in the ports had to be made by the Port of Paris Authority to allow highly efficient handling of the new containers. The barge was re-designed to work with containers on the Seine. The Reach-stacker manufacturer proposed a new equipment enhancement to reduce noise.

The Human Factor: Change management and engaging with people involved were an important part of the innovation. Store managers and employees, warehouse operators, lorry drivers and even river-lock operators all had to collaborate and understand that they would become part of a complex but integrated chain to serve the Paris citizen/consumer.

The Value

The process beginning with the expression of a clear remit, then the launch of the solution, and finally the first barge deliveries on 27 August 2012, took roughly 18 months. The first evaluations of the cost per pallet delivered were not encouraging, but all parties accepted the need to revise and refine their risks; the final cost is in line with traditional road delivery.

Today, the solution is reducing emissions linked to city center deliveries by 37 %, truck travel by over 450 000 km a year, and congestion and noise at no extra cost, and with no reduction in service.

5.3.4 Service providers / process related

Supply chain solution providers which are not exclusively serving the chemical industry, are actively offering process solutions employing technology for network design, asset and fleet management, S&OP, dashboards and control towers, sourcing optimization, and, increasingly, carbon modeling. There is a wide range of applications including the use of sensors in manufacturing processes, decision support developments based on ERP platforms, systems supporting improvements in driver behavior and fleet management, and the use of systems in communities of users.

The chemical industry was an early adopter of ERP solutions (e.g. SAP, Oracle, Baan) to automate transactional processes, but using the data to support systems to optimize working capital and generate forecasts is often dependent on a multitude of spreadsheets and bolt-on applications. Some ERP platforms are working to integrate decision support functionality, which will offer significant savings in time, resources, and quality of decision-making.

There are examples of innovative leadership from the Benelux ports, which have developed community platforms enabling various stakeholders to share logistics information, and to accelerate the processing of export documentation. Details of initiatives from Rotterdam/Amsterdam, and Antwerp/Zeebrugge are included (Case Study 31*).*

The chemical industry has been active over many years in encouraging the use of Behavior-Based Safety (BBS) programs with their LSPs. Apart from basic training, BBS also requires regular in-cab monitoring by driver trainers and coaches to ensure BBS principles are being applied. Technology now allows this monitoring to continuously track all aspects of driver behavior. In addition, technology also enables the continuous tracking of owned fleets and subcontractor vehicles for cost and quality performance. Case studies on Driver Style Evaluation (DSE) and Transport Network Management (FleetFence) provide more details on these developments (see respectively Case Studies 29 and 30).

More examples of **leading edge, innovative technology applications** are described in Section 5.5.

CASE STUDY 28

ENHANCING ERP SUPPORTED DECISIONS

Innovative supply chain technology and business information systems

Introduction

The chemical industry was an early adopter of ERP systems used to handle transactions (purchasing, sales, financial, human resources, etc.). But these systems offered very limited functionality for decision support in supply chain processes (forecasting, inventory management, transport optimization, etc.).

Opportunity

Lack of integration or the simple lack of decision support systems is a supply chain challenge. ERP systems may easily and accurately enable automatic generation and processing of purchase requisitions when stock drops below a threshold, however determining that threshold may be more difficult. Similarly, processing sales orders, booking transportation and handling customs may be relatively simple, however optimizing routes or taxes can be problematic.

The optimization of supply chain operations is a key factor to many companies. To optimize stocks, generate forecasts, optimize footprint, etc., several application software systems have to be implemented and interfaced. This may mean linking Excel spreadsheets, supply chain optimization packages and home-made applications based on data warehouses and statistical software technology. This approach creates complex application architecture and makes it difficult to maintain interfaces between the different applications.

Integrating the decision support functionality into the transaction ERP platform represents a significant step forward. It will lead to significant savings as a result of:

- Data integrity and consistency throughout the integrated platform
- Simulation and optimization on real life transaction sequences
- More frequent use of decision support leading to a better overall optimization level
- Integrated platform being easier to use, maintain, upgrade, etc.

Some ERP platforms have already made good progress in integration, but significant further evolution is anticipated in the coming decade.

The Solution (Technology Application)

Many companies have addressed this shortcoming by adding numerous best-of-breed solutions to the ERP platform often leading to high cost, difficult application and interface maintenance, etc. Examples include PeopleSoft (now Oracle), and Business Objects (now SAP). However, integrating supply chain decision support functionality into a transaction platform requires a number of technological innovations in different areas:

- Data warehouses
- Simulation, optimization and statistical processing algorithms
- Scenario-like decision support based on dashboard visuals
- Service oriented architectures

The Value

Integration of decision support into ERP platforms will lead to more agile and therefore more competitive companies. Although much technology is already available, full adoption will take time. This is due to the risks linked to the business-critical nature of most ERP platforms, and also because the real value from these systems can only be maximized when the importance of the human element is recognized. The right skills, competencies, and regular training have to be in place to exploit the technology.

CASE STUDY 29

SOFT-PEDALING

Driver Style Evaluation service (DSE)

Introduction

Over one third (by weight) of chemicals shipped in Europe travel by road. Fuel accounts for a significant proportion of road haulage costs, so optimizing fuel economy is a key goal and can be essential for business survival. An important factor in fuel use is driver style, which can also impact a range of other costs, including maintenance, tire life, repairs, and potentially also safety performance and insurance.

Opportunity

In most road transport companies, fuel accounts for at least 30 % of operating cost. Fuel management is therefore the logical place to start focusing on cost efficiency.

The Solution (Technology Application)

Studies have shown that drivers can significantly influence fuel consumption.

Other factors known to influence fuel consumption include distances driven, signal stops, trucks required for routes, and time spent in traffic.

There is often a link between driving efficiency and safety. Anticipating required maneuvers, and braking and accelerating lightly makes for a smoother drive, uses less fuel and tends to raise driver awareness of potential accidents. Together, these factors generate savings on truck maintenance costs.

The Qualcomm *FleetVisor DSE* functionality can provide fleet managers with a detailed account of how fuel consumption is being impacted by driver performance. Armed with an overview of individual driver behavior, the fleet manager can identify specific areas where training and coaching can enhance fleet performance. Through detailed analysis and tracking, the strategy can be evaluated and targeted fuel consumption reduction realized.

The Value

The fleet manager is able to control all parameters influencing fuel costs. Saving 1 % on fuel in the current market conditions easily represents €500 per truck per year. In some cases, fuel costs have been reduced by over 8 %. There are also environmental benefits, such as reduced CO_2 emissions.

CASE STUDY 30

NETWORK VISIBILITY AND CONTROL

FleetFence open platform service offering

Introduction

A core challenge for all transportation and shipping providers is to efficiently track and report on a transport status. While chemical industry customers generally look for exception reporting rather than individual shipment tracking, controlling the quality and the cost of any transport network remains a key challenge for fleet operators, particularly when using subcontractors.

FleetFence is an example of a service creating visibility and providing operational control over transport networks, including those provided by subcontractors.

Opportunity

Transport and logistics providers need to control costs and quality while also making use of the flexibility third party carriers can offer.

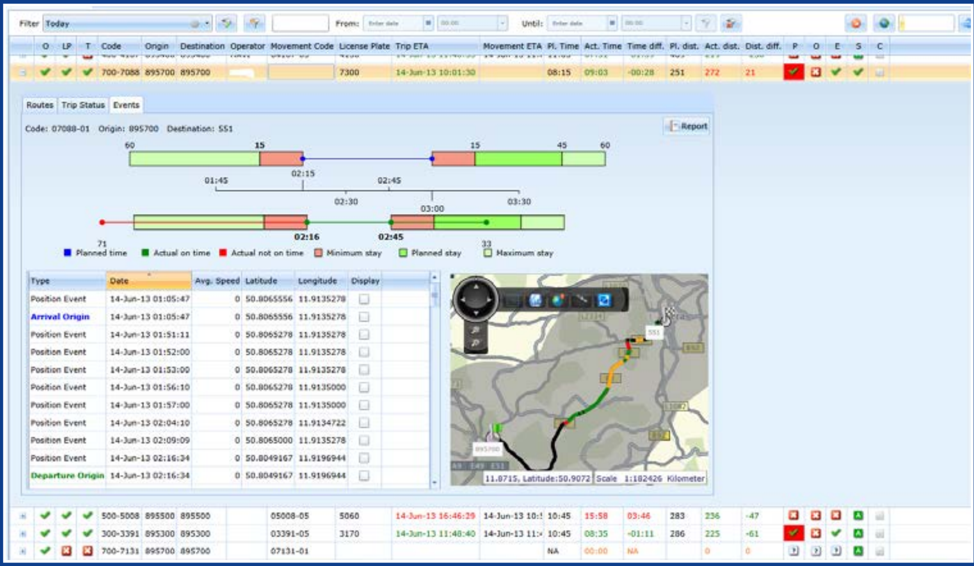
Tracking loads carried by dedicated shippers or third party carriers is a complex, largely manual and often inefficient task. It can be very difficult for shippers and carriers to achieve tracking accuracy levels available within a single carrier fleet. Using third party carriers can also significantly impact transport activity costs.

The Qualcomm FleetFence solution helps to address these challenges and enables shipment tracking across different on-board computer and other telematic systems against planned routes, timings, etc. It also focuses on exception management, concentrating on individual vehicles or subcontractors diverging from plans.

The Solution

The service supports shippers and LSPs by providing updated, real-time status reports on the execution of planned movements. This is useful in challenging operating environments when flexibility and subcontracting may be required.

When exceptions to the plan occur (e.g. diversion from planned route, delay at loading, etc.) the application provides alerts and control, generating direct visibility of progress, potential delays and the quality of the work by trip, depot or subcontractor.



The Value

By reducing or eliminating manual intervention, the solution offers improved control and direct visibility, and can generate significant cost reductions per trip. Other benefits include: reduced travel distances and fuel consumption (by comparing actual against optimal distance); travel time reduction; reduced wear and tear on equipment; faster turnarounds at loading and discharge; and reduced carbon footprint.

CASE STUDY 31

KNOWLEDGE CHANNELS

Enablers of logistics intelligence between private and public business stakeholders

Introduction

The ports of Rotterdam and Amsterdam, and Antwerp and Zeebrugge have actively developed separate systems supporting communities of users and stakeholders in their respective harbors.

- *Portbase* is the neutral hub for all logistics information in the ports of Rotterdam and Amsterdam. *Portbase* strives to optimize all international logistics processes via Dutch ports through information and communication services.
- The Antwerp and Zeebrugge port community system *APCS e-Desk* allows users to streamline electronic communication within the supply chain – already 60 % of all export declarations are submitted via the e-Desk.

Opportunity

For Amsterdam and Rotterdam, the *Portbase* port community system provides a multitude of intelligent services for simple and efficient information exchange, both between companies and between the public and private sector. This enables all the participants to optimize their logistics processes, thereby improving their own competitive position and profitability as well as that of the ports. As confidential information and data are often involved, this can only be handled by an organization with wide support that is both neutral and separate from the parties involved.

For Antwerp and Zeebrugge, each month the *APCS e-Desk* records about 160 000 container documents, 25 % by EDI. More than 650 companies and 1 700 users are registered, coming from 10 EU member states (majority from Belgium and the Netherlands).

The Solution (Technology Application)

The *Portbase* community system has three parts:

- An application layer with the services
- A platform with the facilities common to all services
- A central database to gather all the information that companies and government authorities exchange via *Portbase*

There are 41 different services provided by *Portbase*, including for example, cargo declaration, customs scanning, declarations for food and consumer products, discharge confirmation reports, export control systems, bonded warehouse notifications, and notifications of container arrivals. Each service includes several service processes, which describe the desired message exchange and interaction between parties. This involves messages to and from systems (system messages) and messages between people (notifications). The platform ensures that the processes run in accordance with the established rules. The central database enables the re-use of information in this connection. Companies need only enter data once. Regular training of employees in information security is essential.

Using the Antwerp and Zeebrugge *APCS e-Desk*, declarants can record container details and submit customs declarations. When a container arrives at quayside the terminal operator calls up the information from the e-Desk and uses it to send a declaration of arrival to customs (part of the Export Control System required by Customs). The Customs Department considers registration in the *APCS e-Desk* as an alternative proof of export. Antwerp and Zeebrugge collaborate so the application can be used for both ports.

The Value	Individual stakeholders avoid establishing and maintaining a myriad of bilateral connections to other stakeholders. Much of the information exchange in the ports now runs efficiently through hubs. The services available in the port community systems provide concrete savings in time and money, with the advantages including: • Greater efficiency and fewer errors • Lower costs • Better service provision • Improved and transparent planning • More rapid throughput times through the port • Optimal re-use of information • 24/7 availability

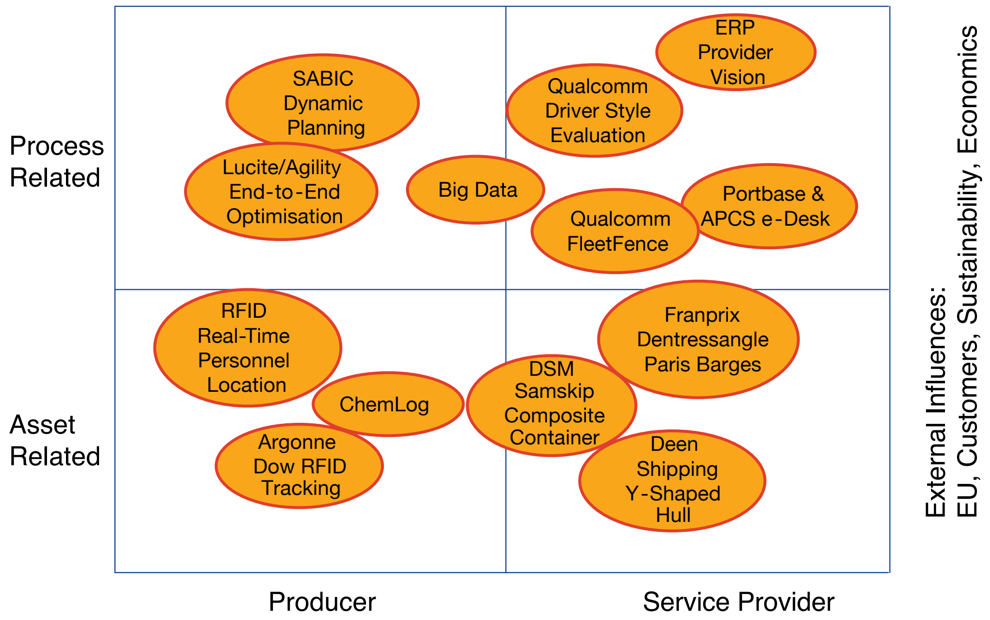
5.4. Technology application matrix and case studies comparative analysis

5.4.1 Technology application matrix

The technology application matrix was used to classify the case studies identified during the project, and that illustrate the use of technology as an enabler of sustainable chemical supply chains (see Figure 5).

There are also a number of external influences driving emerging technology development and application. Among those included are sustainability pressures, European Commission initiatives, customer pressure, and economics, and – in some cases – the impact of "the Cloud" and social networks.

Figure 6 - Technology application matrix referencing processes, assets, users and cases



5.4.2 Lessons learned from the case studies

Table 4 below summarizes the issues faced and technology practices applied in 13 supply chain cases, the impact of these practices on enabling supply chain sustainability, and the competitive performance improvements and benefits that have been obtained.

A wide variety of best practices are employed including:

- Enhancement of existing ERP systems with decision support tools and models
- Tracking and tracing of assets and people
- Modal switch
- Innovation and collaboration in equipment design
- Management of Big Data
- Improving data transparency and information exchange in community systems
- Change management

Supply chain practices discussed in these cases offer a variety of benefits, although in many respects similar to the benefits accrued in Chapter 3. Improvements in efficiency and cost are evident in many cases, and these improvements are usually associated with an improvement in emissions and reduced energy use, as well as safety and security. This is consistent with the results seen from mitigating uncertainty and complexity where it is reported that sustainability benefits are often the result of efforts to improve cost and efficiency (profit).

Three cases address the importance of the human factor and change management if the implementation of new technology is to deliver the anticipated results. People need to understand the vision and case for change, and be trained to understand the use and benefits of the new technology, otherwise they can become a major barrier to progress.

Innovative, visionary and entrepreneurial leadership in the design of new assets is also a theme of several of the case studies. However, there is a similar caveat for technology as for complexity and uncertainty. There needs to be a level of life-cycle maturity in terms of acceptance and adoption before the benefits are felt in the organization and in the bottom line.

Several cases address the opportunities offered by Track & Trace, for both assets and people, with significant safety and security benefits, as well as potential efficiency and sustainability benefits.

Comparison between 13 technology cases presented in Chapter 5:

#	CASE STUDY	ISSUE ADDRESSED	SUPPLY CHAIN PRACTICES	BENEFITS
PRODUCER / PROCESS				
22	SABIC Dynamic Sourcing	Volatility of supply and demand, and availability of transport capacity	Advanced information to carriers – a dynamic process of continuous updating Collaboration	Reliable customer service, secure capacity Reduced empty legs, reduced energy – sustainability (planet)
23	Lucite/Agility End-to-end Supply Chain Optimization	Strategic sourcing Global manufacturing footprint	Decision support based on computer modeling Collaboration	Competitive advantage
24	McKinsey Quarterly: Big Data in Healthcare	Healthcare costs out of control	Application of technology to handle Big Data (increasing variety of data sources, and unstructured data format)	Improved risk sharing Results based More effective prescription of medicines and drugs/customer
SERVICE PROVIDER / PROCESS				
28	Innovative Supply Chain technologies delivered by ERP providers	Strategic competitiveness in IS, and architecture advance	Business Information Systems + Decision Support + Advanced Information	Competitive advantage Dependence on skilled resources
29	Qualcomm Driver Style Evaluation	Managing cost drivers of road transportation	Monitoring driver behavior	Improved driving style Efficiency/cost Reduced energy – sustainability (planet) Safety
30	Qualcomm FleetFence	Tracking and reporting of transport status	Tracking shipments versus defined criteria and using exception-based reporting	Efficiency/cost Reduced km and emissions Reduced energy – sustainability (planet)
31	Dutch and Belgian Ports community systems	Logistics intelligence and transaction efficiency	Information exchange Data transparency Transactional automation	Efficiency/cost More rapid throughput times/customer Dependent on regular employee training

#	CASE STUDY	ISSUE ADDRESSED	SUPPLY CHAIN PRACTICES	BENEFITS
SERVICE PROVIDER / ASSET				
25	DSM/Samskip Composite Container	Improving container payload	Innovation in equipment design Lightweight construction Collaboration	Efficiency/cost Higher payload, easier to clean Sustainability – fewer loads, aerodynamic Reduced energy (planet)
26	Deen Shipping Y-Shaped Hull	Improved barge efficiency and safety	Innovation in equipment design	Efficiency/cost Higher payload per tank Reduced emissions – sustainability (planet)
27	Franprix / Norbert Dentressangle barging products into Paris	Threat of future regulations impacting license to operate	Modal switch Change management Collaboration	Sustainability – limited air and noise pollution (planet)
PRODUCER / ASSET				
19	Argonne / Dow RFID for Track & Trace	Safety in transport of nuclear, radioactive, and TIH products	Track & Trace	Enhanced safety and security Sustainability (people and planet)
20	Statoil/Dow RFID / Real-Time Location Systems	Monitoring of employees operating in hazardous environments	Track & Trace	Employee safety Efficiency – time required to conduct mustering exercises Sustainability (people)
21	German Chemical Cluster ChemLog	Monitoring hazardous products in the intermodal supply chain	Track & Trace Modal switch Collaboration	Safety & security Sustainability – reduced emissions and energy (planet)

Table 4 – Comparative table for technology applications case studies

5.5. Technology horizon: beyond the current technology cycle

This section addresses current cutting edge and future technology breakthroughs that could radically transform chemical supply chains. However, in order to move this forward it is necessary to consider innovations currently in research led by academic or other research institutes. Questions being explored include: What are the potential future impacts of nano-technology or 3-dimensional printing on chemical supply chains? Is the potential of the Cloud and Social Networking fully understood in the context of chemical supply chains? Do they have any potential at all?

Past experience suggests innovations that will have an impact beyond the current technology cycle (5 to 10 years) are still in the academic or even the visionary stage, such as hybrid commercial vehicles, and the SARTRE project (see Section 5.3.3). Section 5.6 proposes a classification scheme for these long-term technological innovations. Using a four-dimensional approach, it assesses whether the initiative for technology innovations comes from producers or LSPs/4PLs, whether technology is asset or process related, and whether there is market pull or industry push, and offers an implementation horizon. The following sections discuss a number of generic technologies that will have a wide impact on every aspect of industrial operations.

5.5.1 Internet of Things

The Internet of Things (IoT) is a vision that has been developed over the last decade. Building in components that provide for an internet-like connectivity in every physical object will create a completely new level of controllability, traceability and smart collaboration. There is still much research to be done on the technology, architecture, standards and governance. However, based on evidence from a number of major industrial corporations, it appears that there is accelerating importance and acceptance, as well as small standalone applications and augmented reality solutions being developed with a focus on domestic and urban community consumers. Recent research has shown the possibility of creating this type of connectivity even for fluid-like or gas-like substances.

The relevance of this vision for chemical supply chains could lead to applications such as:

- Full end-to-end closed loop traceability: when the product (even fluid) carries an inter-connective marker component (at the molecular level) in its own structure, it can be identified and traced at any stage of the process. This could include inside a pipeline or tank truck.
- Automatic safety and compatibility verification: the product can automatically be linked to the right product information, safety instructions, etc.
- Administration, documentation, and information flow based on the IoT could largely eliminate paper documentation throughout the whole supply chain process.
- Aerospace, aviation, and automotive are using the technology for systems status monitoring. Automotive also sees applications in Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communications.
- In Logistics and Supply Chain Management, connectivity could support enhanced VMI, logistics carbon footprint reporting, intelligent pallets and packaging, refining production schedules, container tracking, and asset optimization.
- The chemical industry could benefit from the use of connectivity in developing intelligent containers for managing hazardous goods, chemical compatibility issues, maximum storage limits, and access to hazardous environments.
- The use of sensors across the logistics infrastructure can cut empty mileage, enhance freight platforms and exchanges, enable more local-for-local swap deals, and improve tank utilization.

*"After the World Wide Web (the 1990s) and the mobile Internet (the 2000s) we are now heading to the third and potentially most disruptive phase of the Internet revolution – the **Internet of Things**. The Internet of Things links the objects of the real world with the virtual world, thus enabling anytime, anyplace connectivity for anything and not only for anyone."*

Vision & Challenges for realizing the Internet of Things. March 2010 CERP-IoT

The Internet of Things will generate more information and have a significant impact on Big Data. A case study illustrating the application of Big Data analytics for the US healthcare industry has already been reported in Section 5.3.2.

5.5.2 The Cloud

Storing data and running applications in Cloud-like environments (virtual networks of interconnected storage and processing infrastructure) will dramatically change the way in which our information and processes will be organized. This will have a significant impact on data availability, collaboration opportunities, standardization of processes, and organization of companies in general. Some innovations this might generate include:

- Full end-to-end supply chain collaboration by using and exchanging information that is available in the Cloud
- New generation of IT application architecture: application will run in the Cloud leading to a standardized application framework available to many companies and data that will be fed into this framework through the Cloud
- Outsourcing of complete supply chains: availability of data and applications available in the Cloud will facilitate outsourcing of supply chain processes

As an example, the Japanese manufacturing industry has traditionally used "behind the firewall" based software solutions. Many systems such as ERP platforms have been developed as bespoke platforms to meet the needs of a particular company (as is often the case in the chemical industry). These systems have been supported by extensive global IT resources and network infrastructures including B2B hubs.

Supply chain interruptions (such as the recent earthquake in Japan) and changing customer demand for innovative products have led to many manufacturers establishing partnerships with other producers around the world. To be successful, these partnerships need a flexible B2B platform that encourages collaboration across the supply chain and enables new suppliers or JV partners to be added with ease.

These factors have spawned an interest in Cloud-based B2B environments that offer relatively easy ways for companies to modernize their IT and B2B infrastructure. Following the earthquake, Japanese companies were quick to restructure their supply chains, introducing dual sourcing and moving production to plants in other parts of the world. Having global production operations connected to a single data center in Japan has an associated risk, however the Cloud enables companies to mitigate this risk and build increased supply chain resilience.

Cloud environments have a multitude of features and web-based applications that are accessible anywhere across the business. This means they can foster and enable collaboration between all the business partners and their respective supply chains around the world. They also offer improved supply chain visibility.

(Source: GXSblogs)

5.5.3 Social Media

It is clear that social media have had a huge impact on communication and relationships in our private and professional lives. In business interactions, it is still unclear for many corporations how social media will change processes beyond marketing and public relations. Some of the features that social media might offer to industrial supply chains are:

- Understanding customer needs more quickly and accurately by analyzing data available on social media platforms
- Making business decisions based on informal content from the network: trends and evolutions can lead to new business insights and can be used as an element in decision-making
- Driving business processes from social media applications: customer interactions as well as B2B interactions could in future be processed on social media platforms, provided the necessary security can be put in place

One company successfully employing social media is Maersk Lines. McKinsey & Co have reported that in using social media, Maersk's initial goals were to "raise brand awareness, increase customer loyalty, improve employee engagement, develop customer insights, and control news flow". By May 2013, Maersk said it had more than 800000 fans on *Facebook*, 40000 *Twitter* followers, and 22000 *Instagram* followers. Customers comprised 15-20% of those *Facebook* fans. Although social selling is part of the Maersk scope, the company also believes social media is an important tool for understanding and interacting with customers (for more information, see: http://cmsoforum.mckinsey.com/article/how-maersk-line-made-a-splash-in-social-media).

BMW, in collaboration with the Manchester Business School, has developed a system that uses unstructured data (blogs, wikis, etc.) to de-risk and optimize its global supply chains. The data is filtered using a two-stage cognitive process (first by using relevant tag-words, and second by logical analysis) to pinpoint risks in the supply chain, increase flexibility and visibility, search for new suppliers, and improve collaboration with existing suppliers. Supplier plants and locations are geo-tagged and matched to geographical and surveillance data to identify potential risks, e.g. natural disasters which could affect suppliers' production (for more information, see: http://c.ymcdn.com/sites/www.scmworld.com/resource/resmgr/pdfs/tom_and_alexander_final_ppt.pdf).

5.5.4 Technology for customization

Postponement (i.e. making a product customer-specific as late as possible in the supply chain) is a general trend. Taken to extremes, this leads to consumer customization: basic components or chemicals are supplied to the consumer who uses specific equipment (e.g. 3D printing) to turn these into unique products. This evolution could lead to a real revolution in chemical supply chains organization, such as short, consumer-focused supply chains, and B2B becoming B2C.

5.5.5 Nano-technology

Nano-technology is a very promising evolution enabling development of new high-tech applications and modification of the characteristics of solids and fluids. Although within supply chain processes its applicability is still largely unexplored, nano-technology is expected to have a huge impact on both the material flows and the information flows.

For example, nano-technology has enormous potential in enhancing product and component verification in the supply chain. The first steps have been taken in developing "nano fingerprinted" components: these "nano fingerprints" can only be read by a dedicated machine, which will enable identification of forgeries and fraud.

Nano-technology is a particular issue in the food supply chain, and the European Commission has been active in encouraging retailers to be upfront in explaining the risks and benefits of advances in nano-technology. The EU is also concerned that existing chemicals legislation is not sufficient to regulate nano-materials. It may only be a matter of time before this issue will need to be addressed in chemical supply chains.

5.6. Classification of long-term technological innovations

To classify long-term technological innovation, four dimensions are utilized:

Dimension 1: Producer initiative vs. LSP/4PL initiative
Dimension 2: Asset related vs. process related
Dimension 3: Market pull vs. industry push
Dimension 4: Implementation horizon

	Producer initiative vs. 4PL/LSP initiative	Asset related vs. Process related	Market pull vs. Industry push	Implementation horizon
End-to-end closed loop traceability (IoT)	**4PL/LSP Supported by producer**	**Asset and Process**	**Industry push**	**5 to 10 yrs**
Safety and compatibility verification (IoT)	**Producer**	**Asset and Process**	**Industry push**	**10 to 15 yrs**
IoT-based administrative and process flows	**4PL/LSP Supported by producer**	**Asset and Process**	**Industry push**	**5 to 10 yrs**
End-to-end supply chain collaboration (Cloud)	**4PL/LSP**	**Process**	**Industry push**	**2 to 6 yrs**
Cloud-based application architecture	**Producer supported by service providers**	**Process**	**Industry push**	**4 to 12 yrs**
Cloud-based supply chain outsourcing	**Producer and 4PL/LSP**	**Process and Asset**	**Industry push**	**5 to 15 yrs**
Better understanding of customer needs (social media)	**Producer**	**Process**	**Market pull**	**1 to 5 yrs**
Social network-based business decisions	**Producer and 4PL/LSP**	**Process**	**Market pull**	**3 to 10 yrs**
Social network-driven business processes	**Producer and 4PL/LSP**	**Process**	**Market pull**	**4 to 12 yrs**
Technology for customization	**Producer and 4PL/LSP**	**Process and Asset**	**Market pull**	**1 to 5 yrs**
Nano-technology applications	**Producer and 4PL/LSP**	**Process and Asset**	**Industry push and Market pull**	**5 to 15 yrs**

Table 5 – Timeframe for implementation of long-term technological innovation

5.7. The European Commission's Transport White Paper and Strategic Transport Technology Plan to 2020

In 2011 the European Commission adopted a roadmap (White Paper: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system) with the objective to build a competitive transport system that will increase mobility, remove major barriers in key areas and fuel growth and employment. These goals include CO_2-free city logistics by 2030, a 30 % shift in road freight over 300km to other modes by 2030, and a framework for a European multimodal transport information, management and payment system by 2020 (see also Chapter 6, Section 6.2 and Chapter 8 Appendix, Section 8.5).

The EU Strategic Transport Technology Plan (STTP) recognizes the fact that the White Paper's goals will not be met without innovative technology.

According to the EU Transport White Paper, much can be achieved through innovation, exploiting the strength of each mode by eliminating technical obstacles, encouraging interoperability through increased deployment of ITS, and level playing field pricing to encourage greater use of rail and water to produce more resilient, sustainable solutions.

5.8. Conclusions

In an asset-heavy, process-driven manufacturing environment, the chemical industry is not necessarily an early adopter of supply chain technology.

However, in the course of preparing this part of the report, the participants of the working group have been impressed by the breadth and scope of the technology umbrella.

In the 13 case studies produced in this chapter, technology has been categorized by reference to its relationship with assets (6) or process (7) and whether they are initiated by producers (6) or service providers (7).

77 % of these cases relate to information technology, 15 % to equipment and 7 % to both IT and equipment.

There is an abundance of good examples of technology applications for sustainability improvements ("profit, planet, people"). In Chapter 5, 9 cases (69 %) address "profit", 8 (62 %) "people" and 8 (62 %) "planet". 6 (46 %) of the technology applications quoted enable collaboration, 38 % information sharing and 23 % improved customer service.

The report highlights cutting edge and future technology breakthroughs that could radically transform supply chains. The internet of things, the cloud, social media, customization technology (3D printing) and nanotechnology are put at the forefront with a time horizon for implementation. To be successful in these fields, the industry has to look beyond the numbers, as the business case may not be evident today. This requires leadership and vision. With technology never being stable, and tending to move through 5-10 year cycles, the returns have to meet very challenging criteria in order to justify the investment. Some of the technology developments mentioned in this report have the potential to be game-changing and may arrive faster than expected.

It seems likely that EU policy initiatives, combined with the work undertaken by research institutes, and technology-based companies, will prove to be the driving force for future technology breakthroughs, with the limiting factors, as always, being the human element, the availability of skilled resources, the presence of a real value proposition, and a recognition that breakthroughs are more likely to happen if they originate from, or are driven by industry.

6. Sustainability in chemical supply chain and logistics

6.1. Responsible Care

The commitment of the chemical industry to Responsible Care and sustainable development is a major driver for the chemical industry and its logistics service providers to continuously improve the responsible management of chemicals during transport and logistics operations.

This voluntary chemical industry initiative can be considered as a benchmark for pro-competitive industry collaboration, including authorities.

Responsible Care

Since its inception in Canada in 1985, Responsible Care has been the global chemical industry's initiative to drive continuous improvement in environmental, health and safety (EHS) performance. It achieves this objective by adopting *voluntary initiatives going beyond legislative requirements and regulatory compliance*. Responsible Care is an *ethic* and an industry *commitment* to continuous improvement in the responsible management of chemicals, that seeks to build confidence and trust in an industry that is essential in improving living standards and the quality of life. Responsible Care embodies the chemical industry's commitment to sustainable development through the development of innovative technologies and solutions to societal problems, as well as improved EHS performance.

The fundamental features of Responsible Care have been laid down by the International Council of Chemical Associations (ICCA) of which Cefic is a member. Cefic is in charge of the promotion and implementation of Responsible Care in Europe, in collaboration with the national chemical associations. To extend the implementation of Responsible Care further down the supply and logistics chain, Cefic has concluded partnership agreements with ECTA (European Chemical Transport Association) and Fecc (European Association of Chemical Distributors – Fédération Européenne du Commerce Chimique) representing chemical distributors.

In 2006, the ICCA Responsible Care Global Charter was launched at the first UN International Conference on Chemical Management in 2006, extending the process of continuous improvement beyond chemicals manufacturing to other activities, especially those associated with the safe use and handling of products along the value chain.

The **six core principles** of **Responsible Care** are:

1. Improve the safety, health and environmental performance
2. Use resources efficiently and minimize waste
3. Report openly on achievements and difficulties
4. Engage in dialogue with stakeholders, in particular with the local communities who live around our sites
5. Cooperate with regulators, set standards and go beyond regulation
6. Provide help and advice to foster the responsible management of chemicals throughout the value chain

In the field of supply chain and logistics, the chemical industry has taken several initiatives to enhance EHS improvement in Europe such as:

1. **Preventive measures** to improve safety standards of logistics operations and avoid accidents or spills. The Chemical Distribution Institute (CDI) provides inspection systems for marine and terminal operations (see case study below) while the Cefic Safety & Quality Assessment System (SQAS) delivers assessment systems for land transport service providers, distributors, tank cleaning stations and warehouses. These preventive systems for chemical logistics are complemented by best practice guidelines to improve EHS performance in chemical land logistics operations such as guidelines for safe loading and unloading, truck drivers' safety awareness, and transport equipment. These guidelines have been developed in close cooperation between ECTA (European Chemical Transport Association), Cefic and EPCA. In 2010 ECTA became Cefic's Responsible Care partner for the implementation of Responsible Care and sustainable development in European land transport logistics.

2. **Transport Emergency Response.** The Intervention in Chemical Transport Emergencies (ICE) scheme was established more than 20 years ago by Cefic to provide an effective response to chemical transport accidents. National ICE transport emergency response schemes have been established in 17 countries, providing assistance to the local public emergency services through national ICE centers. The national ICE schemes are supported by a network of more than 600 chemical producers, covering most of the dangerous products that are being transported. In the event of a chemical transport accident, national public emergency services first attempt to contact the owner of the shipped chemical products. If this is not possible, other companies that have detailed knowledge of the products can be contacted through the ICE scheme. In addition certain transport companies specialized in transporting dangerous goods offer support to the national public emergency services.

CASE STUDY 32

CHEMICAL DISTRIBUTION INSTITUTE (CDI) AND THE CEFIC SAFETY & QUALITY ASSESSMENT SYSTEM (SQAS)

Best practice in inspection and assessment schemes for logistics service providers

Introduction

In the late 1980s the chemical industry started to explore ways of improving the operational performance of its logistics and transport operations. Triggered by a series of incidents and the Responsible Care initiative, Cefic initiated the development of voluntary industry inspection schemes for logistics service providers.

Opportunity

Working groups were formed by Cefic with a mandate to create consistent international inspection and assessment schemes for the inspection of bulk liquid tanker ships and the assessment of land logistics service providers. For the ship inspections, an independent organization (CDI) was formed to be responsible for managing the inspection scheme, including the development of a single global ship inspection protocol, the training, qualification and accreditation of inspectors, and the development of a sophisticated database in which inspection data could be promulgated.

In parallel, a similar scheme (SQAS) was developed by Cefic for the assessment of road transport companies. In the second phase, this road transport assessment scheme was extended with additional assessment modules for tank cleaning stations, rail transport companies, warehouses and chemical distributors. The SQAS scheme is based on the same principles as CDI: assessments are carried out by independent third party assessors trained and accredited by Cefic, using uniform assessment questionnaires with all reports made accessible in a central database.

The Solution

In 1994, the Chemical Distribution Institute was established as a non-profit making and non-commercial organization to provide ship inspection data in an electronic report format to the members. At the end of 1996, there were 20 chemical company members and 200 ship owners participating with 657 ships. By 2013, the figures were 72 chemical company members and more than 800 ship operators participating with more than 4 500 ships.

In addition to the CDI-Marine scheme, similar schemes have been established for tank storage terminals (1997) and marine packed cargo (2002). For the inspection of tank barges a separate scheme was created: EBIS (European Barge Inspection Scheme).

The European SQAS scheme managed by Cefic has separate modules for the assessment of road transport companies, tank cleaning stations, rail transport companies, warehouses and chemical distributors. The SQAS scheme is supported by 45 chemical company members. Each year more than 800 assessments of logistics service providers and chemical distributors are carried out.

One of the most important objectives of CDI and SQAS is to drive continuous improvement in the safety standards of logistics operations by providing chemical company members with a cost effective tool for the assessment of their service providers, thus assisting in their commitment to Responsible Care. Chemical companies that are using CDI or SQAS data apply their individual company templates of minimum criteria to gauge which service providers are acceptable to them.

The Value

The chemical industry has been able to leverage the expertise of trained inspectors and the respective administrative and database systems to avoid duplication of assessment efforts within the respective member companies while at the same time raising the overall standard of inspections and driving continuous improvement in the safety performance and quality of its logistics operations.

In addition the CDI and SQAS schemes provide chemical companies with a system that allows them to demonstrate the application of due diligence in selecting the service provider.

The SQAS and CDI schemes represent an outstanding example of collaboration between chemical companies and logistic service providers to deliver best practice sustainable solutions and continuous performance improvement.

6.2. Impact of Authorities (regional, national, local)

6.2.1 The European policy framework and the chemical industry's contribution to sustainable transport systems in Europe

European Policy Framework
In the 2011 Transport White Paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" the European Commission set out the general framework for the European Transport Policy for the next decade. As part of the contribution of transport to the overall EU GHG emission reduction target of 60 % by 2050, the European Transport White Paper defined 10 concrete goals for a competitive and resource efficient transport system.

One of the most prominent targets in this context is the EU's ambition to shift 30 % of road freight over 300km to other modes such as rail or waterborne transport by 2030, and more than 50 % by 2050. The goal is to facilitate this by efficient and green freight corridors. To meet this goal the EU has recognized that this will require the development of appropriate infrastructure, concluding that development efforts "should focus on the completion of missing links – mainly cross-border sections and bottlenecks/bypasses – and the upgrading of existing infrastructure and development of multimodal terminals at sea and river ports".

To implement the vision of the Transport White Paper, the European Commission identified 40 concrete initiatives for the next decade. This includes the creation of a Single European Transport Area with more competition and a fully integrated transport network linking the different modes.

For more details see Section 8.5 of the Appendix.

Pro-active contribution of the chemical industry to sustainable transport systems
The provision of safe, sustainable and competitive transport solutions is the main priority of chemical logistics. The development of sustainable logistics processes forms part of the chemical industry's overall goal of sustainability. The chemical industry did not await the publication of the Transport White Paper to develop several voluntary initiatives in this area.

Although for most chemical companies, **emissions from transport operations** represent only a few percent of their total greenhouse gas (GHG) emissions, the chemical industry has undertaken several initiatives to raise awareness among companies of the importance of further reducing transport emissions as far as possible.

In 2010 Cefic published an extensive report prepared by Professor Alan McKinnon (Heriot-Watt University of Edinburgh) for Cefic on how to measure and manage CO_2 emissions from European chemical transport operations (see http://www.cefic.org/Industry-support/Transport--logistics/Sustainable-Logistics/). As a follow-up to the McKinnon report, Cefic in cooperation with ECTA (European Chemical Transport Association) developed practical industry guidelines for measuring and reducing CO_2 emissions in chemical freight transport. By developing a common calculation methodology for chemicals transport, these guidelines offer individual chemical and transport companies a method for carrying out a self-assessment of their emissions in a uniform way that is comparable across the industry. In addition the guidelines identify a number of potential opportunities for companies to further reduce their transport GHG emissions.

Using the Cefic/ECTA guidelines, ECTA launched in 2011, as part of their Responsible Care program, an annual transport CO_2 emission reporting scheme for their member transport companies. This allows the chemical transport sector to measure continuous progress in reducing its transport CO_2 emissions.

Cefic also responded to the EU target of shifting 30 % of the long distance road freight transport to multimodal combinations, keeping in mind however that the chemical industry has to a large extent already seized current intermodal transport opportunities. In order to enable even greater use of intermodal transport options, Cefic has assessed the future intermodal needs of the European chemical industry on key strategic corridors and put forward recommendations on the further development of the intermodal transport network, highlighting current bottlenecks and obstacles.

Chemical companies are already investing heavily in improving on-site intermodal terminal infrastructure in order to take transport volumes off the road and contribute to further GHG reductions. Several chemical companies are also participating in the Green Freight Europe (GFE) initiative, a leading independent voluntary program for improving environmental performance of freight transport in Europe.

6.2.2 Active involvement and support of regional, national and local authorities

The active involvement and support of regional, national and local authorities is evidenced by the CO3 report in Chapter 4 and the Appendix (8.1.), as well as the Case Studies 5 (Polyolefins from the Middle East to China), 11 (Biofuels), 21 (German chemical cluster ChemLog), 27 (Franprix/Norbert Dentressangle barging products into Paris), 31 (Dutch and Belgian port community systems) and the ICE scheme (Intervention in Chemical Transport Emergencies) mentioned on page 79 of this chapter.

The following Case Study illustrates a successful “planet” oriented initiative, started by three non-petrochemical producers with the participation of a service provider and the support of authorities.

CASE STUDY 33

THE BLUE ROAD

Lean and Green barge project

Introduction

At the beginning of 2012, Heinz, Mars and Bavaria started a dialogue with the Inland Waterways Promotion Centre (Bureau Voorlichting Binnenvaart) in the Netherlands with a view to shifting their supply chain by transporting cargo to the Port of Rotterdam via "the Blue Road", the so-called Lean and Green barge project. The three companies all faced a similar problem in that they had regular flows of product but insufficient volumes to fill the trucks, and were confronted with increasing congestion on the roads around Rotterdam.

There were serious difficulties with the project, especially developing a sound financial business case. During the whole process, the logistics service provider was closely involved to provide the multimodal operator's perspective, offering the shippers full support.

Opportunity

Transporting the production output of the three main locations via barge faced quite a number of operational problems, such as coping with volatility in production planning over three producers, providing the capacity for shunt transport, frequency in the barge schedule and maintaining a good transit time performance. The various parties involved in the set-up of the transport solution needed to be convinced of the barge solution as well as various stakeholders within the companies; from the receiving warehouses and customer services to commercial departments.

The Solution

Due to the complexity of comparing a truck movement with the concentration of loads in barge transport, all parties decided to commit to a pro-competitive collaborative approach based on open communication. During meetings, all parties constantly looked for opportunities to reduce cost until a break-even level against trailer transport was reached. Although a difficult challenge, all parties involved were committed to a creative process and to think out-of-the-box.

After sound analysis of the exact movements from and to the port the partners were able to develop an operational set-up that would enable a modal shift from road to inland waterways.

In January 2013, the first Samskip containers departed by barge from the Inland terminal Cuyk (Heinz) and Inland terminal Veghel (Mars and Bavaria) to the Rotterdam Shortsea Terminal from where these containers were bound for various destinations, i.e. the United Kingdom.

Since the successful implementation of the solution, the parties have continued the search for further optimization, and are looking to attract more shippers into the project. Together with Connekt, the independent organization for stimulating sustainable improvement, and the Inland Waterways Promotion Centre Mars, Bavaria and Heinz have started regional and national information meetings in the Netherlands to inform other organizations about this successful solution.

The Value

As a result of the collaborative (horizontal and vertical) effort, a sustainable solution was developed which will convert 15 000 truck transport journeys from roads to the inland waterway network.

6.3. Sustainability ("people, planet, profit") benefits resulting from the case studies analyzed in Chapters 3, 4, 5, and 6.

The table below presents a comparative overview of all case studies analyzed in this report. The economic (profit), environmental (planet) and social (people) sustainability benefits of each case study are highlighted in this table.

Comparative overview of all case studies presented in this report:

CASE STUDY	ISSUE ADDRESSED	SUPPLY CHAIN PRACTICES	BENEFITS
1. Rock Salt	Managing and reducing uncertainty	Increased stock levels Improved forecasting, central planning Collaboration	Delivery reliability / customer Sustainability (people)
2. PTA	Managing uncertainty	Increased stock levels Outsourcing of logistics Collaboration	Efficiency/cost
3. De-icing fluid	Managing uncertainty	Outsourcing of production Localized distribution centers Centralization and outsourcing of logistics Collaboration	Service/delivery reliability/ customer Responsiveness/flexibility
4. Coatings and adhesives	Reducing complexity	Product portfolio rationalization Specialized plants Localized distribution centers Centralization and outsourcing of logistics Collaboration	Efficiency/cost Responsiveness/flexibility/ customer Sustainability (planet)
5. Polyolefins from Middle East to China	Reducing complexity and uncertainty	Decoupling point (push vs. pull) Outsourcing of logistics Improved forecasting, central planning Collaboration with authorities Training	Efficiency/cost Service/delivery reliability/ customer Sustainability (planet)
6. Ethylene oxide	Managing complexity	Innovation (specialized equipment) Outsourcing of logistics Collaboration Training	Sustainability (people & planet)
7. Global container freight	Reducing complexity	Standardization and outsourcing of logistics Collaboration Improved planning Performance management Innovation (information technology)	Efficiency/cost/customer Service/delivery reliability

CASE STUDY	ISSUE ADDRESSED	SUPPLY CHAIN PRACTICES	BENEFITS
8. Bulk liquids from Western Europe to Russia	Reducing complexity	Standardization of logistics Training	Efficiency/cost Service/delivery reliability/ customer Resilience Sustainability (planet)
9. Agrichemicals	Reducing complexity and uncertainty	Supply chain segmentation Improved forecasting and S&OP Product portfolio rationalization Decoupling point (push vs. pull) Distribution network (central vs. local) Performance management	Efficiency/cost Responsiveness/flexibility/ customer
10. Barge traffic	Managing complexity Reducing uncertainty	Collaborative planning Innovation (information technology)	Service/delivery reliability/ customer Efficiency/cost Sustainability (people & planet)
11. Biofuels	Managing complexity Reducing uncertainty	Vertical integration Collaboration with authorities Flexible sourcing and production	Flexibility Sustainability (planet)
12. Whisky	Reducing complexity and uncertainty	Reduce product mix and harmonize SKUs Implement postponement Customer & product segmentation	Efficiency/cost Improved service/ customer Lower inventory
13. Apparel	Reducing uncertainty of demand Reducing complexity of various channels	Outsource supply chain and logistics Collaborative forecasting & planning Segmentation of supply chains IT and ERP configuration	Efficiency/cost Improved responsiveness Customer
14. Mars, customers, and LSPs' brand collaboration	Establishing trust Shared benefits	Horizontal collaboration between retail customers Establish shared conviction through branding Share tools for collaboration between manufacturers and LSPs	Efficiency/cost Improved truck utilization Service/delivery reliability/ customer Sustainability – reduced emissions and energy
15. Chemical producer and customer joint tendering	Transportation costs reduction Gain-sharing Balance of flows	Joint tendering of single transport contract Drop and swap Collaboration	Efficiency/cost

CASE STUDY	ISSUE ADDRESSED	SUPPLY CHAIN PRACTICES	BENEFITS
16. DSM Engineering Plastics (DEP) and IDS – outsourcing logistics operation	Efficiency improvement	Outsourcing of logistics Linkage of DEP's ERP system to multiple TMSs Collaboration	Efficiency/cost Service/delivery reliability/ customer Efficient alternative to upgrading own systems
17. UCB, Baxter and TRI-VIZOR – third party facilitated horizontal collaboration	Costs, CO_2 and service	Truck-sharing on specific trade lanes Accurate identification of matching truck companies and freight flows Detailed processes, legal framework and operations Cloud-based collaborative ICT tower	Efficiency/cost Sustainability – reduced emissions and energy Service/delivery reliability/ customer
18. Bertschi and chemical producer – LLP concept	More transport productivity, less CO_2	"Lead Logistics Provider" manages contract, operations, finance, IT Redesign supply chain Producer and LLP collaborate to manage implementation progress	Efficiency/cost Modal shift – road to rail Sustainability – reduced emissions and energy Service/delivery reliability/ customer
19. Argonne / Dow RFID for Track & Trace	Safety in transport of nuclear, radioactive, and TIH products	Track & Trace	Improved safety and security Sustainability (people & planet)
20. Statoil/Dow RFID / Real-Time Location Systems	Monitoring of employees operating in hazardous environments	Track & Trace	Employee safety/ sustainability (people) Efficiency – e.g. time required to conduct mustering exercises
21. German Chemical Cluster ChemLog	Monitoring hazardous products in the intermodal supply chain	Track & Trace Modal switch Collaboration with authorities	Safety & security (people) Sustainability – reduced energy and emissions (planet)
22. SABIC Dynamic Sourcing	Volatile supply & demand Availability of transport capacity	Dynamic advanced information to carriers Collaboration	Service/delivery reliability/ customer Secure capacity Reduced empty legs – reduced energy/ sustainability (planet)
23. Lucite/Agility: End-to-end Supply Chain Optimization	Strategic sourcing Global manufacturing footprint	Decision support based on computer modeling Collaboration	Competitive advantage
24. McKinsey Quarterly: Big Data in Healthcare	Healthcare costs out of control	Application of technology to manage Big Data (increasing variety of data sources, and unstructured data format)	Improved risk sharing Results based More effective prescription of medicines and drugs/ customer

CASE STUDY	ISSUE ADDRESSED	SUPPLY CHAIN PRACTICES	BENEFITS
25. DSM/Samskip Composite Container	Improving container payload	Innovation in equipment design – lightweight construction Collaboration	Efficiency/cost Higher payload, easier to clean Sustainability – fewer loads, aerodynamic Reduced energy
26. Deen Shipping Y-Shaped Hull, and dual fuel	Improved barge efficiency and safety	Innovation in equipment design	Efficiency/cost Higher payload per tank/ customer Reduced emissions – sustainability (planet)
27. Franprix / Norbert Dentressangle barging products into Paris	Threat of future regulations restricting operations	Modal switch Change management Collaboration with authorities	Sustainability – limited air and noise pollution (people)
28. Innovative Supply Chain technologies delivered by ERP providers	Strategic competitiveness in IS Architecture advance	Business Information Systems Decision Support + Advanced Information	Competitive advantage Dependence on skilled resources
29. Qualcomm Driver Style Evaluation	Cost drivers of road transportation	Monitoring driver behavior	Improved driving style (people) Efficiency/cost Reduced energy – sustainability (planet) Safety
30. Qualcomm FleetFence	Tracking and reporting of transport status	Tracking shipments vs. defined criteria Exception-based reporting	Efficiency/cost Reduced km and emissions Reduced energy – sustainability (planet)
31. Dutch and Belgian Ports community systems	Logistics intelligence Transaction efficiency	Information exchange Data transparency Transactional automation Collaboration with authorities	Efficiency/cost More rapid throughput times/customer Dependent on regular employee training
32. Chemical Distribution Institute/Safety and Quality Assessment Systems (SQAS)	Improve safety and environmental performance of chemical logistics operations Reduce number of inspections	Standardized industry inspection schemes for logistics service providers	Improved safety and environmental performance – sustainability (planet) Efficiency – reduced number of inspections Customer Training (people)
33. Blue Road	Poor asset utilization	Collaboration Modal switch	Reduced road traffic Reduced emissions Reduced energy – sustainability (planet)

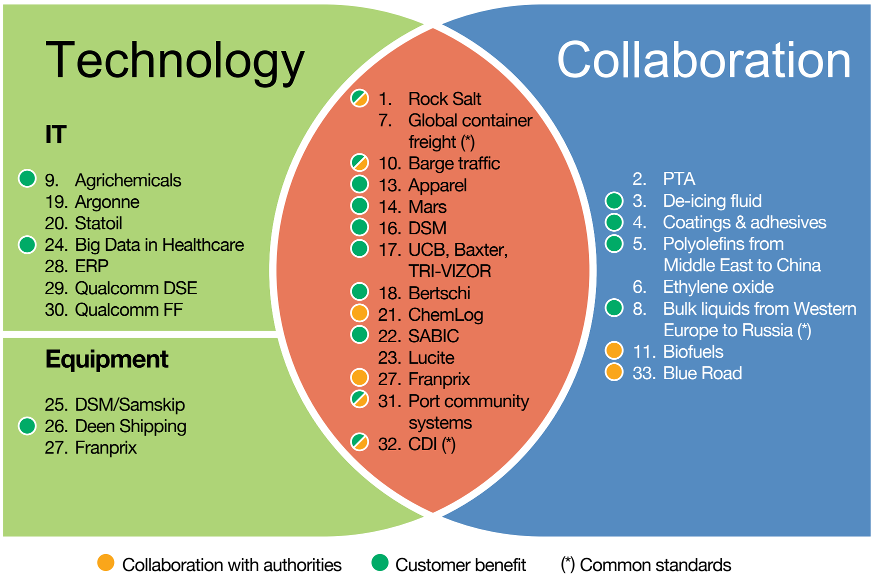
Table 6 – Comparative table for all report case studies using sustainability lens

Figure 7 - "People, planet, profit" benefits in all case studies

An overall review of the drivers of these good practice case studies reveals that whilst the majority of cases produced in this report address "profit", more than half thereof have a positive effect on "planet" and nearly half on "people". 21 % of cases reach the three sustainability goals of "people, planet, profit". The "people" effects consist of change management as well as the need for constant training and development in order to allow individuals to gain the skills required for collaborative approaches and the application of new technologies. Three cases address people's safety and security in connection with dangerous goods.

Figure 8 - 31 case studies integrating technology and/or collaboration, showing in addition collaboration with authorities, customer benefits and use of standards

The vast majority (70 %) of the case studies examined integrate the use of technology, mostly in the field of information exchange, whilst 67 % describe collaborative approaches. 42 % of all cases integrate both technology and collaboration and 8 cases describe collaboration with authorities. 52 % of all cases improve the quality of customer service. 3 cases promote common standards.



These good practice examples show that economic drivers, customer benefits and improvements in the environmental or social sustainability of the supply chain go hand in hand. They illustrate that the chemical industry can generate significant improvement in its sustainability performance through "people/planet/profit" targeted projects. These projects achieve at the same time important environmental sustainability gains through simplifying or better managing complexity and uncertainty, the use of new technology or improved use of existing technologies, and through more openness as well as pro-competitive collaboration in supply chain management. This is also evidenced in previous EPCA logistics efficiency studies, including such things as cost-to-serve and network analysis.

This report recognizes the importance of ensuring people in the supply chain have the right mindset and skills to leverage what is available and develop new technologies to deliver sustainable supply chains. In looking for building supply and logistics chains that conform to the "people" aspect of sustainability, there is a need to integrate the "Principle of Humanity" promoted by Hans Küng: "Being human must be the ethical yardstick for all economic action" (Hans Küng – "Manifesto for a Global Economic Ethic", Tübingen, Global Ethic Foundation, 2009, p.5). This refers to amongst others things the importance of respect and tolerance for others, respect for life, sustainable treatment of the natural environment and the core value of mutual esteem ("The Price of Civilization", Jeffrey Sachs, Random House, New York, 2011, p.181). This can be implemented by supporting the 10 UN Global Compact principles in the areas of human rights, labor, the environment and anti-corruption in supply and logistics chain operations (see www.unglobalcompact.org).

In the same context, an interesting initiative called "Together for Sustainability" (TfS) has been launched recently by 6 multinational leading chemical companies promoting sustainable development and supporting the principles of the United Nations Global Compact, Responsible Care as well as standards developed by the International Labor Organization (ILO), the International Organization for Standardization (ISO), Social Accountability International (SAI), and others.

The purpose of this initiative is to develop and implement a global supplier engagement program to assess and improve sustainability practices within the supply chain of the Chemical Industry. The member companies take responsibility for their own operations and in the sphere of their influence for their supply chains to support adherence to existing regulations and to respond to the needs and expectations of consumers and society.

Within the TfS audit and assessment process the supplier's sustainability performance is verified against a pre-defined set of criteria on management, environment, health & safety, labor & human rights, and governance topics. The objective of the member companies is to share supplier sustainability performance results and capacity building efforts and follow the mission "An audit for one is an audit for all". This reduces double efforts for members and suppliers and free resources for effective improvements.

Founded in August 2011 by the Chief Procurement Officers of BASF, Bayer, Evonik Industries, Henkel, Lanxess, and Solvay, TfS aims at building a collaborative platform for sustainable sourcing practices that is open for other sourcing and supplying organizations all over the world.

7. Conclusions

The chemical industry plays a key role in providing technical solutions to the ever increasing expectations from **society and governments regarding sustainability**. Similarly, the chemical industry needs to provide supply chain and logistics solutions that meet the sustainability strategies and expectations of its customers and other stakeholders.

For over 25 years, the chemical industry has intensified its voluntary efforts towards sustainability and has committed itself to the cause of sustainable development through various initiatives, such as Responsible Care. These efforts also apply to the logistics operations of the chemical industry. The challenge for individual chemical companies and their partners is to **build supply and logistics chains that simultaneously enable overall business strategies and are sustainable** in terms of "people, planet, profit". As many of the case studies in this report demonstrate, efforts to improve performance in one of the three aspects of sustainability often bring benefits to all three.

We live in a world of **rapid change**. Who, back in 1990, imagined the phenomenal enabling power contained in today's leading edge smart phones? Yet we are currently witnessing the advent of technologies such as 3D printing and nano-materials that both enable and increase customization and may well drive **a shift in the balance of chemical supply and logistics chains from business-to-business to business-to-consumer**. The evidence in this report suggests that this might happen sooner rather than later.

At the same time, we are also experiencing a **fundamental shift in the competitiveness of Europe's chemical industry**, due to high energy costs and limited local feedstock. To respond to the expected significant increases in imports of certain chemical materials, important adjustments will be required in European chemical supply chains and logistics. This underscores the increasing importance of chemical supply and logistics chains.

How can we deal with these challenges?

Many answers can be found in the methodologies and case studies contained in this report, and which are summarized in the *comparative case study table and Figures 7 and 8 included in Chapter 6*.

The issues of **complexity and uncertainty** as well as achieving **sustainable ("people, planet, profit") supply and logistics chains**, can be addressed and mitigated through **pro-competitive collaboration and the application of technology**.

- **Pro-competitive collaboration**
  The report shows that pro-competitive *vertical cooperation* with partners in supply and logistics chains may be a way of making outsourcing of logistics services more efficient whilst enhancing positive "people, planet, profit" effects. Pro-competitive *horizontal cooperation* can mitigate economic disadvantages and achieve sustainability goals sought by authorities or customers. Any form of cooperation, especially horizontal cooperation, needs to be fully compliant with competition law. More openness and increased pro-competitive collaboration in the supply chain include local, regional and national authorities.

- **Technology**
  Openness and collaboration in supply and logistics chains are enabled by rapidly and constantly evolving **technological developments**, resulting from business initiatives and reinforced by the pressure of authorities and customers to reduce energy consumption and emissions in supply chain operations. In this respect, effective communication between partners in a collaborative scheme will be enabled by the application of *common standards*.
  The organization of chemical supply and logistics chains may be revolutionized by the introduction of technologies enhancing customization with B2B becoming B2C for certain product segments. The report also shows that equipment development for supply and logistics chain operations contributes to the reduction of energy use and emissions, therefore benefiting all stakeholders.

The cases reproduced in this report show that pro-competitive collaboration and the application of new technologies or the better use of existing technologies, can decrease cost and improve efficiency, while at the same time delivering improved customer service and reducing energy consumption and emissions. Efficiency improvements will lead to the optimization of assets and organizational productivity. In the latter context, this report underscores the importance of individuals in business success and the need to address, in a timely manner, any training gap in the supply chain and logistics segment. It also suggests applying Hans Küng's Principle of Humanity in the building and implementation of chemical supply and logistics chains (Hans Küng – "Manifesto for a Global Economic Ethic", Tübingen, Global Ethic Foundation, 2009) as well as the implementation of the 10 Global Compact principles therein (see www.unglobalcompact.org).

Appendix

8.1. Checklist for Potential Collaborators

Exploration phase – Prepare the collaboration	
Identify win-win situations	
An active and structured search for potential collaboration partners has been conducted	❐
Actions are taken to facilitate collaborations, e.g. synchronized contract start and end dates	❐
All organizational departments involved are cooperating and driving corporate benefits	❐
A fair mechanism for sharing the benefits has been agreed upon with all partners	❐
Build a clear business case	
Implications of data sharing on competition laws are checked	❐
Full transparency of benefits, costs and investments for all partners is established	❐
Own data and data from all partners can be trusted	❐
An accurate business case based on quality data is defined and communicated	❐

Assimilation phase – Set up the collaboration	
Choose the right model/set-up	
A pilot project has proven the feasibility and the benefits of the collaboration	❐
All partners agree and commit to share all relevant data for the collaboration	❐
The feasibility of a neutral mediator to facilitate the collaboration has been considered	❐
The required infrastructure such as IT or technology is in place or plans to introduce it have been agreed	❐
Establish clear rules	
A legal framework that defines information to be shared has been established	❐
The legal framework has been checked with respect to anti-trust regulations	❐
Clear decision processes and responsibilities are set up in case of special events	❐
Non-conformant behavior can be monitored and sanctioned by (pre-)defined measures	❐
Rules and set-up are pragmatic and allow for adaptation to changing environments	❐

Realization phase	
Track and monitor progress and results	
KPIs to effectively track the benefits are clearly defined and agreed upon by all partners	❒
Regular review meetings at management level with all partners are defined	❒
A structured feedback process between all levels of the collaboration partners is in place	❒
KPI deviations are utilized systematically and regularly to trigger actions within the collaboration management	❒
Maintain buy-in and commitment	
Top management's buy-in and commitment to the collaboration are achieved	❒
Stakeholders such as supply chain units, logistics entities and purchasing departments demonstrate a positive attitude towards the collaboration	❒
People selections for key positions have been made considering the high impact of fit and personal chemistry	❒
Issues beyond KPI deviations are openly discussed and jointly resolved within the steering group and at working level	❒

8.2. Index of case studies

8.3. Index of tables

8.4. Index of figures

8.5. European Commission Roadmaps

The **European Commission Roadmap** identifies 40 concrete initiatives for the next decade with the aim of creating a **Single European Transport Area** with more competition and a fully integrated transport network linking the different modes and allowing for a profound shift in transport patterns for passengers and freight. At the same time, the proposal is intended to dramatically reduce Europe's dependence on imported oil and cut transport carbon emissions by 60 % by 2050.

By 2050, key goals will include:

- No more conventionally-fuelled cars in cities
- 40 % use of sustainable low carbon fuels in aviation; at least 40 % cut in shipping emissions
- 50 % shift of medium distance intercity passenger and freight journeys from road to rail and waterborne transport

All of this will contribute to a 60 % cut in transport emissions by the middle of the century.

The above will be achieved by:

- Developing and deploying new and sustainable fuels and propulsion systems
- Optimizing the performance of multimodal logistic chains, including by making greater use of more energy-efficient modes
- Increasing the efficiency of transport and of infrastructure use with information systems and market-based incentives (such as the application of "user pays" and "polluter pays" principles)

A **transformation of the current European transport system** will only be possible through a combination of initiatives at all levels and covering all transport modes.

- In rail transport, the initiatives include the development of a Single European Railway Area, opening the domestic rail passenger market to competition, and establishing an integrated approach to freight corridor management.
- In maritime transport, the European Maritime Transport Space without Barriers would be further developed into a "Blue Belt" of free maritime movement both in and around Europe, with waterborne transport being used to its full potential.
- In road transport, the initiatives include the review of the market situation of road freight transport as well as the degree of convergence on road user charges, social and safety legislation, and transposition and enforcement of legislation in EU countries. The EU particularly focuses on internalizing external cost, which means road haulage will in future have to pay for pollution and congestion.

Glossary

3PL	Third Party Logistics Company
4PL	Fourth Party Logistics Company
ADEME	French Environment and Energy Management Agency
B2B	Business to Business
BBS	Behavior-Based Safety (programs)
Capex	Capital expense
CCNR	Central Commission for the Navigation of the Rhine
CDI	Chemical Distribution Institute
Cefic	European Chemical Industry Council
CO_2	Carbon Dioxide
CRM	Customer Relationship Management
DC	Distribution Center
DOE TRANSCOM	TRANSCOM is the Department of Energy (DOE) unclassified Tracking and Communication Web Application that is used to monitor the progress of “high visibility” shipments, such as spent nuclear fuel, high-level and Transuranic radioactive waste. Authorized TRANSCOM users, such as DOE shippers, carriers, state and local governments and various federal agencies, can access the web application from their PC or from any mobile device
ECTA	European Chemical Transport Association
EDI	Electronic Data Interchange
EPC	The Electronic Product Code (EPC) is designed as a universal identifier that provides a unique identity for every physical object anywhere in the world, for all time. Its structure is defined in the EPCglobal Tag Data Standard, which is an open standard freely available for download from the website of EPCglobal, Inc.
EPCA	European Petrochemical Association
ERP	Enterprise Resource Planning systems, e.g. SAP, ORACLE, BAAN
Galileo	European Satellite Navigation System
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GPS	Global Positioning System
HAZOP	Hazardous Operations

IBC	Intermediate Bulk Container
ICE	International Chemical Environment
ICT	Information and Communications Technology
IoT	Internet of Things
IT	Information Technology
ITS	Information Technology System / Solutions / Services
KPI	Key Performance Indicator
LLP	Lead Logistics Provider
LSP	Logistics Service Provider
POS	Point of Sale
PPE	Personal Protective Equipment
PTA	Purified Terephthalic Acid
PU	Polyurethane
RFID	Radio Frequency Identification
Ro-Ro	Roll on, roll off (Marine Ferry)
S2S	System-to-System connectivity
S&OP	Sales & Operations Planning
SAP APO	SAP's Advanced Planner and Optimizer
SKU	Stock Keeping Unit
SLA	Service Level Agreement
STTP	(EU) Strategic Transport Technology Plan
SQAS	Safety and Quality Assessment System
T&T	Track & Trace
TEN-T	Trans-European Transport Network
TMS	Transport Management System
UWB	Ultra Wide Band
VCI	Verband der Chemischen Industrie (German Chemical Industry Association)
VMI	Vendor Managed Inventory
ZigBee	ZigBee is a specification for a suite of high-level communication protocols using small, low-power digital radios based on an international standard for personal area networks. ZigBee devices are often used in mesh network form to transmit data over longer distances, passing data through intermediate devices to reach more distant ones. This allows ZigBee networks to be formed ad-hoc, with no centralized control or high-power transmitter/receiver able to reach all of the devices. Any ZigBee device can be tasked with running the network.

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Working Group 1 – Complexity and uncertainty

Chair: Neil Moon (Agility)

Participants: Karim Amyuni (Booz & Company); Philip Browitt (Chainology); Luc Cassier (Bertschi AG); Cathy Demeestere (EPCA); Klaus Exinger (Bayer MaterialScience); Peter Baltussen and Michel Pieters (Dow); Duncan Faile (Shell); Paul Gooch (The Logical Group); Joris Hurenkamp (Port of Rotterdam); Xavier Vanrolleghem (Antwerp Port Authority); Toon Bruining and Koert van Wissen (Interbulk Group); and Prof. Dr. Ann Vereecke (Vlerick Business School and Ghent University).

Working Group 2 – Technology as an enabler of sustainable supply chains

Chair: Jérôme Burtin (formerly with Norbert Dentressangle), succeeded by Paul Gooch (The Logical Group)

Participants: Wouter Bleukx (Ineos); Roger Bloemen (formerly with Solutia); Dennis Bontes (Bertschi AG); Philip Browitt (Chainology); Cathy Demeestere (EPCA); Jens Holger Nielsen, Rafael Jimenez and Inigo Rengifo Abbad (Repsol); Brigitte Spetgens-Limpens (SABIC Europe); Prof. Dr. Hendrik Vanmaele (Möbius Consulting and Professor at Ghent University); and Mark Warner (Qualcomm Enterprise Services Europe).

Working Group 3 – Pro-competitive collaboration

Chair: Frank Andreesen (Bayer MaterialScience)

Participants: Philip Browitt (Chainology); Cathy Demeestere (EPCA); Johan Devos (Bertschi AG); Patrick Hore and Andreas Janetzko (DB Schenker); Günther-Friedrich Maas and Thorsten Reichel (Hoyer); Roger Murray (Huntsman); Dr. Walther Ploos van Amstel (University of Amsterdam); Ingo Schroeter and Christian Gasparic (A.T. Kearney); Ralf Spangenberger (Evonik); Jos Verlinden (Cefic); Pieter den Hartogh and Jacco van Holten (Den Hartogh Logistics); Martijn Vermunt (Shell); and Andreas Zink (LKW Walter International).

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The EPCA **steering group**, comprising members of the EPCA Supply Chain Committee and one EPCA Board member, had a major role in initiating the process and monitoring the working group discussions.

EPCA Steering Group

Coordinator: Philip Browitt (Chainology)

Working group chairs: Frank Andreesen (Bayer MaterialScience) (Working Group 3); Jérôme Burtin (formerly with Norbert Dentressangle and former member of the EPCA Supply Chain Program Committee) succeeded by Paul Gooch (The Logical Group) (Working Group 2); and Neil Moon (Agility) (Working Group 1).

Other participants: Raf Bemelmans (SABIC Europe, and Chairman of the EPCA Supply Chain Program Committee); Dr. Hans-Jörg Bertschi (Bertschi AG and EPCA Treasurer as well as EPCA Board member); Romuald de Haut de Sigy (Arkema); Cathy Demeestere (EPCA); Jens Holger Nielsen (Samskip Multimodal Container Logistics); and Jos Verlinden (Cefic).

Many of these people were also part of the editorial board that merged the three working group reports into one.

The making of this report has been very challenging and gratifying. We hope that the learning that can be gained from it will inspire the readers.

May this report contribute to the establishment and implementation of “state of the art” supply and logistics chains adapted to the evolving needs of the chemical business community.

Cathy Demeestere
Secretary General

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