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ICT and e-Business Impact in the **Chemical, Rubber and Plastics Industry**

Study report
No. 01/2008

European Commission, DG Enterprise & Industry

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ICT and e-Business Impact in the Chemical, Rubber and Plastics Industry

A Sectoral e-Business Watch study by

empirica GmbH

Final Report

Vs. 4.0

September 2008

This report was prepared by empirica GmbH on behalf of the European Commission, Enterprise & Industry Directorate General, in the context of the "Sectoral e-Business Watch" programme. The Sectoral e-Business Watch is implemented by empirica GmbH in cooperation with Altran Group, Databank Consulting, DIW Berlin, IDC EMEA, Ipsos, GOPA-Cartermill and Rambøll Management based on a service contract with the European Commission.

About the Sectoral e-Business Watch and this report

The European Commission, Enterprise & Industry Directorate General, launched the Sectoral e-Business Watch (SeBW) to study and assess the impact of ICT on enterprises, industries and the economy in general across different sectors of the economy in the enlarged European Union, EEA and Accession countries. SeBW continues the successful work of the *e-Business W@tch* which, since January 2002, has analysed e-business developments and impacts in manufacturing, construction, financial and service sectors. All results are available on the internet and can be accessed or ordered via the Europa server or directly at the SeBW website (www.europa.eu.int/comm/enterprise/ict/policy/watch/index.htm, www.ebusiness-watch.org).

This report presents the results of a sector impact study, focusing on electronic business in the chemical, rubber and plastics industry. The study describes how companies use ICT for conducting business, and, above all, assesses implications thereof for firms and for the industry as a whole. The findings are based on an international survey of enterprises on their ICT use, case studies and an econometric analysis of the ICT impact on productivity growth in the sector.

Disclaimer

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Executive Summary

About this study

This study by the Sectoral e-Business Watch focuses on ICT usage and e-business in the chemical, rubber and plastics products (CRP) industries. The main study objectives are to describe how companies in this industry use information and communication technology (ICT) for conducting business, to assess impacts of this development for firms and for the industry as a whole, and to indicate possible implications for policy. The analysis is based on literature, an international survey of 911 enterprises from the sector on their ICT usage, expert interviews and case studies.

The sector at stake

The CRP industries as defined for this study cover the following business activities: the **manufacture of chemicals**, chemical products and man-made fibres (NACE Rev. 2 20), and the manufacture of **rubber and plastic products** (NACE Rev. 2 22) – see Section 2.1.[1] It is one of the largest manufacturing sectors, providing jobs for about three million people in the EU. As a major supplier to many other industries, and as a provider of innovative materials and technological solutions, the sector plays an important role for the industrial competitiveness as a whole. Europe is still a major player in the global CRP market, but experiences increasing competition notably from Asian competitors. In the total CRP industries, the EU had a positive trade balance in 2006 with a surplus of about €36 billion (for the EU-27). The chemical industry accounted for most of the surplus (see Section 2.2).

Besides global competition, **key challenges** for the European industry are rising costs of energy and raw materials, coping with new environmental and safety regulations (notably with the implementation of REACH), having access to raw materials, and (for some segments of the sector such as the tyre industry) combating counterfeiting. An important goal for European policy in this context is to ensure a level playing-field, i.e. that EU exporters do not face obstacles which their competitors, when importing into the EU, do not experience (see Section 2.3).

"e-Readiness" of companies has significantly improved

The quality of companies' **ICT infrastructure** has significantly improved since the last measurement by e-Business Watch in 2003, in particular among small and medium-sized enterprises (SMEs) – see Sections 3.1 and 3.2. Examples to demonstrate this include:

- The share of small firms (with 10-49 employees) that have broadband internet connections has increased from 10% (2003) to nearly 40% (2007).
- The diffusion of Wireless LAN (W-LAN) technology has surged; close to 60% of employees in the sector work in companies that operate a W-LAN.
- The share of companies that enable remote access to their computer network –to support mobility and flexible forms of work– has significantly increased.

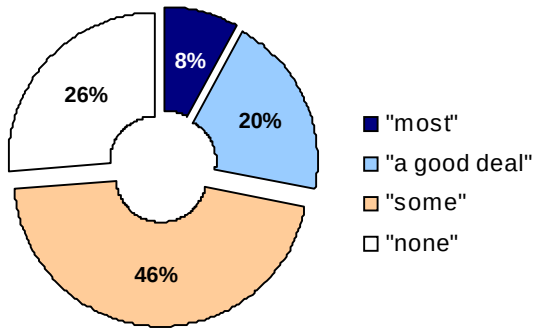
The digitisation of business processes – a highly dynamic development

The improved ICT infrastructure enables companies to introduce more advanced forms of e-business. In fact, the study finds that companies in the sector are increasingly replacing paper-based, manual processes by electronic exchanges. "Real e-business" based on **automated data exchanges** between players in the value network is now evolving at fast pace, empowered by the increased diffusion of e-business software systems.

[1] NACE Revision 2 is a four-digit classification of business activities. It is a revision of the "General Industrial Classification of Economic Activities within the European Communities", known by the acronym NACE and originally published by Eurostat in 1970. NACE Rev. 2 replaced version Rev. 1.1 on 1 January 2008.

More than a quarter of the companies (by their share of employment) feel that at least a good deal of their exchanges with business partners are conducted electronically; three quarters say that at least some of their processes are conducted as e-business (see Section 3.3).

% of companies saying that most / a good deal / some / none of their business processes are conducted as e-business (2007)



The following results of the e-Business Survey 2007 are indicators of the dynamic development of e-business in the sector:

- The installed base of **ERP** (enterprise resource planning) and **SCM** (supply chain management) systems among companies in the sector has significantly increased since 2003. These advanced software systems enable the digital integration within the supply chain.
- **e-Invoicing** on the rise: companies are increasingly sending and receiving invoices electronically. 33% send invoices directly from their computer system to that of a business partner. Adoption will further increase, as large firms impose e-invoicing on their SME trading partners.
- More **e-procurement**: about 70% of the companies (by employment) place at least some of the orders to suppliers online, up from about 50% in 2003. The average share of supplies ordered online has also increased.

A sector-specific ICT opportunity is to facilitate REACH compliance: software vendors of ERP, corporate governance and risk management software are developing specific modules for this purpose.

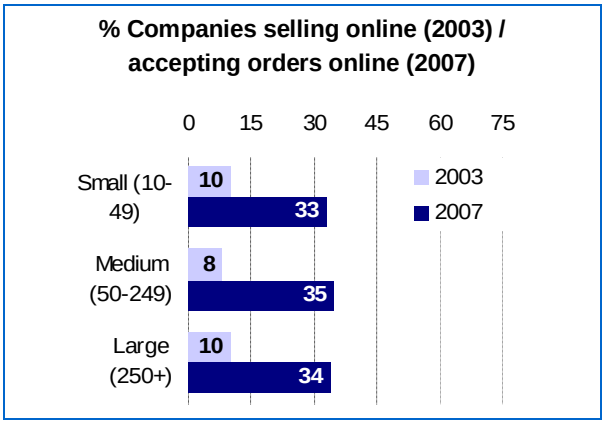
e-Standards and intermediaries facilitate electronic data exchange

Advanced forms of e-business require the agreement on standards for data exchanges; this includes identification, classification, catalogue exchange, transaction and business process standards. **Chem eStandards**, developed by CIDX (an industry-led non-profit organisation focusing on e-business), are the main data exchange format in advanced e-business exchanges in the sector. In contrast to other sectors, this industry-led initiative was successful in establishing an industry-specific standard facilitating data exchanges (see Section 3.4). Many e-business solutions for the chemical industry are compatible with Chem eStandards.

Business process outsourcing to intermediaries is an opportunity to increase the efficiency and productivity. Interoperability challenges have led to the emergence of specialised service providers, which can help companies significantly in connecting digitally. Elemica (see case study, 5.3) is the leading connectivity hub for the sector, matching document delivery and receipt formats between sellers and buyers for a range of processes. e-Procurement solution providers such as cc-hubwoo are working in the line of traditional e-marketplaces. Finally, there are highly specialised service providers focusing on specific business processes such as e-invoicing (see case study on Acordis and OB10, Section 5.1). These intermediaries enhance the deployment of e-business activity, but mostly between large enterprises and within the sector. The new challenge is to expand connectivity to the numerous smaller companies, and between sectors.

From transactions to solutions: the focus on customer service

A forecast of an earlier e-Business Watch study (2004) can be confirmed: there has been a significant uptake of **e-commerce activity** in the past few years in the CRP industries (see Section 3.5). Evidence for this development is that an increasing number of companies offer their products online. About a third of all companies –irrespective of their size– enable customers to order products online (2007), compared to only 10% that said they sold products online in 2003.



In parallel, the intensity of this activity, measured as the average share of orders that are received online, has surged since 2003. The Sectoral e-Business Watch estimates (based on estimates obtained from companies in the survey) that the average share of online sales in the sector –considering those companies that engage in this activity– has increased from about 5-8% (2003) to about 25-30% (2007).

The dynamic adoption of marketing and sales related e-business activities can be regarded as part of an enormous effort companies are undertaking to optimally **serve their customers**. The general trend is to move from merely conducting transactions electronically ("e-commerce") to providing "**e-solutions**" to customers. This comprehensive approach to e-business focuses on providing integrated services such as enhanced access to a wide range of order-related information, for example about the order status and about products which customers have purchased (see case study on BASF, Section 5.2).

Technically, companies can take different routes to e-commerce. Large players usually practice for a **multi-channel approach**. They connect with some business partners via EDI, use Elemica to connect to others and operate sophisticated extranet customer portals, mainly as a customer service for SMEs. These portals typically offer customers a holistic view of their orders and access to all kinds of order-related information. The objective is to offer customers several options how to conduct the business, while at the same time keeping focused on the efficiency of processes. In short, e-business solutions are becoming indispensable tools to meet **customer expectations** and to do enter new markets abroad.

The impact of ICT and e-business: mixed findings

The empirical evidence does note allow straight forward conclusions on the economic impact of ICT. There is **mixed evidence** in this regard: micro-data and case studies point towards a high importance of ICT and e-business, but this is not confirmed by macro-economic analysis for the industry as a whole.

Macro-economic evidence: no pronounced ICT impact on productivity and growth in the CRP industries

An economic analysis based on productivity and growth accounts (macro data) did not find convincing evidence for substantial productivity or growth effects of ICT capital in this sector (see Section 4.1). Growth accounting for the CRP industries in nine EU Member States suggests that non-ICT-capital investments contributed to a higher extent to **value added growth** in the CRP industries than those in ICT-capital (1995-2004), even if ICT-capital also contributed positively in most of the Member States for which data were available. Also, the key driver for **labour productivity growth** (measured as gross production value per working hours) was found to be intermediate inputs intensity, rather than ICT capital.

However, there are some caveats. The econo-metric analysis conducted for this study is based on "ICT capital" as input factor, which is (roughly) defined as investments in information and communication technology products and software, on the basis of selected NACE groups. This does not include all forms of "**embedded ICT**", i.e. ICT components that are embedded in other infrastructure such as the complex equipment of chemical plants. Also, there may be a time lag between ICT adoption and the impact on productivity and growth, which may be fully reflected by the analysis.

Micro-economic evidence: high relevance of ICT for innovation and business process efficiency

On the other hand, case studies and the firm survey conducted for this study (i.e. micro-data evidence) indicate a dynamic development of e-business in the sector. ICT have become a **general purpose technology** that is widely used across all business functions (see Sections 3.1 – 3.5, 6.1).

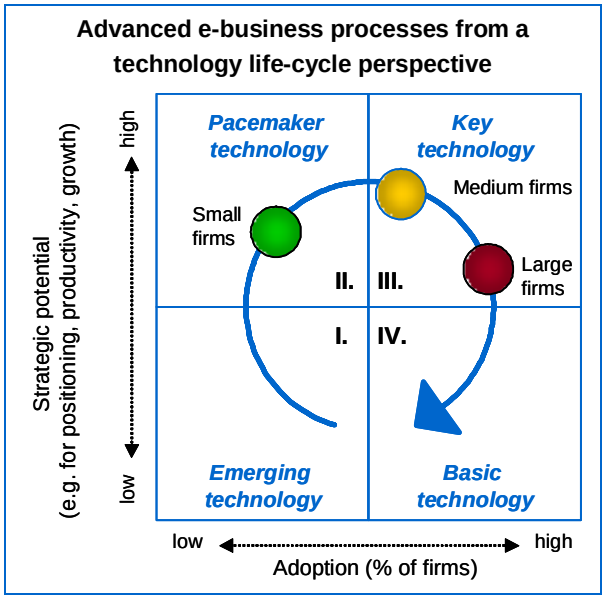
A regression analysis how specific ICT-related factors are linked with **innovation** activity found significant links between e-business activity and the likelihood of conducting innovations (see Section 4.2). While ICT hardware endowment (measured in terms of network infrastructure usage and internet access) by itself is not correlated with the likelihood of introducing organisational changes, the use of **software applications** for e-business is highly correlated. Moreover, Firms with a higher incidence of ICT-enabled innovation activity are more likely to report a turnover increase, i.e. to have experienced a sales growth. (This finding does not claim to establish a direct causality, though.)

ICT impact on competition: About 45% of companies (by employment) believe that ICT has an impact on competition in their sector. Most of them argue that competition has "somewhat increased" due to ICT. However, the assumption that a (perceived) increase in market rivalry triggers ICT adoption (as a measure to withstand the pressure) is difficult to verify by means of simple regression analysis. Companies from the CRP industries that experience an increasing intensity in market competition do not use more ICT than companies feeling that the degree of competition is stable (see Section 4.3)

Outlook

Although the study cannot confirm an immediate economic impact of ICT capital on productivity and growth in the sector, there is much evidence smart use of e-business matters for the **competitiveness** of companies. The importance of an adequate **e-business strategy** will probably further increase. A majority of the companies interviewed for this study are convinced that ICT will actually have an impact on the way they do business in the years to come, in practically all areas of business (see Section 6.1).

This reflects the untapped potential of more advanced forms of e-business. Most companies in the CRP industries, including the smaller ones, have adopted basic ICT infrastructure. There is little strategic potential to be gained from this type of ICT infrastructure in itself; it has become a basic technology for doing business: a "commodity". By contrast, more advanced forms of e-business are not yet as widely deployed and hold a higher strategic potential for many companies, notably for SMEs. Practices such as the exchange of standardised data with suppliers and customers, and the integrated processing of data between different segments can be means to gain competitive advantage. Technologies and applications supporting these processes can be expected to become key technologies for SMEs in the years to come (see Section 6.1).



Policy implications

The empirical evidence do note allow straight forward conclusions whether and to what extent there is a need for ICT-related policy initiatives specifically for the chemical, rubber and plastics industry, as the evidence on ICT impact is mixed (see above). Moreover, the chemical industry is confronted with urgent and highly complex challenges that are not directly related to ICT, such as the rising costs of raw materials and energy, the compliance with new environmental regulations, and increasing global competition (see Section 2.2). These challenges pose, by all measures, more direct concerns for industrial policy than the use of ICT.

Nonetheless, micro-data and case study evidence (see Sections 3 and 5) points towards a rising importance of e-business for the competitiveness of companies and, ultimately, industries. This should not just be ignored. It can be argued that evolutionary ICT-enabled innovation processes should be accelerated by appropriate measures, in order to **sustain and**

enhance the –still existing– **competitive advantage** of the European CRP industry. ICT infrastructure and e-business can be seen as an important factor condition for an economy to achieve competitive advantage, in particular in the emerging knowledge economy.

From a systemic perspective, (European) policy measures in this field should be embedded within the broader policy framework of the European Commission's DG Enterprise and Industry for promoting sustainable industrial development and the competitiveness of European industry, in which innovation plays a central role. They should also be linked with the recommendations of the High Level Group (HLG) on the Competitiveness of the European Chemicals Industry, which was set up by the Commission in June 2007.

The study proposes four lines of possible action to enhance and exploit ICT-driven innovation potential in the CRP industries (see Section 6.3):

e-Skills related actions (I): improving the managerial understanding of e-business among smaller companies

The study confirms that there is still a "digital divide" between large and small companies in e-business practices, notably when it comes to advanced forms of data exchange. Case studies demonstrate that, in smaller companies, the understanding and commitment of the management is a critical factor for introducing ICT-based innovation in the firm. There is a wide range of instruments to raise awareness and to promote the understanding of e-business concepts among this target clientele.

The study recommends to support such activities. Possible measures include the collection and wide dissemination of **best e-business practices** among SMEs in the sector, and grant schemes for SME projects (ideally combined with documentation of best practices afterwards).

e-Skills related actions (II): strategies and new educational schemes to ensure the adequate supply of ICT and e-business professionals in Europe

The study results show the importance of a good skills base. A shortage of ICT and e-business professionals would not only affect the ICT industry itself, but also larger companies in the ICT using sectors. First, they face difficulties in finding professionals for their own IT departments and e-business operations. Second, a shortage of professionals among ICT service providers negatively affects the quality of the services offered to their customers. The study recommends a close cooperation of policy, educational organisations and the ICT industry, typically in the form of "**multi-stakeholder-partnerships**",[2] to address this challenge.

Further harmonisation of the regulatory framework for e-business in Europe

In specific areas, existing regulatory frameworks can be difficult to apply to new ways of electronic data exchange, which can lead to legal uncertainty for business and hinder innovation. It is the main responsibility of policy to address such issues and thus create a favourable overall framework for ICT usage. The study recommends to sustain and enhance existing efforts to solve related problems, for example with regard to cross-border e-invoicing.

Explore opportunities to facilitate REACH compliance by use of ICT

The study concludes with a sector-specific recommendation. It proposes to carefully consider the **potential of ICT** to make the technical implementation of the **REACH regulation** as efficient as possible – for both sides, the companies and the regulatory authorities. Goals should be to ensure that solutions offered by service providers effectively meet the legal requirements and are widely used by enterprises, including SMEs. Means to address this include stakeholder coordination initiatives, involving the ICT industry and federations from the CRP sector, and the provision of targeted information about opportunities to SMEs.

[2] A study by the EC, DG Enterprise and Industry, on "Multi-stakeholder-partnerships for e-skills" (2007) has assessed different approaches, identified best practices and made recommendations how to establish and sustain MSPs.

1 Introduction

This study focuses on the adoption and implications of e-business practice in the chemical, rubber and plastics (CRP) industries. It describes how companies in this sector use information and communications technology (ICT) for conducting business, assesses the impact of ICT for firm performance in a context of global competition, and points at possible implications for policy. The analysis is based on literature, interviews with industry representatives and experts, company case studies and a telephone survey among decision-makers in European enterprises from the CRP industries. The study takes into account results of earlier sector studies on the CRP industries, published by *e-Business W@tch* in 2003 and 2004.[3]

Study structure

The study is structured into **six main sections**. Chapter 1 explains the background and context *why* this study has been conducted: it introduces the Sectoral e-Business Watch (SeBW) programme of the European Commission, a conceptual framework for the analysis of e-business, and the specific methodology used for this study. Chapter 2 provides some general information and key figures about the CRP industries in Europe. Chapter 3 describes the current state-of-play in e-business in this industry, focusing on specific ICT-related issues that were found to be particularly relevant to this sector. Chapter 4 assesses the impact of the developments described in chapter 3 on work processes and employment, innovation and productivity, and –at sector level– on value chain characteristics. Chapter 5 presents company case studies. These have been selected as practical examples and evidence for the issues discussed in chapters 3 and 4. Chapter 6, finally, summarises the key findings and draws conclusions on policy implications that could arise from the observed developments.

Combining descriptive and analytical approaches

The study approach is exploratory, descriptive and explanatory, applying a broad methodological basis: A **qualitative** case study approach (Chapter 5) is combined with a descriptive presentation of **quantitative** survey data (Chapter 3) and an **economic analysis** of ICT adoption and its impacts (Chapter 4). This threefold approach is meant to produce an in-depth understanding of current e-business practice in the industry, while also assessing the economic effects of this practice, for instance on firm productivity and innovation. While the results from these different approaches are presented like self-sustained pieces of research in separate chapters, they are intertwined and cross-referenced.

[3] The previous study reports on the CRP industries are available at the Sectoral e-Business Watch website at http://www.ebusiness-watch.org/studies/on_sectors.htm.

1.1 The Sectoral e-Business Watch

Mission and objectives

The "Sectoral e-Business Watch" (SeBW) studies the adoption, implications and impact of electronic business practices in different sectors of the economy. It continues activities of the preceding "*e-Business W@tch"* which was launched by the European Commission, DG Enterprise and Industry, in late 2001, to support policy in the fields of ICT and e-business. The SeBW is based on a Framework Contract and Specific Contract between DG Enterprise and Industry and empirica GmbH, running until June 2008, with a possible extension of 16 months for two times.

In ICT-related fields, DG Enterprise and Industry has a twofold mission: "*to enhance the competitiveness of the ICT sector, and to facilitate the efficient uptake of ICT for European enterprises in general*." The services of the SeBW are expected to contribute to these goals. This mission can be broken down into the following main objectives:

- to assess the **impact of ICT** on enterprises, industries and the economy in general, including the impacts on productivity and growth, and the role of ICT for innovation and organisational changes;
- to highlight **barriers for ICT uptake**, i.e. issues that are hindering a faster and/or more effective use of ICT by enterprises in Europe;
- to identify and discuss **policy challenges** stemming from the observed developments, notably at the European level;
- to engage in **dialogue with stakeholders** from industry and policy institutions, providing a forum for debating relevant issues.

By delivering evidence on ICT uptake and impact, the SeBW is to support informed policy decision-making in these fields in several policy domains including innovation, competition and structural policy.

Policy context

The initial *e-Business W@tch* programme was rooted in the **eEurope Action Plans** of 2002 and 2005. The eEurope 2005 Action Plan had defined the goal "*to promote take-up of e-business with the aim of increasing the competitiveness of European enterprises and raising productivity and growth through investment in information and communication technologies, human resources (notably e-skills) and new business models*".[4]

The **i2010 policy**[5], a follow-up to eEurope, also stresses the critical role of ICT for productivity and innovation, stating that "*… the adoption and skilful application of ICT is one of the largest contributors to productivity and growth throughout the economy, leading to business innovations in key sectors*" (p. 6). The Communication anticipates "*a new era of e-business solutions*", based on integrated ICT systems and tools, which will lead to an increased business use of ICT. However, it also warns that businesses "*still*

[4] "eEurope 2005: An information society for all". Communication from the Commission, COM(2002) 263 final, 28 May 2002, chapter 3.1.2.

[5] "i2010 – A European Information Society for growth and employment." Communication from the Commission, COM(2005) 229 final.

face a lack of interoperability, reliability and security", which could hamper the realisation of productivity gains (p. 7).

In February 2005, the European Commission proposed a **new start for the Lisbon Strategy**. While it recommended changes in the governance structures, i.e. the way objectives are to be addressed, the overall focus on growth and jobs remained unchanged. Some of the policy areas of the renewed Lisbon objectives address ICT-related issues. Central Policy Area No. 6 deals with facilitating ICT uptake across the European economy. Policy-makers in this area will require thorough analysis of ICT uptake based on accurate and detailed information on the most recent developments. Such evidence-based analysis is also needed when targeting individual sectors to fully exploit the technological advantages, in alignment with Central Policy Area No. 7 "Contributing to a strong European industrial base". Furthermore, Guideline No. 9, addressed to Member States, encouraging the widespread use of ICT,[6] can be effectively addressed only if actions are based on understanding of the potential for and probable effectiveness of interventions.

"ICT are an important tool ..."

"More efforts are needed to improve business processes in European enterprises if the Lisbon targets of competitiveness are to be realised. European companies, under the pressure of their main international competitors, need to find new opportunities to reduce costs and improve performance, internally and in relation to trading partners. ICT are an important tool to increase companies' competitiveness, but their adoption is not enough; they have to be fully integrated into business processes."

Source: European Commission (2005): Information Society Benchmarking Report

Also in 2005, in consideration of globalisation and intense international competition, the European Commission launched a **new industrial policy**[7] to create better framework conditions for manufacturing industries in the coming years. Some of the policy strands described have direct links to ICT usage, recognising the importance of ICT for innovation, competitiveness and growth.

The SeBW is one of several policy instruments used by DG Enterprise and Industry in this context. Other instruments include

- the e-Business Support Network (**eBSN**), a European network of e-business policy makers and business support organisations,
- the **eSkills Forum**, a task force established in 2003 to assess the demand and supply of ICT and e-business skills and to develop policy recommendations,

[6] "Working Together for Growth and Jobs: a New Start for the Lisbon Strategy", Communication, COM (2005) 24, Brussels, 02.02.2005. Available at http://europa.eu.int/growthandjobs/pdf/COM2005_024_en.pdf.

[7] "Implementing the Community Lisbon Programme: A Policy Framework to Strengthen EU Manufacturing - towards a more integrated approach for Industrial Policy." Communication from the Commission, COM(2005) 474 final, 5.10.2005.

- the **ICT Task Force**, a group whose work is to draw together and integrate various activities aiming to strengthen Europe's ICT sector, and
- activities in the areas of **ICT standardisation**, as part of the general standardisation activities of the Commission.[8]

In parallel to the work of the SeBW, the "**Sectoral Innovation Watch**" (see www.europe-innova.org) analyses sectoral innovation performance and challenges across the EU from an economic perspective. Studies cover, inter alia, the following sectors: chemical, automotive, aerospace, food, ICT, textiles, machinery and equipment.

Scope of the programme

Since 2001, the SeBW and its predecessor "e-Business W@tch" have published e-business studies on about **25 sectors**[9] of the European economy, annual comprehensive synthesis reports about the state-of-play in e-business in the European Union, statistical pocketbooks and studies on specific ICT issues. All publications can be downloaded from the programme's website at www.ebusiness-watch.org. In 2007/08, the main studies of the SeBW focus on the following 10 sectors and specific topics:

No.	Sector / topic in focus	NACE Rev. 1.1	Reference to earlier studies by SeBW
1	Chemical, rubber and plastics	24, 25	2004, 2003
2	Steel	27.1-3, 27.51+52	--
3	Furniture	36.12-14	--
4	Retail	52	2004, 2003
5	Transport and logistics services	60, 63 (parts thereof)	--
6	Banking	65.1	2003
7	RFID adoption and implications	(several sectors)	--
8	Intellectual property rights for ICT-producing SMEs	30.01+02, 32.1-3, 33.2+3; 64.2; 72 (parts thereof)	--
9	Impact of ICT and e-business on energy use		--
10	Economic impact and drivers of ICT adoption		--

The SeBW presents a **'wide-angle' perspective** on the adoption and use of ICT in the sectors studied. They assess how ICT is having an influence on business processes, notably by enabling electronic data exchanges between a company and its customers, suppliers, service providers and business partners. (The underlying conceptual framework is explained in more detail in the following section.) In addition, the studies also provide some **background information** on the respective sectors, including a briefing on current trends. Readers, however, should not mistakenly consider this part as the main topic of the analysis. The introduction to the sector is neither intended, nor could it be a substitute for more detailed industrial analysis.

[8] The 2006 ICT Standardisation Work Programme complements the Commission's "Action Plan for European Standardisation" of 2005 by dealing more in detail with ICT matters.

[9] see overview at www.ebusiness-watch.org/studies/on_sectors.htm.

1.2 ICT and e-Business – key terms and concepts

A definition of ICT

This study examines the use of information and communication technology (ICT) in European businesses. ICT is an umbrella term that encompasses a wide array of systems, devices and services used for data processing (the information side of ICT) as well as telecommunications equipment and services for data transmission and communication (the communication side). The European Information Technology Observatory (2007) structures the ICT market into four segments with an estimated total market value of about € 670 billion in 2007 (Exhibit 1.2-1).

Exhibit 1.2-1: The EU ICT market according to EITO (2007)

Market segment	Products / services included (examples)	Market value for EU (2007) (EITO estimate)
ICT equipment	Computer hardware, end-user communications equipment (such as mobile phones), office equipment (such as copiers) and data communications and network equipment (such as switching and routing equipment, cellular mobile infrastructure)	€159 billion
Software products	System and application software	€76 billion
IT services	Consulting, implementation and operations management	€140 billion
Carrier services	Fixed voice telephone and data services, mobile telephone services, cable TV	€293 billion

Source: EITO 2007

In its widest sense, 'e-business' refers to the application of these technologies in business processes, including primary functions (such as production, inbound and outbound logistics or sales), and support functions (such as administration, controlling, procurement and human resources management). Companies in all sectors use ICT, but they do so in different ways. This calls for a **sectoral approach** in studies of ICT usage and impact. The following section introduces a wider framework for the discussion of e-business developments that will be used in the following analysis of the chemical, rubber and plastics industry.

Gaining momentum after a phase of disappointment

When the bust phase of the previous economic cycle – commonly referred to as the 'new economy' – started in 2001, the former internet hype was suddenly replaced by a widespread disappointment with e-business strategies. Companies adopted a more reserved and sceptical attitude towards investing in ICT. Nevertheless, ICT has proved to be the key technology of the past decade (OECD 2004, p. 8), and the **evolutionary development** of e-business has certainly not come to an end. The maturity of ICT-based data exchanges between businesses and their suppliers and customers, fostered by progress in the definition and acceptance of standards, has substantially increased across sectors and regions over the past five years. In parallel, **recent trends** such as "Web 2.0" and social networking are widely discussed in terms of their business implications and it is widely recognised that 'e'-elements have become an essential

component of modern business exchanges. In short, e-business has regained momentum as a topic for enterprise strategy both for large multinationals and SMEs.

> *"Measurement of e-business is of particular interest to policy makers because of the potential productivity impacts of ICT use on business functions. However, the ongoing challenges in this measurement field are significant and include problems associated with measuring a subject which is both complex and changing rapidly."*
>
> *OECD (2005): ICT use by businesses. Revised OECD model survey, p. 17*

Companies use ICT in their business processes mainly for **three purposes**: to reduce costs, to better serve the customer, and to support growth (e.g. by increasing their market reach). In essence, all e-business projects in companies explicitly or implicitly address one or several of these objectives. In almost every case, introducing e-business can be regarded as an ICT-enabled process innovation. Understanding one's business processes and having a clear vision of how they could be improved (be it to save costs or to improve service quality) are therefore critical requirements for firms to effectively use ICT.

The increasing **competitive pressure** on companies, many of which operate in a global economy, has been a strong driver for ICT adoption. Firms are constantly searching for opportunities to cut costs and ICT holds great promise in this respect as it increases the **efficiency of a firm's business processes**, both internally and between trading partners in the value chain. While cutting costs continues to motivate e-business activity, innovative firms have discovered and begun to exploit the potential of ICT for delivering against key business objectives. They have integrated ICT into their production processes and **quality management** and, most recently, in **marketing** and **customer services**. These last sectors are widely considered key to improve competitiveness in the current phase of development of European economies. Competing in mature markets requires not only optimised cost structures, maximal efficiency, and products or services of excellent quality but also the ability to communicate effectively and cooperate with business partners and potential customers.

A definition of e-business

As part of this maturing process, electronic business has progressed from a specific to a very broad topic. A central element is certainly the use of ICT to accomplish **business transactions**, i.e. exchanges between a company and its suppliers or customers. These can be other companies ('B2B' – business-to-business), consumers ('B2C' – business-to-consumers), or governments ('B2G' – business-to-government). In the broad sense, transactions include commercial as well as other exchanges such as sending tax return forms to the tax authorities.

If transactions are conducted electronically ('**e-transactions**'), they constitute e-commerce. Transactions can be broken down into **different phases** and related **business processes**, each of which can be relevant for e-commerce (see Exhibit A.V-2). The pre-sale (or pre-purchase) phase includes the presentation of (or request for) information on the offer, and negotiations over the price. The sale / purchase phase covers the ordering, invoicing, payment and delivery processes. Finally, the after sale / purchase phase covers all processes after the product or service has been delivered to the buyer, such as after sales customer services (e.g. repair, updates).

Glossary

Definitions by standardisation groups (ISO, ebXML)

The term 'business transaction' is a key concept underlying the development of e-standards for B2B exchanges. Therefore, definitions have been developed by standards communities to underpin their practical work. Examples include:

- ***Business**: "a series of processes, each having a clearly understood purpose, involving more than one party, realised through the exchange of information and directed towards some mutually agreed upon goal, extending over a period of time" [ISO/IEC 14662:2004]*
- ***Business transaction**: "a predefined set of activities and/or processes of parties which is initiated by a party to accomplish an explicitly shared business goal and terminated upon recognition of one of the agreed conclusions by all the involved parties even though some of the recognition may be implicit" [ISO/IEC 14662:2004]*
- ***e-Business transaction**: "a logical unit of business conducted by two or more parties that generates a computable success or failure state" [ebXML Glossary]*

Exhibit 1.2-2: Process components of transactions

Pre-sale / pre-purchase phase	Sale / purchase phase	After sale / after-purchase phase
■ Request for offer/proposal ■ Offer delivery ■ Information about offer ■ Negotiations	■ Placing an order ■ Invoicing ■ Payment ■ Delivery	■ Customer service ■ Guarantee management ■ Credit administration ■ Handling returns

Practically each step in a transaction can either be pursued electronically (online) or non-electronically (offline), and all combinations of electronic and non-electronic implementation are possible. It is therefore difficult to decide which components actually have to be conducted online in order to call a transaction (as a whole) 'electronic'.

In 2000, the OECD proposed broad and narrow definitions of electronic commerce, both of which remain valid and useful today[10]. While the narrow definition focuses on 'internet transactions' alone, the broad definition defines e-commerce as "*the sale or purchase of goods or services, whether between businesses, households, individuals, governments, and other public or private organisations, conducted over **computer-mediated networks**. The goods and services are ordered over those networks, but the payment and the ultimate delivery of the goods or service may be conducted on- or offline"* (OECD, 2001). The addendum regarding payment and delivery illustrates the difficulty mentioned above to specify which of the processes along the transaction phases constitute e-commerce (see Exhibit 1.2-2). The OECD definition excludes the pre-sale / pre- purchase phase and focuses instead on the ordering process. The SeBW follows the OECD

[10] In 1999, the OECD Working Party on Indicators for the Information Society (WPIIS) established an Expert Group on Defining and Measuring Electronic Commerce, in order to compile definitions of electronic commerce which are policy-relevant and statistically feasible. By 2000, work of the Group had resulted in definitions for electronic commerce transactions.

position on this issue,[11] while fully recognising the importance of the internet during the pre-purchase phase for the initiation of business.

Glossary

Definition of key terms for this study

- ***e-Transactions****: commercial exchanges between a company and its suppliers or customers which are conducted electronically. Participants can be other companies ('B2B' – business-to-business), consumers ('B2C'), or governments ('B2G'). This includes processes during the pre-sale or pre-purchase phase, the sale or purchase phase, and the after-sale / purchase phase.*
- ***e-Commerce****: the sale or purchase of goods or services, whether between businesses, households, individuals, governments, and other public or private organisations, conducted over computer-mediated networks. (OECD)*
- ***e-Business****: automated business processes (both intra- and inter-firm) over computer mediated networks. (OECD)*
- ***e-Interactions****: covers the full range of e-transactions as well as collaborative business processes,. such as collaborative online design processes which are not directly transaction focused.*

Using the OECD definition, e-commerce is a key component of **e-business** but not the only one. A wider focus oriented on business processes has been widely recognised. This vision of e-commerce also covers the digitisation of **internal business processes** (the internal processing of documents related to transactions) as well as **cooperative** or **collaborative processes** between companies that are not necessarily transaction-focused (for example industrial engineers collaborating on a design in an online environment). The OECD WPIIS[12] proposes a definition of e-business as "*automated business processes (both intra-and inter-firm) over computer mediated networks*" (OECD, 2004, p. 6). In addition, the OECD proposed that e-business processes should integrate tasks and extend beyond a stand-alone or individual application. 'Automation' refers here to the substitution of formerly manual processes. This can be achieved by replacing the paper-based processing of documents by electronic exchanges (machine-to-machine) but it requires the agreement between the participants on electronic **standards** and processes for data exchange.

e-Business and a company's value chains

In some contexts, the term c-commerce (collaborative commerce) is used. Although this concept was mostly abandoned when the 'new economy' bubble burst in 2001, it had the merit of pointing towards the role of ICT in cooperations between enterprises and the increasing digital integration of supply chains. These developments go beyond simple point-to-point exchanges between two companies.

[11] The respective survey questions ask companies whether they "place / accept online orders".

[12] Working Party on Indicators for the Information Society.

Despite dating back 20 years to the pre-e-business era, Michael Porter's framework of the company value chain and value system between companies[13] remains useful to understand the relevance of e-business in this context. A **value chain** logically presents the main functional areas ('value activities') of a company and differentiates between primary and support activities. However, these are "*not a collection of independent activities but a system of interdependent activities*", which are "*related by linkages within the value chain*".[14] These linkages can lead to competitive advantage through optimisation and coordination. This is where ICT can have a major impact, in the key role of **optimising linkages** and increasing the efficiency of processes.

The **value system** expands this concept by extending its scale beyond the single company. The firm's value chain is linked to the value chains of (upstream) suppliers and (downstream) buyers; the resulting larger set of processes is referred to as the value system. All e-commerce and therefore electronic transactions occur within this value system. Key dimensions of Porter's framework (notably inbound and outbound logistics, operations, and the value system) are reflected in the **Supply Chain Management** (SCM) concept. Here, the focus is on optimising the procurement-production-delivery processes, not only between a company and its direct suppliers and customers, but also aiming at a full vertical integration of the entire supply chain (Tier 1, Tier 2, Tier n suppliers). In this concept, each basic supply chain is a chain of sourcing, production, and delivery processes with the respective process interfaces within and between companies.[15] Analysing the digital integration of supply chains in various industries has been an important theme in most sector studies by the SeBW.

Applying the concept to the chemical, rubber and plastics industry

The conceptual framework outlined above is fully applicable to e-business in the chemical, rubber and plastics industry. In this sector, companies use ICT for a broad range of applications along the value chain: for procurement, in production, to support inbound and outbound logistics, for marketing, sales and customer service. All basic goals of e-business are highly relevant in this sector: reducing costs by increasing the efficiency of processes, optimally serving the customer by innovative means of information provision and communication, and enabling growth and expansion by increasing the market reach. This study shows that the development has been very dynamic in recent years in this industry, in particular with regard to achieving process efficiency gains; however, the study also points at some of the bottlenecks and challenges for an even wider and faster adoption of e-business activity.

[13] Porter, Michael E. (1985). Competitive Advantage. New York: Free Press. Page references in quotations refer to the Free Press Export Edition 2004.

[14] ibid., p. 48.

[15] cf. SCOR Supply-Chain Council: Supply-Chain Operations Reference-model. SCOR Version 7.0. Available at www.supply-chain.org (accessed in March 2006).

1.3 Study objectives and methodology

Research objectives

The CRP industries are a mature, capital-intensive sector with predictable demand and relatively high barriers for market entry. Therefore, a basic assumption for this study was that ICT and e-business would not have a fundamental impact on industry structure as a whole (at least not as much as in tourism, banking and ICT services). However, the globalisation of markets and the increasing rivalry in the market-place (see Section 2.3) should be strong drivers for companies to pro-actively exploit all opportunities for improving their processes, internally and in exchanges with suppliers and customers. As ICT is a major enabler of process efficiency in manufacturing in general,[16] another assumption was that ICT would be increasingly used by CRP companies in all segments of the value chain, notably by the large players. Based on these general assumptions, and on findings in earlier studies conducted on the CRP industries, the study addresses the following research questions:

- **Dynamics of adoption**: Has there been a dynamic adoption of ICT and e-business in the period since 2003/04?
- **Drivers and barriers**: What drives e-business adoption, what do companies perceive as the main challenges and barriers?
- **Impact on firm and sector level**: What are the main impacts of ICT adoption on firm performance and on the industry as a whole (notably in terms of productivity effects and skills requirements)?
- **Impact on international competition**: Is there a link between e-business developments and the scenario for international competition?
- **Policy implications**: Do the findings on these research questions above have implications for policy, for example in the fields of economic, competition or R&D and innovation policy?

The methodological framework of the SeBW builds upon the methodology established for the preceding "e-Business W@tch" programme. It has been adapted to the new focus of activity, enabling the progress from monitoring "e-readiness" and "e-activity" to the evidence-based **analysis of "e-impact"**.

Data collection

The study is based on a mix of data sources and methodologies, including primary data collection, desk research and case studies. More specifically, information was collected from the following sources:

Sectoral e-Business Watch Survey (2007): The CRP industries was one of three sectors (besides the furniture and the steel industries) covered by the SeBW Survey on manufacturing industries. 911 interviews were conducted with decision-makers in companies from 7 EU countries and in the USA in the CRP sector. The SeBW Survey was the main source for analysing the state of play in ICT adoption, B2B process integration and automation. Detailed information about this survey is available in Annex I.

[16] This was confirmed by most e-Business Watch sector studies, e.g. on ICT manufacturing, consumer electronics and on the pulp and paper industry (2006).

Case studies: 10 case studies describing the e-business strategy of companies from the sector were conducted. They have been selected to match the topics in focus, and with a view to achieve a balanced coverage of countries, business activities (sub-sectors) and company size-bands.

Interviews: interviews have been conducted with firm representatives as part of the case study work. In addition, further in-depth interviews with company representatives and industry experts, including the Advisory Board members, have been held.

Sources of industry federations: Annual reports and position papers of industry federations were used, notably from the following federations:

- **CEFIC**, the European Chemical Industry Council (www.cefic.org), founded in 1972, representing, directly or indirectly, about 29,000 companies which employ about 1.3 million people and account for nearly a third of the world chemical production;
- **ETRMA**, the European Tyre and Rubber Manufacturers' Association (www.etrma.org), representing about 4,200 companies with a direct employment of about 360,000 people, including the nine largest European tyre corporate companies;
- **APME**, the Association of plastic manufacturers Europe (www.plasticseurope.org), with more than 100 members that represent over 90% of all polymer producers across the 27 EU Member States, Norway, Switzerland, Croatia and Turkey;
- **EuPC**, the EU-level Trade Association representing European plastics converters (www.plasticsconverters.eu), represents about 37,000 companies with more than 1.5 million employees.

EU-KLEMS: The EU KLEMS Growth and Productivity Accounts are the result of a research project, financed by the European Commission, to analyse productivity in the European Union at the industry level. This project is meant to support the analysis of the relationship between skill formation, technological progress and innovation on the one hand, and productivity on the other. EU-KLEMS Growth Accounts include measures of economic growth, productivity, employment creation, capital formation and technological change at the industry level for 25 EU Member States as well as for the United States. In general, data for 1970-2005 are available for the former EU-15 EU MS and for the US, while data from 1995-2005 are available for 10 new MS that joined the EU in 2004. The growth accounts are based on the growth accounting methodology as theoretically seminal contribution by Jorgenson and Griliches (1967) and put into a more general input-output framework by Jorgenson, Gollop and Fraumeni (1987). The data sources that have been used to create the EU-KLEMS data series are large based on series from the national statistical institutes (e.g. investment series), but also from a variety of national sources, in cases where no international database or statistics from the NSIs were available (e.g. for hours worked by labour type). Various series were linked in order to bridge different vintages of the national accounts according to a common methodology. Due to the broad range of sources used and data limitations in these sources, the level of detail in the EU-KLEMS database varies across countries, industries and variables.[17]

[17] For more information about the database, see: EU-KLEMS Growth and Productivity Accounts, Version 1.0, Part I Methodology. March 2007, prepared the Groningen Growth and Development Centre and the National Institute of Economic Research on behalf of the EU-KLEMS consortium, available via www.euklems.net/.

Data analysis

For data analysis, descriptive and analytical statistical methods were used:

Descriptive statistics: The discussion of the SeBW survey results in Chapter 3 is mostly based on descriptive cross-tabular presentation of simple frequencies (typically percentages of enterprises with a certain activity). This constitutes the first and most basic step in data presentation. The requirement for this step is that micro-data have been aggregated and that weighting has been applied. Weighting is an important issue for data presentation, as –unfortunately– it is not well understood by many users of data. However, **weighting** is necessary, as due to stratified sampling the sample size in each size-band is not proportional to the population numbers. If proportional allocation had been used, the sample sizes in the 250+ size-band would have been extremely small, not allowing any reasonable presentation of results (see Annex I for details).

Analytical statistical methods: Descriptive presentation and discussion of survey results, including the use of compound indicators derived from simple frequencies, is useful as a first step; however, it is limited in its power to explain ICT impact. Therefore, advanced statistical methods (such as growth accounting) were used to gain better evidence on the economic impact of ICT. This economic analysis, which is mainly presented in Chapter 4, focuses on links between ICT adoption on the one hand and productivity growth, innovation dynamics and market characteristics on the other. It combines micro-data analysis (using data from the e-Business Survey 2007) and macro-data analysis (using the EU-KLEMS Growth and Productivity Accounts). More information about the econometric analysis methodology is provided in Annex II.

Validation of results – the Advisory Board

The study was conducted in close consultation with an Advisory Board, consisting of the following experts (in alphabetical order):

- Ms Fazilet Cinaralp, Director, ETRMA - European Tyre & Rubber Manufacturers
- Mr Herbert Fisch, Director eCommerce Global, BASF
- Mr Henry Ryan, Lios Geal Consultants
- Mr Dave Wallis, independent consultant

Three meetings of the Advisory Board were held, in addition to informal exchanges with the members in between and to their contributions on specific sections of the study. The first meetings took place on 29 May 2007 in Brussels. At this meeting, the study exposé and research plan were validated. At the second meeting on 18 January 2008 in Brussels the interim report was discussed. The third meeting took place in May 2008 (in the context of the e-Business Conference 2008) to draw conclusions for future research.

2 Context and Background

2.1 Sector definition – scope of the study

Business activities covered

The chemical, rubber and plastics (CRP) sector has been defined for the purpose of the study as those business activities described by NACE Rev. 2 Divisions 20 and 21: [18]

- the manufacture of chemicals, chemical products and man-made fibres (NACE Rev. 2 20), and
- the manufacture of rubber and plastic products (NACE Rev. 2 22).

This combined CRP sector covers quite diverse business activities. The respective NACE Rev. 2 groups and their correspondence in NACE Rev. 1.1[19] is shown in Exhibit 2.1-1. The names of business activities refer to NACE Rev. 2.

Exhibit 2.1-1: Business activities covered by the chemicals industry (NACE Rev. 2 and 1.1)

NACE Rev. 2		NACE Rev. 1.1		Business activities Manufacturing of…
20		**DG 24**		**Chemicals, chemical products and man-made fibres**
	20.1		24.1	Basic chemicals, fertilizers and nitrogen compounds, plastics and synthetic rubber in primary forms
	20.2		24.2	Pesticides and other agro-chemical products
	20.3		24.3	Paints, varnishes and similar coatings, printing inks and mastics
	20.4		24.5	Soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
	20.5		24.6	Other chemical products
	20.6		24.7	Chemical fibres
22		**DH 25**		**Rubber and plastic products**
	22.1		25.1	Rubber products
	22.2		25.2	Plastic products

This excludes the manufacture of pharmaceuticals, which used to be NACE Rev. 1.1 24.4 and has now become a distinct Division in NACE Rev. 2 (Division 21). The pharmaceutical industry was specifically covered by an earlier *e-Business W@tch* sector study in 2005.[20] The change in the NACE classification from Revision 1.1 to 2 confirms the special characteristics of this sector within the broader cluster of the combined chemical industries, for example in terms of its different customer segments and the

[18] NACE Revision 2 is a four-digit classification of business activities. It is a revision of the "General Industrial Classification of Economic Activities within the European Communities", known by the acronym NACE and originally published by Eurostat in 1970. NACE Rev. 2 replaced the earlier used version Rev. 1.1 on 1 January 2008.

[19] The definition of the sector on the basis of NACE Rev. 1.1 was necessary because the survey was conducted in 2007. At that time, business directories (which were used for sampling) were still based on the older version of NACE and not yet on Rev. 2.

[20] The study report is available at www.ebusiness-watch.org (see "eBiz Studies")

highly important role of R&D in pre-production phases. For these reasons, the pharmaceutical industry has not been included in the study.

Otherwise, there have been only minor changes in the NACE classifications from Rev. 1.1 to Rev. 2, which are hardly relevant for the purpose of this study. This continuity indicates that the chemical sector consists of highly mature industries with stable product categories, players and value systems.[21] In the following, all references to the NACE classification are based on the new version (Rev. 2) if not explicitly stated otherwise.

The main value systems of the CRP industries

The use as well as the impact of e-business depends to a large extent on the structure of value systems and the business relationships within, rather than on product characteristics only. The sector under study consists of at least five main value systems. The chemical industry (NACE 20) has adopted a convention of defining itself in three main sub-sectors, which are not directly corresponding to the NACE classification: basic chemicals, fine and speciality chemicals, and formulated chemicals. These are complemented by the value systems of the manufacture of rubber and plastic products (NACE 22).

Basic chemicals (mostly covered by NACE 20.1) form the foundation of the chemical industry. Its manufacturers produce inputs for the remainder of the chemical industry from raw minerals, crude oil, gas and energy, typically in large-scale plants. Much of the produced output remains in the chemical industry itself, where it is refined to downstream products. Some examples for output are petrochemicals, basic inorganics, basic organics, and industrial gases. The production is characterised by large output volumes as well as by high capital and energy intensity. Raw materials (referred to as "feedstock") are basic commodities and the main input besides capital. Production costs therefore depend considerably on the prices for feedstock, which are typically commodity prices. Outputs are also commodities, i.e., standardised products that are bought in huge amounts with price being the major decision criterion for the buyer. R&D intensity is comparatively low, due to the limited potential for product differentiation. Outputs are starting materials for colorants, paints, adhesives, coatings, medicines and other products. Typically, the output markets are highly transparent. Due to the high market transparency and standardised product characteristics the switching costs for buyers are low and the markets are very competitive, implying comparatively low profit margins. Thus, cost leadership strategies dominate in this segment,[22] favouring large players.

Fine and speciality chemicals are the next element in the chemical industry's value system. The companies in this segment use basic chemicals as a major input to produce a large variety of special substances, often in relatively small volumes. One part of the output is used by other segments of the CRP industries (e.g. plastics as input for plastic products, soaps as input for toiletries). Another part is sold to outside the combined chemical industries. For example, food additives serve as inputs for the food processing industry or man-made fibres (NACE 20.6) as input for the textile industry.

Production differs considerably from the basic chemicals industry. Much of the output is custom-manufactured for specific customers, imposing highly specific requirements onto

[21] The term "value system" is used in this study according to Porter (1985). While a "value chain" categorises the generic value-adding activities of an organisation, a "value system" refers to interconnected systems beyond individual organisations.

[22] Cf. Cesaroni et al. (2004), p. 124.

production plants. Often, product specifications are developed in co-operation with the customer from the start. This implies a higher R&D intensity than in the basic chemicals segment (as companies compete mainly in quality and specialisation), as well as higher switching-costs for customers. Overall, the manufacture of fine and speciality chemicals is an industry with comparatively high profit margins, where price is not the determining factor for establishing business relationships. Some products, however, sometimes called "bulk specialities", are easier to substitute. Pricing for these products has become highly competitive, as market transparency has increased.

Manufacturers of **formulated chemicals** typically use basic chemicals as well as speciality chemicals as inputs. This segment differs from the former two sub-sectors in that its goods are mostly produced for end users and not as inputs for other products. Outputs of this sector include pesticides (NACE 20.2), paints and coatings (20.3), soap, detergents, cleaning and polishing products, as well as perfumes and toilet preparations (20.4). The formulated chemicals sector is characterised by a higher R&D intensity. The brand name and quality are very important in this segment; therefore, companies that are well positioned can command premiums and earn relatively high margins. Still, competition by non-branded products exists and forms the foundation for a low-price segment of the market.

The manufacture of **rubber products** (NACE 22.1) can be broken down into two main segments: the manufacture of tyres (for passenger cars and commercial vehicles), and the manufacture of general rubber goods (other than tyres). In the **tyre industry**, seven out of the ten world leaders –accounting for 77% of world sales– have major production facilities in Europe. According to ETRMA, the European Tyre and Rubber Manufacturers' Association, there are about 90 tyre plants in Europe, located in 18 countries. Their production capacity has increased by more than four times since the mid 1990s. In the manufacture of **general rubber goods**, five EU companies are ranked in the worldwide top-6. The general rubber goods market is fragmented with a wide range of products, notably for use in the automotive industry (44% of total production in the EU is for this sector), in construction and building and for medical and pharmaceutical articles.[23] Rubber products are either made of natural rubber or synthetic rubber. In the EU, the total consumption of synthetic rubber (in tonnes) is about twice the consumption of natural rubber. Of the worldwide natural rubber production,[24] around 70 % is supplied to the tyre industry.

The **plastics industry** (NACE 22.2) gathers the plastics converters, i.e. the producers of plastics products. The sector is characterised by a high number of SMEs. Firms buy raw material in granular or powder form, subject it to a process involving pressure, heat and/or chemistry and apply design expertise to manufacture their products. They produce semi-finished and finished products for a wide range of industrial and consumer markets, in particular for the automotive, electrical and electronics, consumer goods, construction and healthcare industries. Plastics manufacturers often undertake additional finishing operations such as printing and assembly work to add further value to their products. **Packaging** is the largest consumer of plastics in Europe. According to EuPC, the Association of European Plastics Converters about half of all goods are now packaged in

[23] cf. ERTMA, Key figures (www.etrma.org, Sep. 2007).

[24] NR is cultivated over a long gestation period of about 6-7 years and is highly labour intensive. It is mainly produced by small farmers in the developing countries of Asia, Africa and Latin America – cf. http://www.etrma.org/public/keyfiguresnrsr.asp.

plastics.[25] While many companies concentrate solely on extrusion, others are integrated forward into the production of fabricated products, such as complete windows and patio doors. In 2005, according to PlasticsEurope,[26] about 230 million tonnes of plastics were consumed world wide. Of this, about 48 million tonnes were converted in the EU, Norway and Switzerland.

2.2 Industry background

The chemical, rubber and plastics (CRP) industries is one of the largest manufacturing sectors, providing jobs for about three million people in the EU.[27] It is a major supplier to many other industries, a provider of innovative materials and technological solutions, and thus plays an important role for the industrial competitiveness as a whole.[28] Moreover, products and services provided by the CRP industries are pervasive in everyday life, as they can be found in food, clothing, housing, transport, communications and consumer electronics. In many ways, the industry also plays a very important role to cope with key future challenges. For example, innovative products made of plastics are vital components of technologies to address climate change, to provide health-care services and to save energy.[29]

The figures presented in this section are mostly based on collections from Eurostat, notably from the Structural Business Statistics (SBS), and on publications of the main European industry federations in the CRP sector (see Section 1.3).

Employment, labour costs, production and value added

In total, the CRP industries as defined for this study **employed** more than three million people in the EU in 2004 (latest available figures). Out of those, 43% are employed in the chemical, 45% in the plastics and 12% in the rubber industry (see Exhibit 2.2-1).

Average **personnel costs** in the CRP sector were about €39,000 per employee in the EU-27 in 2004, which is more than 40% above the non-financial business economy average.[30] Within the sector, personnel costs are much higher in the chemical industry (€47,000 per employee) than in rubber and plastics manufacturing (€30,000).[31]

According to Eurostat SBS, the sector generated a **value added** of about 110 billion euros in 2004. In this respect, the chemical industry is by far the largest sub-sector, accounting for close to 60% of total value added –-twice as much as the plastics industry and six times as much as rubber manufacturing. Thus, the average value added per person his higher in the chemical industry than in the other sub-sectors. In total, the EU-

[25] See EuPC, Association of European Plastics Converters (www.plasticsconverters.eu, Sep. 2007).

[26] PlasticsEurope (facts & figures), see http://www.plasticseurope.org/Content/Default.asp?PageID=957.

[27] Eurostat (2006)

[28] Cf. European Commission, DG Enterprise and Industry: High-level group on competitiveness of the European chemical industry (http://ec.europa.eu/enterprise/chemicals/hlg/index_en.htm, September 2007).

[29] Cf. PlasticsEurope (2007). The World in 2030. Summary and Initial Industry Response.

[30] see Eurostat (2007), p. 104.

[31] Eurostat (2007). Note that figures for the chemical industry include pharmaceuticals.

27 CRP sector accounted for about 5% of value added in the non-financial business economy (NACE sections C to I and K) in 2004.

Exhibit 2.2-1: Employment and labour costs in the CRP industries in the EU-25 (2003)

Sector	Employment		Value added	
	thousands	%	EUR million	%
Chemicals and chemical products	**1.350**	**43**	**110.460**	**59**
• *Basic chemicals; pesticides and other agro-chemical products*	*650*	21	*64.200*	34
• *Miscellaneous chemical products*	*650*	21	*44.000*	23
• *Man-made fibres*	*50*	2	*2.900*	2
Rubber products	**370**	**12**	**18.000**	**10**
Plastic products	**1.400**	**44**	**60.000**	**32**
TOTAL	**3.180**		**188.460**	

* without the pharmaceuticals industry (NACE Rev. 1.1 24.4)

Source: Adapted from Eurostat SBS
(cf. European business – facts and figures. 2007 edition, p. 101).

About 65% of the value added in the CRP sector is produced by large enterprises with at least 250 employees (2004). About 25% is contributed by medium-sized firms and most of the remaining 10% by small firms with 10-49 employees. Micro-enterprises (with fewer than 10 employees) make only marginal contributions to value added, not even in the rubber and plastics industry (which counts more micro-enterprises than the chemical industry).[32] Against this background, this study focuses only on enterprises with at least 10 employees.

Labour productivity in the CRP sector was more than a third higher than the industrial average at €66,500 of added value per person employed in the EU-27 in 2004. However, sub-sectors differ considerably in that respect. Labour productivity is highest in the manufacture of basic chemicals (NACE Rev. 2 20.1) with about €100,000. By contrast, labour productivity of plastics and rubber products manufacturing was below the industrial average (Eurostat 2007). Labour productivity in the chemical industry has been growing faster than in the total manufacturing industry; the average growth rate between 2000 and 2005 was 3.5% in the chemical industry, compared to 1.9% in the total industry.[33] The implications of ICT capital investments for labour productivity growth are analysed in detail in Section 4.1.3.

Labour costs account for about 20% of total production costs in the chemical industry, thus constituting a significant source of competitiveness. Labour cost per employee in the EU chemical industry increased by an average of 5.8% from 1979-2001.[34] However, the impact of these increases on profitability was mitigated by the substantial productivity gains in the same period.[35]

[32] Eurostat (2007), p. 102.

[33] CEFIC / Eurostat, quoted in CEFIC 2006, p. 36.

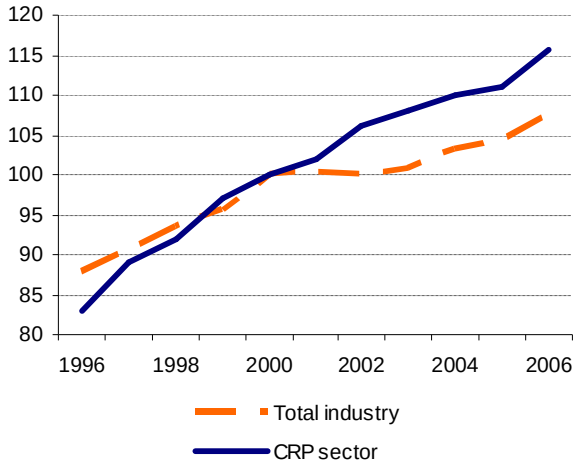
[34] O'Mahony and Van Ark (2003), quoted in European Commission / Innovation Watch (2006).

[35] European Commission / Innovation Watch (2006).

The **production** of the CRP industries increased steadily in the EU in the period 1996 to 2006, at an average output growth rate or 3.3% per annum. Thus, the sector's production growth rate was higher than that of the industry as a whole.

However, the dynamics in the various subsectors differed in that respect. While the production of basic chemicals has increased by nearly 4% per year during this period, the output of pesticides and other agro-chemical products, and of man-made fibres both decreased by 2.4% (mostly in the period from 2001-2005).

Exhibit 2.2-2: Production index of the CRP industries* vs. the total industry (2000 = 100)



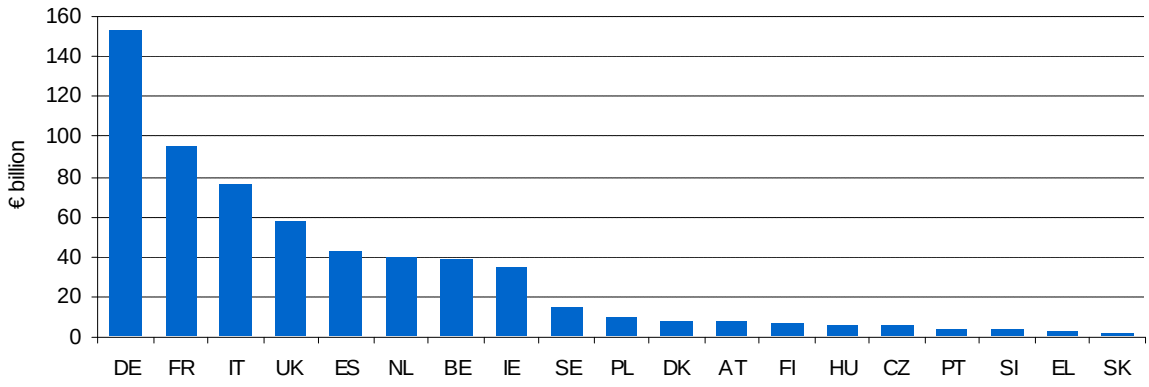
* including the pharmaceutical industry

Source: Adapted from Eurostat, European business – facts and figures. 2007 edition, p. 102

Within the EU, Germany is the largest producer of chemicals, rubber and plastics, accounting for about a quarter of the value added. The next largest producers are the United Kingdom and France, each accounting for about 15% of value added. In relative terms, Ireland appears to be the most specialised Member State in these activities; the CRP sector accounted for more than one third of Irish manufacturing value added (NACE Rev. 1.1 D).[36]

In the chemical industries, according to CEFIC, total sales amounted to about €613 billion in the EU-25 in 2005, again with Germany being the largest industry. CEFIC refers to Germany, France, Italy, the UK, the Netherlands, Belgium and Ireland as the industry's "big-8", as firms from these countries account for nearly 90% of total sales in the EU (see Exhibit 2.2-3).

Exhibit 2.2-3: EU chemicals industry sales (2005) by country



Source: CEFIC (2006)

[36] Eurostat (2007), p. 101.

The total **rubber production** in the EU was estimated at 2.7 million tonnes of synthetic rubber for 2006, which corresponds to 22% of the global production (about 12.5 million tonnes). Natural rubber production (in Latin America, Africa and Asia) in the same year amounted to 9.7 million tonnes.[37]

In the **plastics** industry, the EU (plus Norway and Switzerland) represented about 25% of global production in 2005 (about 230 million tonnes), a similar share as that of North America (24%). Asia (including Japan) is world leader (36%). Within Europe, Germany is the major producer, accounting for 8% of global production. PlasticsEurope anticipates significant growth in worldwide demand for plastics, mainly due to the industrialisation in the emerging economies of Asia and Latin America. Currently, consumption is about 100 kg per capita and year in Western Europe and North America, with a potential to grow to 130 kg by the year to 2010. In Asia, for comparison, consumption is currently only around 20 kg. The annual growth rate in consumption in Europe was about 3.7% between 1980 and 2005. [38]

Industry structure

While the chemical industry, and in particular the manufacture of basic chemicals, is dominated by large or even global players, the rubber and plastics products industries are characterised by a much larger number of small and medium-sized enterprises (SMEs), many of whom are highly specialised. In the chemical industry, more than 60% of the employees work in large enterprises (with at least 250 employees), and about 70% of the value added are generated in large firms (see Exhibit 2.2-4). In the rubber and plastics products industry, for comparison, large firms account for only about 40% of employment and value added generation.

Exhibit 2.2-4: Structure of the chemical industry:* enterprises, sales and employment by size-class

	Number of enterprises	Added value	Sales	Employment
Micro (1-9)	63%	2%	2%	4%
Small (10-49)	23%	7%	7%	10%
Medium (50-249)	10%	19%	21%	23%
Large (250+)	4%	72%	70%	63%
Total	**100%**	**100%**	**100%**	**100%**

* without pharmaceuticals

Source: CEFIC / Eurostat, cf. CEFIC 2006 (data based on Eurostat, 2001)

[37] cf. International Rubber Study Group (www.rubberstudy.com/statistics-quarstat.aspx, Oct. 2007)

[38] PlasticsEurope (facts & figures), see http://www.plasticseurope.org/Content/Default.asp?PageID=957.

EU global market shares and trade balance

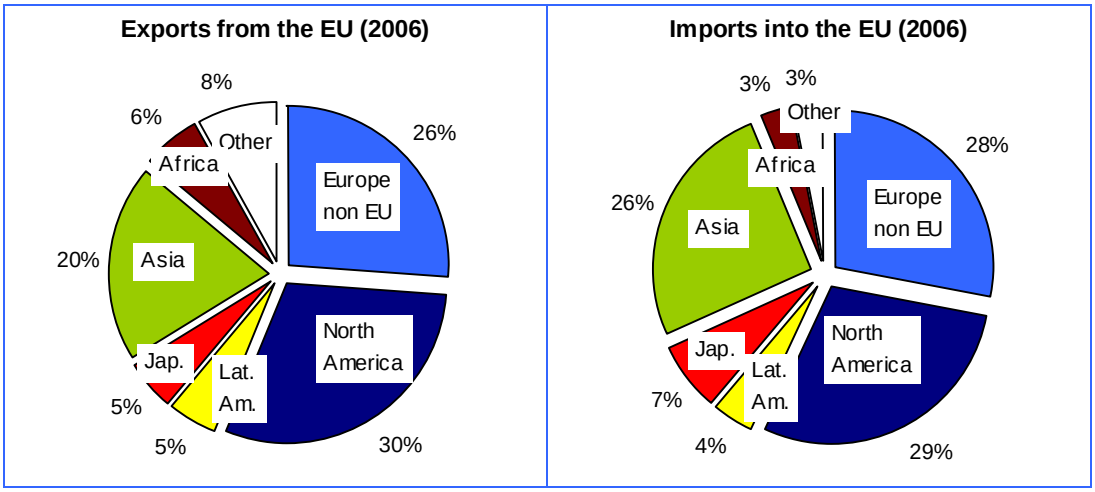
The EU is a strong player in the global CRP market, but experiences increasing competition notably from Asian competitors. In the chemical industry (excluding pharmaceuticals), world chemical sales were estimated at €1,641 billion in 2006. The EU chemical industry is still in a top position with a **market share** of about 30% (€476 billion), but Asia (including China and Japan) has taken the first place in this ranking (€546 billion), mainly due to the rise of China and India. Together, the EU, Asia and North America account for almost 90% of the world turnover.[39]

In the worldwide production of tyres for passenger cars and commercial vehicles, Europe had a market share of about 23% in 2004. This is similar to the shares of North America (21%), Asia/Oceania (29%) and China (19%).[40]

In the total CRP sector, the EU had a positive **trade balance** in 2006 with a surplus of about €36 billion (for the EU-27). The chemical industry (NACE 20) accounts for most of the surplus with €32 billion. The total value of exports in 2006 was about €125 billion. EU companies trade mostly with the United States and Switzerland. Germany was by far the largest exporter among the EU Member States.[41]

The EU trade surplus has significantly increased since the late 1990s, in particular from 1999-2002. The trade balance in 2006 was positive in particular with North America (a surplus of €13.6 billion) and the rest of Europe (€8.9 billion), but also with Asia (€3.5 billion). Companies export mainly to the North American market (30% of total exports), Asia (25% including Japan) and other European countries which are not members of the EU (26%). Imports are mainly from Asia (33% including Japan) and North America (29%) – see Exhibit 2.2-5.[42]

Exhibit 2.2-5: EU chemical industry: trade flows with major world regions (2006)



Source: Developed from CEFIC (2007), Table Report, Chart 2.2

For the chemical industry, recent figures indicate that the excellent trade performances of 2005 and 2006 could probably not be maintained in 2007. The extra-EU chemical trade

[39] cf. CEFIC 2007.

[40] cf. ERTMA, Key figures (www.etrma.org/public/keyfigurestyreind.asp, Sep. 2007).

[41] Cf. Eurostat 2007, p. 105, Table 5.5 – data exclude pharmaceuticals; figures provided by CEFIC are slightly different: CEFIC (2007, p. 15) reports a total trade surplus of about €41 billion.

[42] cf. CEFIC 2007, Table Report, Chart 2.2; and report, Chapter 2 (International trade).

balance (excluding pharmaceuticals) shrank by about 14% over the first seven months of 2007 compared to the same period of 2006. The main reason is the superior growth of imports to exports: while chemical imports (excluding pharmaceuticals) grew by about 13%, exports grew by 'only' about 4%.[43]

In tyre production, imports into EU Member States are mainly from Asia (76% of imports). Exports of tyres produced in the EU are mainly to other European countries (32% of exports) and to North America (29%), but also to Asia (21%). European tyre manufacturers are among the sub-sectors of the CPR industry which are mostly exposed to increasing competitive pressure from importers. Future procurement decisions of tier-1 suppliers to the automotive industry will play a critical role in this context.

In fact, if trade flows are taken as an indicator of competitiveness, there are signs of a loss in competitiveness of Europe in recent years in the chemical trade. While Europe still has a competitive advantage in some subsectors (e.g. in specialties, polymers and consumers chemicals), other subsectors are experiencing a deteriorating balance or even an increasing trade deficit (e.g. base chemicals).[44]

One of the key messages of this study is to regard ICT and e-business as important instruments which companies must use to stay as competitive as possible. ICT cannot countervail structural imbalances in global competition, but if ICT is not properly used by firms, the loss in competitiveness will most probably be more significant.

2.3 Trends and challenges

The industry is undergoing a process of structural changes, primarily caused by a sharp rise in competition from emerging economies in Asia, notably from China, Korea and India, but also from the Gulf States and –to a lesser extent– Latin America. In addition to global competition, key issues for the European industry are coping with environmental regulation (notably REACH), having access to raw materials, and (for some segments of the industry) combating counterfeiting.[45]

Compliance with regulation – REACH

The CRP sector, notably the chemical industry, plays an important role for achieving environmental objectives. Due to the underpinning role of this industry in manufacturing (as a supplier of raw materials), innovation in the production of chemicals can contribute to improving the overall environmental balance of manufacturing. At the same time, however, chemicals are hazardous products; their production, transport, usage and disposal creates environmental challenges and risks. As a result, companies from the chemical industry (or their products) have often been in the focus of public attention in environmental contexts, be it as a cause of pollution or in connection with environmental disasters.

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[43] Cefic, Chemicals Trends Report No. 2007-12, p. 1 (http://www.cefic.org/files/Downloads/2007-12CeficChemicalsTrendsReport.pdf, download in February 2008).

[44] Trade Flows as Indicator of Competitiveness. Presentation by Dr. Moncef Hadhri, Cefic, at the Ad hoc Group Meeting on Trade and Competitiveness with Other Regions, 2 June, 2008. Available at http://ec.europa.eu/enterprise/chemicals/hlg/meetings_en.htm (June 2008).

[45] This assessment is based on interviews with industry representatives and experts conducted for this study (see references).

The chemical industries are therefore subject to strict safety regulations compared to other sectors. While the need for this is not called into question, the details of respective regulations, and their practical implementation, have always been subject of intensive debate among stakeholders involved. The challenge for the EU is to protect its citizens from risks and to improve environmental sustainability, without undermining the competitiveness of companies in Europe vis-à-vis their international counterparts.

The key regulatory framework in Europe is "REACH", the new Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals. REACH entered into force on 1 June 2007, streamlining the former legislative framework on chemicals of the European Union. The main aims of REACH are "*to improve the protection of human health and the environment from the risks that can be posed by chemicals, the promotion of alternative test methods, the free circulation of substances on the internal market and enhancing competitiveness and innovation*."[46]

REACH requires that any enterprise that manufactures or imports more than one tonne of a chemical substance (per year) must register this by means of a registration dossier, which must be submitted to the European Chemicals Agency (ECHA), which was specifically founded for coordinating this activity.[47] REACH also foresees an authorisation system aiming to ensure that substances of very high concern are properly controlled, and progressively replaced by suitable alternative substances or technologies where these are economically and technically viable.[48] A major effect of REACH is that it reverses the burden of proof, moving it away from Member States' authorities to producing and importing companies, who will be responsible for demonstrating that substances can be used safely.

The main elements of the REACH system are to provide evaluation and authorisation of chemicals, while striking a balance between environmental, economic and social priorities. About 30,000 existing chemical substances will be processed on a phased basis over a period of 11 years (ending 2012), starting with those marketed in the highest volumes. While this will require an additional effort from industry in terms of costs and manpower, REACH is expected to reduce testing requirements for new substances to encourage innovation.

The implementation of REACH is a very important topic for European companies in the CRP industry and therefore ranks high on the agenda of industry federations. They are committed to providing support to SMEs in how to comply with REACH and, at the same time, to discuss technical details with ECHA and policy representatives. CEFIC, for example, has established a "REACH Experts Network", in order to provide harmonised answers to Frequently Asked Questions in a co-ordinated manner amongst CEFIC national member associations, to have a commonly agreed interpretation of the REACH legal text and to achieve consistency amongst industry.[49]

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[46] see DG Enterprise and Industry (http://ec.europa.eu/enterprise/reach/index_en.htm, November 2007).

[47] ECHA, which is based in Helsinki, started its operations in June 2007. It was set up by the European Commission, with an initial staff of about 100 (to be increased to over 400 persons by 2010). Cf. www.cefic.org.

[48] ibid.

[49] cf. http://www.cefic.org (> REACH); November 2007.

It is estimated that producers and importers will have to pay between 1,600 and 31,000 euros for the registration of chemicals, depending on the annual production volume.[50]

Besides the REACH Regulation, there is a broad range of specific environmental and social regulations with relevance for specific segments of the CRP industry. For example, in July 2006, the European Commission issued a new proposal for a regulation on plant protection products under the thematic strategy[51] on the sustainable use of pesticides, waste and water, climate change and air pollution, and allocations of CO2 emissions during the period 2008–2012 under the Emissions Trading Scheme.

It is not the topic and objective of this study to enter into the details of these regulatory frameworks, as there are no immediate linkages with ICT and e-business, except that specialised ICT solutions can help companies in their compliance with REACH (see Section 3.3.3). In conclusion, policy is confronted with a "prisoner's dilemma"[52] situation: national (and even European) regulation, if not backed by international agreements, could back-fire the initial intention, if market shares of those companies that have to comply with stricter regulation decrease. This would create a strong negative incentive for companies to follow any schemes targeting sustainability such as REACH.

Access to raw materials & energy costs

The sharp increase in prices for raw materials (in particular for crude oil) and energy costs over the past few years poses a big challenge to the CPR industries. The chemical industry is a major energy user, accounting for 12% of total energy demand in Europe.[53] More than half of the energy consumed by the industry, notably oil, is processed as feedstock, which means it is transformed into added-value products such as plastics, food packaging and other materials. The price of energy and other raw materials used in production has therefore major cost implications (see business example) and is a critical factor for the industry to stay competitive internationally.

Business example:

Price increase for chemical products due to rising raw material and energy costs

The Swiss chemical company Clariant International AG announced an increase of prices for its products by 5-12%. The company said that although it had significantly reduced its production costs and made restructuring efforts, a rise of prices could not be avoided due to the sharp increase in raw material and energy costs.

Source: eNewsletter "Chemical-Newsflash", 4 Dec. 2007, by FAZ-Institut.de

In spite of increasing competition in the market, chemical companies often still have the negotiation power to successfully command higher prices. Eastman Chemical Co, the

[50] Cf. chemical news-flash by FAZ Institut, 13.-19. November 2007, http://www.chemical-newsflash.de/de/news/201107/news2.htm.

[51] COM(2006) 372.

[52] According to game theory, the only concern of each individual player ("prisoner") is maximising his/her own payoff, without any concern for the other player's payoff. This explains the – mostly – disappointing outcomes in achieving international agreements on environmental targets.

[53] cf. CEFIC information about energy (www.cefic.org), Nov. 2007.

second largest US chemical company, announced in late 2007 that it expected better results fort he fourth quarter of 2007 than predicted by analysts; the reason was that sales prices had increased more than raw materials and energy costs.[54] In other words, the company was able to pass on the higher costs for supplies to its customers.

The European chemical industry is therefore committed to take an active role in the EU Energy Action Plan, which specifies the goal to save 20% of energy by 2020 and measures to achieve this within 10 priority actions.[55] It supports the emphasis on the central role of market mechanisms to achieve cost-effective emission reductions, but is concerned about unjustified transfer of resources from energy consumers to producers. Notwithstanding the still huge demand for energy in chemical, rubber and plastics production, CEFIC points out that the European chemicals industry has reduced energy consumption per unit of production by almost 40% from 1990 to 2004. In the same time, it decreased emissions of greenhouse gases by more than 20% despite overall chemicals production increased by more than 50%.[56] This demonstrates the potential of technological progress for energy efficiency. The industry also stresses that its activities in research and development and the resulting innovative products are critical to address the global energy challenge.

An important strategic issue for the future that goes far beyond the cost aspect, notably for the chemical and plastics industry, is to prepare for shortages in oil supply. While any forecasts in this area are highly controversial, many experts expect that oil will be in short supply by 2030 latest. By then, oil extraction will have peaked and demand will have outgrown supplies. This will have enormous implications for the CRP industries, for whom crude oil is a major raw material; however, there are no obvious links with ICT, therefore the issue is not discussed in this study.

Protection of Intellectual Property Rights

As in several manufacturing industries (notably in the consumer goods industry), European companies in the CRP industry have difficulties in protecting their intellectual property rights. For example, tyre producers of high quality products with a recognised brand report a rapid increase in counterfeiting. In addition to the economic damage, counterfeited tyres, which are normally of lower quality, pose a security risk.

While counterfeit and pirated products are being produced and consumed in virtually all countries, Asia (and notably China) is emerging as the single largest source (cf. OECD 2007[57]), certainly in the rubber and plastics industries.

Information technology is often mentioned as a potential tool in support of combating counterfeiting and product piracy. For example, RFID technology can be used for tracking individual items through the supply chain, thus ensuring the authenticity of objects, and in this respect representing a protection against counterfeiting. However, RFID is not yet widely deployed and rarely used at the item level (usage currently focuses on pallet

[54] Cf. Chemical news-flash by FAZ Institut, 15 January 2008.

[55] Communication from the Commission: Action Plan for Energy Efficiency: Realising the Potential. COM(2006)545 final, 19 October 2006.

[56] CEFIC news release: "European chemical industry to take active role in EU Energy Action Plan. International commitment to emission reductions encouraged", Brussels, 9 April 2007.

[57] For a brief abstract of this report, see www.oecdobserver.org/news/fullstory.php/aid/2278/.

tracking). Thus, RFID is still a technology that holds promises mainly for the future;[58] nevertheless, there are examples of effective RFID usage in production processes of CRP companies already today (see case study on Michelin, Section 5.5, and Section 3.3.3).

Business example:

Michelin is intensifying its fight against unauthorised reproduction of its tyres

In late 2005, Michelin took steps to thwart the unauthorised copying of the tread patterns of its new truck tyres. Michelin notified American, Asian and European tyre dealers of the risks associated with the sale of copied products. Lawsuits were filed on the three continents against manufacturers and/or tyre dealers of these unauthorised copies. Michelin also put on alert various administrative agencies (e.g. customs, police). Michelin announced to focus on the copies of those products embodying 'Michelin Durable Technologies', which were introduced in early 2005. The company said it would take "any and all steps including legal actions, necessary to vigorously enforce all its rights including its intellectual property rights."

Source: Michelin, Online news, 11 December 2006 (www.michelin.co.uk)[59]

The internet also causes some problems in this respect. The web has arguably facilitated the distribution of counterfeited products, notably if they are intended for the consumer market (e.g. tyres), as they can be sold on online auction platforms such as eBay. The extent to which the platform provider is responsible to ban counterfeited products from being sold via its platform is subject to legal disputes.[60] However, not only consumer goods are prone to counterfeiting. For example, counterfeit chemicals are found in cosmetics and pharmaceuticals,[61] with obvious risks for health.

Globalisation – a mix of opportunities and challenges

The rapid industrialisation of emerging markets in Asia and Latin America has a two-fold effect for the CPR industries in Europe. On the one hand, world-wide demand for the sector's products increases, which creates opportunities for European companies to increase their exports and thus compensate for stagnating or even decreasing domestic

[58] Potential benefits of RFID for supply chain management are analysed in more detail in the Sectoral e-Business Watch studies on RFID adoption and implications (2008) and on the footwear industry (2006), available at www.ebusiness-watch.org.

[59] http://www.michelin.co.uk/uk/front/act_affich.jsp?news_id=19000&lang=EN&codeRubrique=43

[60] Tiffany has launched a lawsuit against eBay, because imitations of its products are frequently sold on eBay. According to James Swire, a lawyer for Tiffany, a full 75% of 325 items that Tiffany has bought on eBay through a buying programme the company started in 2004 were counterfeit. The lawsuit was already filed in 2004, but proceedings were set to open in November 2007 (cf. "Are Counterfeit Products eBay's Responsibility?", posted on 15 Nov 2007 by Deidre Woollard, http://www.luxist.com/2007/11/15/are-counterfeit-products-ebays-responsibility).

[61] In June 2007, the European Commission released figures revealing a five-fold increase in fake pharmaceuticals across Europe, with 2006 seizures hitting an all-time high of 2.5 million items. Quoted from in-Pharma Technologist.com, "Massive counterfeit drug ring cracked", by Anna Lewcock, 18 September 2007 (http://www.in-pharmatechnologist.com).

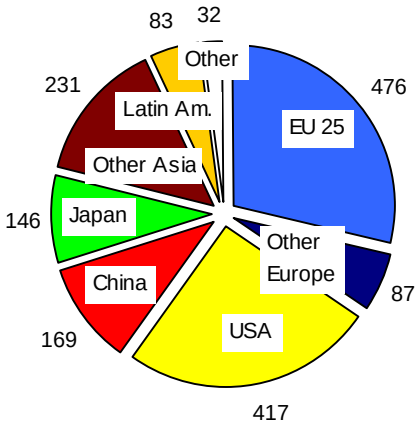
demand.[62] On the other hand, trade is not a one-way route, and rivalry in the market also increases. Companies in the emerging markets are making fast progress (in terms of production and marketing know-how) and are now targeting European markets, leveraging their lower production costs (mainly due to cheap labour) as a competitive advantage.

CEFIC (2006, p. 2) summarises this international competitive scenario for European companies as follows: "*The European chemical industry can still be portrayed as vibrant and strong. However, worldwide competition is getting fiercer.*" This can be demonstrated by comparing current world-wide sales figures with growth rates.

The EU chemical industry is the world leader with total sales of €476bn (in 2006). For comparison, sales of companies in the NAFTA area are estimated at €417bn, those of Japanese firms at €146bn. In a country ranking, China occupied third place in worldwide chemical sales and India ranked ninth, so both are among the world's 10 largest chemical producers (CEFIC 2006, see Exhibit 2.3-1).

However, as in most industries, production in the emerging economies, notably the Asian-Pacific and Latin American markets, has experienced enormous growth since the late 1990s. Annual production in Asia has increased by more than 70% between 1994 and 2007, compared to about 20% in the EU (see Exhibit 2.3-2).

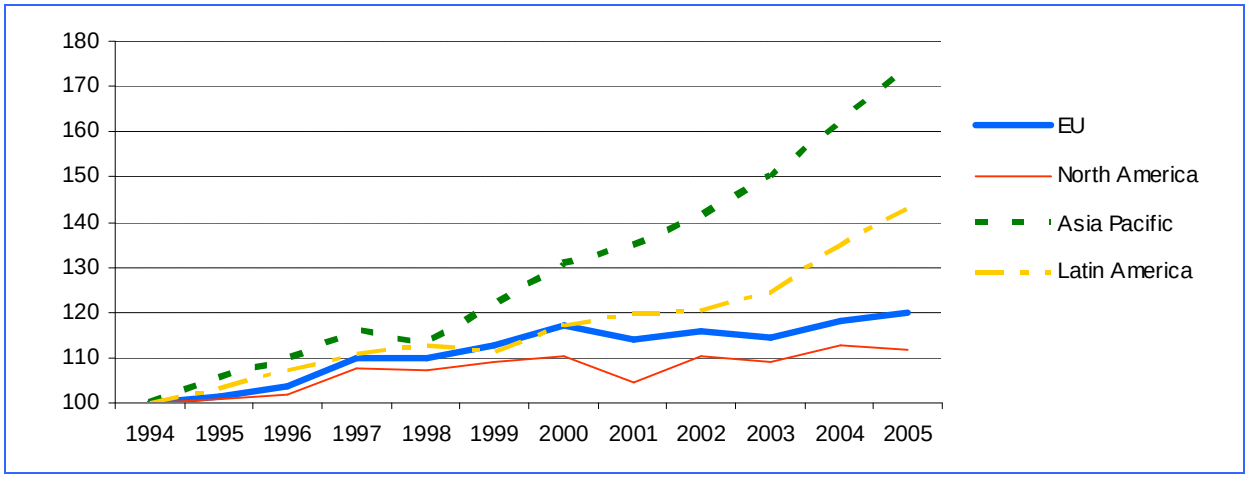
Exhibit 2.3-1: Geographic breakdown of world chemicals sales in € bn (2005)



(excludes pharmaceuticals)

Source: CEFIC (2007), Table Report, Table 1.1

Exhibit 2.3-2: Growth in chemicals production – production index 1994-2005 (1994 = 100)



Source: Developed from CEFIC (2006)

Thus, new market opportunities and rising competitive pressure exist in parallel. Depending on the sub-sector and the positioning of the individual company, either of the two can prevail. On the whole, the short and medium-term outlook for the European CRP

[62] In the EU chemical industry, for instance, domestic sales have been stable since 1995 (see CEFIC 2006, p. 6), thus steadily decreasing in importance as % of total sales.

industry is still positive, provided that there will be no major disruptions in the world economic development (e.g. as a result of a crisis in international finance).

Anecdotal evidence indicates, however, the mixed trends. The forecast for the German chemical industry for 2008 is an example for a positive scenario: the sector expects further growth, albeit not at the (record) level of 2007 (see fact box).

Fact box

German chemical industry breaks all records – positive outlook for 2008

The German chemical industry benefited in 2007 from increasing international demand for chemical products, in particular from the emerging markets. Exports increased by 8% to about 95 billion euros. According to VCI, the sector employment increased in 2007 for the first time since 1991.

For 2007, VCI expects sales to grow by 7.5% (to about 174 billion euros), and output by about 4.5%. For 2008, further growth is anticipated, but not at the same level: sales are expected to increase by 4.5%, output by 2.5%. The lower growth rates are ascribed mainly to the strong Euro, high oil prices and difficulties in the financial markets.

Source: VCI – Association of the German Chemical Industry, quoted in eNewsletter "Chemical-Newsflash" by FAZ-Institut.de, 7 December 2007 (http://www.chemical-newsflash.de/de/news/111207/news1.htm)

Similarly, and for comparison, chemical companies in the USA are also mostly optimistic for 2008, in spite of the threat of an economic recession in the domestic market. Dupont, for example, has upgraded its forecast for 2008 in January 2008, now expecting 11% growth in profits. The company expects that global growth in agriculture and food production will more than compensate for a possibly negative development in the domestic market.[63]

In the tyre industry, companies are less optimistic, as the trade balance with emerging markets has a negative trend. Exports into the four largest emerging markets –-the "BRIC" countries (Brazil, Russia, India, China)–- account for only 11% of total exports, while imports of tyres notably from China have surged between 2000 to 2006.

It is not only the lower production costs, however, that benefit competitors in Asia; the imbalance in terms of the maturity of market conditions are also in favour of exports from Asia to Europe rather than in the other direction. Without being prejudiced against the emerging economies, it can be argued that the high transparency and advanced legal foundations of the European market cannot be compared with the current conditions in China, India or other Eastern markets when doing international business.[64] The European Commission is aware of this challenge, pointing out that EU exporters face a number of obstacles, including "complex standards and technical regulations governing chemicals, weak Intellectual Property Right protection."[65] To improve the situation, a number of directions are being explored, and cooperation with WTO is sought.

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[63] Chemical news-flash by FAZ Institut, 15 January 2008.

[64] This is a challenge for European exporters, as for instance ETRMA points out in support of its members (interview with Ms F. Cinaralp, 29 November 2007).

[65] see http://ec.europa.eu/trade/issues/sectoral/industry/chem/index_en.htm.

3 Deployment of ICT and e-Business Applications

As part of their efforts to cope with the challenging business environment described in the previous section, companies need to take decisions about their e-business strategy. This implies investments in ICT, skills requirements and often organisational changes and ICT investments. This chapter explores the current ICT use and e-business activities in the CRP industries. It presents recent data on the diffusion of ICT systems and standards for e-business in this sector, where companies see the main drivers and barriers for e-business, and discusses issues such as the demand for ICT skills and the outsourcing of services.

The main objective of this chapter is to provide a concise and up-to-date description of the state-of-play in e-business in this sector and to outline major developments in the framework conditions for ICT usage, taking into account (to the extent possible) the different requirements of small and large companies and of various value-systems within the industry. This broad picture of sectoral e-business activity is the basis for a more analytical assessment on drivers and impacts of ICT adoption presented in Chapter 4. The presentation has been structured into six main themes:

- **Review – the situation in 2003/04**: Section 3.1 summarises the main findings of an earlier e-Business Watch study on the chemical industries conducted in 2003/04. The results of that study serve as a benchmark to assess the dynamics of the developments since then.
- **Access to ICT networks & endowment with basic infrastructure:** Section 3.2 looks at companies' access to ICT networks and their endowment with basic infrastructure. The objective is to assess the sector's overall "e-readiness", i.e. the basis for doing business electronically.
- **ICT for value chain integration and process efficiency** (Section 3.3). Improving the efficiency of production and supply chain processes is a key objective in all manufacturing sectors. However, depending on the structure and characteristics of supply chain processes, the potential for improvement will not be the same for all players involved. In particular, the "digital divide"[66] between large and small companies is believed to hamper the optimal use of ICT network effects. This section analyses how ICT is used to improve business processes in the value networks of the CPR industries, and assesses the impact of the digital divide in this context.
- **Use of e-standards and the role of intermediaries** (Section 3.4). Chemical industries are in a preferred position to benefit from standardisation since many of the products traded can easily be categorised in e-catalogues. The e-Business Watch sector study of 2004 focused on how companies use the Chem eStandards by CIDX (Chemical Industry Data Exchange) in supply chain processes. Section 3.4 of this report updates this analysis, looking at the developments since and the deployment of this standard today. Furthermore, the section discusses the role of Business process outsourcing (BPO) for process efficiency in the industry. It

[66] The term "digital divide" refers to differences between various groups in their ICT adoption and usage. It can be applied to individuals and households (e.g. "digital divides" between young and old people) as well as to companies.

assesses how companies can benefit from the offer of specialised service providers such as e-invoicing operators or B2B connectivity hubs.

- **ICT potential for customer service** (Section 3.5). An earlier study of 2004 concluded that ICT presented opportunities for "*innovative, better focused marketing approaches to reach new customers*," but raised this as a question mark, arguing that the respective opportunities "*… were not yet exploited*."[67] This section presents new evidence that marketing and customer service is becoming a major focus of e-business activity even in traditional manufacturing sectors, notably in the context of global competition.
- **Barriers to e-business**: an assessment of the main barriers that keep companies from adopting e-business (Section 3.6).

In all sections, the study tries to assess the **developments since 2003/04**. This will be done mostly by comparing results of the e-Business Watch surveys of 2003 and 2007, to the extent that the respective variables were covered in both surveys.[68] When comparing data from these two surveys, some differences must be taken into account however. In the survey of 2003, the pharmaceutical industry was part of the sub-sectors covered. Second, the sample consisted of 7 EU countries in 2007 but only 5 in 2003 – Poland and Sweden were not covered by the survey of 2003. Finally, the survey of 2003 also included micro-firms with fewer than 10 employees; therefore, comparisons are only made within size-bands, but not for totals. To further assess the developments in the past few years, an earlier case study (of 2004) on the world's largest chemical company, BASF, and the analysis of the deployment of Chem eStandards have been updated for this study.

[67] e-Business Sector Study on the chemical, rubber and plastics industry, August 2004, Section 3.1. Available at http://www.ebusiness-watch.org/studies/on_sectors.htm (2004b).

[68] Data presented in the e-Business W@tch sector study on the chemical industries of 2004 are based on a survey conducted in 2003.

3.1 The state-of-play in 2003/04 – review of an earlier sector study

This section summarises the main findings of an earlier e-Business Watch study (2004) on the chemical, rubber and plastics industries.[69] The results of this study serve as a benchmark to assessment the dynamics of the developments in the past 3-4 years as discussed in the following sections.

Main conclusions

In the e-Business Survey of 2003, companies that represented about 60% of employment in the CRP sector said that e-business constituted at least some part of the way they operate. This was close to the average of the 10 sectors surveyed in this year. Those enterprises that said that e-business did not yet have any significance for their business were asked about possible reasons why this was the case. The most important reason, particularly in the 10 new EU Member States, was that interviewees considered their company to be too small for drawing benefits from electronic business. The second important reason is closely related to the first one – the costs for technology.

Large companies in the sector were found to be well equipped with ICT systems and advanced users of e-business, albeit not frontrunners such as companies in the ICT producing industries. In summary, the study concluded that the combined chemical industries had been a rather conservative sector when it came to using ICT for linking business processes and interacting with their suppliers and customers. It was pointed out, however, that this did not mean that companies from the sector refused adoption and innovation. It meant rather that management in chemical companies often pressed even harder than it may be the case in other sectors for concrete return-on-investment figures before approving the implementation of new IT architectures or software applications.

Earlier study findings

e-Business in the CRP industries as a continuous, evolutionary process

Developments appear to take place as a continuous, evolutionary process and not as a technological revolution. Most of the larger companies from the sector have already introduced electronic business processes into their day-to-day operations. Communication with customers and suppliers, as well as transactions within the value chain, are increasingly ICT based. Procurement and supply chain integration constitute the most important application areas in this sector, as there are proven benefits for companies (…). Thus, electronic business is a reality and not a vague promise of the future.

Source: e-Business W@tch sector study on the chemical industries, May 2004, p. 59 (conclusions)

[69] European Commission / e-Business W@tch (2004): Electronic Business in the Chemical Industries. The study findings are presented in two reports. Report I: The quantitative picture: diffusion of ICT and e-business in 2003/04 (May 2004). Report II: Key issues, case studies, conclusions (August 2004).

Because of the very deliberate and careful application of ICT, it was found to be unlikely that e-business would have a major impact on the fundamentals of how chemical, rubber and plastics products are traded. The major forces driving change in this sector were seen in the internationalisation of markets and in changes of the regulatory frameworks, rather than information technology and e-business by themselves.

Notwithstanding this general conclusion, it was also found that the internet had increased the international market transparency for products and conditions, just as in probably any other business sector.

Finally, in spite of cutting costs still being a major driver for e-business adoption, the study forecast that companies' attention would gradually shift toward using ICT for customer facing strategies. The main argument was that many of the large players from the sector had already optimised their supply side processes in advanced ways and might now seek opportunities to further modernise their communication and marketing strategies. If this has been the case in recent years will be analysed in the following sections.

Opportunities and risks, drivers and barriers

The study of 2004 argued that the main opportunity and objective of electronic business in the CRP industries (at that time) was not strictly e-commerce related, but addressed the improvement of business processes with respect to efficiency, quality assurance and speed. However, this would also imply challenges, notably for small firms. e-Business had accelerated the speed of process innovation in the sector, especially when compared to the pre-digital era, implying an "*ongoing process of further improvements and refinements of the systems.*" The study observed that it was quite demanding for companies to follow this constant innovation and to draw the correct conclusions about adoption. A certain level of know-how about the state-of-the-art in e-business, however, was regarded as a basic, indispensable skill for firms operating in today's international business environment. In a way, managing electronic relationships with customers and vendors would be "*a natural extension of managing the same kind of relationships in a traditional, more paper-based way*."

With regard to drivers and barriers (see Exhibit 3.1-1), the study found that "*the major push for doing business electronically in the chemical industries comes from the pressure to save costs wherever possible.*" Identified barriers included the wide-spread reluctance among smaller companies to re-engineer business processes, the digital divide and the shortage of investment capital.

Exhibit 3.1-1: e-Business related opportunities and challenges for CRP firms

e-Business related opportunities	e-Business related challenges
• Save costs by improving the efficiency of supply chain processes, in many cases with a rapid return on investment • Reduce the error rates in B2B transactions by eliminating paper-based processes • Faster accomplishment of tasks by using electronic planning and controlling tools • For buyers: reduced procurement costs • Not yet fully exploited: innovative marketing approaches to reach new customers	• For suppliers: Further pressure on profit margins due to sophisticated e-procurement mechanisms (such as e-auctioning) • Investment risks due to uncertainty about the technology and market development: Potential lock-in to specific applications and B2B connectivity modes
e-Business drivers	**e-Business barriers**
• International competition and resulting pressure on exploiting all cost saving potentials • Structure of supply chain processes in the sector is well suited for B2B online trading • Sector is well suited for use of e-standards • Growing maturity of e-business software and focus of providers on the not-yet-exploited small company market	• Reluctance to re-engineer business processes among smaller firms • Dichotomy between large players and small firms • Shortage of investment capital after the overall economic downturn

Source: e-Business W@tch sector study on the chemical industries (August 2004)

No major policy implications

The e-Business W@tch study of 2004 concluded that the research findings would not point at an urgent need for e-business specific policies in the chemical sector. The adoption and use of ICT in the would be unlikely to cause dramatic changes or stir-ups in the industry value-chain. It was argued that the restructuring process in the chemical industries were related to general economic developments (such as globalisation) rather than caused by technological determinants. e-Business was seen as a facilitator of these developments, but not as the cause. In conclusion, e-business related interventions from the public sector were not considered necessary. One area was identified where policy might consider activities: helping SMEs taking informed decisions by providing information about e-business opportunities and necessary preconditions to grasp them. It was argued that, without proper preparation for e-business, smaller companies might be unable at some point of time to meet technical requirements (such as providing all business documents electronically) of doing business with larger customers.

3.2 Access to ICT networks, e-skills and ICT expenditure

This section looks at companies' access to ICT networks and their endowment with basic infrastructure in 2007. The objectives are to assess

- the sector's overall "e-readiness", i.e. to what extent the basic ICT infrastructure for doing business electronically is in place;
- the adoption dynamics since the last point of measurement in 2003;
- current trends in ICT budgeting.

Internet access – the deployment of broadband

As in most industries, doing business in the CRP industries without having **internet access** is no longer possible. Practically all companies (99%) from the sector with at least 10 employees are connected to the internet (see Exhibit 3.1-1). While this was already the case in 2003, the quality of companies' internet access has significantly improved since, notably among SMEs. The share of small firms (with 10-49 employees) that say they are connected with **broadband**[70] has increased from 10% in 2003 to nearly 40% in 2007; among medium-sized firms, broadband diffusion has more than doubled from about 20% to 44%. Broadband adoption among large companies, by contrast, has only slightly increased from about 40% to 50%.

Exhibit 3.2-1: % of companies / employees with Internet access (2007)

	Companies with internet access		Companies with internet access >2 Mbit/s		Average share of employees with internet access in firms	
Weighting scheme:	% of empl.	% of firms	% of empl.	% of firms	% of empl.	% of firms
CRP – 2007 total (EU-7)	**100**	**99**	**46**	**40**	**45**	**36**
NACE 24: chemical	100	100	63	43	61	48
NACE 25: rubber & plast.	100	98	34	38	35	30
CRP – USA	**100**	**99**	**47**	**47**	**64**	**42**
CRP – by size (EU-7)						
Small (10-49 empl.)		99		38		35
Medium (50-249 empl.)		100		44		38
Large (250+ empl.)		100		50		50
Other sectors (EU-7)						
Steel	100	100	34	41	30	24
Furniture	100	99	46	39	26	24
CRP – 2003 (EU-5)						
Small (10-49 empl.)		*96*		*10*		*n.a.*
Medium (50-249 empl.)		*99*		*21*		*n.a.*
Large (250+ empl.)		*99*		*38*		*n.a.*
Base (100%)	all firms		firms with internet access, excl. DK		all firms, excl. DK	
N (CRP, 2007, EU-7+USA)	911		777		903	
Questionnaire reference	A1		A3c		A2	
The survey was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.						

Source: e-Business Surveys 2003 / 2007 by the SeBW

[70] Broadband has been defined in this study as internet connection with a bandwidth of at least 2 Mbit/s.

At the same time, the percentage of companies which still access the internet with low-bandwidth connections (of less than 144 kbit/s) has decreased to only about 5%, irrespectively of the firm size. Back in 2003, about 25% of small companies still said that they used analogue dial-up for connecting to the internet, typically at a rate of 56 kbit/s. This type of low-bandwidth internet access has mostly disappeared from the market since. Currently, the split between firms that connect with a rate between 144 kbit/s – 2 Mbit/s, and those that connect by broadband (with more than 2 Mbit/s) is about even. Thus there is still scope for improvement. Broadband internet access should be considered as basic infrastructure and become the norm for the majority of companies.

The maximum available bandwidth is an ICT infrastructure indicator, but does not provide information about the actual usage. A different indicator is how many employees use the internet as part of their day-to-day work. In CRP companies, the **average share of employees with internet access** at their workplace is about 45%. This is more than in the steel and furniture sectors (about 25-30%), but similar to other manufacturing industries such as pulp and paper.[71]

The share of employees that have internet access at their work space can be seen as an indicator for the degree of automation of work and production processes in manufacturing. In sectors where traditional, manual work is still an important element of the manufacture (for example in the textile and furniture industries), fewer workers need ICT to perform their tasks. In other sectors, by contrast, ICT is increasingly used to manage and control production processes. The CRP sector is a good example, notably in the chemical industry, where it is estimated that about 60% of employees have internet access. In the rubber & plastics industry, the percentage is significantly lower (35%).

This observation can be linked with another characteristics of the CRP sectors: labour productivity is higher in the manufacture of chemicals than in the rubber and plastics industry (see Section 2.2). The higher degree of process automation in work processes appears to correlate with labour productivity. However, it has also to do with firm size. The average share of employees with internet access tends to be higher in large firms (50%) than in SMEs (about 35%), which partly explains the different results for sub-sectors (due to their different structure).

As in other industries, many of the smaller firms have taken the first steps to connect to the internet rather late. Often, they started with only one central e-mail address for the whole company, which explains the still lower degree of internet access among employees. At this early stage of ICT adoption, incoming e-mails would typically be printed out by a secretary (if it is not a one-person-company) and be handed (in paper-format) to the receiver, who will then instruct the secretary how to reply. In many cases, this is sub-optimal, since direct communication with the specific target person in the company would be more efficient for the communication with customers or suppliers.

Use of internal networks

Similarly to internet access, the use of ICT to connect computers internally to a company network (Local Area Networks – **LAN**) has become a commonplace, even for small firms (see Exhibit 3.2-2). This was not necessarily the case in 2003, when "only" about 50% of small companies reported the use of a LAN. Diffusion has increased to 75% in 2007.

[71] See SeBW study on the pulp and paper industry (2006), p 31f.

The diffusion of **Wireless LAN** (W-LAN) technology has surged in recent years. This technology was not much used back in 2003; in the meantime, close to 60% of employees work in companies that operate a W-LAN. In large firms, the adoption rate has reached 70%. For comparison, the adoption rate among large pulp & paper manufacturers was about 50% in 2006; since ICT adoption levels tend to be similar in these manufacturing sectors, this is indicative for the fast diffusion of W-LAN as a means to facilitate network access within a site or building.

Exhibit 3.2-2: Internal networks used (2003 / 2007)

	LAN		W-LAN		Intranet		Remote access to company network	
Weighting scheme:	% of empl.	% of firms	% of empl.	% of empl.	% of empl.	% of firms	% of empl.	% of firms
CRP – 2007 total (EU-7)	**95**	**82**	**58**	**38**	**69**	**43**	**77**	**49**
NACE 24: chemical	97	86	66	44	79	48	81	59
NACE 25: rubber & plast.	94	80	52	35	63	41	75	44
CRP – USA	**92**	**85**	**49**	**30**	**82**	**56**	**89**	**65**
CRP – by size (EU-7)								
Small (10-49 empl.)		76		32		36		39
Medium (50-249 empl.)		95		47		58		68
Large (250+ empl.)		100		70		85		90
Other sectors								
Steel	94	78	49	30	71	36	63	37
Furniture	84	71	47	30	45	31	50	30
CRP – 2003 (EU-5)								
Small (10-49 empl.)		53		*n.a.*		32		26
Medium (50-249 empl.)		88		*n.a.*		58		51
Large (250+ empl.)		92		*n.a.*		79		71
Base (100%)	all firms		all firms		all firms		all firms	
N (CRP, 2007, EU-7+USA)	911		911		911		911	
Questionnaire reference	A4a		A4b		A4d		A5	
The survey was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.								

Source: e-Business Surveys 2003 / 2007 by the SeBW

Another good indicator for "e-readiness" is the share of companies that enable **remote access** to their computer network. This means that employees can access data from a company's network remotely, e.g. when working from home or travelling. In the CRP industries, about 50% of firms with at least 10 employees (comprising 77% of the sector's employment) enable remote access (see Exhibit 3.2-2). Just as broadband access, remote access is a good indicator for SMEs' progress on the e-maturity ladder. Diffusion of this functionality in the CRP industries has increased from about 25% to 40% for small firms and from about 50% to nearly 70% for medium-sized firms between 2003 and 2007.

By contrast, no significant increase can be observed for the diffusion of **intranet**. In 2007, about 70% of employees work in firms which operate an intranet. This technology, which is mainly used for internal knowledge sharing, seems to have reached the saturation level.

For most of the ICT infrastructure indicators discussed in this section (internet access, LAN / W-LAN, remote access), there are differences between the two sub-sectors (chemicals / the converting industries, i.e. the manufacture of rubber and plastics). Diffusion is more advanced among chemical companies. However, these variations on

the aggregate level partly reflect structural differences between the two sub-sectors, i.e. the dominance of SMEs in the converting industries (see Section 2.2). The aspect of the digital divide and its implications for the deployment of more advanced e-business practices will be discussed in more detail in the following section.

ICT skills requirements

Improving e-business skills, especially among SMEs, has been identified as a relevant concern for policy in various studies by e-Business Watch and by the eBSN. A clear distinction has to be made in this context between (larger) companies that can afford **employing ICT practitioners**, i.e. staff with the specialised skills and tasks of planning, implementing and maintaining ICT infrastructure,[72] and (typically smaller) companies that do not employ practitioners.

The critical divide here is between small and medium-sized firms. In total, 22% of all CRP companies with at least 10 employees said that they employed ICT practitioners in 2007 (see Exhibit 3.2-3). Among medium-sized firms, 40% of firms have specialists for ICT tasks; among large firms, about 60% employs practitioners. These figures are similar to findings for other process manufacturing sectors such as the steel and the pulp & paper manufacturing industries. If employing practitioners is used as a proxy for having an IT department, it may come as a surprise that 'only' 60% of large companies report that they employ ICT practitioners.

Assuming that most companies with 250 or more employees have some sort of IT department with at least 1-2 people mainly charged with IT-related tasks, why then does every second enterprise appear to have the perception that it does not employ ICT practitioners? Maybe the term "ICT practitioner" in itself can be misleading in time-constrained telephone interviews, and some companies do not count their PC and network administrator(s) in, although they are mainly charged with ICT tasks.

Out of those firms that employ practitioners, about 15% reported that they had experienced **difficulties in finding qualified practitioners** in the past 12 months (see Exhibit 3.2-3). The incidence was slightly higher among larger firms (about 20%), due to their higher demand. However, these figures appear to be surprisingly low, considering the attention which policy is paying to the presumed ICT skills gap. The findings indicate that the shortage in ICT skills is mostly a problem for the ICT industries themselves (e.g. for the large providers of e-business software), but only to a lesser extent for the user industries, at least in manufacturing sectors. This is supported by evidence from the steel and furniture industries, where the percentage of firms that reported difficulties is even lower. However, anecdotal evidence confirms that a lack of qualified ICT and e-business practitioners is a relevant concern at least for very large companies with their advanced and sophisticated e-business practices. Most of the e-business managers from large firms interviewed for this study (e.g. for case studies) said that their companies experienced difficulties in finding the right people for their e-business departments. The mixed evidence from the survey and from interviews shows that the demand for e-skills can vary widely within an industry, depending on a company's business model and e-business strategy.

[72] The European eSkills Forum, established by the EC in March 2003, defined "ICT practitioner skills" as the "capabilities required for researching, developing and designing, managing, producing, consulting, marketing and selling, integrating, installing and administrating, maintaining, supporting and service of ICT systems." Cf. eSkills For Europe: The Way Forward", Synthesis Report by the eSkills Forum, September 2004.

Exhibit 3.2-3: ICT skills requirements and outsourcing (2007)

	Employ ICT practitioners		Have experienced difficulties in finding qualified practitioners		Say that e-business has a significant impact on skills requirements		Have outsourced ICT services previously conducted in house in past 12 months	
Weighting scheme:	% of empl.	% of firms	% of empl.	% of empl.	% of empl.	% of firms	% of empl.	% of firms
CRP – 2007 total (EU-7)	**45**	**22**	**21**	**15**	**40**	**36**	**30**	**28**
NACE 24: chemical	50	26	21	16	35	33	31	32
NACE 25: rubber & plast.	42	20	20	15	43	37	28	26
CRP – USA	**47**	**27**	**25**	**16**	**40**	**27**	**33**	**20**
CRP – by size (EU-7)								
Small (10-49 empl.)		14		11		31		26
Medium (50-249 empl.)		40		18		48		34
Large (250+ empl.)		59		22		40		35
Other sectors								
Steel	52	24	20	5	36	28	19	22
Furniture	33	18	7	9	53	39	24	21
Base (100%)	all firms		firms employing practitioners		all firms		all firms	
N (CRP, 2007, EU-7+USA)	911		911		911		911	
Questionnaire reference	E1		E3		E5		E9	
The survey was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.								

Source: e-Business Surveys 2003 / 2007 by the SeBW

Even if companies do not employ ICT practitioners, e-business can have an impact on **skills requirements**. In fact, about 40% of the companies in the sector believe so (see Exhibit 3.2-3). The case study on Medikémia (Section 5.4) concludes that the impact of e-business on the company is manifested in the development of employment and skills requirements, while the main hierarchical and functional characteristics have not changed much with the deployment of ICT. This is because the introduction of e-business can have a profound impact on work and production processes (see Section 3.3.3); employees have to adapt to the new processes and learn to use e-business applications. This can be a challenge, as the benefits of introducing a new system may not be spread even across all departments. The case study on Probos (Section 5.6) shows that employees in production initially perceived a new system mostly as a burden, as it caused additional work for them (entering more data into the system than was needed before), while the sales force immediately benefited from the new system.

Outsourcing of ICT services

The demand for e-skills is also related to outsourcing strategies. In fact, there is evidence that companies increasingly **outsource ICT and e-business functions**, either partially of fully, to specialised service providers. About 3 in 10 companies interviewed in 2007 said that they had outsourced ICT functions to external service providers which they had previously conducted in-house in the past 12 months (prior to the interview). Outsourcing can mean a wide array of practices in this context. It includes the "**SaaS**" ("Software as a Service") distribution model, where companies pay a license to use a software online which is hosted and operated by the service provider, rather than purchasing the software

to be installed within the company. It can also mean that whole **business processes** are outsourced to specialised service providers (this aspect, which is highly relevant in the CRP industries, is discussed in more detail in Sections 3.4.2, and in the case study on OB10, Section 5.1). The case study shows that successful outsourcing can help a company to achieve **productivity growth**, as it enables companies to focus more on their core business.

However, outsourcing ICT services does not mean that a company does no longer need a proper understanding of ICT and e-business related opportunities. On the contrary, there is evidence that companies with a better ICT infrastructure and a good knowledge of e-business are more likely to draw benefits from outsourcing specific ICT services (see economic analysis of links between ICT and outsourcing in Section 4.3.3), paradoxically because they can leverage their own ICT infrastructure to better manage the interfaces with the external service provider (to whom they have outsourced specific processes).

ICT investment and budget trends

The general climate for ICT investments has significantly improved over the past few years. This has a number of reasons: first, the positive economic framework conditions since 2004 have made it easier for companies to make investments;[73] second, the wide-spread distrust of ICT for some years after the crash of the "new economy" in 2001 has mostly faded away; and third, ICT solutions have become more mature and better adapted to the requirements of specific firms. It may also help that there are plenty of business cases which demonstrate that well-planned investments in ICT can generate return-on-investment even in the short term, often within less than two years.[74]

The Sectoral e-Business Watch asked companies in 2007 whether they had made investments in ICT during the past 12 months (prior to the interview), for example for new hardware, software or networks. About two thirds of all small firms and more than 80% of medium-sized and large firms said that they had done so (see Exhibit 3.2-4). Companies where also asked whether, in the forthcoming financial year, they would rather increase their ICT budget, decrease it or keep it roughly the same. A vast majority of nearly 80% said that they would keep the ICT budget at about the same level. About 20% of companies said they would increase the budget (about half of those by up to 10% and the other half by more than 10%). Only very few companies (about 4%) said they would decrease the budget (see Exhibit 3.2-5).

The finding that companies expect to either maintain or increase their budgets is confirmed by other market studies. Some of them are even more "bullish" in their forecasts: IDC, an ICT market research company, estimates that German enterprises spent about 76 billion euros for ICT hardware, software and services in 2007, and forecasts that this figure would increase by 7.5% in 2008.[75]

[73] It remains to be seen whether the risk of an economic downturn / recession in the wake of the financial market crisis of late 2007 will have a sizable impact on companies' ICT expenditure.

[74] See, for example, business cases of ICT investments by SMEs documented by the German "PROZEUS" initiative (www.prozeus.de).

[75] quoted from: "Pflicht und Kür", in: WirtschaftsWoche, No. 10/2008, 3 March 2008, p. 98.

Exhibit 3.2-4: % of companies that made investments in ICT hardware or software in 2006/07

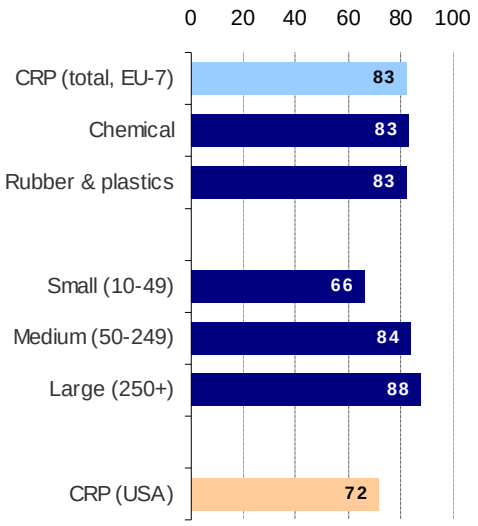
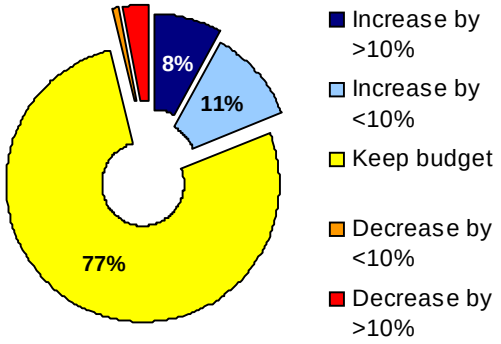


Exhibit 3.2-5: % of companies planning to increase / decrease their ICT budget in the forthcoming financial year



Reading example: "11% of all companies (by their share of employment) said that they expected to increase their ICT budget by up to 10% in the forthcoming financial year."

The survey was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.
Base (100%) = companies with at least 10 employees and using computers;
N (Chemical, EU-7 and USA) = 911.

Weighting: Figures for sector totals and countries are weighted by employment ("firms representing x% of employment in the sector / country"), figures for size-bands in % of firms.

Source: e-Business Survey 2007 by the SeBW

However, the right ICT strategy it by no means a simple equation of "the more the better". A survey by the consulting company Accenture among 700 companies world-wide found that companies with a high turnover and profit spend on average 17% less for IT than their competitors. Typically, these companies have specified clear priority areas for their ICT investments and implemented sophisticated reporting systems to keep control of their ICT budgets.[76] This holds true as a general recommendation, in particular for SMEs: they should carefully think about ICT priorities, and then focus their resources on these areas.

[76] ibid.

Summary of key points: access to ICT networks, e-skills and ICT budgets

Nearly all companies in the sector are connected to the internet, and most of them with a better quality than a few years ago. However, even if the "e-readiness" of enterprises has significantly improved in the past few years, there is still scope for further infrastructure improvement. A shortage of ICT practitioners is not experienced as a major bottleneck for e-business uptake by companies in this sector.

- **Dynamic development since 2003**: the quality of SMEs' internet access has significantly improved between 2003 and 2007. However, there is still scope for improvement. Currently, about 40% of firms are connected with >2 Mbit/s. The percentage of SMEs enabling remote access to their computer network has also significantly increased.
- **Wireless LAN on the rise**: diffusion of internal W-LANs has been rapid. Close to 60% of employees work in companies that operate a W-LAN, and even more than 30% of small firms do.
- **More "e-workers" in the chemical industry**: in the chemical industry, the average share of employees that have access to the internet is higher than in the rubber and plastics industry. This reflects the higher degree of automation in production processes in this industry segment.
- **ICT skills**: about 20% of all firms employ ICT specialists. Only one in seven of those reported difficulties in finding qualified ICT practitioners.
- **ICT investments and budgets**: companies representing more than 80% of employment made investments in ICT in 2006/07. Most companies plan to keep the ICT budget unchanged in the forthcoming financial year, 20% plan to increase their budget, hardly any company says it will reduce the budget.

3.3 ICT for supply chain integration and process efficiency

Improving the efficiency of production and supply chain processes is an important objective for all manufacturing businesses. However, the potential depends on the structure and characteristics of the respective supply chain. This section explores the impact of ICT on business processes of companies from the CRP industries and assesses where the major potential sources for innovation and productivity improvements are located. The assessment and conclusions are based on desk research, case studies (see Chapter 5), interviews with industry representatives and data from the e-Business Survey 2007.

A significant challenge is how to draw valid general conclusions. Not only differ the subsectors in their characteristics (see Section 2.2), but conclusions are presumably different for small and large firms. To the extent possible, differences are taken into account. However, some generalisations (for "the industry") are proposed where applicable.

Companies from the CRP industry, depending on the segment and size of operations, have chosen different approaches to building their supply chain, linking to suppliers such as raw material providers (upstream) and to customers, including those within the same sector as well as in other sectors such as the automotive, construction and retail sectors (downstream). Supply chain integration via connecting ERP systems (or similar standard software packages) is the most advanced approach which medium-sized and larger companies in the sector prefer to manage their operations, provided that business partners have the required systems in place. However, not all cases are success stories; untapping the ICT potential to save costs in supply chain operations is by no means an easy undertaking.

Quote

Untapped potential?

"For the past 10 years, companies worldwide have pursued the means to a radical reduction in the cost of their supply chains. For a variety of reasons while many have made progress, the ultimate goal appears to have eluded the majority."

Chris Miller – ex-Head of Strategic Sourcing , Shell

As a starting point, Section 3.3.1 presents a general assessment whether electronic data exchange between companies has reached a break-through in the CRP industries, or whether manual processing of document still dominates. Section 3.3.2 will then look at the deployment and use of major e-business systems for process integration and supply chain management, in particular ERP (enterprise resource planning) and SCM (supply chain management). It will be discussed to what extent these advanced ICT systems have been become affordable for SMEs. Finally, Section 3.3.3 will discuss the implications of ICT for work and production processes. As the issues discussed in this section are central to most of the topics discussed in this report, readers are advised also to look at Sections 3.4 (on the role of e-standards and intermediaries) and 3.5 (on e-marketing and sales) to get a complete picture.

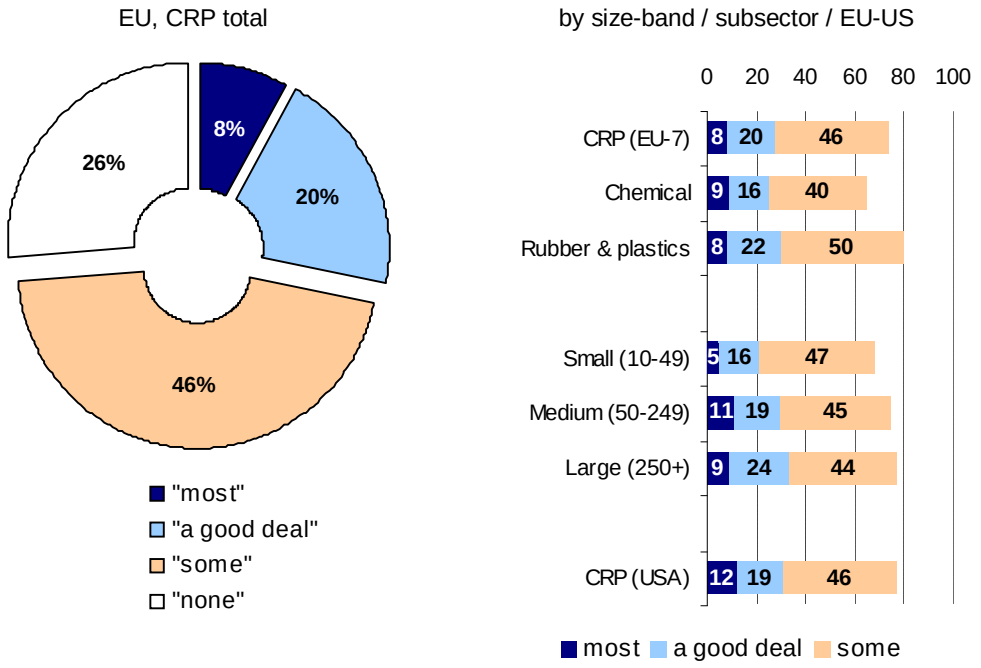
3.3.1 Electronic vs. manual data processing

Which share of business processes is conducted electronically?

By its very definition, e-business means "automating business processes" (see Section 1.2), that is **replacing** formerly **paper-based document exchanges** and their manual processing by **electronic exchanges**. Ideally, data that are exchanged in this way are machine-to-machine readable, that is they go directly into a company's ICT system without having to be re-keyed into the system manually. It is immediately clear that this general concept includes a broad range of activities processes and systems. A simple, direct measurement of the degree to which a company has digitised its processes is not possible. Nevertheless, in order to get an idea where companies position themselves on the road towards e-business, the SeBW introduced some new questions in its survey of 2007. For instance, companies were asked to estimate whether "most", "a good deal", "some" or "none" of their business processes are conducted as e-business. In total, about three quarters of all companies in the CRP industries (with at least 10 employees) said that at least some of their process were conducted electronically (see Exhibit 3.3-1). About a quarter (28%) regarded themselves as intensive users, saying that e-business accounted for "most" or "a good deal" of their business activity.

Exhibit 3.3-1: Share of business processes conducted electronically (2007)

Percentage of companies saying that most / a good deal / some / none of their business processes are conducted as e-business (2007)



The survey was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.

Base (100%) = companies with at least 10 employees, excl. those saying "don't know".
N (Chemical, EU-7 and USA) = 891.

Weighting: Figures for sector totals and countries are weighted by employment ("firms representing x% of employment in the sector / country"), figures for size-bands in % of firms.

Source: e-Business Survey 2007 by the SeBW

There is hardly a difference between European and US companies from the sector in the perceived share of e-business. Furthermore, the difference between large companies and

SMEs in this respect is less pronounced than could be expected. Even about two thirds of the small companies said that at least some of their processes were "e-business", while, on the other hand, there is a relatively high percentage of large companies which reported to have no electronic processes (23%). This raises questions, as this contradicts the empirical evidence found in case studies. It is possible, however, that interviewees had a different concept of "e-business" in mind when responding to this question.

To gain further evidence, companies were also asked to assess which of the following statements best described the way they exchanged data with business partners: whether "orders and related messages were mostly …

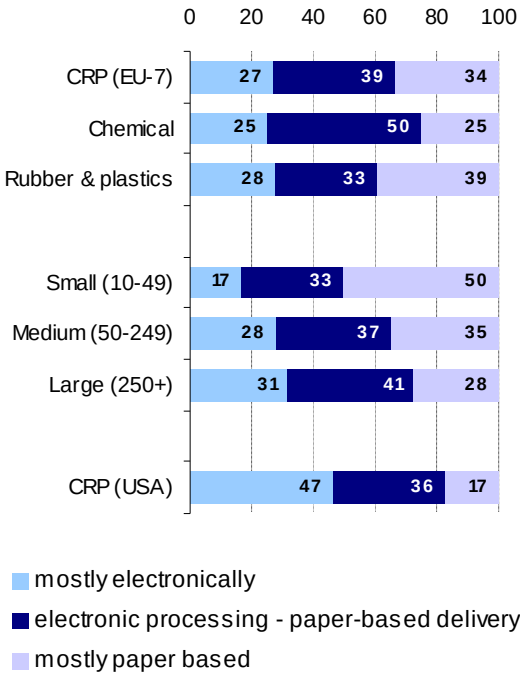
- processed and exchanged electronically;
- electronically processed internally, but then exchanged in a paper-based format; or
- processed and exchanged in paper based format, i.e. by letter or fax.

Exhibit 3.3-2 shows how firms assessed their own position within these categories, comparing different size-bands and European with US companies.

In Europe, about 30% of the medium-sized and large firms say that their data exchanges with business partners are "mostly processed and exchanged electronically", while only 8% of small firms say so. In total, firms representing 27% of employment feel that their exchanges are mostly digitised. It strikes that more US companies appear to have reached this status, at least in terms of their self-perception. In the USA, 47% (by employment) place themselves into the highly digitised category. Among the European countries covered by the survey, the percentage of firms in the digitised category was highest in Sweden, the UK and Spain (about 35% each), while the group of companies saying that paper-based exchanges dominate was highest in Italy (46%).

Among small companies with up to 49 employees, paper-based manual processing of documents is still the dominating reality – 50% say that this characterises their exchanges with suppliers and customers.

Exhibit 3.3-2: % of companies saying that they exchange and process documents … (2007)



The survey was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.

Base (100%) = companies with at least 10 employees excl. those saying "don't know". N (Chemical, EU-7 and USA) = 891.

Weighting: Figures for sector totals and countries are weighted by employment ("firms representing x% of employment in the sector / country"), figures for size-bands in % of firms.

Source: e-Business Survey 2007 by the SeBW

Structural differences, i.e. the higher number of small firms in NACE 25 (see Section 2.2) are also the main reason why in Europe relatively more companies in the converting industries (NACE 25) say they are still trading in a mostly paper-based environment than in the chemical industry (NACE 24).

All in all, however, the fact that companies representing two thirds of employment in the sector say that they process data internally electronically demonstrates the progress in e-business. Without having the evidence, it is unlikely that this percentage would have been similarly high a few years ago. The replacement of paper-based, manual data processing is in full gear; the dynamic adoption of e-invoicing as shown in the following is a good example.

The objective of replacing paper-based processes is not just relevant for exchanges between businesses, but also for company-internal processes. An example is presented in the case study on Michelin Reifenwerke, which introduced the use of Digital Personnel Records at the personnel department in its location in Karlsruhe, to cope with increasing challenges in document management (see Section 5.5). The case study mentions a dilemma in this context: many companies opt for a replacement of traditional personnel records through a "mixed mode", i.e. using digital information from existing IT systems while keeping extensive paper files in parallel. However, this is often not a satisfactory solution, leading to laborious searches for documents as a common symptom. Michelin therefore aimed to achieve a full digitisation, replacing paper based archiving as much as possible.

Adoption of e-invoicing

Another example where formerly paper-based processes can be digitised is invoicing. It is widely recognised that electronic invoicing promises rather **easy-to-achieve cost savings** for both parties involved (i.e. the invoicing entity and receiving entity), because processing invoices in a standardised, electronic format can be accomplished much faster compared to the often cumbersome handling of printed invoices. The cost saving potential obviously depends on the number of invoices that have to be processed; companies and sectors differ widely in this respect. In recent years, of e-invoicing has therefore attracted much **attention** not only within the business community, but also in **e-business policy** making. Regional and even cross-border initiatives to promote adoption have been launched in several countries, for example in Finland and Slovenia; furthermore, the European e-Business Support Network (eBSN) has e-invoicing as one of its priorities, in particular to solve cross-border problems.[77]

Reflecting the broad interest in this topic, the e-Business Surveys of 2006 and 2007, paid special attention to the uptake of e-invoicing among companies. e-Invoicing can be broadly defined as a computer-mediated transaction between a seller / biller (invoicing entity) and a buyer / payer (receiving entity), which replaces traditional paper-based invoicing processes. The invoice is electronically generated and sent by the biller, and electronically received, processed and archived by the payer. In practice, e-invoicing typically goes hand in hand with making payments electronically.

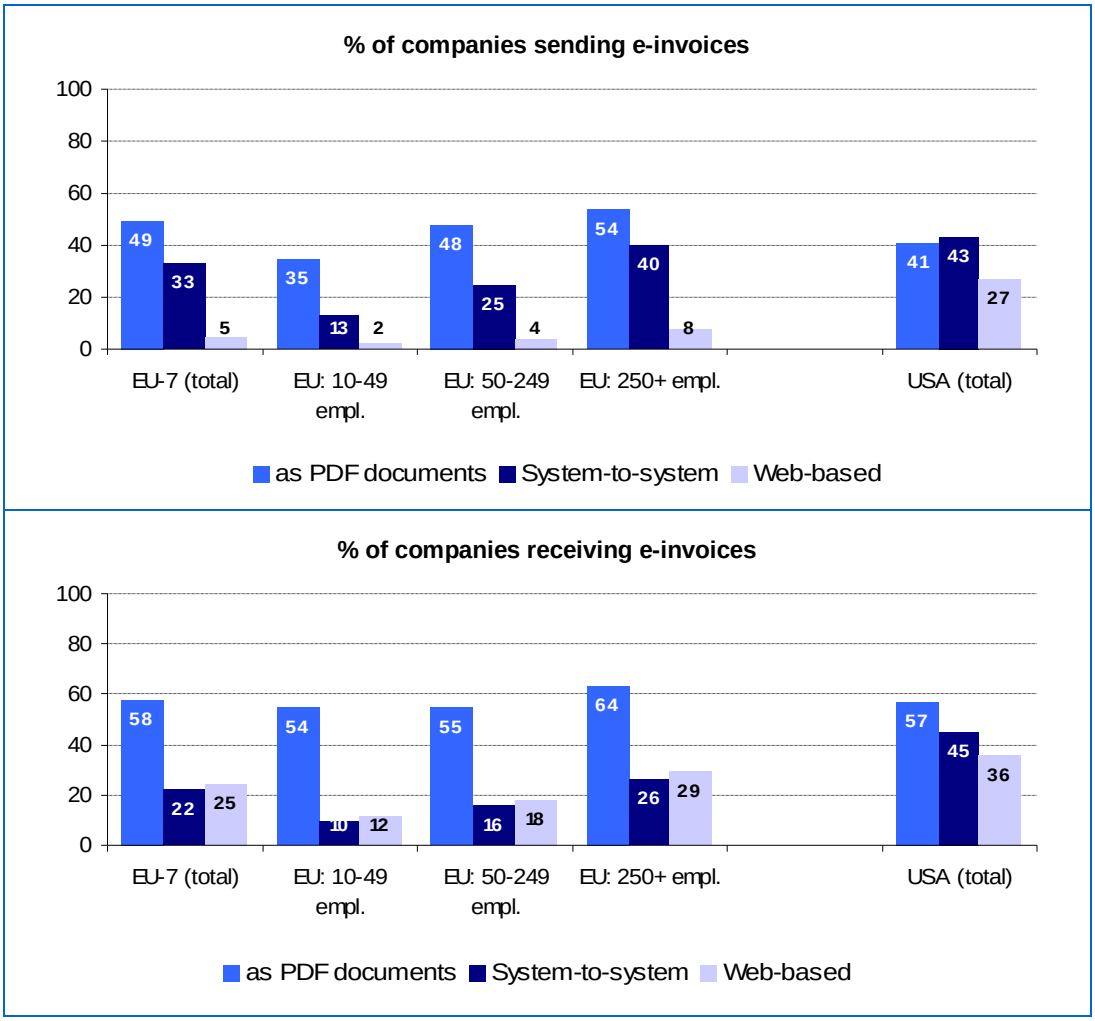
However, the challenge is that there are **different technical ways** of delivering an invoice electronically, and different views on which of these ways actually constitutes an "e-invoice". Notably, there is **disagreement whether** an invoice sent as a **PDF** document

[77] see European Commission, DG Enterprise and Industry (2007), and website of the eBSN (http://ec.europa.eu/enterprise/e-bsn/index_en.html).

(typically a scan from a paper invoice) by e-mail is an e-invoice. The counterargument is that this document is not machine-readable, thus data have to be keyed in manually by the receiver into his system. It is only *sent* electronically, but not *processed* electronically; savings are therefore significantly reduced.

"Real" e-invoicing can either be accomplished in a **web-based** environment, or processes can be integrated with the **ERP** system of a company. ERP-based systems (which are used in B2B exchanges) promise the highest cost-saving potential for companies. The broad installed base of ERP systems in the CRP industries (see following section) could thus provide a solid basis for wide adoption of e-invoicing, at least among medium-sized and large firms. To assess the adoption of different ways of sending and receiving e-invoices, the Sectoral e-Business Watch asked companies whether they send/receive invoices (a) as PDF documents via e-mail, (b) directly from their computer system to that of a customer so that data can be processed automatically, and (c) whether they issued online-invoices which customers can access on a website. Exhibit 3.3-3 shows the adoption rates for each of these methods for different size-bands, comparing European with US companies.

Exhibit 3.3-3: % of companies sending / receiving e-invoices in 2007 (different methods)



The survey was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.

Base (100%) = companies with at least 10 employees. N (Chemical, EU-7 and USA) = 911.

Weighting: Figures for sector totals and countries are weighted by employment ("firms representing x% of employment in the sector / country"), figures for size-bands in % of firms.

Source: e-Business Survey 2007 by the SeBW

The survey results confirm the dynamic adoption of e-invoicing in the past 3 years, including the more advanced forms. In the CRP industries, firms representing a third of employment said that they send **e-invoices directly from their computer system**, and more than 20% said they were capable of receiving invoices in this way (see Exhibit 3.3-3). However, this most advanced form of e-invoicing is still a domain of the larger firms. It can be expected, though, that the large companies will make substantial efforts to eliminate paper-based invoices as much as possible. This requires that their SME trading partners are capable of sending / receiving invoices electronically, and, in fact, they are exerting pressure on smaller companies to support this move (see business example BASF in the case study on Elemica, Section 5.3).

Presenting invoices on the web, which is often referred to as **Electronic Bill Presentment** (EBP) is only used by few European companies from the CRP industries (5%); however, it appears to be more popular among US companies (27%). More companies both in Europe and the USA say that they download some of their invoices from suppliers in a web-based environment (25% and 36% respectively). This method is wider diffused in service sectors such as telecommunications, where service providers try to eliminate paper-based delivery to customers by presenting the invoices on their website (for download through pass-word protected log in).

Sending invoices as **PDF documents** by e-mail is still the most widely used practice. About 50% of companies (by employment) say that they send some of their invoices in this way, and close to 60% (both in the EU and the USA) say they receive PDF invoices. Sometimes, this method is called "the e-invoice of the small company". This may be true for now, as relatively few small companies use the more advanced forms of e-invoicing; however, it is to be expected that many smaller companies that trade in B2B markets will move to "real" e-invoicing in the next couple of years, partly due to pressure from their large customers.

The overall deployment of "real" e-invoicing, measured as the percentage of all invoices sent and received in a way that companies can directly process them without having to manually re-key in the data, is very difficult to assess. The Sectoral e-Business Watch asked the users of advanced e-invoicing[78] to estimate the percentage of invoices sent / received in such a way. These companies estimated in 2007 that they sent about a third of all invoices directly from their computer system, and that they received about 15-20% of invoices directly from their suppliers' systems in a machine-readable way.

The figures are plausible, as a comparison with a real case in this study indicates: the **case study** on Acordis and OB10 (see Section 5.1) illustrates in detail how e-invoicing has been systematically introduced in a company (in this case with support of an intermediary, the e-invoicing service provider OB10), and the benefits that can be achieved. Acordis, a UK chemical company, had estimated that it would take up to 18 months to on-board the 50% target pool of in-scope suppliers, but managed to achieve this number in about six months. By mid 2007, 56% of Acordis invoices in project scope were routinely delivered electronically by OB10, with a further 15% ready, or capable of adding their volumes as of September 2007.

In summary, e-invoicing is certainly an application that has been dynamically developed over the past few years, as it offers companies a relatively easy-to-achieve way to save costs. In larger firms, the reduced time for processing invoices can translate into

[78] i.e. companies that said that they sent invoices directly from their computer system and/or or received invoices directly from the system of their suppliers.

personnel reductions in the accounting department. In smaller companies, this is rather not the case[79]; however, they benefit as the accountant can use his/her time for higher added value activities than for processing invoice documents.

3.3.2 Adoption of e-business software systems

The automation of business processes as discussed in the previous section, particularly the more advanced forms, are supported and facilitated by special software systems. The most important systems in this context are ERP (enterprise resource planning) and SCM (supply chain management). This section focuses on the deployment of these systems in the CRP industry and on trends in the software markets that could affect future adoption.

ERP, SCM & Co. – an introduction

To non e-business specialists, the acronyms (but also the full names) that specify ICT software packages for business process management can be a closed book. The most widely used systems used for planning and managing business operations in manufacturing companies are therefore briefly introduced in the following.

Enterprise Resource Planning (**ERP**) systems are software systems that help to integrate and cover all major business activities within a company, including product planning, parts purchasing, inventory management, order tracking, human resources, projects management, and finance. Ideally, they link business processes electronically across different business functions and thus help to improve efficiency in operating those processes. In addition, ERP systems can play an important role in supporting connectivity between enterprises. For manufacturing companies, ERP systems are an important "hub" for much of their e-business activities with other companies. This applies certainly to the CRP industries, where B2B data exchanges as well as planning and controlling processes are largely based on functionalities provided by ERP systems. Historically, to introduce some further acronyms, ERP systems can be considered an evolution of material requirement planning (**MRP**) and manufacturing resources planning (**MRP II**) systems, which were introduced mainly in the 1970s and 1980s. The case study on Probos (Section 5.6) illustrates how MRP and MRP II and ERP systems are functionally related to each other in a company producing plastics products.

Supply chain management (**SCM**) software help companies to match supply and demand through integrated and collaborative interaction tools. SCM provides an oversight of the flows of products/materials, information and finances, as they move in a process from supplier to manufacturer to wholesaler to retailer to consumer. SCM coordinates and integrates these flows both within and among companies. One of the key objectives of any effective SCM system is to reduce inventory (with the assumption that products are available when needed). SCM is sometimes considered as a sub-function of ERP systems, but this is not correct. However, SCM software needs to be well integrated with existing ERP applications in order to deliver the promised benefit. For example, ERP systems can provide real-time data (e.g. about inventory levels) which can the be used for supply chain decisions (e.g. for ordering raw materials) through the SCM system. Some overlap between the two e-business systems exists however, as ERP vendors are

[79] Small firms with about 50 employees typically employ one part-time or full-time accountant; they will still need this person even if e-invoicing saves some of his/her time.

adding more SCM functionality to their products, while SCM vendors are also expanding their functionality in areas traditionally handled by the ERP vendors.[80]

Besides ERP and SCM, there are several further software systems that support companies in replacing paper-based processes. For example, document management system (**DMS**) help companies to store and track electronic documents, including scanned images of paper documents. DMS is often seen as a component of Enterprise Content Management (**ECM**). Typically, they provide functionalities such as storage, versioning, metadata, security, indexing and retrieval tools.

Product lifecycle management (**PLM**) is the process of managing the entire lifecycle of a product from its conception, through design and manufacture, to service and disposal.[81] The link to ICT is that service providers have developed specific software applications to manage product data along the various phases of its lifecycle. PLM normally requires that companies have an ERP system and, possibly, even a SCM system, as it builds on functions of those basic systems.

Adoption in 2007 compared to 2003

The use of ERP systems is widespread among companies from the CRP industry. It was already found in the earlier study of 2004 the chemical industries are among the sectors with the highest ERP adoption rates. In 2007, companies representing close to 70% of employment said they had an ERP system in place. The main gap in ERP adoption is between small firms on the one hand and the medium-sized and large firms on the other. In the CRP industry, about 80% of large companies and 60% of medium-sized ones said they had an ERP system, but only about 25% of small firms did (see Exhibit 3.3-4).

A finding that comes as a surprise and raises questions is that ERP usage appears to be much more widespread among European companies than among US firms (68% vs. 36%). This is somewhat in contradiction with the finding in Section 3.3.1 that more US firms regard their data exchanges and processing to be "mostly electronically", considering that ERP is a key system for advanced digitisation of business processes.

Results for the diffusion of SCM systems, by contrast, are similar for European and US companies (39% vs. 36% by share of employment). The higher figure for the USA in the percentage of enterprises using a SCM system is mainly due to the relatively lower number of small companies in the USA.[82] Again, diffusion increases almost linearly by firm-size.

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[80] CVOC – Center for Virtual Organisation and Commerce: Enterprise Resources Planning systems and Supply Chain management (http://projects.bus.lsu.edu/independent_study/vdhing1/erp/).

[81] Definition by Wikipedia (http://en.wikipedia.org/wiki/Product_Lifecycle_Management#_note-0); similar definitions are used by software vendors and technology handbooks.

[82] The average number of employees in the firms interviewed in the USA was about 360, compared to about 60-130 in the European countries. This reflects that companies are –on average– larger in the USA than in Europe.

Exhibit 3.3-4: Adoption of e-business software packages in the CRP industries (2003/2007)

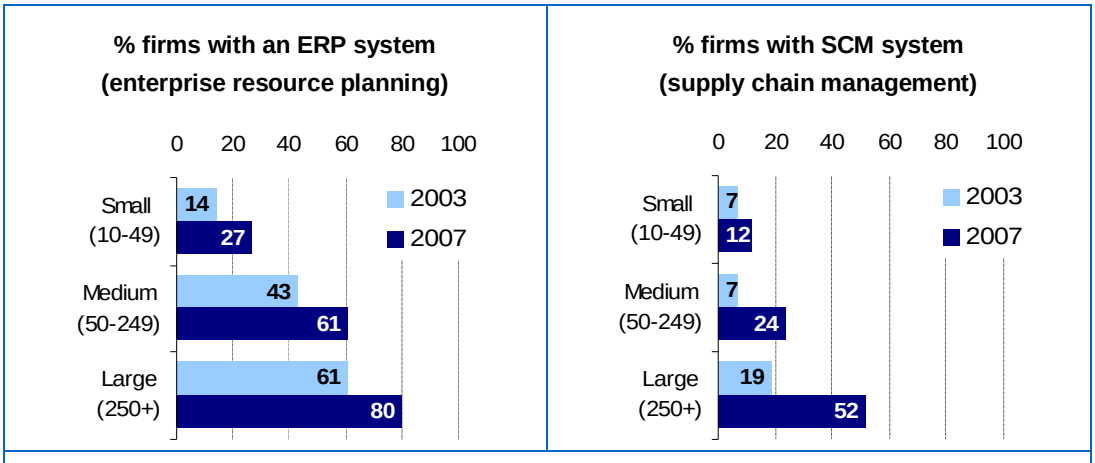
	ERP		SCM		DMS		PLM	
Weighting scheme:	% of empl.	% of firms	% of empl.	% of empl.	% of empl.	% of firms	% of empl.	% of firms
CRP – 2007 total (EU-7)	**68**	**38**	**39**	**17**	**38**	**22**	**16**	**6**
NACE 24: chemical	68	45	44	19	43	20	17	8
NACE 25: rubber & plast.	67	35	36	16	34	22	15	5
CRP – USA	**36**	**27**	**36**	**31**	**38**	**24**	**14**	**11**
CRP – by size (EU-7)								
Small (10-49 empl.)		27		12		18		3
Medium (50-249 empl.)		61		24		25		12
Large (250+ empl.)		80		52		47		22
Other sectors								
Steel	59	33	27	14	27	20	16	7
Furniture	39	21	15	10	25	19	9	5
CRP – 2003 (EU-5)								
Small (10-49 empl.)		*14*		*7*		*n.a.*		*n.a.*
Medium (50-249 empl.)		*43*		*7*		*n.a.*		*n.a.*
Large (250+ empl.)		*61*		*19*		*n.a.*		*n.a.*
Base (100%)	all firms		all firms		all firms		all firms	
N (CRP, 2007, EU-7+USA)	911		911		911		911	
Questionnaire reference	A7a		A7b		A7d		A7e	

ERP = Enterprise Resource Planning; SCM = Supply Chain Management;
DMS = Document Management Systems; PLM = Product Lifecycle Management
The survey of 2007 was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.

Source: e-Business Surveys 2003 / 2007 by the SeBW

The most important finding is that the deployment of these software systems has **significantly increased since 2003** (see Exhibit 3.3-4) in all size bands. ERP adoption among small enterprises has almost doubled; this trend could be further encouraged as ICT service providers have turned their attention to the SME market in recent years, developing more affordable solutions. SCM adoption has surged among large firms.

Exhibit 3.3-5: Adoption of ERP and SCM software systems in the CRP industries (2003/07)



Base (100%) = companies with at least 10 employees, 5 EU countries (2003) / 7 EU countries (2007)
N (2007) = 811, N (2003) = 502. Weighting: % of firms in the size-band.

Source: e-Business Surveys 2003 / 2007 by the SeBW

The implementation of an ERP system is a complex venture and critical milestone for any company. It inevitably requires a critical review of existing business processes and to introduce changes as necessary. Thus, ERP implementation is closely linked with process innovation and possibly organisational changes. Many companies which have gone through this experience confirm that there is a "time before and after ERP introduction", and that this can be considered the beginning of "real" e-business.[83]

Some of the case studies in this report also deal with ERP introduction in companies. The case of Zachem, Poland, describes how a large state-owned company used the implementation of an ERP system to adapt to changing market conditions. For Zachem, the main objective, as well as the main challenge, was to abandon a complex and inflexible organisational structure and create an efficient information management system (see Section 5.9).

The case study on Toly Products (Section 5.6) is a good example of a company with about 400 employees that has taken an important and successful step towards e-business by implementing a new system for customer relationship management, but has also realised that the ultimate goal must be to have a fully functioning ERP system. Toly says it would have been easier to buy an ERP system off-the-shelve and customise it, but it would have never given the company the flexibility that their current system has. The current systems have cost Toly about €120,000. In 1999, when they decided to switch from the old system to the new one, an off-the-shelf solution for manufacturing would have been at least 10 times more expensive. This case also illustrates the huge impact which introducing and ERP system typically has on process organisation. Toly says that the full deployment of the system's processes has been a continuous development, and that the company is still learning to use more functionalities even four years after the launch.

Many ERP software vendors optimise their solutions for specific industries. A common approach is to offer a system consisting of several components: a standard component with basic functionalities (such as finance, production, distribution and logistics); a second component with sector-specific applications or objects, and a third component with add-ons for specific functionalities (for example the integration of CAD, CRM or SCM solutions, inventory management, workflow suites).

3.3.3 ICT implications on work and production processes

A common development in most manufacturing sectors has been the automation and growing complexity of production and distribution processes in the past 10-15 years. Technological innovation, including ICT-related developments, and globalisation have been drivers of this change. This holds true for the manufacture of chemicals, rubber and plastics products, where ICT can be embedded in many work processes.

Examples of this development described in this study include the use of RFID technology in tyre production (see case study on Michelin, Part I, Section 5.5), ICT-based quality control (case study on Medikémia, Section 5.4), and the increasing importance of ICT systems in support functions such as administration and human resources management (see case study on Michelin, Part II, Section 5.5). In general, the growth in complexity of

[83] See, for example, case study on Mayr-Melnhof Cardboard GmbH in the Sectoral e-Business Watch study on the pulp and paper industry (2006).

work processes translates into increasing needs to monitor and control them. In addition, shorter product life-cycles in specialised caused by more rapid innovation and increasing competition in a globalising economy makes it necessary to keep track of a multitude of information from heterogeneous sources and the necessity to integrate and disseminate them to managers, shop-floor workers, subcontractors in the value chain and customers to accomplish timely delivery and support.

This needs sophisticated information and communication processes between all stakeholders to make business processes work smoothly and maintain a high level of customer satisfaction. An integrated information and communication platform is a requirement for larger companies maintain their competitiveness. Without sufficient monitoring and enterprise resource planning coordination failures could lead to substantial inefficiencies in business process and diminishing productivity.

This section of the study provides evidence how ICT is used by CRP companies to support procurement, production and related work flow processes, with a special focus on opportunities to support REACH compliance. This sector-specific issue is a good example how compliance with regulatory requirements can have far-reaching implications for business process management in companies.

e-Procurement

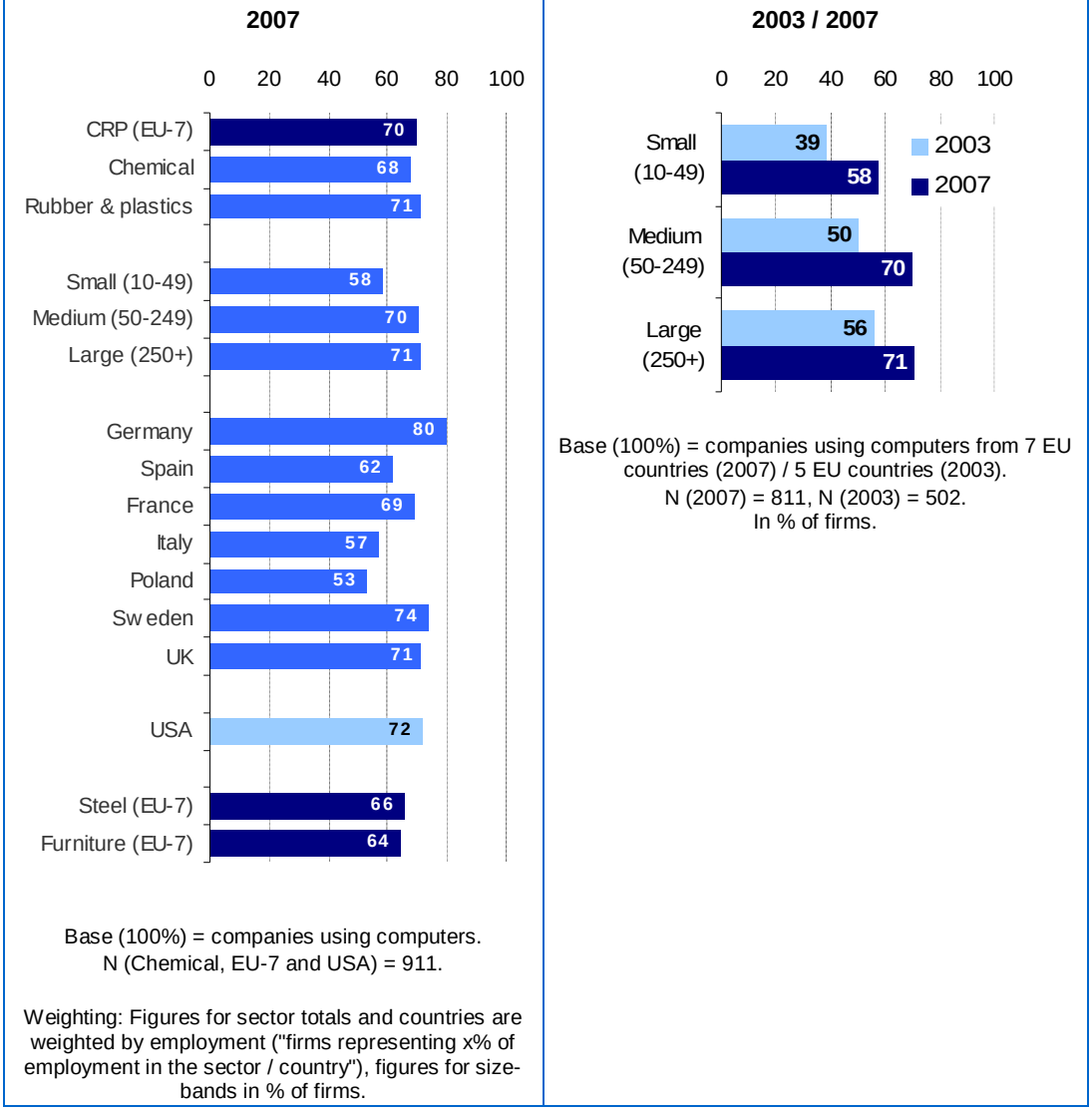
Efficient management of procurement is a fundamental activity in most manufacturing industries, in particular if value chains are complex and fragmented. The larger the number of transactions, the more will even slight improvements in this domain produce significant overall **cost savings**. Online procurement can be carried out regardless of a real integration of systems with suppliers, for instance by placing orders via a supplier's website. This is often the first step towards a more comprehensive and integrated use of ICT in business processes.

For chemical companies producing basic chemicals, inputs that can be sourced and procured online from suppliers are mainly raw materials (basic substances referred to as "feed stock"), crude oil and gas. A special situation with regard to procurement in the chemical industry is that "the chemical industry's most important customer is chemistry itself" (VCI 2007, 3): for producers of fine and specialty chemicals, basic chemicals constitute a major supply good; producers of formulated chemicals need basic as well as specialty chemicals as inputs (see Section 2.1). For companies from the converting industries, i.e. manufacturers of plastics and rubber products, the raw materials (rubber, plastics) are essential supplies, but they may also need specific ready-made intermediate inputs, depending on the products (e.g. valves for the production of tyres). Online sourcing and procurement can relate to different types of inputs. In addition to direct supply goods (raw materials and intermediary products), online procurement is often used for "MRO goods" (maintenance, repair, and operating supplies). This category typically includes office supplies and diverse other items which are not materials or components directly used for the products or services which a company produces. ICT equipment falls into this category.

In the seven EU countries surveyed, companies representing about 70% of employment in the CRP industries said that they place at least some orders to suppliers online (see Exhibit 3.3-6). There is not much difference between companies of different sizes in this regard, and diffusion is nearly the same as in the USA. Within the EU, the diffusion has

increased since 2003 (see Exhibit 3.3-6), even if a direct comparison of these figures is problematic as the underlying survey question differs slightly.[84]

Exhibit 3.3-6: Percentage of companies placing orders to suppliers online



Source: e-Business Surveys 2003 / 2007 by the SeBW

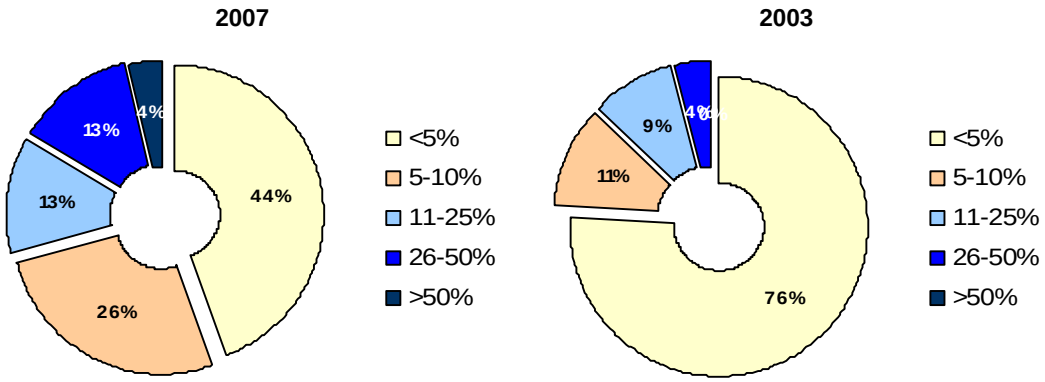
A new finding compared to previous surveys is that the intensity of e-procurement activity has increased – it is no longer a marginal activity. Back in 2003, 75% of those companies in the CRP sector that used e-procurement said that they purchased only up to 5% of their total supplies online (see Exhibit 3.3-7).[85] This indicated that most companies would only occasionally use e-procurement (e.g. for ordering office supplies), rather than practising e-procurement in a regular and systematic way. In 2007, the share of "low users" (with an e-procurement share of less than 5%) has decreased to 46%. 17% said

[84] The question in the e-Business Survey 2003 was slightly different compared to 2007. In 2007, companies where asked whether they "use the internet or other computer-mediated networks to *place orders* for goods or services online". In 2003, the question was whether they "use the internet or other computer-mediated networks to *purchase* goods or services online".

[85] Companies are asked to estimate how large a share of their total purchases (2003, 2005) / orders (2006, 2007) is conducted online.

the e-procurement accounted for more than a quarter of their supply goods, compared to only 4% in 2003.

Exhibit 3.3-7: Average percentage of orders for supplies placed online (EU-7, 2003 / 2007)



Reading example:

"In 2007, firms representing 44% of employment (among those companies that place orders for supplies online) said that their online orders accounted for up to 5% of their total orders from suppliers."

Base (100%) = companies from 7 EU countries (2007) / 5 EU countries (2003) accepting orders online.
N (2007) = 562 / N (2003) = 185. Weighting: Figures are weighted by employment.

Source: e-Business Surveys 2003 / 2007 by the SeBW

There are **different channels** and technical solutions which companies can use for e-procurement. These are, of course, the same channels which companies use for selling their products online, but have to be viewed from the perspective of the buyer. The main channels used for B2B trade in the CRP industries are briefly introduced in Section 3.5.1 on e-commerce (see Exhibit 3.5-1). Even if the channels are the same, the way how the transaction is processed on the buyer's and the seller's side can then be quite different. For instance, a small company may order supplies from a large supplier's website (or via the supplier's extranet), as a way of communicating the order, without any digital integration of the preceding or subsequent processes that are related to this order. On the seller's side, however, the same order (which comes in through the website or extranet) might be processed automatically, if the sales system is part of a larger internal system for processing incoming orders until delivery.

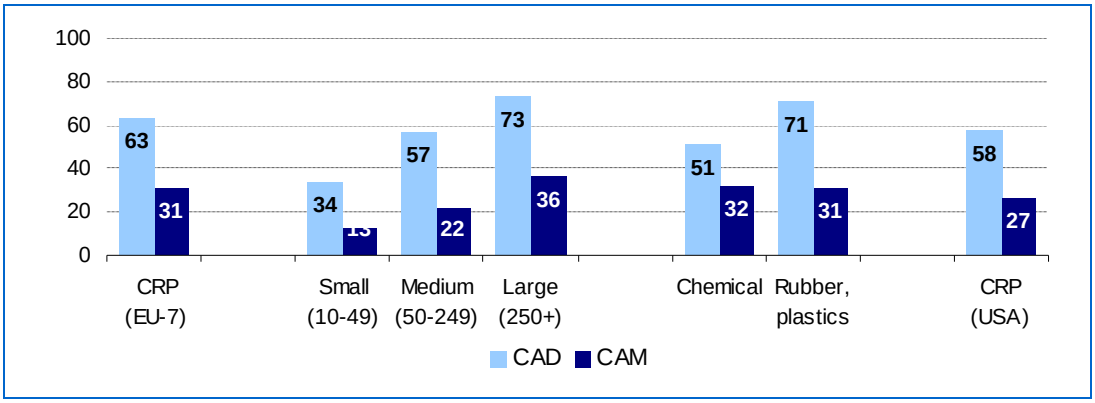
Notwithstanding these caveats, the findings demonstrate that B2B trade exchanges in the CRP industries are increasingly being conducted online. More companies have started to procure raw materials and other supplies electronically. From the buyer's perspective, the main objective is normally to save costs, either by finding a cheaper supplier online, or– more importantly– by reducing **processing costs**. Elemica, an e-business intermediary facilitating B2B exchanges (see Section 3.4.2) estimates that e-procurement via its system leads to a 75% reduction in invoice errors, 60% in order processing time and 50% in payment processing time compared to manual, paper-based procurement processes (see Case study on Elemica, Section 5.3).

Production-oriented ICT systems

Production processes in the sector different considerably between the chemical and the converting industries. While the processes are highly complex in all segments, the design of products is important in the manufacturing of rubber and plastics products. Special software for **Computer-Aided Design** (CAD) is a commonly used tool to support the design of new rubber or plastics products. CAD systems include hard- and software that create and store drawings as well as related text and numeric information that can be viewed, printed or updated as required. From being able to merely develop flat two-dimensional drawings, today's CAD systems create mathematically enriched three-dimensional (3D) models. Furthermore, **Computer-Aided Manufacturing** (CAM) may be used to automate the manufacturing process, for example with industry robots, automatic warehouses and driverless transport. Furthermore, Computer-aided engineering (CAE) systems that analyse engineering designs are becoming increasingly important. Most CAD and CAM systems have a CAE component, but there are also independent CAE systems. CAE systems are able to simulate a design under a variety of conditions to see if it actually works.

In the EU countries surveyed, companies representing 63% of employees in the CRP industry said in 2007 that they used a CAD system. Among manufacturers of rubber and plastics products, 73% said so (see Exhibit 3.3-8). The adoption rate of CAD / CAM systems increases by firm size.

Exhibit 3.3-8: Adoption of CAD / CAM systems* in the CRP industries (% of firms, 2007)



Base (100%) = companies with at least 10 employees that use computers. N (Chemical, EU-7 and USA) = 911. Weighting: Figures for sector totals and countries are weighted by employment ("firms representing x% of employment in the sector / country"), figures for size-bands in % of firms.

* CAD = Computer Aided Design; CAM = Computer Aided Manufacturing

Source: e-Business Survey 2007 by the SeBW

The application and way how CAD / CAM software systems are used in the CRP industry differ between the sub-sectors, depending mainly on the type of product that is manufactured. In principle, these software systems helps companies to design, visualise and document ideas more clearly and efficiently, promising companies to increase the efficiency of work processes and thus their productivity. The following examples illustrate how these systems are used in practice. The example of Agrium / Autodesk from the USA shows that CAD systems are not only used for the design of the products themselves, but also to support operations (in this case for the documentation of the pipeline system).

Business examples

Use of CAD systems used in the CRP industries

***UK**: Delcam, located in Cambridge, UK, is a leading provider of advanced CAD/CAM solutions for the manufacturing industry. Their portfolio includes specific solutions for the plastics industry, which promise manufacturers support in developing more innovative designs, improvements in quality and shorter lead times. For example, many plastic components feature complex external surfaces needing surface modelling, together with relatively simple internal geometry, such as ribs or bosses, that can be created more efficiently with solid modelling.*

Source: Delcam (http://www.plastics-cadcam.com)

***USA**: Located in Kenai, Alaska, Agrium KNO processes natural gas to produce nutrient-rich fertilizers such as ammonia and urea. The company's nitrogen operations require access to detailed piping and instrumentation diagrams. The company needed a digital format that would allow people to zoom in on the piping and instrumentation diagrams as much as necessary. The solution was an AutoCAD system provided by Autodesk: DWF™, a format that was specifically developed to handle engineering design data. With this system in place, Agrium KNO managed to significantly enhance the availability of important operational data and thus to improve the efficiency of work processes.*

Source: Autodesk (http://usa.autodesk.com – AutoCAD, customer stories)

Apart from specific production-oriented ICT systems such as CAD/CAM, a broad range of ICT-based applications is used in production processes. A technology with rising importance and a high potential is **RFID** (Radio Frequency Identification). A concrete example how RFID is used in production processes is presented in Section 5.5: With the introduction of an RFID system, Michelin Reifenwerke in Homburg was able to optimise the work flows in tyre retreading. A major advantage of the RFID system over the former barcode system is that RFID tags are re-writable, i.e. additional data can be entered (or data changed) during the production process, and not only in advance. This increases significantly the flexibility of the system. For this reason, no read-only tags are used in this project.

RFID is still an emerging technology which is currently used mainly by the large companies.[86] In the CRP industries, close to 20% of large firms, but only 6% of medium-sized and 1% of small firms said they used RFID-based applications in 2007 (e-Business Survey by the SeBW).

[86] Detailed information about the usage and potential of RFID for companies in manufacturing sectors is available in the Sectoral e-Business Watch study on RFID adoption and implications (2008). Available at http://www.ebusiness-watch.org/studies/special_topics.htm.

ICT to support REACH compliance

The new requirements for compliance with the REACH regulation (see Section 2.3) have opened up a new, potentially highly relevant and sector-specific ICT application area. The REACH regulation is complex and difficult for companies to implement, since they have to rethink their organisation, processes and information systems to be able to gather, manage and declare large sets of information about the chemical substances they use and produce. The question is whether specialised software modules can help companies to deal with this challenge.

To assess the opportunities, the Sectoral e-Business Watch explored the current offer in the market. A spot check in the market[87] showed that several software companies have developed (or are currently developing) specific REACH applications, which are either sold as stand-alone solutions or as add-on modules to existing software, notably ERP systems. In particular, the large vendors such as SAP and service providers that have specialised on solutions for governance, risk and compliance have developed specific applications or modules. However, software for REACH compliance is still a very recent development; the deployment of these applications has only begun. At the beginning of 2008, it is still too early to speculate about the diffusion which these solutions will have. It is by no means a mainstream issues covered by all software firms. The following business examples illustrate the different routes towards REACH compliance solutions, depending on the service provider's specialisation. In summary, however, they document that solutions are now available on the market; they differ considerably in terms of how they are linked and integrated with other software services provided by the respective ICT companies.

[87] A comprehensive survey of the software market was not possible; however, an exploratory research was made by means of a web-based research and interviews with some vendors.

Business example

SAP REACH Compliance – an integrated approach

SAP, the leading provider of ERP solutions in the chemical industry, has developed SAP REACH Compliance, a software module that is based on the SAP Environment, Health & Safety (EH&S) solution. Deployment of the new REACH module started in March 2008. Potential customers are in the first line existing SAP customers in the chemical industry (about 1200 in Europe) and in related industries where REACH is also relevant (notably the pharmaceutical, oil and gas industries). The main target groups are large and technologically advanced medium-sized companies.

Companies need to fulfil two technical requirements to be able to use the new module: they need to have SAP EH&S, and SAP NetWeaver 7.0. Costs for implementing the REACH Compliance module depend on the company's turnover. This reflects that the potential value the software has for a firm increases with the number of substances that have to be registered. SAP says that the software can normally be implemented and operational within four months but, depending on the scope and complexity of the company, can also take longer.

SAP REACH Compliance is tightly linked with the ERP system. It combines registration management (as requested by REACH) with supply chain management functions. By integrating ERP and REACH processes in an advanced way, the effort for data entry and maintenance shall be minimised and errors be avoided, enabling optimal gains in process efficiency in the long run. Furthermore, the software links substance registration with production, logistics, procurement and distribution processes, recognising that legal REACH requirements go beyond the registration obligations and impact business processes, too. The company ideally has full transparency in which products which substances have been used.

Although targeted towards SAP customers, the company points out that tools from other providers (e.g. for material safety data sheet reporting) can be integrated with the application, and that EU REACH exchange formats such as IUCLID 5 are supported.

Sources: Telephone interview with Mr Marko Lange, Solution Management, Industry Business Unit Chemicals, SAP, 29 February 2008; "SAP Reach Compliance – Chemische Stoffe sicher zulassen und dokumentieren" (information leaflet);

Business example

Reachway Dialogue

REACHWAY Oy is a Finnish ICT service provider, focusing specifically on companies in the chemical industry. The company combines expertise of REACH regulation, chemical safety and IT. It has developed "Reachway Dialogue", a service-based IT solution that promises to secure REACH compliance and to reduce business risks. REACHWAY claims that its solution can be implemented very fast (within a few business days), with "no up-front or installation costs" and a "minimum demand on IT resources". Users access the software through a browser-based interface, with minimal training requirement.

Thus, Reachway Dialogue is not a module that goes hand in hand with an existing ERP solution; however, it has interfaces for data import and export to/from ERP and CRM systems, including SAP. The software contains data analysis, reporting and communication tools. The focus is thus on supporting a company in its REACH supply chain communication, rather than integrating all internal business processes related to the registration and handling of new substances.

Source: www.reachway.eu; "IT innovation to assist companies using and making chemicals" (REACHWAY Dialogue, 14 December 2007).

Business example

Enablon CMS supports compliance with REACH

Enablon is a software solutions provider for sustainable development reporting and management, corporate governance and risk management.

The company developed Enablon CMS as a solution dedicated to the management of chemical substances and REACH compliance monitoring. Enablon CMS enables companies to draw up a specific inventory of all the chemical substances used, to identify the substances that are subject to registration, authorisation or restriction, and to share all the data throughout the whole production chain. The solution supports the automated production of regulatory documents, in compliance with the IUCLID 5 format. Enablon points out that their CMS solution can easily be integrated with the IT system in place, including SAP. The solution is embedded in a full-web secure architecture, where information can be shared between the company's internal teams, suppliers and partners in a flexible way.

Sources: http://enablon.com

Business example

The Wercs' REACH 1 2 3

The Wercs, Ltd, is a major ICT service provider in the field of environmental regulatory compliance solutions, including solutions for hazard communication. The company is headquartered in the USA (Latham, NY) and has offices in Belgium and Denmark. Their main focus is on MSDS software, i.e. solutions for the creation, management and distribution of Material Safety Data Sheets. It has now developed "REACH 1 2 3", a set of modules that integrates on to an organisation's ICT infrastructure and synchronises to the REACH-IT workflow system through IUCLID 5.

Modules include WercsSIMS™, the Substance Information Management System, which is a comprehensive chemical, physical and toxicological database management tool. This database helps manufacturers to assess which chemicals will be impacted by REACH. In addition, they can see the impact certain chemicals will have on their formulations.

The Wercs regards the REACH framework as an "accurate hazard communication through material safety data sheets (SDS)". It argues that SDS will continue to be a critical component in communicating the safe handling of newly registered chemicals, while REACH will require manufacturers to create "extended" SDSs for certain products. The company points out that its software enables integration with a company's ERP system (from all major vendors), with out-of-the-box standard interfaces for integration with any ERP orders processing modules.

Sources: http://www.thewercs.com/solutions/reach123.asp?lang=en

These examples demonstrate that ICT service providers have started responding to this potential market opportunity and developed REACH-specific solutions. The results

- ICT solutions that support companies in their REACH compliance are available in the market. However, it is a very recent development, and the deployment process has only started.
- Most of the solutions are optimised for larger companies or advanced mid-sized companies. This has to do with economies of scale: the value of these systems increases with the number of substances that have to be registered (fixed cost degression).
- Service providers that are active in this field belong mostly to one of two groups: providers that have specialised in the fields of corporate governance and risk management are developing specific solutions; providers of advanced integrated enterprise management software (ERP) are developing REACH modules that can be docked to their ERP systems.
- The value of these systems increases if data can be linked with other existing systems, notably those for production and supply chain management. Therefore, companies which have already a well-developed data management system in place will be in a preferred position to gain from buying and implementing a specialised REACH compliance software system.

Summary of key points: ICT for supply chain management and process integration

Notwithstanding the many challenges they need to tackle: companies in the CRP industries are eagerly embracing any opportunity to substitute paper-based manual processes by electronic exchanges. The development in this field has been very dynamic and is likely to gain further momentum – the "real e-business" with automated data exchanges between players is now evolving at fast pace, empowered by the increased diffusion of e-business software systems.

- **Electronic data exchanges on the rise**: more than a quarter of the companies (by their share of employment) feel that at least a good deal of their exchanges with business partners are conducted electronically; three quarters say that at least some of their processes are conducted as e business.
- **Wider use of ERP and SCM systems**: the installed base of ERP and SCM system among companies in the sector has significantly increased since 2003.
- **Dynamic adoption of e-invoicing**: companies are increasingly sending and receiving invoices electronically. 33% send invoices directly from their computer system to that of a customer or supplier. Adoption will further increase, as many large firms impose e-invoicing on their SME trading partners.
- **Increase in e-procurement**: about 70% of the companies (by their share of employment) place at least some of the orders to suppliers online, up from about 50% in 2003. In parallel, the significance of e-procurement has increased: the average share of supplies ordered online is higher.
- **Production-oriented ICT systems**: CAD systems widely used, in particular by manufacturers of rubber and plastics products
- **ICT to support REACH compliance**: providers of advanced integrated enterprise management software (ERP) are developing REACH modules that can be docked to their ERP systems; software vendors in the fields of corporate governance and risk management are developing specific solutions to support companies in complying with REACH.

3.4 Use of e-standards and the role of intermediaries

A "**standard**", used as a technical term, is "*a technical specification approved by a recognised standardisation body for repeated or continuous application, with which compliance is not compulsory*".[88] There are national, European and international technical standards. In addition to such formal standards there are also industry specifications which result from collaboration, in consortia or smaller partnerships, subject to differing levels of openness and participation. Whatever the source, agreement on shared technical standards is an instrument to achieve interoperability between different systems. In this sense, standardisation activities complement market-based competition. Without interoperability of ICT systems, which requires standards and compatibility between standards, advanced forms of e-business (such as the digital integration of systems in B2B exchanges) are hardly possible.

The European Commission emphasises the importance of standards for innovation, pointing out that *"… the lack of standards, the limited uptake of new standardisation items or the slow updating of existing standards hamper the uptake of innovation*," while *"… standardisation that is lively and strong has the power to accelerate the access of innovation to both domestic and global markets.*"[89] One of four priority areas identified is "the integration of ICT in industry and administrations", since the Commission sees an important potential here to improve the competitive position of the European economy through a more efficient and effective use of ICT tools.

This section explores what types of e-business standards are used in the CRP industries (3.4.1), and presents some **sector specific initiatives** and service providers that support companies connecting digitally with each other (3.4.2). The objective is to assess the significance of these initiatives and intermediaries for making e-business work today and in the future.

e-Business standards can be grouped into different categories, depending on what they used for and according to their technical foundations. Exhibit 3.4-1 shows an overview of widely used standards in five application areas: standards for identification, classification, catalogue exchange, transactions and business processes. It would be beyond the scope of this study to assess in detail the deployment of each type of standard. The study therefore focuses on the main families of standards (e.g. EDI and XML-based standards) and on sector-specific initiatives (e.g. CIDX).

[88] Directive 98/34/EC of the European Parliament and the Council of 22 June 1998, laying down a procedure for the provision of information in the field of technical standards and regulations, see http://europa.eu.int/eur-lex/pri/en/ oj/dat/1998/l_204/l_20419980721en00370048.pdf.

[89] European Commission (2008) Towards an increased contribution from standardisation to innovation in Europe. Communication from the Commission, COM(2008) 133 final. Brussels, 11.3.2008.

Exhibit 3.4-1: Types of e-business standards

Type of standards	Description	Examples
Identification standards	enable the identification of a product by providing structured information, for example about its name, the producer, the production date, in a machine-readable way; the barcode is the best known example	EAN
Classification standards	hierarchical systems to describe and structure sectors, products and services	GPC, eCl@ss, proficl@ss, UNSPSC, ETIM, NACE
Catalogue exchange standards	facilitate the exchange of data from e-catalogues between suppliers and their customers, for instance updating product data without having to transmit the full catalogue	XML-based formats: BMEcat, cXML, xCBL, RosettaNet CSV-/EDIFACT-based formats: Datanorm / Eldanorm, PRICAT
Transaction standards	transaction-related document standards for business documents, for example for orders, order confirmations, delivery notes and invoices; enable automated processing of these documents (e.g. in the ERP system)	EDIFACT/EANCOM, ODETTE, OAGIS, openTRANS, TRADACOMS, UBL, xCBL, CIDX
Business process standards	specify business processes rather than single documents within the process	ebXML, CIDX, RosettaNet,

Sources: Developed from "eBusiness 2007/08 – Jahrbuch der deutschen Wirtschaft" (2007), p. 46f., and from PROZEUS information brochures (www.prozeus.de)

3.4.1 Adoption of e-business standards

EDI and XML-based standards

EDI-based standards (EDI stands for electronic data interchange), such as UN/EDIFACT, are still among the preferred e-business messaging standards in the CRP industry, in particular among medium-sized and large firms. Close to 30% of medium-sized and close to 50% of large firms reported that they used EDI. Only 8% of small companies do so (see Exhibit 3.4-2). Thus, this relatively old format of data exchange is still a major channel for e-commerce.[90] Adoption rates are very similar for European and US companies.

EDI is basically a set of standards for structuring information that is to be electronically exchanged between and within businesses or other organisations, thus rather representing a business conversation between two entities than a technology. In fact, EDI messages can be transmitted through a variety of technologies, including internet-based EDI. The "traditional" (non-internet-based) EDI transmission technologies are gradually being replaced by internet-based EDI. Within the EDI standards family, UN/EDIFACT (United Nations electronic data interchange for administration, commerce and transport) is probably the most important one, at least outside North America. There are different sub-sets of EDIFACT for different industries; the CEFIC subset was developed for the chemical industry.

[90] See Section 3.5.1, "e-Commerce via EDI and extranet", for more information about the characteristics and usage of this widely used legacy system for e-business.

The case study on Medikémia (see Section 5.4) illustrates the function of EDI for companies in the sector. Multinational retail chains selling chemical products often prefer to use **web-based EDI** for exchanging data with its product suppliers, in particular to enable a continuous monitoring of the stock. Medikémia maintains EDI-connections with almost all its multinational retailers located in Hungary (such as Metro, Tesco, Praktiker, Baumax and Obi). In total, the company is connected with about 140 stores by EDI. It says that EDI has been experienced as much more efficient and time-saving than any other data exchange system the company has used so far. In contrast to the retail chains, according to Medikémia, wholesale traders usually do not use e-business; they still prefer to make their orders by telephone.

Exhibit 3.4-2: Use of eStandards in the CRP industries (2007)

	EDI-based standards		**XML-based standards**		**Proprietary standards**		**Other technical standards**	
Weighting scheme:	% of empl.	% of firms	% of empl.	% of empl.	% of empl.	% of firms	% of empl.	% of firms
CRP – 2007 total (EU-7)	**38**	**15**	**16**	**11**	**31**	**18**	**15**	**12**
NACE 24: chemical	43	16	25	13	26	14	11	10
NACE 25: rubber & plast.	34	14	10	9	34	20	17	13
CRP – USA	**45**	**22**	**8**	**11**	**35**	**30**	**1**	**2**
CRP – by size (EU-7)								
Small (10-49 empl.)		8		8		15		11
Medium (50-249 empl.)		28		17		25		13
Large (250+ empl.)		48		21		36		16
Other sectors (EU-7)								
Steel	34	12	22	10	22	14	11	11
Furniture	21	8	16	9	34	18	16	11
Base (100%)	all firms		all firms		all firms		all firms	
N (CRP, 2007, EU-7+USA)	911		911		911		911	
Questionnaire reference	C1a		C1b		C1c		C1f	
The survey was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.								

Source: e-Business Surveys 2003 / 2007 by the SeBW

The usage of **XML-based standards** for e-business is only slowly gaining ground. In 2007, about 10% of firms (accounting for 16% of employment) said they used XML. Among medium-sized and large firms, XML is used by about 20% (see Exhibit 3.4-2). XML is not a document standard specifically for e-business in itself, but a general-purpose markup language, enabling the presentation of hierarchically structured data in form of text files. Users can define their own elements within this structure. Thus, XML facilitates the sharing of structured data across different information systems, which makes it a perfect basis for e-business exchange formats. It is an open standard that can be freely used by anybody.

Using XML, the **ebXML** architecture ("Electronic Business using eXtensible Markup Language") has been developed specifically for e-business purposes. This family of XML based standards was started in 1999 as a joint initiative between the United Nations Centre for Trade facilitation and Electronic Business (UN/CEFACT) and Organization for the Advancement of Structured Information Standards (OASIS). Five ebXML specifications have been approved as the ISO 15000 standard, including ebXML Collaborative Partner Profile Agreement and ebXML Messaging Service Specification. XML-based standards are used to develop catalogue exchange standards, transaction standards as well as business process standards (see overview in Exhibit 3.4-1).

Proprietary standards, i.e. data exchange standards specifically agreed upon by business partners for their exchanges, are still widely used by close to 20% of firms in the sector (see Exhibit 3.4-2). 12% of firms said that they used standards other than EDI and XML-based ones (and other than the Chem eStandards – see next section) for their e-business exchanges.

CIDX – the Chemical Industry Data Exchange

The Chemical Industry Data Exchange (CIDX) is a non-profit organisation dedicated to improving the ease, speed and cost of securely conducting business electronically in the Chemical Industry. It is headquartered in the USA (Chicago, Illinois), but has a presence in Europe and Japan and claims to "mirror the global nature of the chemical industry with substantial work groups and efforts around the world" (www.cidx.org). CIDX coordinates the development of Chem eStandards™, on behalf of its member companies and the chemical industry at large.

Although CIDX is a sectoral initiative, it recognises the cross-sectoral business relationships which many chemical companies maintain; to this end, CIDX cooperates with other industry trade associations and standards bodies in the definition of common standards for more efficient cross-industry trading. For example, efforts are made to make CIDX standards compatible with the following other industry standards: RAPID (agricultural inputs industry), PIDX (petroleum industry), papiNet (paper and forest products industry), AIAG (automotive industry), RosettaNet (electronics industry), and GUSI (consumer packaged goods industry).[91]

In the previous study on the CRP industries of 2004, the Sectoral e-Business Watch described the achievements of Chem eStandards™ and assessed their relevance to the enhancement of new e-business processes in this sector.[92] This Section summarises the developments of the past 3-4 years, focusing on key issues CIDX has been working on.

The Chem eStandards™ by CIDX have been developed specifically for data exchanges related to the buying, selling and the delivery of chemical products. They are based on XML and were developed through a cooperative effort of more than 20 chemical companies in late 2000.[93] The core part of the Chem eStandards™ are the message standards (current version 4.0). They are available in a "starter edition" which supports basic aspects of the order-to-invoice process, and as a "complete edition" with additional components for more advanced users. The starter edition includes the following document specifications:

- OrderCreate (purchase order from buyer to seller)
- OrderResponse (purchase order response from seller to buyer)
- OrderChange (purchase order change from buyer to seller)
- ShipNotice (ship notice from seller to buyer)
- Invoice (invoice from seller to buyer)

In addition, CIDX has developed the Chem eStandards™ Business Process Guidelines (BPGs), which document common business processes in the chemical industry. They are

[91] see also "CIDX® White Paper Defines Roadmap for Cross-Industry eBusiness Interoperability", Press release of 15 August 2007.

[92] European Commission / e-Business W@tch (2004), Report II, Section 2.3 (p. 33f.).

[93] see http://www.cidx.org – "About About Chem eStandards".

intended to provide context for message use. The publication of Chem eStandards™ version 5.0 is scheduled for 2008.

It is difficult to assess the actual deployment of Chem eStandards™, in terms of companies using them for their data exchanges as well as in terms of numbers of exchanges accomplished. Industry representatives and standards experts say that Chem eStandards™ are the main data exchange format for the industry in all advanced e-business exchanges. For example, Chem eStandards™ are used by Elemica, an e-business intermediary facilitating B2B exchanges, for its "Connected Solution" (see Section 3.4.2), which offers full ERP connectivity between companies. Elemica also ensures that Chem eStandards™ are interoperable with other solutions. For instance, Elemica TransLink, a hosted application with complete real-time road, rail and marine logistics booking, execution and visibility capabilities, fully complies with CIDX Chem eStandards™. This facilitates the data exchange between chemical companies and logistics service providers using TransLink. Similarly, many e-business solutions of other ICT service providers that are optimised for the chemical industry use Chem eStandards™. For example SEEBURGER, a provider of business integration solutions, uses Chem eStandards™ in its Chemicals packaged solutions and argues that chemical companies have "*taken the lead on implementing more than basic EDI document exchange*", as "*market leading companies are taking full advantage of process integration via the CIDX standard*".[94]

Chem eStandards™ are thus embedded in many e-business solutions, and company representatives may not even be aware that their company actually exchanges data with other companies based on this standard. Therefore, the survey results are probably underestimating the actual deployment and importance of this standard for the industry: in total, only about 6% of all European and 8% of US companies in the sector (by their share of employment) reported the use of Chem eStandards™ in 2007.[95] The standard was mainly used by larger enterprises (with at least 250 employees). XML-based standards (in total, including Chem eStandards™) are used by about three times as many firms, according to the survey.

The results are very similar to those for the adoption of the papiNet™ standard as reported in the Sectoral e-Business Watch study on the pulp and paper industry (2006). The study found that companies representing 7% of employment in the pulp and paper industry used papiNet for their e-business; this is nearly the same figure as for Chem eStandards (6%). The study concluded that *"… papiNet® derives its importance not from the number of enterprises that use it, but from the fact that it is used by the large players, and – as a result – the value of the transactions that is accomplished electronically on the basis of this standard"* (p. 43). A similar argument can be made for Chem eStandards™. Their impact on e-business developments in the CRP industry should therefore not be underestimated.

[94] see http://www.seeburger.com/chemicals/.

[95] In the survey, company representatives were directly asked if their company uses Chem eStandards.

3.4.2 Connectivity hubs for data exchange

How e-marketplaces turned into connectivity hubs

The CRP –and notably the chemical– industries are among those sectors where internet based trading platforms were expected during the new economy boom phase to become very important. In the broadest sense, the concept of such electronic marketplace can be defined as a business-to-business Internet trading forum in which buyers and sellers exchange goods and services. From the beginning, this term was not without problems, since different marketplaces in fact offer different types of transaction functionality. e-Marketplaces can be categorised according to these functionalities, including for example catalogue-based e-markets, pinboards (message boards), exchanges and auction services.[96]

After the e-marketplace hype of 1999 and 2000, and the subsequent shakeout, several marketplaces changed their business models. Although the chemical industries are still one of the more important sectors for B2B marketplaces, the role and importance of 3rd party trading platforms is quite limited even in this sector, compared to other forms of e-commerce. In this section, two of the most important intermediaries that provide e-business related services to the CRP industries are presented: Elemica and cc-hubwoo.

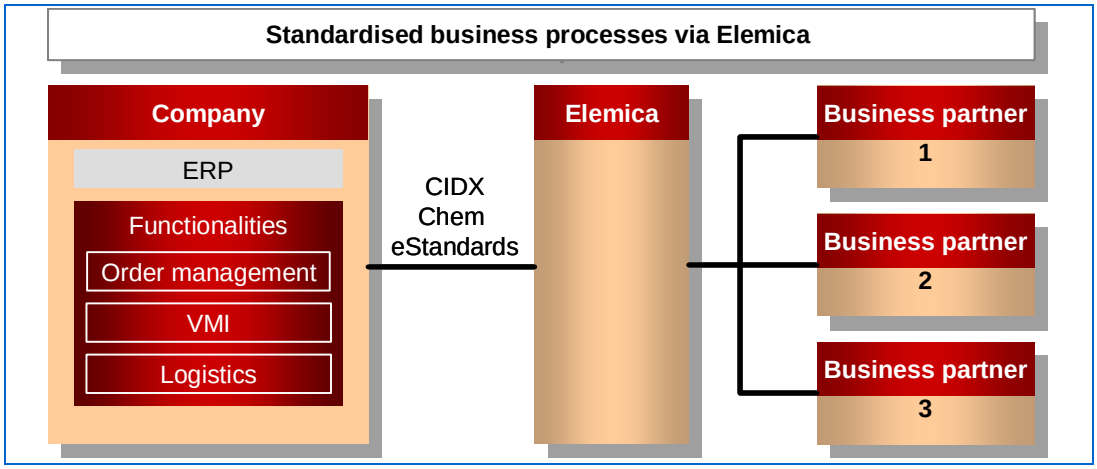
Elemica – a connectivity hub for the industry

Elemica (www.elemica.com) is a platform and network provider for the global chemical industry, developed by 22 leading chemical companies in 2000. The service focuses on improving supply chain efficiency by offering browser-based and Enterprise Resource Planning (ERP) connectivity. Elemica claims that it is not an "aggregator" of chemical purchasing, nor a "buyer," "seller," or "owner" of products, but a facilitator of transactions (order processing and supply chain management of contract and repeat chemical transactions). The similarity with marketplaces (such as ebay) and other intermediaries (such as credit card companies) is that Elemica is financed by transaction fees: for each transaction conducted by members through the Elemica network, a certain fee is charged.

However, apart from this parallel, Elemica is a horizontal and vertical B2B intermediary which does not present itself as an e-marketplace in the sense of a trading platform that openly displays offers or demand. Essentially, it is an IT service company that promises customers a more cost-efficient way of trading with business partners. The motto is "connect once – connect to all", (instead of maintaining numerous point-to-point connections with trading partners via EDI, for example) – see Exhibit 3.4-3.

[96] A more detailed definition of various types of electronic marketplaces, and an overview of recent developments, is available in a Special Briefing by the *e-Business W@tch* to the European Commission: "The Current State of B2B E-Markets", Jan. 2004. The briefing has not been published but may be made available by the EC on request (e-mail: entr-ict-e-commerce@cec.eu.int).

Exhibit 3.4-3: Elemica – a horizontal and vertical e-intermediary



Source: adapted from SEEBURGER
(see: www.seeburger.de – solutions for the chemical industry)

The goal is to offer customers a "one-stop" experience through browser-based and Enterprise Resource Planning (ERP) connectivity with their business partners. To achieve this, Elemica offers different solutions, including light connectivity and more sophisticated forms of system integration. Smaller companies, notably those without an ERP system, will typically opt for the light modules ("Buyer Direct" / "Seller Direct"), while larger customers may prefer the fully-blown Elemica Connected Solution. The services portfolio includes the following options:

- **Elemica Connected Solution** ("Connect Once - Connect to All"): the most advanced type of connection, offering full ERP connectivity
- **Elemica Buyer Direct**: the "light" integration connectivity for buyers or sellers
- **Elemica Web Solutions** – **Elemica Seller Direct**: this complements standard ERP connectivity by supporting additional electronic message types; it functions as the technology bridge that allows a seller to receive and process orders from an ERP-connected buyer using a web browser interface.
- **Elemica Supply Chain Solutions**, such as supply chain planning, VMI (vendor managed inventory, and CPFR (collaborative planning, forecasting and replenishment);

In 2007 about €35 billion worth of transactions were handled through Elemica, involving over 1,800 industry trading partners.[97] Customers include companies in a variety of industries including chemicals companies and their customers and suppliers, notably from the automotive, consumer packaged goods, paper, plastics and pharmaceutical industries.

The benefits which companies that connect via Elemica aim to reap is an increased efficiency and effectiveness in transaction processes; "effectiveness" means in particular a reduced error rate compared to manual or other non-standardised forms for data entry and transmission; "efficiency" means in particular reduced processing times. Ultimately, these improvements are expected to turn into cost savings. Elemica claims that in sales

[97] The figure quoted by Elemica is US$ 50 billion; converted into EUR by the study authors. See http://www.elemica.com/About/History/page.aspx (accessed in January 2008).

companies can achieve an 80% reduction in order entry time and a 20% reduction in the number of order changes; in procurement, Elemica expects a 75% reduction in invoice errors, 60% in order processing time and 50% in payment processing time.[98] Even if these figures are biased toward the optimistic side of the range, for larger companies such gains in process efficiency can translate into significant savings. Celanese, for example, one of the users of Elemica, is quoted to have realised cost savings of over US$ 700k by managing their logistics through Elemica.[99] The following business example shows how one of the founding members of Elemica, BASF, uses Elemica's invoicing solution to introduce a large scale e-invoicing scheme.

As most of the large chemical companies use a multi-channel approach to e-business, there are different options how to connect with suppliers or customers. Options typically include connection via the extranet portal, via EDI, or through intermediaries such as Elemica. The following business example shows how a chemical company responded to customer requirements to set up online ordering, but convinced the customer to use a different channel than the one initially proposed by the customer.

Examples demonstrating why and how companies work with Elemica are provided in the case study on Elemica in Section 5.3.

cc-hubwoo – e-procurement and sourcing service provider

cc-hubwoo Group (www.cc-hubwoo.com) is a leading global service provider of e-procurement and e-sourcing solutions ("Source-to-Pay") and in supplier network management. The company offers its customers on-demand supplier relationship management solutions which allow large companies to automate purchase and procurement processes, connect with suppliers, access electronic catalogues and execute electronic transactions. It argues that suppliers benefit as well through reductions in transaction and settlement costs.

This history of cc-hubwoo is one of mergers and acquisitions of different initiatives after the shakeout in e-marketplaces and thus a typical story of the new economy crisis after the stock-market crash in 2001.

Milestones in the history of cc-hubwoo / cc-chemplorer[100]

- 2000: Avisium founded in partnership agreement with SAP; Hubwoo.com floated on the New Market of the Paris Bourse
- 2001: Merger of the marketplaces cc-markets and chemplorer, forming a joint marketplace (cc-chemplorer), the leading German e-procurement platform
- 2003: Merger of the marketplaces Hubwoo.com and Avisum
- 2004: Merger of the marketplaces Hubwoo-Avisum (French) and cc-chemplorer (German) into cc-hubwoo Group
- 2005: Acquisition of Trade-Ranger by cc-hubwoo Group

cc-hubwoo offers a range of different solutions, which basically have in common that they aim at facilitating e-procurement activities of its members. As such, it can be considered a "marketplace"; however, a comparison with typical and well-known marketplaces in the

98 Elemica – Connect once connect to all. Company presentation by Mike Mc Guigan, May 2007, p. 12.

99 ibid.

100 cf. http://www.cc-hubwoo.com (History).

business-to-consumer area (such as ebay) is difficult. In the business-to-business area, the focus is much more on enabling the technical connectivity between a buyer's and a seller's systems, while in B2C the focus is on presenting and showcasing the offer to attract potential buyers.

Solutions offered by cc-hubwoo include:

- Hosted e-Procurement
- e-Catalogues and content management
- Transactional Hub
- eInvoicing
- Supplier Order Management

The hosted e-procurement system lies at the heart of the cc-hubwoo solutions offering. It includes standard SAP functionalities as well as specific on demand features developed by cc-hubwoo. Interfaces to cc-hubwoo can be implemented into dedicated systems or into shared ASP (Application Service Provider) applications. According to cc-hubwoo, the e-procurement system enables close to 60,000 users (December 2007) to engage in online requisitioning and procurement. On the supplier side, more than 12,000 suppliers are transacting business daily on this network. In 2007, according to the company, the value of transactions processed through the supplier network was over €5bn.

Purchasing companies and their suppliers are also supported in creating electronic catalogues. In this area, cc-hubwoo undertakes the hosting, application management and regular updating of all modules as well as the implementation of agreed schedule updates for multi-supplier-catalogues. Registered users have direct access to the Order Management Tool (OMT), the supplier- and buyer gate, to their business partners and to the general trading partner directory via the main navigation.

Customers of cc-hubwoo include major players, customers and suppliers of the chemical and pharmaceutical industry, notably in Germany and France, such as Bayer, BASF, Basell, Chemfidence, Degussa, Repsol, Schering, Shell, Solvay and Statoil .

Other intermediaries

Besides e-procurement solution providers such as cc.hubwoo and connectivity managers such as Elemica, there are other intermediaries that focus on **specific e-applications**. The business model is to convince companies that they can gain from business process outsourcing – it works if the fees for the service provider are compensated by savings in personnel and/or process efficiency. **Electronic invoicing** is currently the prime example of a process where specialised third party service providers have established themselves as intermediaries.

The market of service providers offering B2B e-invoicing services differs considerably between EU countries; banks are active in this field as well as specialised companies. Most of these companies are not operating in specific sectors, but provide their services to basically all companies. A case study approach was therefore selected for this report to illustrate how these intermediaries facilitate e-business processes between companies.

The case study on OB10/Acordis (see Section 5.1) presents how Acordis, a chemical company in the UK, has benefited from outsourcing the receipt of supplier e-invoices to OB10, a globally operating service provider in this market.

Summary of key points: use of e-standards and intermediaries

Advanced forms of e-business require the agreement on standards for data exchanges; this includes identification standards, classification standards, catalogue exchange standards, transaction standards and business process standards. Interoperability between the broad range of ICT systems in place is still a big issue and challenge.

The large players of the sector have jointly started various initiatives to address this problem; key initiatives include the development of Chem eStandards (by CIDX) and the emergence of specialised "connectivity hubs" such as Elemica and cc-hubwoo. They have made significant contributions to the advancement of e-business, but notably between large enterprises and within the sector. The new challenge is to expand connectivity to the numerous smaller companies, and between sectors.

- **EDI still widely used**: among large firms, EDI-based standards are still widely used for B2B exchanges; nearly 50% of large firms maintain EDI connections with business partners. XML-based standards are used by about 20% of large firms. Comparatively few small companies say that exchange data in these formats.
- **Chem eStandards™**, developed by CIDX, are the main data exchange format in advanced e-business exchanges in the sector. In contrast to other sectors, this industry-led initiative was quite successful in establishing an industry-specific standard facilitating data exchanges. Most e-business solutions for the chemical industry are compatible with Chem eStandards™, for example those offered by Elemica.
- **Business process outsourcing as an opportunity**: interoperability challenges have led to the emergence of specialised service providers, which can help companies significantly in connecting digitally. Elemica is the leading connectivity hub for the sector, matching document delivery and receipt formats between sellers and buyers for a range of processes. e-Procurement solution providers such as cc-hubwoo are working in the line of traditional e-marketplaces. Finally, there are highly specialised e-invoicing service providers focusing on single business processes (such as OB10).

3.5 ICT for marketing and customer service

ICT, and in particular the internet, can be used in various ways to support marketing activities, including the communication with customers, offering products for sale, and developing new marketing strategies. The former e-Business Watch study on the CRP industries (2004) concluded that these application areas would gain in importance in this sector (see Section 3.1). It was argued that ICT presented opportunities to companies in the sector for "*innovative, better focused marketing approaches to reach new customers*," but that the respective opportunities were "*not yet exploited*" at that time.[101] This section explores whether e-commerce with customers is more widespread now. e-Business indicators which were included in both surveys of 2003 and 2007 will be used to assess the dynamics of the development since 2003.

3.5.1 e-Commerce adoption

In this section, the term "e-commerce" describes the sale of chemicals, rubber and plastic products over the internet or other computer-mediated networks. e-Commerce in the CRP industries is mainly business-to-business (B2B): manufacturers of chemicals, rubber and plastics products typically do not directly sell to end consumers, but to other companies; these can be users of CRP products in other industries (for example the automotive and construction industries), but also wholesalers and retailers. Technically, companies can take different routes to e-commerce. Exhibit 3.5-1 summarises the most important channels and platforms used and their specific characteristics.

Exhibit 3.5-1: e-Commerce platforms used by companies

Type	Key characteristics	Typical users in CRP industry
EDI (Electronic Data Interchange)	Point-to-point connection between two companies based on EDI standards; high set-up cost, because of repeated costs for every installation; efficient means for trade with regular customers, often involving frequent exchanges and large order volumes	Mainly used by large firms – widely diffused legacy system dating back to the 1970s/80s.
ERP-to-ERP	Most advanced form of electronic data exchange – enables automated processing of data from order to invoice	Mainly among large firms – see Section 3.3 on process efficiency.
Extranet	A sales portal on a company website with restricted access (typically password protected) for customers. Functions typically include a well-structured overview of the status of all orders a customer has placed and their supply fulfilment.	Mainly operated by larger companies, often as a service for their SME customers which do not have their own advanced systems for data exchange and managing orders.
Company website	A website with an online shop function, enabling any visitor to place an order for products offered by the company.	More popular in B2C e-commerce (e.g. retail); does not play a major role in the CRP industries. Websites are mostly used for company presentations.

[101] e-Business Sector Study on the chemical, rubber and plastics industry, August 2004, Section 3.1. Available at http://www.ebusiness-watch.org/studies/on_sectors.htm (2004b).

Internet trading platforms (operated by 3rd parties)	An internet market place operated by a third party (or consortia from the sector), where sellers can offer their products to potential buyers; often supporting different types of sales such as fixed price offers, responding to requests for offers/proposals, and auctions.	Have not been successful in the CRP industries. Most B2B platforms did not survive the new economy crisis after 2001. See Section 3.3.
Intermediaries / connection-hubs	A third-party service provider acting as an "integrator" between a seller and a buyer, by matching document formats and processes between the two trading parties. In contrast to trading platforms, connection-hubs are no market makers – they do not aim to help finding buyers/suppliers, but to facilitate data exchanges between established business partners.	Elemica is the best known and most important example of a connection-hub for companies in the CRP industries. It was developed by 22 of the leading chemical companies. See Section 3.3.

In the following, it will first be assessed to what extent e-commerce has increased in general; then a closer look will be made at the developments in the use of the probably most important e-commerce channels – EDI and extranet.

Accepting and processing customer orders online

About a third of all firms active in the CRP industries said in 2007 that they **enabled customers to order products online**. This includes orders placed on their own website,[102] through internet trading platforms, extranet connections with customers and via EDI. There is practically no difference between companies from the various size-bands in this respect (see Exhibit 3.5-3), an observation which holds true for many sectors.

Two details in the survey results raise some questions in this respect. First, the adoption of e-commerce is apparently more widespread among US companies. While in the USA, CRP companies accounting for about 65% of employment said they received online orders, figures for European companies are in a range between 20-45%. This was found for other sectors as well, not only for the CRP industry; however, there is no evidence that US companies use more advanced infrastructure or e-business software systems than their European competitors.

Second, it does not fit the picture that the percentage of companies that claim to have "a software to manage the placing or receipt of orders online" is much higher than the share of firms that actually receives orders online from customers: firms representing nearly 80% of employment say they use such a software. Even among SMEs, more than 60% say they use such a system. Two explanations may help to solve this puzzle. First, these systems can also be used for procurement rather than for sales; in fact, the share of companies that order from suppliers online is higher (70%) than those that sell online (33%). Second, the underlying survey question leaves room for different interpretations; it

[102] Having a website has become a commonplace for firms with more than 10 employees. About 85% of companies from the CRP industries said in the survey of 2007 that they had a website. Figures are very similar to those of 2003. Diffusion is thus close to the saturation level. Just having a website is no longer indicative for e-business activity. This section therefore looks at which transaction processes a company supports via its website or other channels.

cannot be excluded that some companies that simply order goods from a supplier's website feel that the internet browser is a "software to managing placing orders online", thus increasing the incidence.[103]

Exhibit 3.5-2: Percentage of companies with a software to manage the placing or receipt of orders online (2007)

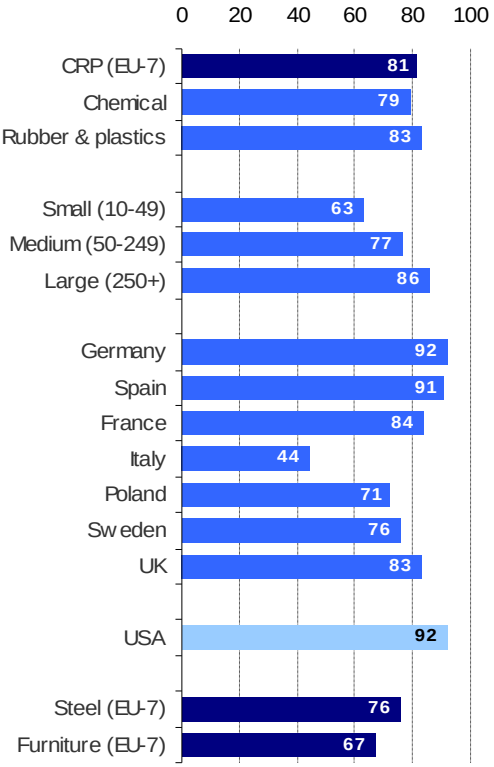
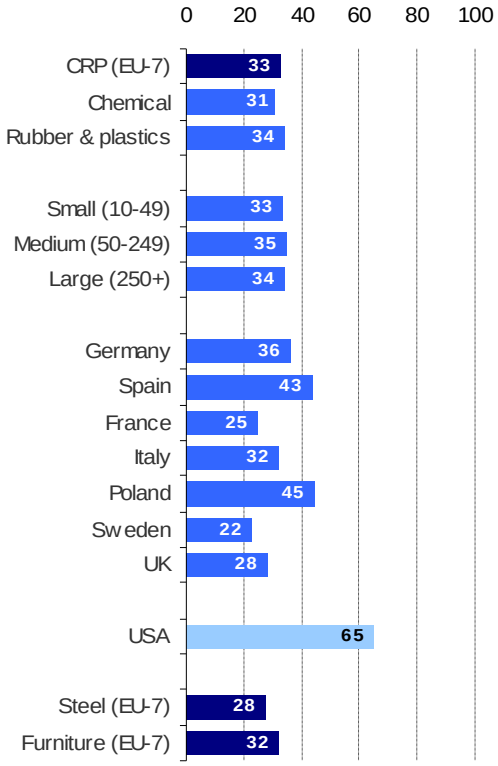


Exhibit 3.5-3: Percentage of companies receiving orders from customers online (2007)



The survey was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.
Base (100%) = companies with at least 10 employees. N (Chemical, EU-7 and USA) = 911.
Weighting: Figures for sector totals and countries are weighted by employment ("firms representing x% of employment in the sector / country"), figures for size-bands in % of firms.

Source: e-Business Survey 2007 by the SeBW

In general, e-commerce adoption has most certainly significantly increased since 2003. Although comparisons with the earlier survey are only indicative due to a change in the wording of the underlying survey question,[104] the trend is obvious: the number of companies that offer their products online has increased since 2003 when only about 10% of firms said that they sold products online (see Exhibit 3.5-4).

[103] The survey question was newly introduced in 2007, modifying an earlier follow-up question on whether companies used a "specific ICT solution to support marketing or sales processes". In the earlier question, the following specification was added: "By IT solutions we do not mean Word, Excel, plain-text e-mail or search engines like Google, but rather specific software solutions or Internet-based services."

[104] In 2006 and 2007, companies where asked whether they "**enable customers to order** goods or services online from the website or through other computer-mediated networks". In previous surveys, the question was whether they used "the internet or other computer-mediated networks **to sell** goods or services online".

To confirm this trend, it may help to look at the adoption of **CRM** (customer relationship management) systems, one of the main e-business software systems which are used for a broad range of purposes in marketing and sales. Here, the trend is clear and not distorted by a change in the survey question: the diffusion has significantly increased in all size-bands from 2003 to 2007. Adoption levels have nearly doubled in SMEs and nearly tripled among large firms (from 19% in 2003 to 53% in 2007, see Exhibit 3.5-5).

Exhibit 3.5-4: Percentage of companies selling goods online / accepting online orders (2003/2007)

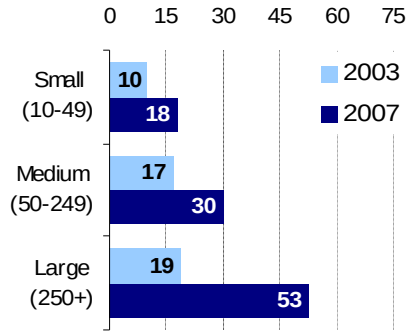
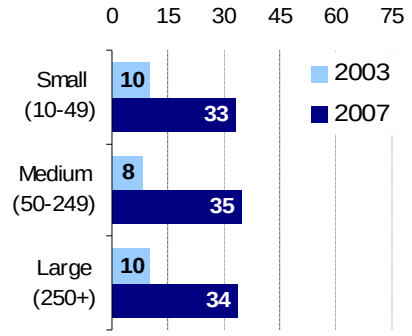


Exhibit 3.5-5: Percentage of companies using a CRM system (2003/2007)



Base (100%) = companies with at least 10 employees, 5 EU countries (2003) / 7 EU countries (2007)
N (2007) = 811, N (2003) = 502. Weighting: % of firms in the size-band.

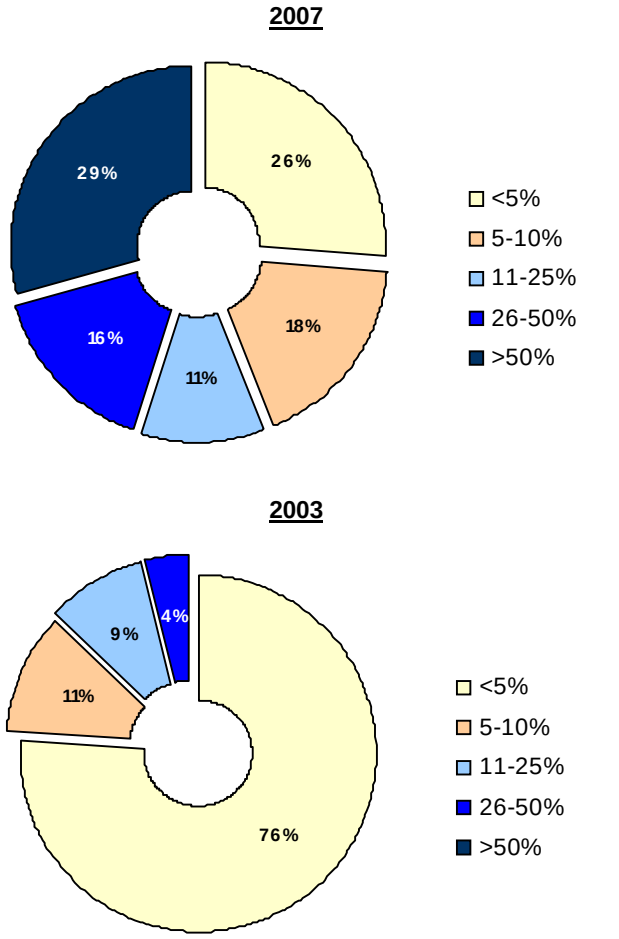
Source: e-Business Surveys 2003 / 2007 by the SeBW

The most amazing and dynamic development, however, concerns the **intensity of e-commerce** measured as the average share of orders that are received online. In 2003 as well as in 2007, companies were asked to estimate how large a share of their total sales to customers (2003) / orders from customers (2007) was conducted online. Back in 2003, a majority of those firms that sold online (about 75%) said that online sales accounted for less than 5% of their total sales. Thus, it was only a marginal sales channel. According to the new survey results of 2007, this has enormously changed since. In 2007, 30% of the firms that receive online orders said that these orders already make up more than 50% of their total orders, and 16% said it was in the range of 25-50% of their total orders (see Exhibit 3.5-6). A simple computation of answers to this survey question, assuming that the average share will rather be towards the lower end in each of the ranges offered as options for their answer,[105] suggests that the total share of sales that are conducted online in the CRP industries (by those companies that actually sell online) has increased form about 5-8% in 2003 to about 25-30% in 2007. Counting in all companies, including those that do not accept orders online, the total share of online sales (as % of total sales) has probably increased from less than 1% (2003) to about 10% (2007).

Notwithstanding the methodological risks of this extrapolation (different wording of the survey question, answers based on estimates of interviewees, no direct information on value of online transactions), the evidence of a significant increase in online sales is clear.

[105] In both surveys, companies were given five options for their answer: "less than 5% of total sales", "5-10%", "11-25%", "26-50%" and "more than 50% of total sales". To adjust for the larger sales volumes of large companies, employment-weighted figures were used.

Exhibit 3.5-6: Average percentage of orders received online: 2003 vs. 2007



Reading example (for 2007):

"Firms representing 26% of employment (out of those companies accepting orders online) say that customers' online orders account for up to 5% of total orders."

Base (100%) = companies accepting orders online.

N (2007) = 294, N (2003) = 42

Weighting: Figures for are weighted by employment ("firms representing x% of employment in the sector").

Source: e-Business Surveys 2003 / 2007 by the SeBW

e-Commerce via EDI and extranet

Two technical platforms are particularly relevant for e-commerce in the CRP industries (but also in other manufacturing sectors): the "old" legacy of EDI connections, and the more recent development of establishing advanced web-portals for customer (extranets).

EDI (electronic data interchange) is still one of the preferred messaging standards for e-commerce among medium-sized and large firms in the CRP industries. Close to 30% of medium-sized companies and nearly 50% of large firms report that they used EDI in 2007. Only 8% of small companies use EDI (see Exhibit 3.5-7). In total, companies representing about 40% of the sector's employment said they used EDI. Diffusion is thus similar as in the steel industry (34%) but higher than in SME dominated sectors such as the furniture industry (21%).

Exhibit 3.5-7: Percentage of companies using EDI-based standards (2007)

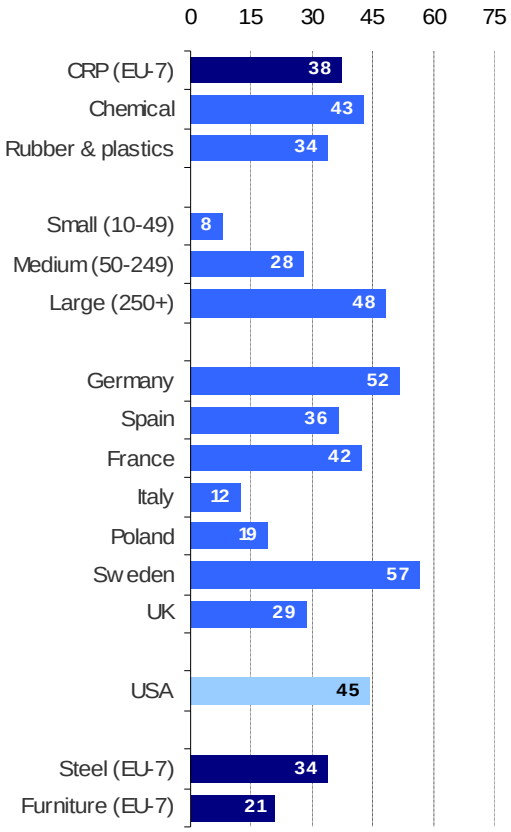
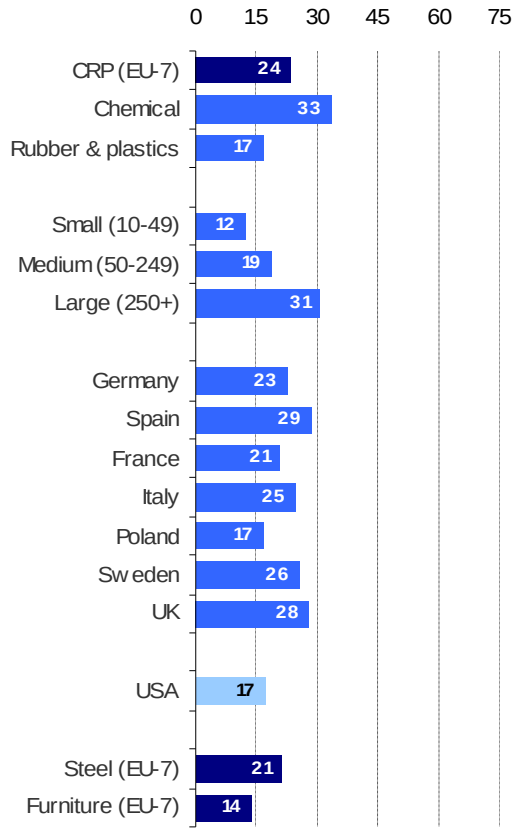


Exhibit 3.5-8: Percentage of companies with an extranet (2007)



The survey was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.
Base (100%) = companies with at least 10 employees. N (Chemical, EU-7 and USA) = 911.
Weighting: Figures for sector totals and countries are weighted by employment ("firms representing x% of employment in the sector / country"), figures for size-bands in % of firms.

Source: e-Business Survey 2007 by the SeBW

Several earlier sector studies by e-Business Watch found that EDI was an important legacy system for e-business in manufacturing sectors that can be quite stable and constitute a barrier for the adoption of new technologies.[106] The set-up of an EDI infrastructure, which typically consists of point-to-point connections between specific enterprises, is quite costly. Companies that have invested a lot of money in this infrastructure will therefore be inclined to use it as long as possible.

The high relevance of EDI connections for e-commerce was already found in the previous sector study of 2004: about 50% of those companies that sold products online said that they used EDI for this purpose. The only other sales channel with a similar popularity was the company website; however, while large firms typically use EDI, a lot of smaller firms used their website to offer products. It can be concluded that the transaction volumes traded via EDI are much larger than those ordered by suppliers from websites.

While the diffusion of EDI appears to be stable, the use of **extranets** for e-commerce purposes has gained momentum. Not only has the diffusion increased, but the portals

[106] See, for example, sector studies on the pulp and paper industry (2006) and the automotive industry (2005).

themselves have become much more sophisticated in recent years. In the survey of 2003, out of those firms that made online sales, about 20% (by their share of employment) said they used an extranet for this purpose. Considering that only 10% reported online sales, the use of extranets was apparently not widespread. In 2007, the picture is different. Nearly a quarter of *all firms* (by their share of employment) said they operated an extranet. Among large companies, about 30% said so (see Exhibit 3.5-8).

Extranets are mainly used by larger companies, often as a service for their SME customers which do not have their own advanced systems for data exchange and managing orders. The functionality of the newer generation of extranet solutions goes far beyond enabling customers to place an order. Customers, when logging in to their account, are offered a 24/7 information service about the their order(s), functionalities to generate reports, and additional information resources related to their orders (e.g. material data and certificates of analysis). Internally, the extranet is typically linked with and fed by the ERP system. A notable example of a highly sophisticated extranet, serving as a key platform for global e-commerce, is the BASF e-solution "WorldAccount" (see case study, Section 5.2). Extranets are not only used by very large firms, however. The case study of Probos (a company with about 260 employees, see case study in Section 5.7) also mentions the use of extranet to enable clients to check the current status of their order(s).

In essence, a well-managed extranet can be an extremely useful and important service which companies can offer their customers, notably to SMEs, and lead to a win-win situation. Both trading partners should benefit from conducting business on such portals, as it enhances the quality of data exchange and communication. However, in order to fulfil this expectation, the underlying ICT system from which the extranet is fed –typically the ERP system– must be perfectly organised. Companies need to make sure that a well organised system is in place where all the relevant business data are seamlessly linked, before they can build applications and services upon this basis.[107]

3.5.2 Customer requirements as a driver of e-business – from e-transactions to e-solutions

Customer requirements as a driver of e-business adoption

In a market environment which is characterised by increasing international competition (see Section 2.3), the rivalry in the market and the **negotiation power of customers** will also increase. In turn, companies can be expected to be more attentive and responsive to their customers' requirements than in a less competitive market. A typical situation is that large buyers aim at improving their supply chain processes and, to this end, urge their suppliers that they must comply with their own data exchange formats and processes.[108] This may require adapting ICT solutions or should comply with their own standards not only for e-commerce uptake, but also for adapting ICT solutions and data exchange formats. A good example is the case of Air Products & Chemicals (APC), a global provider of gases and chemicals (see Elemica case study, Section 5.3): in mid 2004, a

[107] See case study "Enhancing relations with business partners: Mayr-Melnhof Cartonboard Group, Austria", in the e-Business Watch sector study on the pulp and paper industry (2006).

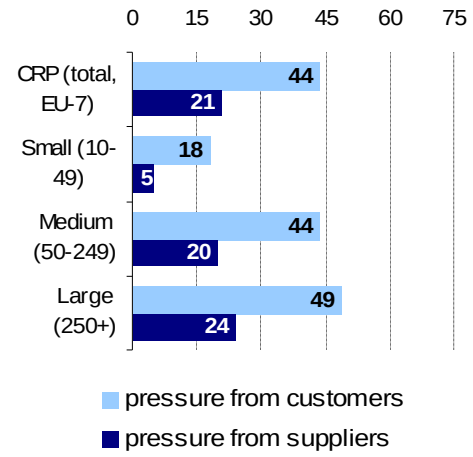
[108] This observation has led to e-business policy initiatives aiming to support SMEs in this process, for instance the "ICT-SMEs 2010" action plan in France. Cf. study by DG Enterprise & Industry on "Sectoral e-Business Policies in Support of SMEs" (2007).

major customer asked APC for online ordering and requested the company to log on to its new online portal every day and update delivery quantities, shipment arrival dates as well as railcar identifications. Finally, APC agreed with its customer to exchange data via Elemica; this enabled APC to provide the functionalities demanded by the customer in a much more cost efficient this way than the method initially proposed by the customer (via the customer's portal).

To get more evidence on the role of customers in e-business adoption, some new questions were introduced in the survey of 2007. Companies were asked whether they had "experienced pressure from customers / suppliers that they should adapt their ICT solutions or data exchange formats". In fact, survey results provide evidence that such pressure from customers could be a key driver for e-business adoption. Companies representing 44% of employment confirmed that there was pressure from customers (see Exhibit 3.5-9), notably medium-sized and large firms. Small firms with fewer than 50 employees, however, reported pressure only to a lesser extent (18%). One reason is that transaction volumes in trade with small firms are usually lower; from the perspective of their customers, there is often no "critical mass" in trade with small suppliers that justifies any efforts to harmonise data exchanges.

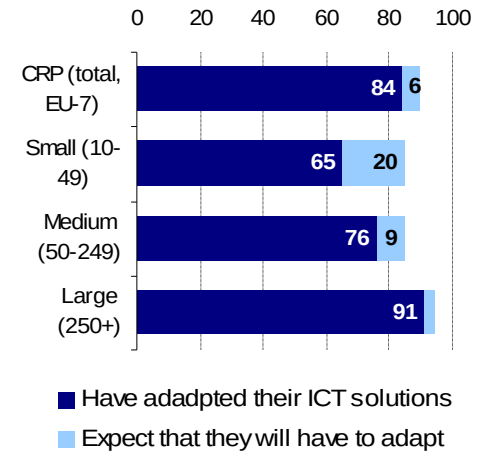
As can be expected in a highly competitive context, companies who have been asked by customers to adapt their ICT systems or exchange formats are highly responsive to such requests. About 90% of large firms and about 75% of medium-sized companies said that they made the requested changes in order to satisfy their customers' expectations (see Exhibit 3.5-10). Among small firms, "only" 65% reacted to the pressure.

Exhibit 3.5-9: Companies which experienced pressure from customers / suppliers that they should adapt their ICT solutions or data exchange formats (2007)



Base (100%) = companies with at least 10 employees, 7 EU countries. N = 811.

Exhibit 3.5-10: Companies that introduced new ICT solutions or exchange formats in order to comply with customer requests / expect that they will have to introduce (2007)



Base (100%) = companies that have experienced pressure from customers to adapt their systems, from 7 EU countries. N = 292.

Figures for sector totals and countries are weighted by employment ("firms representing x% of employment in the sector / country"), figures for size-bands in % of firms.

Source: e-Business Survey 2007 by the SeBW

Another example besides APC illustrating how customer preferences can determine the adoption (or non-adoption) of e-business is the case study on Zandleven Coatings

(Section 5.10). Zandleven has introduced a web-order application, but makes only limited use of it, because it has concerns that a full move towards integrated online sales could be in conflict with the core-competence of the company, i.e. their made-to-order and flexible (on-demand) planning system. Currently, the web-order application is used by about 10% of all customers and for specific orders only; it has therefore little impact on both internal processes and on external domains. Nonetheless, Zandleven Coatings observes that the application has had a positive effect on the image of the company as an innovative and flexible organisation. The customers that use the system today are seen as early adopters. Zandleven expects that, if the number of customers with automated planning systems increase, as well as the number of repetitive orders, the share of orders that will be processed through the web application will increase in the future. Therefore, the company considers the option of directly linking the web-order form to the ERP system to create a fully integrated sales application. Thus, adoption is linked with the development of customer requirements.

From e-transactions to e-solutions

In the light of this evidence, the dynamic adoption of marketing and sales related e-business activities can be regarded as part of an enormous effort companies are undertaking to optimally serve their customers, in response to increasing competition in the market. This has triggered a general trend to move from using e-business for merely conducting transactions electronically ("e-commerce") to a much broader understanding of service provision. The most advanced companies do not only offer e-commerce, they offer "e-solutions" to customers. This comprehensive approach to e-business focuses on providing integrated services such as enhanced access to a wide range of order-related information, for example about the order status and about products which customers have purchased. The approach is illustrated by the case study on BASF (see Section 5.2). BASF operates WorldAccount (www.worldaccount.basf.com), a globally integrated extranet platform for sellers and buyers based on the latest XML technology. WorldAccount stands for more than 60 % of BASF's e-business, but constitutes only one pillar in the portfolio of BASF's **business solutions**. Depending on the customer interaction models of its different business units, the company offers different solutions how to connect and conduct trade.

Enabling the clients to have access to up-to-date information on their order status can have a **wider impact** on work and production processes in a company. The case study on Probos (see Section 5.6) finds that this has increased the involvement of customers in the manufacturing process and that this has, ultimately, led to greater levels of customer satisfaction. Moreover, the improved transparency of the production environment brought advantages for managers as well as for the sales force, creating synergies and learning effects. For example, the greater client involvement in the manufacturing process led to a more direct contact with salesmen, which in turn led to greater expertise in predicting potential future orders.

Another learning point of this case study in this regard is that initial levels of internal acceptance of providing this type of customer service was "unexpectedly uneven". While salesmen started using the new features almost immediately, there was some resistance among employees in production, as they initially perceived it mostly as a burden of additional work (entering more data into the system than was needed before) to be done besides their main business. In retrospect, more effort should have been devoted to explaining and discussing the benefits of the system with all employees (and in particular with production staff) in advance.

Summary of key points: ICT for marketing and sales

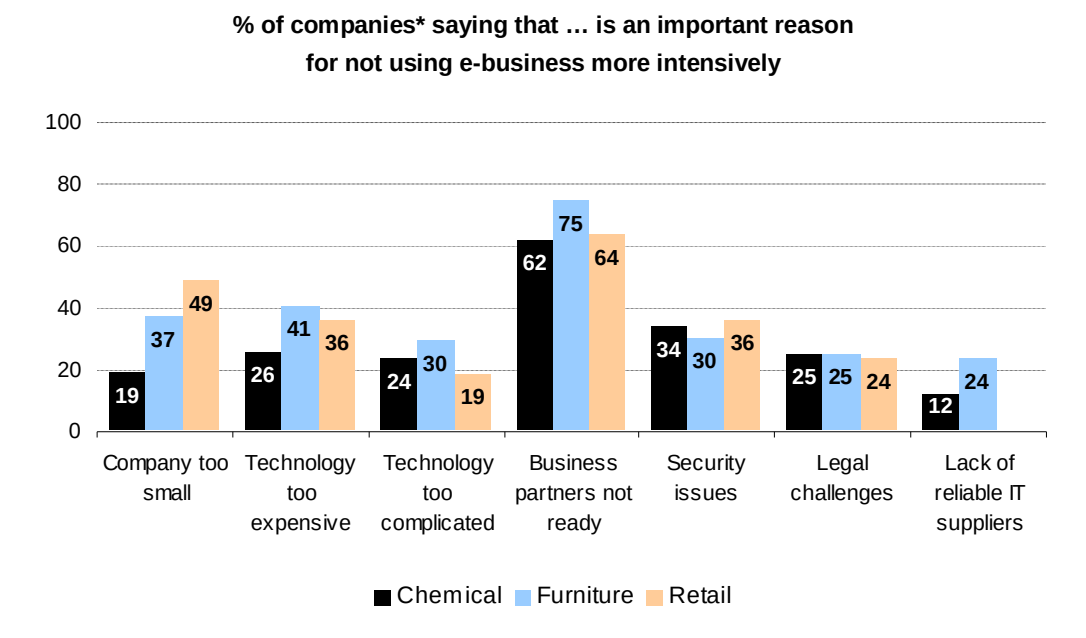
A forecast of the earlier e-Business Watch study can be confirmed: there has been a significant uptake of e-commerce activity in the past few years in the CRP industries. This dynamic development is likely to continue, as there is room for further diffusion. A major trend in this context is the move from focusing on e-transactions to providing "e-solutions".

- **More companies offer products online**: about a third of all companies – irrespective of their size– enable customers to order products online. In 2003, only 10% said they sold products online.
- **Average share of online orders has increased**: the average share of orders that are received online has significantly increased since 2003.
- **Increasing use of extranet portals**: the large players in particular increasingly maintain sophisticated extranet portals for their clients; modern extranets offer customers a holistic view of their orders and access to all kinds of order-related information. This is a vital element of a general trend to use ICT not only to accomplish e-transactions, but to provide comprehensive services ("e-solutions") to customers.
- **Customer requirements drive e-business developments**: 45-50% of medium-sized and large firms report that customers asked them to adapt their ICT systems or data exchange formats in order to facilitate data exchange with them. More than 80% of those firms have reacted to this request and introduced changes.

3.6 Barriers for ICT adoption

What keeps companies from using ICT and e-business in their daily business? To assess potential barriers, those companies that had stated that only "some" or even "none" of their business processes were conducted electronically were asked why they did not use e-business more intensively. Among seven possible reasons, the circumstance that "**suppliers or customers are not prepared for e-business**" stands out as the major barrier, not only in the CRP industries (see Exhibit 3.6-1). Companies representing more than 60% of employment said that this was an important barrier. This points towards a "chicken-and-egg" problem, as non-users are in a way blaming each other, confirming Metcalfe's law[109] regarding the (perceived and actual) value of network technology. It also demonstrates the importance of **critical mass** in ICT adoption for achieving aggregate effects: only when a sufficient base of companies are capable of exchanging data electronically, substantial aggregate effects (e.g. on productivity) can be achieved.

Exhibit 3.6-1: Barriers to e-business adoption as perceived by chemical companies (2007)



The survey was conducted in seven EU Member States (Germany, France, Italy, Spain, Poland, Sweden, United Kingdom) and in the USA.

Base (100%) = European companies with at least 10 employees and using computers, saying that some or none of their business processes are conducted electronically.
N (Chemical, EU-7) = 678.

* Weighting: Figures are weighted by employment ("firms representing x% of employment in the sector / country"). Questionnaire reference: F2.

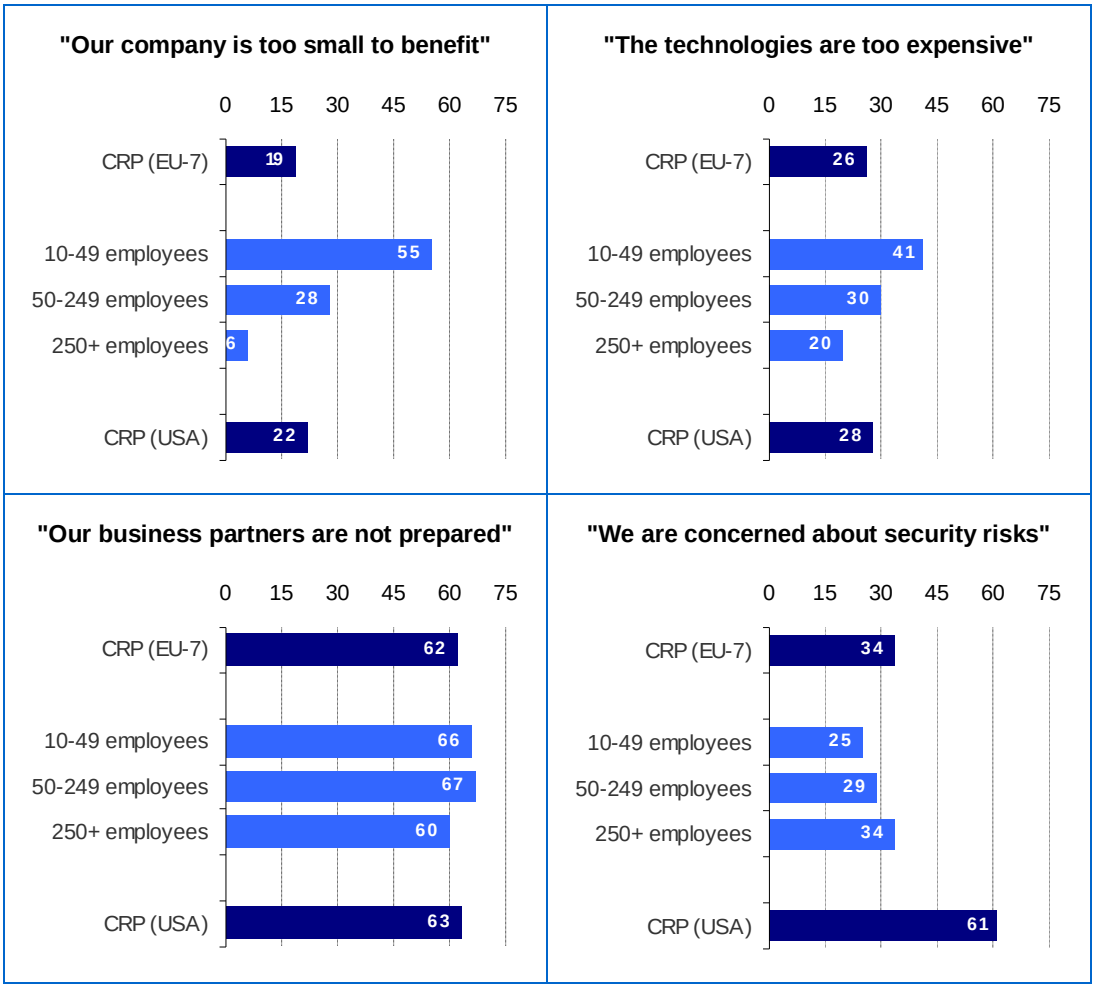
Source: e-Business Survey 2007

[109] The value of a network is proportional to the square of the number of users of the system. First formulated with regard to the internet by Robert Metcalfe, founder of 3Com and co-inventor of the Ethernet protocol.

SME typical barriers

Some of the barriers are more relevant for smaller companies than for larger ones. In particular, small firms perceive **firm size** as a main barrier in itself. 55% of small firms (out of those that do not engage actively in e-business) think that they are too small for practising e-business (see Exhibit 3.6-2). The second most important reason which small firms confirm in interviews is that they feel the "**technology is too expensive**" (about 40% of small firms). This shows that many small companies still have the impression that e-business is mainly useful for larger firms, and that they themselves have neither the critical size nor the budgetary capabilities to engage in e-business activities. However, while it is true that larger manufacturing companies are in a preferred position to benefit from ICT, the reality is more complex. It cannot be brought down to the simple formula that e-business is only for the large companies, as case studies in this report clearly show. The finding rather indicates that there is a lack of awareness, and / or of accessible information about suitable and affordable e-business technologies for smaller enterprises. The policy implications proposed in Section 6.2 addresses this issue, recommending actions to further improve the managerial understanding of e-business among smaller companies.

Exhibit 3.6-2: Barriers to e-business adoption by size class (2007)



Source: e-Business Survey 2007

Barriers for large companies

Most of the large firms which do not use e-business intensively argue that their customers and suppliers are not yet prepared. Furthermore, security concerns are more pronounced among large firms than among SMEs. Otherwise, there is no major relevant barrier. It appears that many of these companies take a deliberate decision not to use ICT for certain activities, although the firms do not see a major impediment in case they would decide otherwise. In other words, there are hardly any significant "barriers" – it is more a matter of business strategy.

The least important reason among the ones suggested –for small and large companies– was "to find reliable IT suppliers". Only about 20% of SMEs and only 5% of large firms regarded this to be an important barrier. This does not confirm the frequently made observation that the reputation of ICT service providers is still damaged as a result of unrealistic promises and disappointing results during the new economy boom.

4 ICT Impact

Chapter 3 assessed the current state-of-play in e-business in the CRP industry. It focused on trends in ICT usage, the diffusion of ICT-based applications and how they are used by companies, both for internal processes and for exchanges with other organisations or consumers. This Chapter focuses on the **economic impact of ICT** in the CRP industry, in particular by analysing links between ICT adoption and productivity growth, innovation, market structure and value chain characteristics. It combines macro and micro data analysis, using different analytical statistical approaches such as econometric analysis and regression analysis.

The analysis is based on a conceptual framework that was developed from the "structure-conduct-performance" (SCP) paradigm (see below). For the **macro-data** analysis of the impact on productivity and links with the skills base, the EU KLEMS Growth and Productivity Accounts data have been used.[110] The analysis of links between ICT adoption and innovation, market structure and value chain characteristics is based on **micro-data** from the e-Business Survey 2007.

The "structure-conduct-performance" paradigm

Economic literature suggests that the ongoing diffusion of ICT and e-business technologies and services among firms in the economy at large is a striking example of the possible dynamics of technological change and economic development (see, for example Breshnahan and Trajtenberg, 1995, Helpman, 1998a and 1998b). The adoption and diffusion of new technologies can be spurred by many different drivers and can have far-reaching consequences. Virtually all economic spheres can be affected by technologically induced changes, including innovation dynamics, productivity and growth, the development of market structures, firm performance, and the composition of the demand for labour. For this study, an extended **Structure – Conduct – Performance (SCP)** paradigm was used as a conceptual framework for the analysis of ICT impacts.[111] Developed by Mason (1939) and Bain (1951), the paradigm states that firm and industry performance is determined by the conduct of buyers and sellers, which is a function of the market structure.

The term **structure** is used here meaning “industry structure”, which includes but goes beyond market structure characteristics of the original concept. The primary features of an industry’s structure are related to market structure in the conventional sense: the number and size of supplying firms as well as the number and preferences of customers and their size in case of businesses. An important aspect of market structure dynamics is the level of ease of market entry. Further industry structure characteristics are related to products, production and production factors: the degree of product differentiation, the

[110] The "EU KLEMS Growth and Productivity Accounts" are a database on measures of economic growth, productivity, employment creation, capital formation and technological change at the industry level for all European Union member states from 1970 onwards. The compilation of this database was a project funded by the European Commission, Research Directorate General, as part of the 6th Framework Programme, Priority 8, "Policy Support and Anticipating Scientific and Technological Needs". See www.euklems.net.

[111] Following the discussion with Advisory Board members, the SCP paradigm was chosen over other alternatives because it constitutes a comprehensive framework that allows to capture and study the interdependencies between sector characteristics and firms’ behaviour.

degree of vertical integration of production, i.e. value chain characteristic, the technologies available to the firms, the firms' cost structure (i.e. the relative importance of costs for items such as production facilities, energy, personnel), and finally the workforce composition and the demand for labour, most importantly with regard to knowledge and skills. All these characteristics determine the level of competition in the industry.

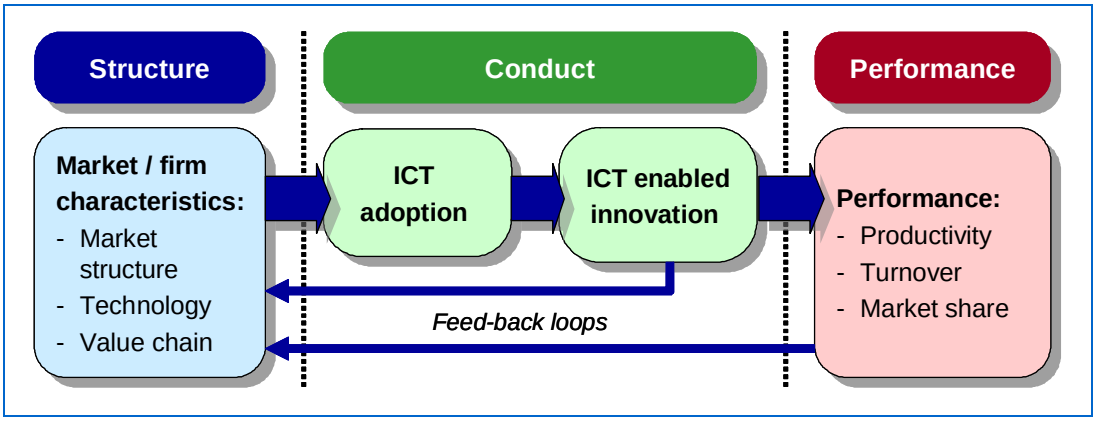
These industry structure components influence a firm's **conduct**. The conduct aspects most important here are production strategies, particularly with regard to inter-firm collaboration, as well as investments in ICT and in ICT-enabled innovation.

Finally, a firm's **performance** is assumed to be the outcome of its conduct. Successful innovations improve firm performance by, for example, reducing production cost, increasing productivity, improving product quality or enabling it to enter new markets. This may eventually lead to increased sales, turnover and market shares.

Extending the SCP paradigm: feedback effects

In contrast to the standard SCP paradigm, the flow of causality is in fact not one-directional (Fauchart and Keilbach, 2002 and Nepelski, 2003). As an example of feedback between performance and industry structure, successful and innovative companies are more likely to grow and increase their market share at the expense of less progressive firms, which transforms the market structure. There may also be feedbacks between conduct and industry structure: for example, depending on the innovation type – i.e. product or process innovation, ICT-enabled or not –, innovations influence the choice of products manufactured and a firm's cost structure. Innovations may also change the incentives to perform activities in-house versus outsourcing them and, consequently, may influence the demand for labour and its composition. It may also further shape the relationships with suppliers and customers, for example with regard to collaboration intensity. Thus, in the following discussion it is assumed that firm performance may have a feedback effect on both firm conduct and industry structure, and conduct may have a feedback on structure. This conceptualisation allows for an enhanced economic approach that studies the drivers and impacts of ICT and ICT-enabled innovations at the firm and sector level.

Exhibit 4.0-1: Conceptual framework for the analysis of drivers and impact of ICT adoption



Applying the SCM paradigm to an analysis of ICT drivers and impacts

Exhibit 4.0-1 illustrates the SCP model and the bi-directional relationships of its elements. The model allows one to identify firm and industry dimensions that can be considered as relevant for the diffusion of ICT. For each of the links to be analysed, a number of

hypotheses are proposed, based on a literature review and considering the data that are available for a given sector in EU-KLEMS and from the Sectoral e-Business Watch surveys. These hypotheses can be mapped against the extended SCP paradigm. For example, it will be empirically tested how certain aspects of market structure ("structure") are linked with the degree of ICT adoption ("conduct"); it will be assessed how the adoption of ICT hardware and software correlates with innovation activity of firms ("conduct"), and whether there are any significant links between innovation activity ("conduct") and turnover growth ("performance").

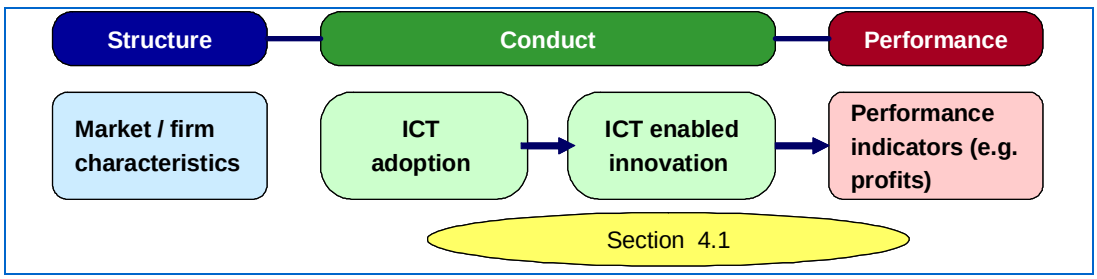
The Chapter is structured in three sections, each of which explores links between ICT adoption and a specific segment of the SCP model: Section 4.1 focuses on ICT impacts on **output** and **productivity growth**, considering the skills composition of the workforce as a complementary factor; Section 4.2 analyses links between ICT and **innovation dynamics**; and Section 4.3 looks at the relationship between ICT deployment and **competition** (market structure implications) and implications for outsourcing decisions.

4.1 ICT and productivity growth

4.1.1 Background and hypotheses

Studies on the impact of ICT confirm productivity increasing effects in both the user sectors and in the ICT producing sectors (Oliner and Sichel, 2000). In particular, ICT was found to have positive effects on labour productivity and total factor productivity (Pilat, 2005). An important finding is, however, that ICT-induced productivity effects vary significantly between sectors and among countries (Nordhaus, 2002). Recent research suggests that the largest productivity growth effect occurs in the ICT-producing sectors themselves, and in selected service industry sectors like banking, wholesale, retailing, and telecommunication (Jorgenson, Ho, Samuels, Stiroh, 2007, Jorgenson, Ho, Stiroh, 2007, Inklaar, Timmer, van Ark, 2007).

These results indicate that ICT-induced productivity effects are relatively less pronounced in capital intensive, mature manufacturing industries such as the chemical industry. On the other hand, micro-data evidence shows that particularly the larger companies in the CRP industries have dynamically adopted ICT for a variety of purposes, notably for managing production processes and the supply chain (see Sections 3.1 and 3.2). Thus, ICT investments should lead to productivity effects in this industry as well, not only on the firm- but also on the industry-level. Against this background, this section will specifically analyse to what extent ICT-capital investments have effects on productivity growth (as compared to other factors) in the chemical industry. With reference to the Structure-Conduct-Performance framework, the analysis in this section focuses on the links between conduct (ICT adoption and innovation) and performance.



ICT-capital investment and total factor productivity growth

For the study of ICT impacts on firm-level productivity, two considerations are essential. First, as depicted in the conceptual framework (see above), ICT investment does not lead to productivity growth at firm-level by itself. It depends on how the technology is actually used in business processes, i.e. on a company's ability to innovate its work processes and business routines with support of ICT. Thus, only if ICT investment is combined with complementary investment in working practices, human capital, and firm restructuring will it have an impact on performance (cf. Brynjolfsson and Hitt, 2000). These complementary investments and organisational changes are highly sector- and firm-specific; therefore, returns to ICT investments vary strongly across organisations (Pilat, 2005). The need for complementary investments is commonly confirmed in case studies on ICT adoption. For example, the case study on Unicorn in this report (see Section 5.8) concludes that "*the decision to implement an IT solution is only half of the success. The other half is to integrate the system with the company's targets and strategy.*"

Second, it has to be considered that outsourcing is an organisational innovation which can change firm-level productivity (Erber, Sayed-Ahmed, 2005). The case study on Acordis in this report (see Section 5.1) demonstrates that this holds true for companies in the CRP industries; in this case, Business Process Outsourcing (BPO) for the receipt of supplier e-invoices has enabled productivity growth.

Notwithstanding these considerations, the first step of the analysis is to assess the contribution of ICT-capital investment to productivity growth (see Hypothesis P.1).[112]

Hypothesis P.1: ICT-capital investment has become a main element in value added and productivity growth in the CRP industry, while other capital inputs summarised as non-ICT-capital have diminished in their respective importance. [113]

There are complementarities between other factor inputs which are imperfectly incorporated in the traditional factors included in productivity measurement and growth accounting, such as labour and intermediate inputs. The second step is to consider the apparent need for companies to not only invest into ICT but also into complementary items in order to increase productivity. A certain part of such complementary investment is linked with **total factor productivity** (TFP). TFP represents output growth not caused by input growth. The attribute "total" refers to the unknown complete set of influencing factors. TFP effects may be caused by numerous factors, e.g. organisational changes in the company such as outsourcing that lead to improved workflows and increased

[112] TFP is a measure for disembodied technical change in a production process. Since no particular factor could be assigned as its sole origin, it has been labelled by some economists as a measure of ignorance. It is a residual between growth of an output indicator like gross value added or gross production value minus an aggregate index of factor inputs weighted by their respective factor shares. TFP is also named Solow-residual, because Robert Solow (1957) was one of the first economists who pointed out the significance of disembodied technical change for economic growth opposite to the classical view that in particular capital accumulation, i.e. embodied technical change is the key driver of growth.

[113] The hypothesis has been tested on the basis of data from the EU-KLEMS project (see introduction to this chapter), using a number of variables such as:

- Contribution of ICT capital services to output growth (percentage points)
- Contribution of non-ICT capital services to output growth (percentage points)
- Contribution of labour services to value added growth (percentage points)
- Contribution of hours worked to value added growth (percentage points)

productivity.[114] Thus one can assume that ICT capital investment has become a key driver of total factor productivity (TFP) growth. This will be tested as a second hypothesis:

Hypothesis P.2: TFP growth in the CRP industries has accelerated together with increased investment in ICT-capital.[115]

Another important factor that may influence on the extent to which ICT enables productivity growth is the complementarity between ICT capital and **skills**. A large body of literature on the "**skill-bias**" of innovation supports the finding that technical change is biased towards skilled workers, reducing demand for unskilled labour and increasing wage inequality and polarisation (Acemoglu, 2002). The impact is clearly visible in today's advanced economies; unskilled jobs have long been declining in absolute terms in Europe and growing only slowly in the US, while skilled jobs for educated workers are being created at a faster pace in most countries (Pianta, 2004).

ICT tends to be a skill-biased technology and, thus, the application of ICT may increase the demand and wages for skilled labour and decrease the same for unskilled labour. The analysis in this study focuses on the interdependence of ICT investments with skills requirements in the CRP industries. The links between ICT adoption and skills are illustrated by the case study on Medikémia, a chemical company in Hungary (see Section 5.4). ICT has enabled Medikémia to reduce the number of employees by automating formerly manual work processes (for instance, many positions in administration such as like that of a typewriting secretary or an archivist were made redundant). At the same time, however, the remaining workforce needs to be better qualified to be capable of operating the technology. Exploring the relationship between ICT adoption and skills requirements is probably a more relevant question for policy than just assessing the net impact on total sector employment. The following hypothesis addresses this issue.

Hypothesis P.3: ICT has together with high- and medium-skilled labour a positive impact on labour productivity growth.[116]

[114] In terms of calculation, TFP is a residual between growth of an output indicator, like gross value added or gross production value, minus an aggregate index of factor inputs such as labour and capital, weighted by their respective factor shares. TFP is also named 'Solow residual', because Robert Solow (1957) was one of the first economists who pointed out the significance of disembodied technical change for economic growth opposite to the classical view that in particular capital accumulation, i.e. embodied technical change, is the key driver of growth.

[115] The hypothesis has also been tested on the basis of data from the EU-KLEMS project, using a number of variables such as:

- ICT capital services, volume indices, 1995 = 100
- Gross value added, volume indices, 1995 = 100
- Growth rate of value added volume (% per year)
- Contribution of TFP to value added growth (percentage points)

[116] The hypothesis has been tested on the basis of data from the EU-KLEMS project, using a number of variables such as:

- Contribution of labour composition change to value added growth (percentage points)
- Hours worked by high-skilled persons engaged (share in total hours)
- Hours worked by medium-skilled persons engaged (share in total hours)
- Hours worked by low-skilled persons engaged (share in total hours)

The analysis to confirm or reject these hypotheses has been conducted in the following steps:

1. Section 4.1.2 looks at the overall development of **value added growth** in the CRP industries and analyses the **contribution of different factors** including ICT-capital and non-ICT-capital, working hours and labour quality by means of growth accounting.
2. Section 4.1.3 looks at the overall development of **labour productivity growth** in the CRP industries (from 1985-2004) and analyses the **impact of ICT-capital** investment on labour productivity growth, estimating a stochastic possibility frontier (SPF).
3. Finally, on the basis of the results, it is assessed whether the initial **hypotheses** can be confirmed or not (Section 4.1.4).

4.1.2 ICT impact on value added growth

Gross value added growth in the CRP industries

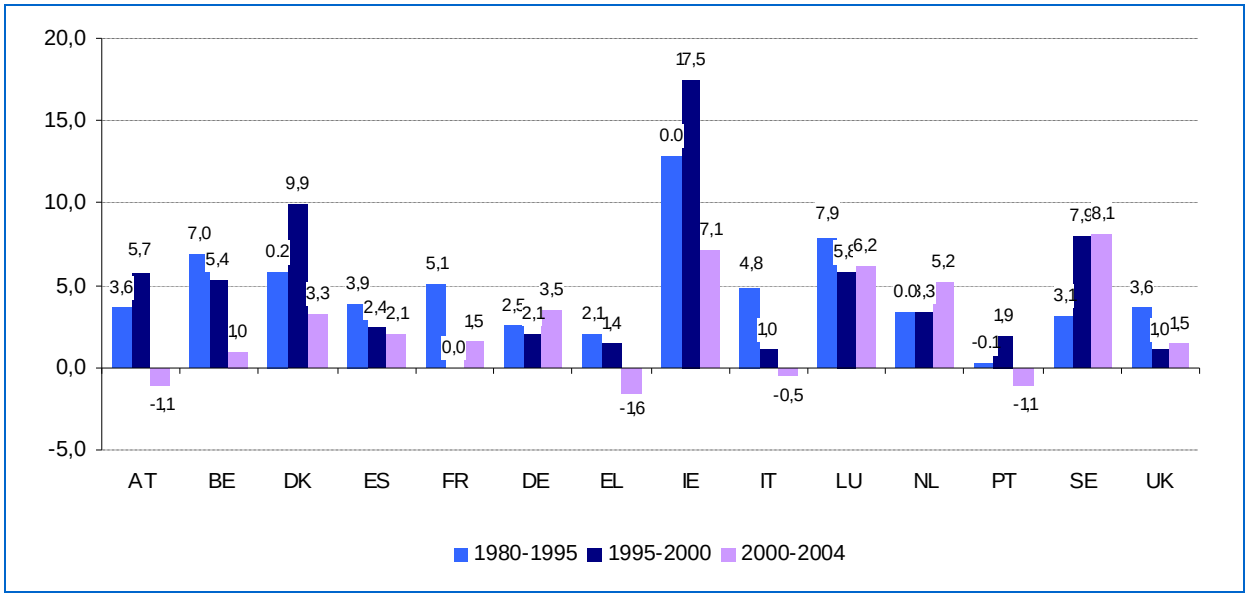
As shown in Chapter 3, the CRP industries[117] are among the advanced ICT-using industries, notably the larger firms in the sector. For example, many chemical companies are serving global markets and can benefit in this regard from using ICT-systems to disseminate and search for information, in order to adjust their production and marketing activities.

In fact, most countries out of those for which data were available experienced fairly high growth (in terms of real gross value added) of their chemical industries in the period 2000-2004, the exceptions being Austria, Greece, Portugal and Italy, which experienced a decrease during this period (see Exhibit 4.1-1). However, only some countries (notably Sweden, Ireland, Luxembourg, the Netherlands, Germany and Denmark) were able to maintain their high growth pattern of more than 3% annually after the bust of the new economy bubble in 2000. This could indicate that chemical industries inside the EU Member States are relocating according to comparative advantages inside the EU. However, it is too early to identify this as a medium or long-term trend. Globalisation of supply chains, together with further market integration within the EU, could lead to changes in the economic geography of the chemical industries according to their comparative locational advantages.[118]

[117] Note that the sector aggregation used for the econometric analyses presented in this section deviates from for the sector definition specified in Section 2.1 (and applied for the other parts of the study), as it includes the pharmaceutical industry (NACE 24.4) and, for the growth accounting analysis, the manufacture of coke, refined petroleum products and nuclear fuel (NACE 23). The aggregation levels of EU-KLEMS database did not allow the exclusion of these industries for the respective purposes.

[118] For more literature on this issue of new economic geography see e.g. Krugman, Venables (1995), Aiginger, Pfaffermayr (2004), Brülhart, Traeger (2004) and Barrios, Strobel (2004).

Exhibit 4.1-1: Growth of gross value added in the CRP industries (NACE 24+25), 1986 – 2004



Source: EUKLEMS data base, GGDC; own calculation.

Growth accounting of gross value added

Growth accounting is a widely used approach to study the contribution of different factor inputs on overall output growth. Using standard techniques (see e.g. Jorgenson, Gollop, Fraumeni 1987) a decomposition of the real gross value added by different factor inputs is obtained for nine EU Member States (see Exhibits 4.1-2 and 4.1-3).[119]

The main source of differences in gross value added growth is to be found in the **total factor productivity (TFP) growth** which differs widely between Member States. France, Denmark and the Netherlands experienced high TFP-growth from 1995-2004, Germany and Austria followed suit. The other countries (including the UK, Spain, Belgium and Italy) exhibit nearly no or even declining TFP change rates. This is in stark contrast to the decade before (see Exhibit 4.1-2) for all countries compared.

ICT-capital contributed positively to overall output growth in nearly all EU-countries, ranging from 0.9% for Belgium to as low as 0.1% for the Netherlands. Italy was the only country with a slightly negative impact of ICT-capital (-0.1%) in the period 1995 to 2004. **Non-ICT-capital**, however, contributed to a higher extent to growth in gross value added on average. The only countries where this was not the case are the UK and Austria; there, non-ICT-capital had a lower growth impact than ICT-capital (see Exhibit 4.1-2).

[119] Due to data limitations this analysis is based on NACE 23t25 and is therefore not fully compatible with the analysis of the previous and following sections of this chapter.

Exhibit 4.1-2: Decomposition of gross value added growth by different factor inputs

Countries	gross value added	contribution of labour inputs	*contribution of total working hours*	*contribution labour quality change*	contribution of capital	*contibution of ICT capital*	*contribution of Non-ICT capital*	contribution total factor productivity
	(1)=(2)+(5)+(8)	(2)=(3)+(4)	(3)	(4)	(5)=(6)+(7)	(6)	(7)	(8)
				average annual growth rates, in %				
				1986-1995				
Austria	4.4	-0.7	-0.9	0.2	0.6	0.1	0.5	4.5
Belgium	4.2	0.4	0.0	0.4	3.7	0.8	2.9	0.1
Denmark	5.2	1.2	0.8	0.4	1.6	0.5	1.1	2.5
Spain	4.4	0.1	0.0	0.1	1.4	0.3	1.1	2.9
France	7.6	-0.5	-0.6	0.1	1.3	0.3	1.1	6.8
Germany	1.5	-1.2	-1.1	0.0	0.9	0.1	0.7	1.8
Italy	2.9	-0.4	-0.2	-0.2	1.3	0.2	1.1	2.0
Netherlands	2.0	0.1	-0.1	0.1	1.1	0.5	0.7	0.8
United Kingdom	3.9	-1.1	-1.1	0.1	0.6	0.4	0.2	4.3
				1995-2004				
Austria	1.2	-1.1	-1.0	-0.1	0.2	0.3	-0.1	2.1
Belgium	2.6	0.4	0.2	0.2	2.7	0.9	1.8	-0.5
Denmark	6.4	1.4	1.0	0.4	1.9	0.8	1.1	3.0
Spain	2.7	1.4	1.2	0.3	1.6	0.3	1.3	-0.4
France	4.1	0.0	-0.2	0.2	0.6	0.3	0.3	3.5
Germany	2.0	-0.8	-0.9	0.1	0.4	0.2	0.3	2.5
Italy	-0.8	0.1	0.2	-0.1	0.9	-0.1	1.0	-1.8
Netherlands	3.8	0.4	0.1	0.3	0.5	0.1	0.3	2.9
United Kingdom	0.9	0.0	-0.7	0.7	0.7	0.7	0.0	0.3

VA - Gross Value Added growth
L - Contribution of Labour input growth
H - Contribution of Total hours worked
LC - Contribution of Labour composition
K - Contribution of Capital input growth
KIT - Contribution of ICT capital
KNIT - Contribution of Non-ICT capital
TFP Contribution of Total Factor Productivity growth

Source: DIW Berlin, developed from EU-KLEMS data

Exhibit 4.1-3: Decomposition of gross value added growth by components of labour input

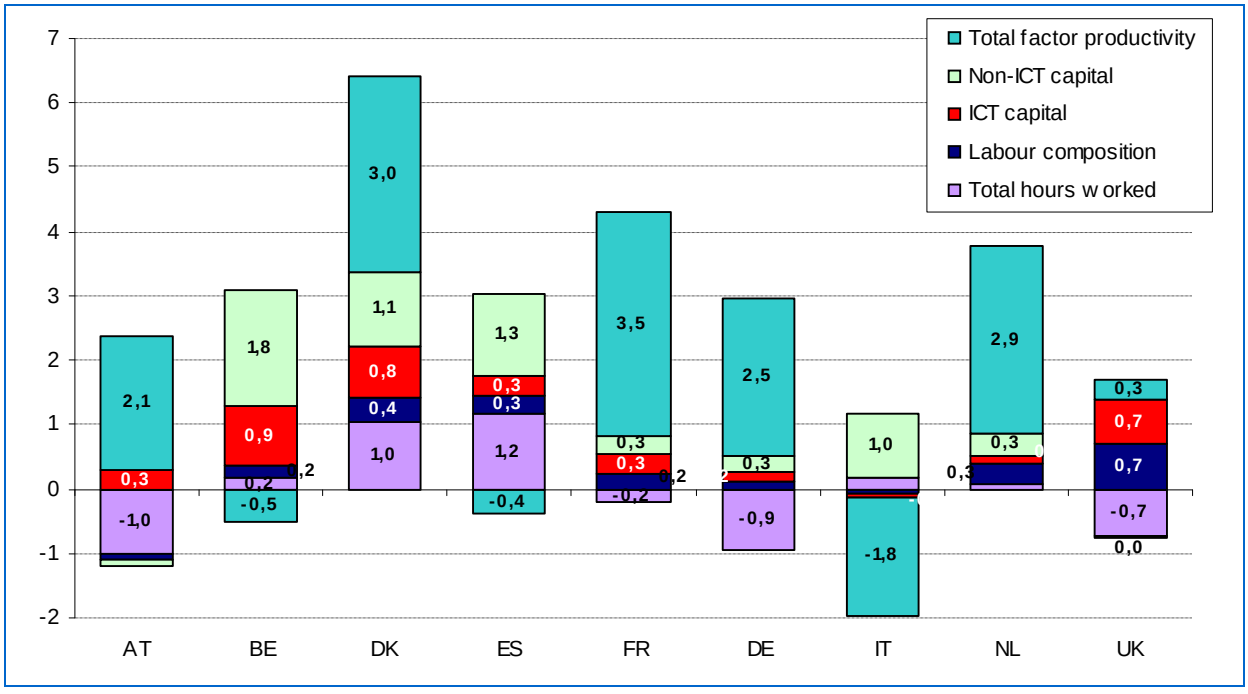
Countries	Gross Value Added	*Gross value added per hours worked*	Total hours worked	*Total persons engaged*	*Average working hours per person*
	(1)=(2)+(3)	(2)	(3)=(4)+(5)	(4)	(5)
			average annual growth rates, in %		
			1980-1995		
Austria	3.6	5.8	-2.2	-1.7	-0.4
Belgium	7.0	7.7	-0.8	-0.3	-0.5
Denmark	5.7	4.9	0.9	1.2	-0.4
Spain	3.9	5.5	-1.6	-1.0	-0.6
France	5.1	7.5	-2.4	-1.8	-0.6
Germany	2.5	4.5	-2.0	-1.4	-0.6
Greece	2.1	3.2	-1.1	-1.1	0.0
Ireland	12.8	10.6	2.3	2.7	-0.4
Italy	4.8	7.0	-2.2	-2.5	0.3
Luxembourg	7.9	3.7	4.2	4.2	0.0
Netherlands	3.3	4.3	-1.0	-0.8	-0.2
Portugal	0.2	3.8	-3.6	-3.2	-0.4
Sweden	3.1	3.6	-0.5	-1.5	1.0
United Kingdom	3.6	7.0	-3.4	-3.4	0.0
			1995-2000		
Austria	5.7	8.1	-2.4	0.0	-2.5
Belgium	5.4	4.8	0.6	0.7	-0.1
Denmark	9.9	10.6	-0.7	-1.4	0.7
Spain	2.4	0.0	2.4	2.4	0.0
France	0.0	2.3	-2.3	-1.6	-0.7
Germany	2.1	4.8	-2.8	-2.3	-0.5
Greece	1.4	2.3	-0.9	-0.9	-0.1
Ireland	17.5	14.7	2.8	4.1	-1.3
Italy	1.0	-0.2	1.2	-0.4	1.6
Luxembourg	5.8	2.0	3.8	3.0	0.7
Netherlands	3.3	4.5	-1.2	-0.8	-0.3
Portugal	1.9	5.0	-3.1	-2.3	-0.8
Sweden	7.9	6.3	1.6	1.3	0.3
United Kingdom	1.0	1.9	-0.8	-0.7	-0.2
			2000-2004		
Austria	-1.1	0.2	-1.3	-0.3	-1.0
Belgium	1.0	2.6	-1.6	-1.2	-0.4
Denmark	3.3	0.6	2.6	2.8	-0.1
Spain	2.1	3.2	-1.2	-0.7	-0.4
France	1.5	2.9	-1.4	-0.7	-0.6
Germany	3.5	5.9	-2.4	-2.3	-0.1
Greece	-1.6	-4.4	2.8	2.7	0.1
Ireland	7.1	4.8	2.3	2.4	-0.1
Italy	-0.5	0.9	-1.4	-1.1	-0.3
Luxembourg	6.2	8.4	-2.2	-1.2	-0.9
Netherlands	5.2	5.8	-0.6	-1.0	0.5
Portugal	-1.1	-0.4	-0.7	-0.7	-0.1
Sweden	8.1	8.5	-0.4	-0.6	0.2
United Kingdom	1.5	4.1	-2.6	-2.3	-0.3

Source: DIW Berlin, developed from EU-KLEMS data

At first sight, this confirms the view that ICT-investments by themselves are not driving output in the CRP industries – this sector appears not to depend on ICT in its core businesses in the same way as other sectors, notably service industries. However, it must be considered that ICT is often embedded in the complex equipment of chemical plants. Thus, there is probably "**hidden ICT**" which cannot be separated by the approach to measure ICT-investment taken by the EU-KLEMS database, and the actual impact might be implicitly higher than the figures in Exhibit 4.1-2 suggest.

Looking at the impacts of **labour compositional change**, one observes that the labour quality change component from low-skilled towards medium- and high-skilled labour had a positive growth impact for most of the countries (the exceptions being Austria and Italy). This indicates that a **skill-biased technological change** is taking place with ICT-capital as its complementary factor for driving growth of the CRP industries. In contrast, the impact of the change in total working hours does not show a consistent picture for the different countries. Austria, Germany, the UK and France experienced moderate decline in overall working hours. In Spain and Denmark, by contrast, working hours contributed positively to the industry's growth (about 1%). For the other countries, the growth in total working hours had no significant impact (see Exhibit 4.1-4).

Exhibit 4.1-4: Growth accounts for gross value added for the CRP industries in selected EU Member States, 1995-2004 (contributions in percentage points)



Source: EUKLEMS data base, GGDC; own calculation.

Summing-up the results of the growth accounting, it can be concluded that the key drivers to industry growth come from TFP-growth, capital investments and changes in labour quality (i.e. skills). As a rule of thumb, the higher TFP-growth and capital investments are, the higher is the value added. The overall high capital-intensity of the chemical industries lead to the result that labour inputs and moderate labour quality changes are of secondary importance. This finding is quite specific for the CRP industries among the six

sectors analysed,[120] in particular in comparison to service industries such as financial intermediation and retailing, where labour inputs and skill-bias play a significantly more important role.

4.1.3 ICT impact on labour productivity growth

Labour productivity growth in the CRP industries

An analysis of the annual labour productivity growth rates for 14 EU Member States (all of them members of the former EU-15) for the time period 1980-2004[121] shows that the average annual growth rates have been very **heterogeneous across countries and periods** (see Exhibit 4.1-5). The observation period has been divided into three sub-periods (1986-1995, 1995-2000 and 2000-2004) which represent the main phases discussed in the literature concerning the labour productivity resurgence for the US at the aggregate level.

High average sustained annual labour productivity growth is observed in a few countries such as Germany, Sweden, Ireland and the Netherlands; here, average annual growth rates are above 5% for the whole observation period (1980-2004) and most of the respective sub-periods (see Exhibit 4.1-5). A few countries such as Belgium and Greece experienced low growth rates, while most countries are in between in this respect, with considerable fluctuations of labour productivity growth during the three periods; some countries experienced higher labour productivity growth rates in the earlier period (1986-1995), others in the later period. In summary, no common pattern can be observed for the manufacture of chemical, rubber and plastics products as might have been expected from the literature which focused on the US experience.

This may have to do with a delayed convergence in the chemical industries in the EU and Eurozone even after introducing the common currency. However, more homogeneous increases in labour productivity can be expected for the years since 2004 and the near future, due to the restructuring of industries inside the common market of the EU (according to locational comparative advantages). Since chemical products continue to be important export items in international trade (see Sections 2.2 and 2.3), this would significantly contribute to the global competitiveness of the EU as a whole. ICT is playing an important part in this context by enhancing the coordination of the different global supply chains in the chemical industries (see Section 3.3).

Labour productivity growth based on working hours can be decomposed in the two components of employment change and changes in average working hours per employee. Exhibits 4.1-6 and 4.1-7 show that only Ireland experienced persistent positive employment growth over the whole period 1980 until 2004. This might be attributable to the fact that Ireland setup its chemical industries quite recently and is focussing on those areas with high growth perspectives. In most other countries employment shrank more or less drastically especially in those large ones with a long history in the production of chemicals like Germany, France, the Netherlands and the UK. Growth in the chemical

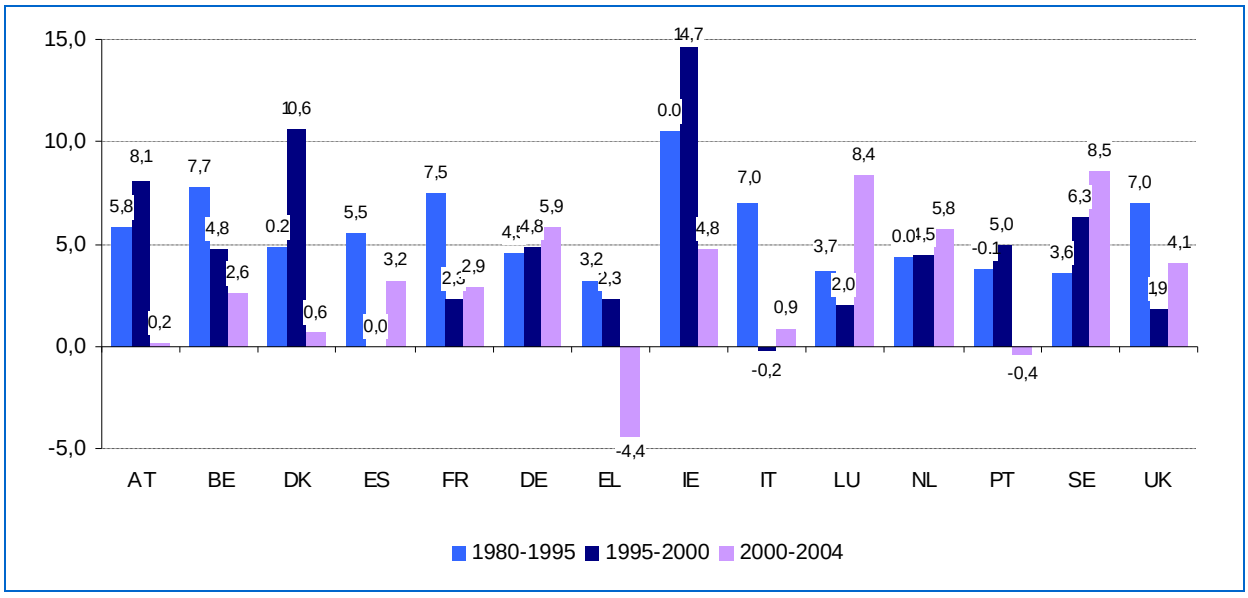
[120] Other sectors analysed are the steel and furniture manufacturing industries, retail, transport and logistics, and financial intermediations.

[121] These are the most recent data available from the EU-KLEMS dataset published in March 2007. This might change in June 2008 when an update will be released.

industries are in most of the EU countries covered by the analysis insufficient to create or even maintain the overall employment.

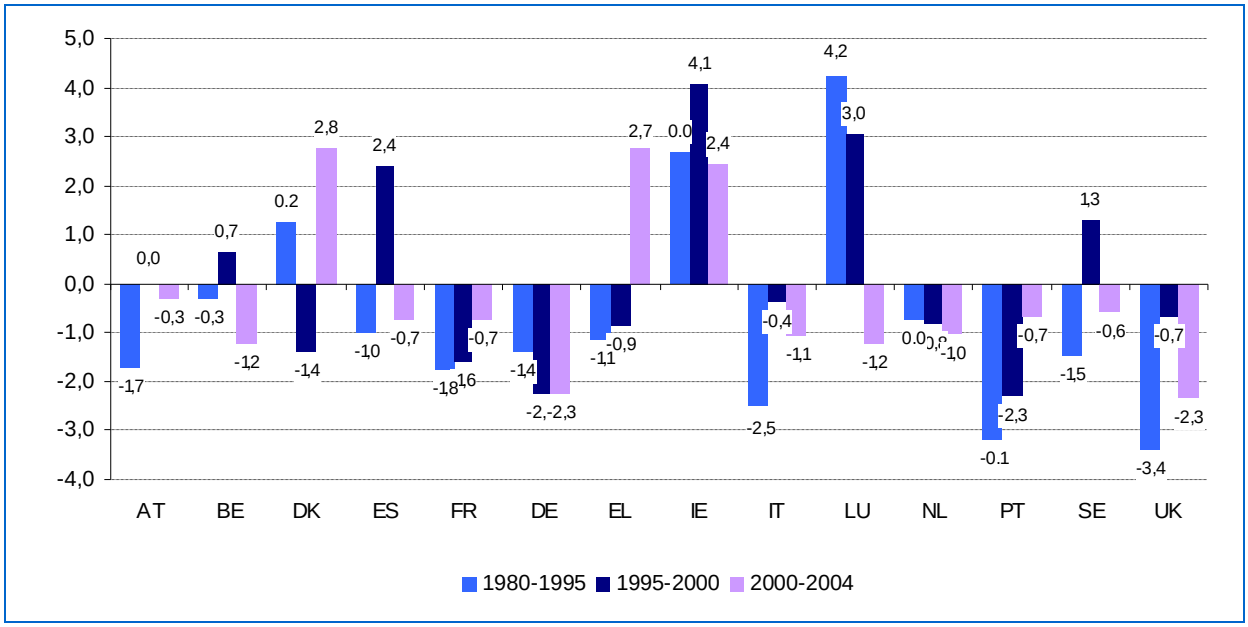
During the same time on average working hours per employee were decreasing with few exceptions in most countries. Only in Italy with 1.6%, Denmark and Luxembourg with 0.7% working hours per employee increased significantly during the period 1995-2000. Furthermore Sweden had positive increases in average working hours in the period 1980-1995 of 1% annually. Labour productivity growth was therefore associated in most countries on average by labour shake out and decreasing working hours per employee. Therefore economic development in the chemical industries is on average overall labour saving. The growth in the chemicals industries is insufficient to exceed the labour productivity growth to create by this additional employment opportunities. However, trends in diminishing average working hours per employee are quite moderate. It might even be that since 2004 in many countries the trend to reduce average working hours has reversed since cost pressures from international competition encourage the management to negotiate longer working hours contracts with the trade unions to maintain the competitiveness of the location where chemical plants currently are situated. In Germany there evidence that the long-term trend to reduce average working hours per employee has already been reversed. Similar developments are underway in France under the new government.

Exhibit 4.1-5: Labour productivity growth in the CRP industries (NACE 24+25), 1986-2004 (annual average growth rates in %)



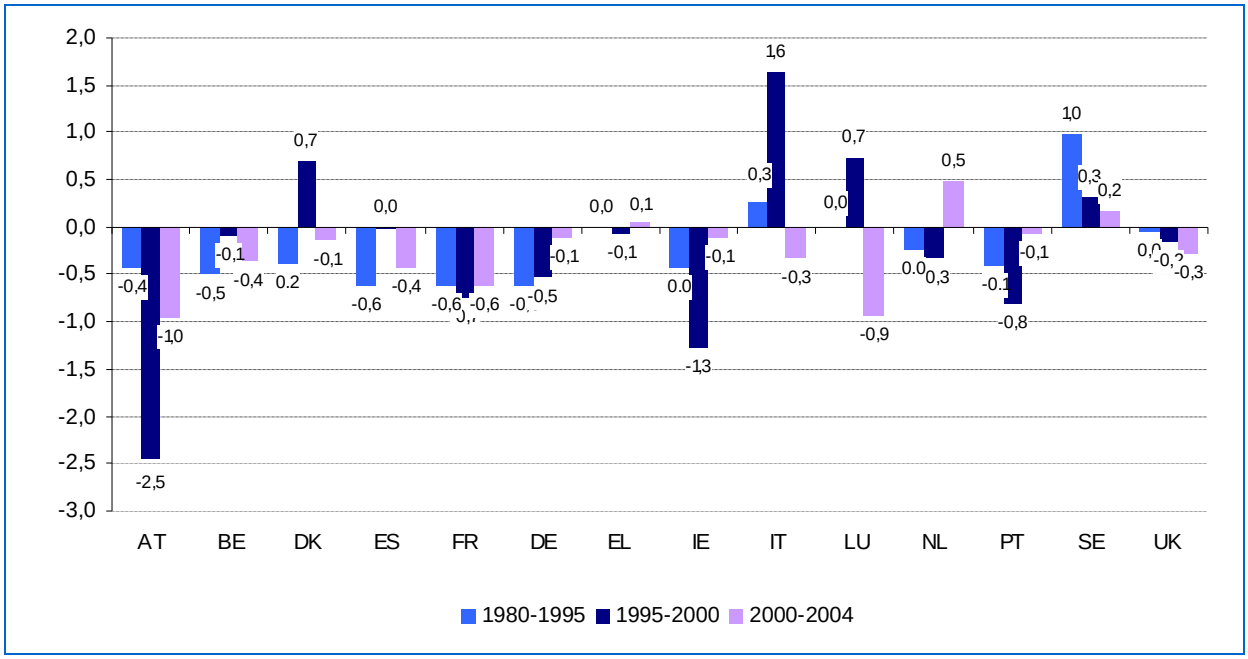
Source: EUKLEMS data base, GGDC; own calculation.

Exhibit 4.1-6: Employment growth in chemicals (NACE 24 + 25), 1980 – 2004 (annual average growth rates)



Source: EUKLEMS data base, GGDC; own calculation

Exhibit 4.1-7: Average working hours per employee in chemicals (NACE 24 + 25), 1980 – 2004 (annual average growth rates)



Source: EUKLEMS data base, GGDC; own calculation.

The impact of ICT on labour productivity growth

In existing literature, the chemical industries have not been identified as one of those sectors where intensifying ICT-capital usage contributed significantly to aggregate labour productivity growth acceleration in the US (see van Ark, Inklaar, McGuckin 2002). Therefore, this study analyses the particular developments and factors which led in the selected sample of EU Member States to fairly different overall outcomes than those that could be expected when the Lisbon Agenda was setup in 2000. At this time, it was expected that a similar resurgence of productivity growth due to ICT investments as observed in the US since the mid-1990s would take place in Europe (as a catching-up process to the US as leader in development).

The following analysis is based on 16 out of the 27 EU Member States.[122] For these countries, a complete dataset running at least over the time period from 1995 until 2004 was available from the EU-KLEMS database. They are denoted as the "EU-16" in this section. Data are available for the following variables: gross production value, total intermediate inputs, total working hours, ICT-capital stock and non-ICT capital stock input plus total working hours. The latter is broken down into working hours for three separate skill categories: high, medium and low skills.

Based on the secondary intermediate inputs and the two primary input factors (capital broken down into ICT- and non-ICT-capital stock) and labour measured by working hours (broken down into three different skill-types), a **stochastic possibility frontier** (SPF)[123] was estimated using a panel data set for the EU-16.

As a particular specification the error component model of Battese and Coelli (1992) was used, which allows for estimating average efficiency levels by country (i.e. 100 is equal to full-scale efficiency, values below measure the percentage points below the overall efficiency level of an industry production possibility frontier at a certain time period). To guarantee constant returns to scale for the possibility frontier, the output and input variables were normalised by the total working hours. This led to an accordingly restricted stochastic possibility frontier where the real gross production value per working hour is explained by six factor intensities using total working hours as the denominator. As an additional variable, a time trend beside the constant term was included to measure the autonomous technical change. For the econometric estimation the Frontiers 4.1 software programme was used (Coelli, 1996). The estimation results using a Cobb-Douglas production function specification are summarised in Exhibit 4.1-8.

The parameter estimates obtained are measures for the respective output elasticity of the respective input factor, i.e. an increase of one unit in the respective input factor increases the output variable by the respective output units.

[122] Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Luxembourg, Netherlands, Poland, Slovenia, Spain, Sweden, and the UK.

[123] A "stochastic possibility frontier" introduces a theoretical benchmark which usually cannot be matched by any actual producer, industry or country. It is a quasi-ideal production frontier which, due to all kinds of impediments in the particular situations of each player, cannot be matched completely (at least permanently). This gives sufficient incentive for even the best-practice player to search for further improvements. For detailed information about the mathematical model, see Annex II, and Erber 2005.

Exhibit 4.1-8: Parameter estimates of a stochastic possibility frontier (SPF) for chemicals (NACE 24 + 25), error component model, 1995-2004

Gross Production Value per Total Working Hours based on EU-16[1] Multi-Country-Panel

Explanatory variables	parameter	standard-error	t-value
Constant	0.22	0.04	5.58
Intermediate Input per TWH[2]	0.84	0.02	39.89
ICT-Capital Stock per TWH[2]	0.02	0.01	3.09
Low-Skilled-WH per TWH[2]	0.04	0.01	2.52
Medium-Skilled-WH per TWH[2]	0.02	0.01	1.41
sigma square	0.16	0.06	2.65
gamma	0.98	0.01	98.10
eta	-0.01	0.01	-2.20
Log-Likelihood	180.1		
No. of iterations	28		

[1] EU-16 - Austria, Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Italy, Luxembourg, Netherlands, Poland, Slovenia, Spain, Sweden, UK

[2] TWH - total working hours

Source: EUKLEMS database of GGDC, own calculations. **DIW** Berlin 2008

Looking at the significance of the estimated parameter values one observes that the least significant output elasticity has to be attributed to the medium-skilled labour intensity. All other parameter values listed in Exhibit 4.1-8 are found to be significantly different from zero at the 5% significance level.[124] High-skilled labour and non-ICT-capital intensities are not included here since they were found to be insignificant even at the 10%-level.

The results obtained from the SPF-analysis indicate a **moderate impact of physical ICT-capital investment** on labour productivity. Furthermore, the highly significant impact of non-ICT-capital investments that was found in the growth accounting analysis cannot be confirmed. A **key driver for labour productivity growth** based on gross production values per working hours is found to be related to the **intensity of intermediate inputs** such as energy, materials and services (the respective output elasticity is 0.84).

This high value might be attributable to the productivity enhancing of **outsourcing** of activities in the CRP industries. By focussing on the core competencies and outsourcing those activities where companies in this sector and in a particular country lack comparative advantages, they can improve their efficiency significantly. Restructuring business activities according to the make-or-buy decision suggested by Coase's theory of transaction costs (Coase 1937) can contribute significantly to productivity growth in the CRP industries. This aspect has been neglected in studies which exclude intermediate inputs from their analysis.

Finally, **no significant average annual rate** of technical progress for the common possibility frontier was found (see description of the approach in Annex II) for the CRP industries. This again is in contrast to the results of the growth accounting analysis presented in the previous section. However, in growth accounting, intermediate inputs had been omitted from the analysis; this may have shifted their highly significant impact towards the TFP-growth rate as a residual. In any case, intermediate inputs are a key driver for efficiency enhancing innovations in the chemicals industry. A more detailed analysis of this specific issue, where the impacts of the different components of

[124] *t*-values above 2 assure by a rule of thumb this 5%-signficance threshold of the test.

intermediate inputs on productivity growth in the CRP industries are disentangled, can be found in another Sectoral e-Business Watch study of 2008 on "ICT implications for energy efficiency".[125]

4.1.4 Summary: ICT impact on productivity growth

This section analysed by means of econometric tools to what extent ICT adoption (measured as ICT capital investments) contributes to growth of gross value added and productivity. The results indicate that ICT capital by itself is not the main element, but requires complementary investments and organisational innovation.

- Growth accounting for the CRP industries in 9 EU Member States suggests that the **key components of growth** in this sector (in terms of gross value added) are total factor productivity growth, growth in capital investments and changes in labour quality (i.e. a higher skilled workforce).
- **Non-ICT-capital** investments contributed to a higher extent to value added growth in the CRP industries than those in ICT-capital, although ICT-capital also contributed positively in most of the nine Member States.
- However, ICT can be embedded in other infrastructure, for example in the complex equipment of chemical plants. Thus, there is probably a "**hidden ICT-impact**" which cannot be measured by means of the data on ICT-investment available in the database.
- A key driver for **labour productivity growth** (measured as gross production value per working hours) is found to be related to the **intermediate inputs** intensity.
- No significant average annual rate of technical progress towards the estimated possibility frontier was found: this implies that the **time lag** between ICT investment and visible impacts on productivity can be considerable.

These observations have implications for policy. They suggest that **investments in training and skill-formation** are at least equally important as investments in ICT capital themselves in order to realise the optimal benefits. In other words, in a knowledge economy driven by rapid technical change, the ability to empower the work force is a necessary complementary measure to ICT adoption. Without having the right skills in place, costly investments bear the risk of becoming ineffective. Thus, revisiting the two initially specified **working hypotheses** (see Section 4.1.1), these cannot be confirmed:

[125] see www.ebusiness-watch.org.

No.	Hypotheses	Results	
P.1	ICT-capital investment has become a main element in value added and productivity growth in the in the CRP industry, while other capital inputs summarised as non-ICT-capital have diminished in their respective importance.	Cannot be confirmed. Growth accounting points at larger impact of non-ICT capital inputs; SPF analysis points at intermediate inputs as key drivers of labour productivity growth. ICT by itself is not the key driver of growth in this sector.	**no**
P.2	TFP growth in the CRP industries has accelerated together with increased investment in ICT-capital.	No significant average annual rate of technical progress for the common possibility frontier was found.	**no**
P.3	ICT has together with high- and medium-skilled labour positive impact on output growth.	Labour quality change from low-skilled towards medium- and high-skilled labour had a positive growth impact **à** indicates a skill-biased technological change with ICT-capital as its complementary factor driving growth of the CRP industries.	**(yes)**

With regard to Hypothesis P.1, there is **mixed evidence** On the one hand, growth accounting confirms that, on the whole, ICT-capital played an important role in this industry in all countries. On the other hand, the analysis based on a stochastic possibility frontier revealed that, due to greater detailed structure on the labour inputs decomposed on skill-classes and the inclusion of intermediate inputs, the direct positive link between ICT-capital investments and labour productivity growth is probably much weaker. Human capital inputs, organisational changes incorporated in the total factor productivity growth, outsourcing of non-core activities included in the intermediate inputs play a predominant role rather than pure ICT-capital growth.

With regard to Hypothesis P.2, there is some preliminary evidence concerning the time structure when TFP-growth accelerates. The standard approach in growth accounting typically assumes that TFP-growth instantaneously increases with increased investments in ICT-capital. This view raises caveats, however, as there may be a time lag between the initial investment and implementation of new technology (and the respective organisational changes) and their actual impact on TFP-growth.[126] This might partly explain the mixed results found in the EU-KLEMS database when comparing the changes between ICT-capital stock growth and TFP-growth across the sample of EU Member States for the two time periods 1980-1995 and 1995-2004 (see Exhibit 4.1-2). The hypothesis that there is an instantaneous impact of ICT-capital investments on total factor productivity growth has to be refuted on the basis of this empirical analysis.

Hypothesis P.3 was largely confirmed (see Section 4.1.3). The analysis indicates a skill-biased technological change with ICT-capital as the complementary factor driving growth of the CRP industries. However, it was also found that moderate labour quality changes are of secondary importance.

[126] This was confirmed, for example, for the telecommunication industry by an analysis on the J-curve of innovation (Erber 2005, Aral, Brynolfsson, Wu 2006).

4.2 ICT and innovation dynamics

4.2.1 ICT and Innovation activity in the CRP industries

The growing diffusion of ICT in all areas of business is a major enabler of technological change, innovation and thus –ultimately– economic development. ICT-driven innovation activity is central to the subsequent effects of ICT economic impact. ICT can have significant effects for downstream innovation in manufacturing. For example, product innovation in the plastics industry enables innovation in the automotive industry, if these products are used in cars. The links between the adoption of new e-business technologies and innovation are broadly recognised. ICT investments in general, and e-business applications in particular, enable and drive process innovation. They are drivers, because ICT implementation, to be successful, typically requires changes in working routines. In micro-economic terms, a product innovation corresponds to the generation of a new production function. A process innovation, on the other hand, can be viewed as an outward shift of an existing supply function, which corresponds to lower variable costs in the production of an existing product or service, and is therefore a productivity increase. Thus, ICT-driven technological change moves firms towards new technological trajectory.

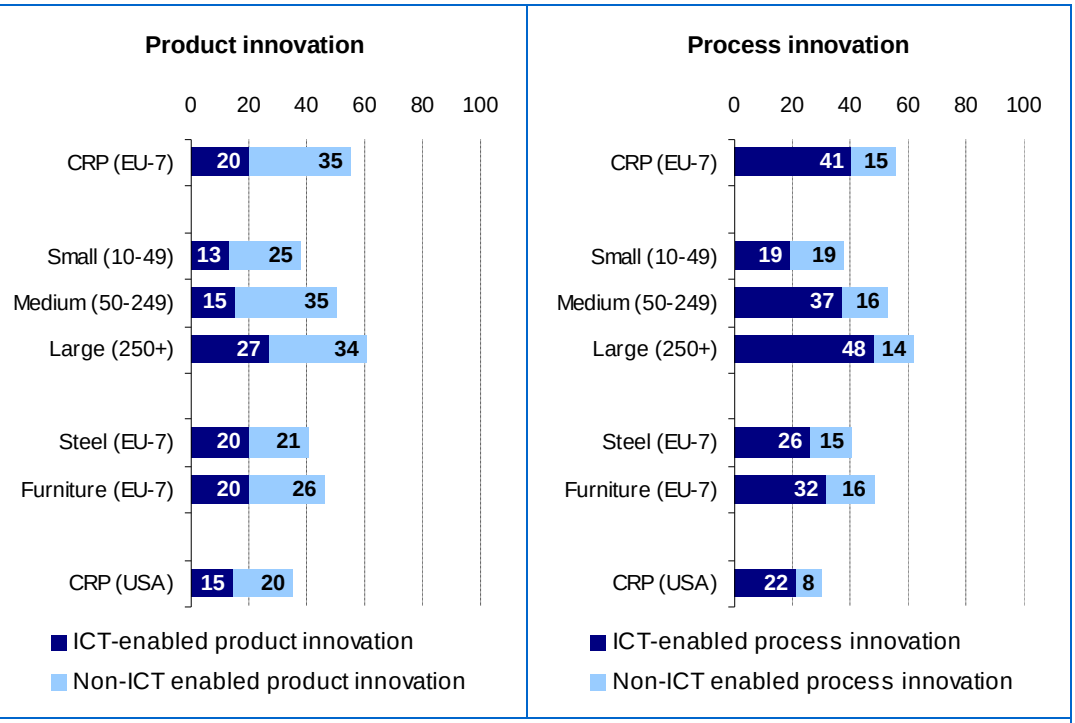
The capability for innovation is considered very important by European companies in the CRP industry in order to face global competition and to keep their position in higher market segments, which rely on differentiation and quality. In this competitive scenario, companies should have a strong incentive to use latest technology to innovate products, to enhance their quality and broaden the use of materials. Process innovation in the CRP industries is either centred on production processes, such as automated and computer-based manufacturing systems, or on supply chain processes.

To get some evidence on the role of ICT for innovation, the Sectoral e-Business Watch asked companies from the sectors studied in 2007 whether they had "launched any new or substantially improved products or services" during the 12 months prior to the interview, and if they had introduced "new or significantly improved internal processes" in the same period of time. Innovators were then asked follow-up questions whether their innovation(s) had been enabled by ICT. This question was not asked in the survey of 2003 (when the CRP industries were last covered), thus results are new for this sector. Results broadly confirm the picture found for most manufacturing industries. The majority of process innovations in the industry, according to the innovating companies, are linked with ICT usage. For product innovation, ICT matter as well, but to a lesser extent.

The role of ICT for product and process innovation in the CRP industries

Enterprises representing about 55% of sector employment in the CRP industries said that they had launched new (or improved) products in 2006/07. More than a third of those said that their product innovations had been directly related to or enabled by ICT (see Exhibit 4.2-1). This high share indicates the increasingly important role of ICT for product planning and manufacturing processes, in particular in larger enterprises. Nearly 30% of the sector's large companies said they had introduced ICT-enabled product innovation. Compared to the furniture and steel industry, more companies from the CRP industries have conducted product innovation; the surplus is in the area of non-ICT related innovations; the percentage of firms with ICT-related innovations is the same in all sectors. Thus, ICT appear to be relatively more important for product innovation in the other manufacturing sectors studied in 2007.

Exhibit 4.2-1: % of companies having introduced product/ process innovation (ICT enabled vs. non-ICT enabled, 2007)



The survey was conducted in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) and in the USA.
Base (100%) = companies with at least 10 employees. N (Chemical, EU-7) = 811.
Weighting: Figures for sector totals are weighted by employment ("firms representing x% of employment in the sector / country"), figures for size-bands in % of firms.

Source: e-Business Survey 2007 by the SeBW

It was a consistent finding in e-Business Watch sector studies that ICT play a **crucial role** to support process innovation, in manufacturing as well as in service industries. This can be confirmed for the CRP industries: out of all companies that said they had introduced new or significantly improved processes, more than 70% (by their share of employment) said that the new processes are enabled by ICT. However, within the sector, the picture for small companies differs from the one for medium-sized and large firms: in small firms, "only" about 50% of companies reported that their process innovation(s) were ICT-enabled. In medium-sized firms, the share was about 70%, in large firms even 80%. This is evidence for the relatively higher importance of ICT for planning and managing business processes in larger companies.

In a **cross-sectoral comparison**, the share of ICT-enabled process innovation is broadly in line with findings for other manufacturing sectors. Exhibit 4.2-2 shows that results for various sectors studied by e-Business Watch over the past 3 years are fairly consistent. The role of ICT for process innovation was found to be most important in the publishing and automotive industries. Differences are more pronounced for product innovation, obviously depending on the nature of the goods and services produced. Notably in service industries such as telecommunications and transport and logistics, ICT is essential for the development of new products/services.

Exhibit 4.2-2: Cross-sectoral comparison: percentage of product / process innovations that are ICT-enabled

Sector	Product innovation: % ICT-linked		Process innovation: % ICT-linked		Year of survey*
Manufacturing					
Chemical, rubber, plastics	36%	~ ~	73%	~ ~ ~	2007
Food	15%	~	62%	~ ~ ~	2006
Pulp and paper	34%	~ ~	59%	~ ~ ~	2006
ICT manufacturing	54%	~ ~ ~	70%	~ ~ ~	2006
Steel	48%	~ ~	64%	~ ~ ~	2007
Furniture	44%	~ ~	67%	~ ~ ~	2007
Automotive	21%	~	86%	~ ~ ~ ~	2005
Pharmaceutical	18%	~	72%	~ ~ ~	2005
Machinery & equipment	25%	~	66%	~ ~ ~	2005
Publishing	65%	~ ~ ~	83%	~ ~ ~ ~	2005
Retail and services					
Retail	70%	~ ~ ~	81%	~ ~ ~ ~	2007
Transport and logistics	76%	~ ~ ~ ~	75%	~ ~ ~	2007
Telecommunications	86%	~ ~ ~ ~	92%	~ ~ ~ ~	2006

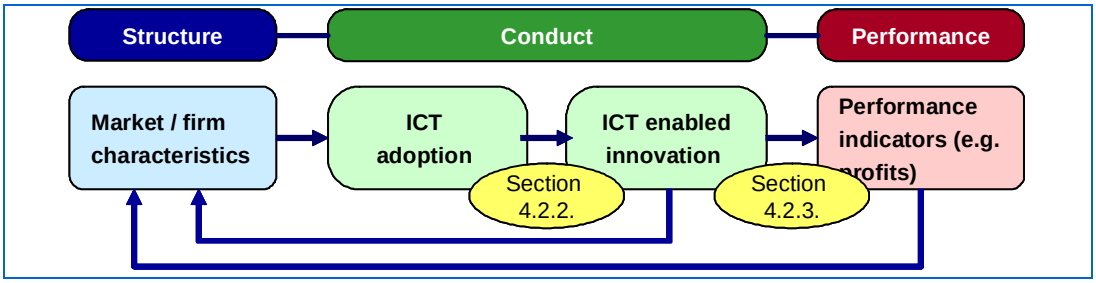
* Surveys of 2005 and 2006 include micro-firms with up to 9 employees

Data weighted by employment. Reading example: "Out of those companies in the food industry which said they had introduced new or significantly improved internal processes in the past 12 months, 62% said that at least some of these process innovations were enabled by ICT."

Source: e-Business Surveys 2005, 2006 and 2007 by the SeBW

The **case studies** in this report provide examples how organisational changes and process innovation are intertwined with ICT deployment. In these cases, the introduction of a new ICT system is the core element of the innovation process. However, this does not mean that the ICT system is a goal in itself; it was selected and implemented to enable organisational improvements, such as more efficient business processes and better transparency. The case study on Unicorn Ltd. (see Section 5.4) shows how process innovation can depend on ICT infrastructure even in small firms: the company replaced its former accounting system with a new business management software because the old system was unsuitable to provide the information which was needed for more efficient purchasing and inventory planning.

The following sections offer further insights to what degree specific factors are linked with ICT-enabled innovation in the CRP industries (Section 4.2.2), and whether companies which conduct ICT-enabled innovation are likely to exhibit superior performance (4.2.3). In the Structure-Conduct-Performance framework (see introduction to this section), this analysis explores links between ICT adoption and ICT-enabled innovation, links between innovation and performance.



4.2.2 Links between skills, e-collaboration and ICT-enabled innovation

This section explores how the following two factors are linked with the degree of ICT-enabled innovation in a company.

- the **skills composition** of a company (measured as the percentage of employees with a college or university degree
- the use of **e-collaboration tools** (such as SCM or other applications to share information about inventory levels with business partners) to share data with business partners

The analysis is conducted at the micro-level, using data from the e-Business Watch Survey 2007.

Internal capacity and ICT-enabled innovation

Knowledge stock and skills are the basis of a firm's absorptive capacity to adopt new technologies (Cohen and Levinthal, 1989). This, in turn, can have a positive impact on a firm's innovation performance. Thus, in order to develop marketable products or feasible production processes based on GPT, a firm needs to build up its knowledge stock and expertise, i.e. complementary assets. The most obvious example of investments in complementary assets include investments in software, training and organisational transformations that accompany ICT investments. In other words, firms that are able to combine a high level of ICT endowment with a highly skilled workforce are likely to achieve superior innovation performance.

The case study on process and organisational innovation at Zachem (linked with the implementation of an ERP system) illustrates the critical importance of skills for successfully introducing innovations. In retrospect, the company says that the main cost for introducing the new system "*was caused by the lack of knowledge and expertise*" (see Section 5.9). Nearly 300 employees had to go through extensive training programmes. However, the company believes that this accrued knowledge would help them now to carry out a similar project much more efficiently.

It is difficult to empirically test the relationship between skills and innovation performance, mainly because the knowledge stock or skills of a company cannot easily be quantified[127] and pressed into mathematical models. Hypothesis I.1 uses the percentage of employees with a university degree as a crude proxy, acknowledging that this variable is not fully satisfactory for the construct to be represented.

Hypothesis I.1: Firms characterised by a higher share of employees with a college or university degree are more likely to conduct ICT-enabled innovations in comparison with their peer-group in the same sector.[128]

[127] It would be extremely difficult to obtain better measures from a telephone survey, as there is no easy way to directly measure the knowledge stock in a standardised way.

[128] The hypothesis has been tested on the basis of data from the e-Business Survey 2007, using the following variables:

- Question D2: "Have any of these product or service innovations been directly related to or enabled by information or communication technology?" (asked to companies having introduced new products / services)

In order to focus the analysis only on ICT-enabled innovations, a dummy variable was constructed out of the companies' answers to the questions on whether their product or service innovations introduced by a company in the last 12 months were directly related or enabled by information or communication technology. It takes a value of "1" if any product or process innovations were directly related to or enabled by ICT, and "0" otherwise. The main explanatory variable is the share of employees with a college or university degree. To additionally account for the effect of internal capacity on innovation, a variable controlling for the presence of ICT practitioners was added. This should control for the effect of ICT-specific skills on a company's innovative potential. Furthermore, the model includes also variables controlling for firm size, age and country of origin. Except for the variable on the share of educated employees, all independent variables are dummy variables, taking a value of "1" if a specific characteristic is identified, and "0" otherwise.

To analyse the relationship between ICT-enabled innovation and the share of employees with a university degree, a probit regression was run.[129] Exhibit 4.2-3 shows the results of the regression which lead to the following conclusions:[130]

- **Specific rather than general skills matter**: Changes in the share of employees with a college or university degree do not affect the likelihood of conducting ICT-enabled innovations. In contrast, employing ICT practitioners significantly increases a firm's propensity to use ICT to develop new products and services. This finding supports the view that the success of the ICT-driven innovative process is linked with the availability and quality of the a highly-skilled workforce.
- **Firm size is an advantage**: Whereas firm age is not significantly linked with the incidence of conducting ICT-enables innovations, being a smaller company is negatively correlated with conducting innovations. However, this is to be expected, as a larger scale of operations implies a higher likelihood that at least one new product or new process is introduced during any given time period (compared to a smaller firm). In addition, large firms can exploit economies of scale or scope also when it comes to overcoming barriers to innovation.

- Question D4: "Have any of these process innovations been directly related to or enabled by information or communication technology?" (asked to companies having introduced new processes)
- Question G11: "Please estimate the percentage share of employees with a college or university degree in your company."
- Question E1: "Does your company currently employ ICT practitioners?"

[129] Probit regressions are used to estimate the effect of a set of explanatory variables on a dependent variable that only takes on values of 0 or 1 (binary indicator variable).

[130] Coefficient estimates indicate how changes of dependent variables influence the dependent variable. The estimation results do not allow for conclusions about the direction of causality, mainly because the dependent and the independent variables are reported for the same time period.

Exhibit 4.2-3: Links between skills variables and ICT-enabled innovation activity

Independent variable [a]	Coefficient	Standard Error
% of employees with higher university degree (G11)	0.002	0.003
Firm employs ICT practitioners (E1)	0.678***	0.109
Firm has <249 employees (Z2b)	-0.347*	0.195
Firm founded before 1998 (G2)	0.059	0.118
Model diagnostics		
N =797		
R-squared = 0.10		
Note: Probit estimates. Reference groups: firms with >250 employees (reference group for firms with <249 employees), firms founded after 1998 (for firms founded before 1998) [a] Codes in brackets refer to questions in e-Business Survey 2007. Dependent variables: D2 and D4 Significance levels: * 90%, ** 95%, *** 99%. Coefficients with no asterisk indicate no relationship.		

Source: Sectoral e-Business Watch, DIW Berlin (2008)

Intra and inter-firm collaboration and ICT-enabled innovation

ICT has a direct impact on process innovation in an organisational setting by facilitating inter-organisational links. This holds true in particular for manufacturing sectors such as the CRP industries (see Section 4.2.1 above). ICT-enabled inter-organisational integration and collaboration beyond the company's value chain enhance the innovation capabilities by providing opportunities for shared learning, transfer of technical knowledge and resource exchange. The most obvious benefit of information integration with the help of ICT is the optimisation of the supply chain that eliminates the bullwhip effect. Other, less obvious consequences for firms' innovativeness include creating communication infrastructures facilitating production networks or enabling partners to align the incentives of multiple players by creating joint business units or teams managing the same tasks (McAfee, 2006).

The case study on Toly Products (see Section 5.7) illustrates how ICT facilitate knowledge sharing between locally separated units of a producer of plastics products. Toly used CRM to tackle the problem that dealing with multiple sales offices (notably comparative reporting between business units) was time-consuming and cumbersome. They figured out the following scenario: If users could share, use and rely on a central system, administrative effort could be reduced and management reporting improved.

On the basis of these considerations, the following hypothesis is proposed and tested on the basis of data from the e-Business Survey 2007.[131]

[131] The following variable have been used to test the hypothesis:

- Dependent variable: Question D2: "Have any of these product or service innovations been directly related to or enabled by information or communication technology?" (asked to companies having introduced new products / services)
- Independent variables: Question D4: "Have any of these process innovations been directly related to or enabled by information or communication technology?" (asked to companies having introduced new processes); Question B9: "Does your company share information on inventory levels or production plans electronically with business partners?"; Question A7: "Does your company use a Supply Chain Management system?"; Question B10: "Does your company use software applications other than e-mail to collaborate with business partners in the design of new products or services?"

Hypothesis I.2: Firms that use ICT applications to exchange information or collaborate with business partners are more likely to introduce ICT enabled innovations, compared with their peer-group in the same sector.

Again, the analysis focuses only on ICT-enabled innovations. Independent variables control for the use of SCM systems, applications to collaborate with business partners in the design of new products or services, and sharing information on inventory levels electronically with business partners (for survey questions, see footnote). The regression includes also variables controlling for firm size, age and country of origin. All independent variables are dummy variables, taking a value of "1" if a specific characteristic is identified, and "0" otherwise. To analyse the relationship between ICT-enabled innovation and the use of electronic data and information exchange between business partners, a probit regression was run. Exhibit 4.2-4 shows the results of the regression which lead to the following conclusions:

- **e-Collaboration is positively correlated with innovative output**: The use of applications and practices supporting the electronic exchange of information between companies is positively linked with the likelihood of conducting ICT-enabled innovations. Out of the three variables tested, the use of applications to collaborate with business partners in the design of new products or services has the strongest correlation with a firm's propensity to introduce ICT-enabled innovations. Usage of SCM software (see Section 3.3) is also positively correlated.
- **Firm size matters**: Again, the age of a company does not have any implications for conducting ICT-enables innovations, while size does: small firm size negatively affects the likelihood of conducting such innovations.

Exhibit 4.2-4: Effect of electronic collaboration with business partners on ICT-enabled innovation activity

Independent variable [a]	**Coefficient**	**Standard Error**
Use of SCM (A7)	0.345***	0.108
Share information electronically (B9)	0.291**	0.122
Applications to collaborate (B10)	0.481***	0.119
Firm has <249 employees (Z2b)	-0.400**	0.168
Firm founded before 1998 (G2)	0.132	0.107
Model diagnostics		
N =910		
R-squared = 0.06		
Note: Probit estimates. Reference groups: firms with >250 employees (reference group for firms with <249 employees), firms founded after 1998 (for firms founded before 1998). [a] Codes in brackets refer to questions in e-Business Survey 2007. Dependent variables: D2 and D4 Significance levels: * 90%, ** 95%, *** 99%. Coefficients with no asterisk indicate no relationship.		

Source: Sectoral e-Business Watch, DIW Berlin (2008)

4.2.3 ICT-enabled innovation and firm performance

Studies on the effect of ICT on corporate performance come to different conclusions; not all studies find clear payoffs from ICT investments (Chan, 2000, Kohli and Devaraj, 2003). One of the reasons is that results vary depending on how performance and ICT payoffs are measured and analysed. For example, Brynjolfsson and Hitt (1996) find positive impacts of ICT investments on productivity, but not on profits. Prasad and Harker (1997) did not find positive effects of ICT capital on productivity, while ICT labour positively contributed to output and profitability.

These somewhat ambiguous results of the impact of ICT on corporate performance can be explained if the simplistic assumption of a direct link between ICT investments and corporate performance is dropped. The key to understanding the impacts of ICT on performance is probably to view ICT as an enabler of innovation (Koellinger 2005).

Indeed, Clayton and Waldron (2003), in a study on e-commerce adoption and business impact, find that businesses maintaining higher levels of new and improved product sales relative to turnover achieve above sector average rates of sales growth, i.e. they increase market share. The effect is present in both manufacturing and service sectors.

Most of the case studies conducted for this report also indicate that ICT is a critical enabler of innovation in the CRP industries, notably for process innovation, with mostly positive effects on firm performance in various respects. For example, Probos reports that the number of new customers has increased by about 8% since the company had introduced a new system for customer relationship management (see Section 5.7).

Based on these considerations, the following hypothesis was specified and tested on the basis of data from the e-Business Survey 2007:[132]

Hypothesis I.3: ICT-enabled innovations are correlated with a firm's turnover.

The analysis focuses only on whether and how ICT-enabled innovations affect firms' performance. The dependent variable is a dummy variable that takes a value "1" if a firm reported a turnover increase in the last 12 months or "0" otherwise. Explanatory variables control for the introduction of any ICT-enabled innovations in the same time period, firm size, age and country of origin. All independent variables are dummy variables, taking a value of "1" if a specific characteristic is identified, and "0" otherwise. To analyse the relationship between a firm's turnover change and ICT-enabled innovation activity, a probit regression was run. Exhibit 4.2-5 shows the results of the regression which lead to the following conclusions:

- **ICT-enabled output is positively linked with turnover increase**: Firms with a higher incidence of ICT-enabled innovation activity are more likely to report a turnover increase, i.e. to have experienced a sales growth. Although turnover

[132] The following variables have been used to test the hypothesis:

- Question G9: "Has the turnover of your company increased, decreased or stayed roughly the same when comparing the last financial year with the year before?"
- Question D2: "Have any of these product or service innovations been directly related to or enabled by information or communication technology?" (asked to companies having introduced new products / services)
- Question D4: "Have any of these process innovations been directly related to or enabled by information or communication technology?" (asked to companies having introduced new processes).

increase was used as dependant variable, this should not be read as a simple formula for success ("the more ICT-enabled innovation, the more turnover a firm will have"), as there are possible confounding factors[133] such as growth of a company in general. A similar result might also have been obtained by exchanging the dependent and independent variables, in the sense that successful companies (i.e. firms experiencing turnover growth) are more innovative. In any case, the results indicate that the dynamics of business growth and innovativeness are strongly linked, possibly reinforcing each other.

- **Firm size and age irrelevant for positive turnover development**: Firm age and size do not have any implications for positive turnover change.

Exhibit 4.2-5: Effect of ICT-enabled innovation activity on turnover increase

Independent variable [a]	Coefficient	Standard Error
ICT enabled innovation (D2, D4)	0.252***	0.094
Firms with <249 employees (Z2b)	0.063	0.171
Firm founded before 1998 (G2)	0.130	0.102
Model diagnostics		
N = 910		
R-squared = 0.10		
Note: Probit estimates. Reference groups: firms with >250 employees (reference group for firms with <249 employees), firms founded after 1998 (for firms founded before 1998). [a] Codes in brackets refer to questions in e-Business Survey 2007. Dependent variable: G9 Significance levels: * 90%, ** 95%, *** 99%. Coefficients with no asterisk indicate no relationship.		

Source: Sectoral e-Business Watch, DIW Berlin (2008)

Links between ICT adoption and organisational change

In order to enable innovation –and ultimately better performance– ICT adoption will normally lead to changes in a company's organisation, for example in structure of a company's departments and functions and in the processes between them. Organisational innovation may include the rearrangement of arrangements and workflows, and may have implications for the importance of departments and employees working in them. Outsourcing also implies organisational changes (see Section 4.3.3).

ICT transformed the process of replicating business innovations across organisations (Brynjolfsson et al., 2006). Traditionally, deploying business innovation on a larger scale took time and required considerable involvement of resources and employees. Today, ICT enables companies to embed business innovations and then implement them across the organisation at a smaller cost than before without compromising on quality. Every location or unit implements and follows all steps of the new process in a way specified in the software design.

The "copy-exactly strategy" is particularly beneficial if the initial understanding of the process is low, the lifecycle is short and the process is difficult to improve (Terwiesch and

[133] Regression analysis is a technique used for the modelling and analysis of data, assuming that one variable is dependent upon another single independent variable (simple regression) or several independent variables (multiple regression). Although regression can be used for the modelling of causal relationships, one must be very cautious in drawing conclusions regarding causality, because there is typically a broad range of potential non-causal explanations of links between variables. In statistics, this is referred to as "confounding", i.e. a confounding variable is associated with both the assumed cause (independent variable) and the assumed outcome (dependent variable).

Xu, 2004). This holds true for manufacturing industries with rapidly changing production technologies and intensive technological competition. In traditional manufacturing sector such as the CRP industries, direct links between ICT usage and substantial organisational changes is often centred on the introduction of an ERP system. The decision to use these systems tends to go hand in hand with a critical review of existing business processes, their redesign and the necessary organisational changes. In fact, the need for organisational restructuring and the realisation that the company needs to improve its information management systems are often interconnected (as an example, see case study about Zachem in this report).

On the basis of these considerations, the following hypothesis is proposed and tested on the basis of data from the e-Business Survey 2007:

Hypothesis I.4: ICT use is positively correlated with organisational changes.

The dependent variable controlling for organisational changes is based on companies' answers to four questions of whether they introduced changes

(i) in their corporate strategy,

(ii) the management techniques,

(iii) the organisational structure and / or

(iv) (iv) in their marketing concepts in the past 12 months prior to the interview.[134]

For each positive answer a firm scores one point. Consequently, the dependent variable takes a value between "0", if a company did not carry out any of the listed changes, and "4" if it undertook all of them. In order to account for various effects of different ICT components on organisations, the following explanatory variables were introduced:

- An **infrastructure endowment index** that comprises of hardware components used by a firm and includes the share of employees with an internet access at their workplace, internet connection capacity and the use of LAN, Intranet and Extranet.
- A **software endowment index** that comprises of software applications used by a firm. The index includes the following applications: a software application to manage the placing or receipt of orders, ERM, SCM, CRM and the use of the internet to buy and sell goods.
- An ICT **human capital** variable that controls for the presence of ICT practitioners in the company.

In addition, the regression includes dummy variables controlling for the percentage of employees with a higher university degree, firm size, age and country of origin. To analyse the relationship between ICT-enabled innovation and the use of electronic data and information exchange between business partners, an ordered logit regression was run.[135] Exhibit 4.2-6 shows the results of the regression which lead to the following conclusions:

- **ICT hardware is not linked with organisational changes**: Hardware endowment, measured in terms of network infrastructure usage and internet access, is not correlated with the likelihood of introducing organisational changes.

[134] Questions D5a-d of the questionnaire.

[135] Similar to probit/logit regressions, ordered logit model is used when the dependent variable is ordinal. In contrast, however, to probit/logit an ordered logit model can be applied if the dependent variable has more than two levels.

- **Software use goes hand in hand with organisational changes**: The use of software applications for e-business is strongly linked with a firm's incidence of introducing organisational changes. Simply speaking, the more e-business software systems a company is using, the higher is the incidence of organisational innovation of the types described above. Again, it is not possible to establish a simple causality; the regression analysis just confirms the positive links between these characteristics of a company.

A possible reading of this evidence is that ICT software and hardware may have different implications for companies' conduct and performance. Whereas hardware is a necessary condition for an efficient ICT use, it is not a sufficient condition for business transformation. It is rather innovative software that enables firms to rearrange their operations, functions and workflows, i.e. find innovative ways of doing business. Hardware infrastructure, in contrast, is in many cases already a commodity that does not offer companies much potential to create a competitive advantage anymore.[136]

Exhibit 4.2-6: ICT use and organisational change

Independent variable [a]	**Coefficient**	**Standard Error**
Infrastructure index (A2, A3, A4)	0.001	0.003
Software index (A6, A7, B1, B3)	0.389***	0.059
IT practitioners (E1)	0.093	0.176
% of employees with higher university degree (G11)	0.006	0.005
<249 employees (G2)	0.361	0.313
Firm founded before 1998 (Z2b)	-0.047	0.178
Model diagnostics		
N = 673		
R-squared = 0.04		

Note: Ordered probit estimates. Reference groups: firms with >250 employees (reference group for firms with <249 employees), firms founded after 1998 (for firms founded before 1998).
[a] Codes in brackets refer to questions in e-Business Survey 2007. Dependent variable: D5
Significance levels: * 90%, ** 95%, *** 99%. Coefficients with no asterisk indicate no relationship.

Source: Sectoral e-Business Watch, DIW Berlin (2008)

[136] The discussion whether ICT can still create competitive advantage has been intensively led in recent years, triggered by a provocative article by Nicholas Carr (2003) in the Harvard Business Review ("IT Doesn't Matter").

4.2.4 Summary: ICT and innovation dynamics

Links between the adoption of new e-business technologies and innovation dynamics are broadly recognised. ICT play a crucial role in particular to support process innovation in the CRP industries. According to the Sectoral e-Business Watch survey, out of all companies that had introduced new or significantly improved processes within a period of 12 months prior to the interview, more than 70% (by their share of employment) said that these new processes were enabled by ICT. Case studies in this report (e.g. Unicorn, Zachem) demonstrate that the introduction of new ICT systems often triggers innovation processes, e.g. organisational and/or process innovation.

A regression analysis how specific factors are linked with innovation activity found the following evidence:

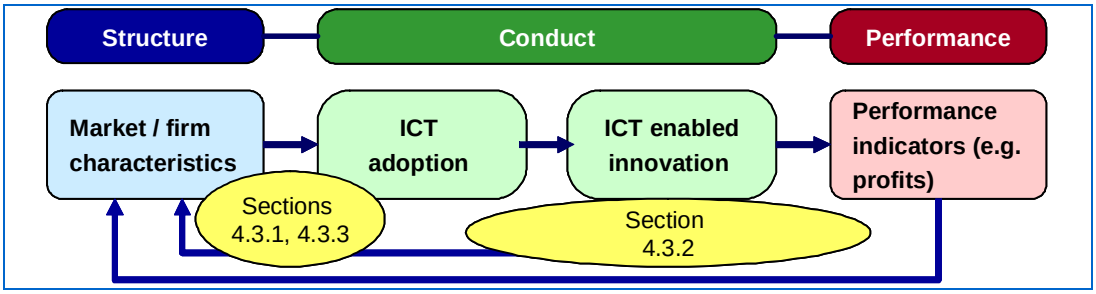
- **ICT skills matter for innovation**: companies that employ ICT practitioners were found to be more likely to introduce ICT-enabled innovations.
- **e-Collaboration is positively correlated with innovative output**: The use of ICT applications and practices that support the electronic exchange of information between companies is positively linked with the likelihood of conducting ICT-enabled innovations.
- **Links between ICT adoption and organisational change**: While ICT hardware endowment (measured in terms of network infrastructure usage and internet access) is not correlated with the likelihood of introducing organisational changes, the use of software applications for e-business is highly correlated.
- **ICT-enabled innovation correlates positively with turnover increase**: Firms with a higher incidence of ICT-enabled innovation activity are more likely to report a turnover increase, i.e. to have experienced a sales growth. This finding does not claim to establish a direct causality, though.

4.3 ICT, rivalry in the market and outsourcing

This section explores to what extent the deployment of ICT is linked with competition in the market, the development of a company's share in this market, and firms' propensity towards outsourcing . More specifically, the following questions are studied:

1. How do companies perceive the impact of ICT on competition?
2. Does the intensity of competition, notably a perceived increase in the market rivalry, constitute an incentive to adopt ICT (as a tool to withstand competitive pressure, e.g. by cutting costs)?
3. Are companies that use ICT more intensively also more likely to experience market share?
4. Does a higher level of ICT endowment have an impact on a firm's "make or buy" decisions by facilitating the outsourcing of business processes?

In the SCP framework, these questions concern the relationship between market structure (market rivalry) and ICT adoption, as well as possible links between ICT adoption and performance, if market share is taken as a measure of performance.



4.3.1 Market structure as a determinant of ICT diffusion

Increasing rivalry in the market could be expected to be important factor that drives the adoption of new technologies and innovation, because more intense competition drives companies to search for opportunities to cut costs. Moreover, firms aim to escape competition by innovating. Successful innovation protected from imitating by means of a patent, a trademark, or a copyright enables companies to secure or increase their share of the market or even to become the market leader. By being the first in the market, a firm may secure an unchallenged position by building up the necessary capacity to enjoy substantial economies of scale, or strategic know-how. Rivalry in the CRP industries is increasing, mainly due to rising competition from emerging markets in Asia and Latin America. Companies are forced to cut costs, even if European companies will not be able to compete with producers in cheap-labour countries purely on a cost basis. Based on these considerations, the following hypothesis is proposed:

Hypothesis M.1: Increasing rivalry in the market is a driver for the adoption of e-business software systems in the chemical, rubber and plastics industries.[137]

[137] The hypothesis has been tested on the basis of data from the e-Business Survey 2007, using the following variables:

- Question G8a: "Please describe the type of competition in your main market. Do you agree that rivalry in the market is increasing?"

The dependent variable accounting for the intensity of the ICT usage is a sum of answers to 14 questions about the use of network and software applications (see footnote). Thus, the variable can take values between "0" (if a company uses none of the applications) and "14" (if all applications are used). The independent variable indicates whether the rivalry in a firm's market increased in the last 12 months or not and takes a value "1" or "0" respectively, based on the company's perception of the market. In addition, the regression includes dummy variables controlling for firm size, age and country of origin.

To analyse the relationship between market rivalry and ICT adoption intensity, an ordinary least-squares regression was run. Exhibit 4.3-1 shows the results of the regression which lead to the following conclusions:

No significant correlation – hypothesis not confirmed: The hypothesised relevance of a (perceived) increasing market rivalry for ICT adoption could not be confirmed. It has to be taken into account that the index of ICT adoption represents the status-quo at a certain point of time, while the perceived increase in market rivalry describes a process. Thus, if ICT adoption is seen as a reaction to increased rivalry, there is an issue of a potential time lag between the developments in the market and the actual ICT adoption in companies (as a means to address the new challenges). Companies that experience an increase in competition may need a few years to actually upgrade their ICT infrastructure. In the medium and long term, market pressure may well be a strong incentive for ICT adoption. Such longer-term impacts were not (statistically) analysed as part of this study.

Exhibit 4.3-1: Market rivalry and the intensity of ICT use

Independent variable [a]	**Coefficient**	**Standard Error**
Increasing rivalry (G8a)	0.202	0.246
Firm has <249 employees (Z2b)	-2.233***	0.436
Firm founded before 1998 (G2)	-0.388	0.267
Model diagnostics		
N = 910		
R-squared = 0.08		
Note: OLS regression. [a] Codes in brackets refer to questions in e-Business Survey 2007. Dependent variables (index): A2, A3, A4, A6, A7, B1 and B3. Significance levels: * 90%, ** 95%, *** 99%. Coefficients with no asterisk indicate no relationship.		

Source: Sectoral e-Business Watch, DIW Berlin (2008)

The case study on Medikémia (Section 6.4) is an example where the market share has not significantly been increased by introducing e-business. However, the company argues that ICT-based innovation and e-business are nevertheless essential for coping with new market challenges and, ultimately, surviving.

- Index on ICT endowment, based on 14 component indicators on ICT usage: internet connection type (score between 1 and 4), the use of LAN, WLAN, WWW, Intranet, Extranet, ERM, SCM, CRM, the use of the internet to sell and buy goods and employing IT practitioners (one score for each positive answer).

4.3.2 ICT impact on market structure

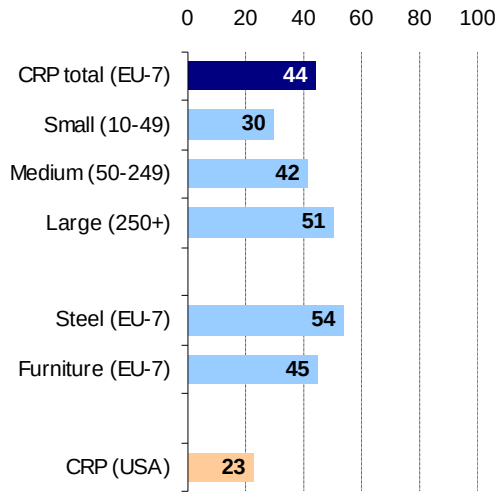
Historically, distance to market and transportation cost limited the number of customers a firm could reach. With the emergence of the internet in business in the 1990s, a common believe was that ICT and e-commerce would significantly reduce the limitations of location by enabling firms to expand nearly regardless of geographical locations (see, for example, Cairncross 1997). Although the impact of this potential has possibly been overestimated during the height of the new economy, It is still widely recognised that e-commerce enables existing firms (and in particular SMEs) to expand their market reach which they would not have without the internet.

However, there is also the other side of the coin. The digitisation of distribution channels and products or product components has facilitated "business migration", i.e. companies are not only expanding geographically into new markets, but also into new industries. Former sectoral boundaries are being blurred.[138] The entry of new players (be it from the same or other industries) has an impact on competition and can lead to changes in the market structure. In the following, both aspects are considered: first, the perceived general impact of ICT on competition in the sector; second, the links between a company's ICT usage and its own performance in the market.

How companies see the impact of ICT on competition in their sector

To get a feeling how companies themselves assess the role of ICT for the intensity of competition, the Sectoral e-Business Watch asked companies whether they believed that ICT had an impact on competition in their sector or not.

Exhibit 4.3-2: % of companies saying that ICT has an influence on competition in their sector



In total, about 45% of companies from the CRP sector (by their share of employment) believed in 2007 that ICT had an influence on competition. This is similar as in the other manufacturing sectors surveyed. The share increases by firm size from 30% of small companies to about 50% of large ones. European companies are more likely to state ICT-induced effects on competition than their US counterparts, were less than 25% say so. This is only a measure for the perception and not for the actual influence, though, which is not directly measurable.

Base (100%) = companies using computers in 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) / in the USA.. N = 811 (CRP, EU-7) / 100 (CRP, USA)

Weighting: Figures for sector totals and countries are weighted by employment ("firms representing x% of employment in the sector / country"), figures for size-bands in % of firms.

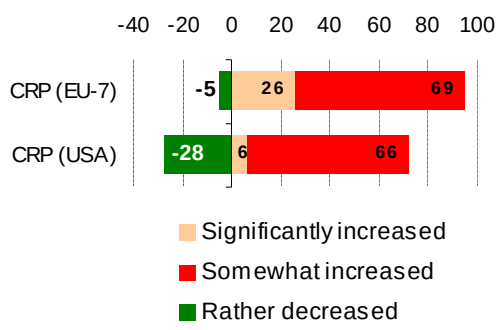
Source: e-Business Survey 2007 by the SeBW

Those firms that believed ICT had an impact on competition were then asked to assess to what extent competition had changed due to ICT. They were given three options to

[138] for instance in the converging media and telecommunications industries.

choose from: competition had "significantly increased" (due to ICT), "somewhat increased" or "rather decreased" (see Exhibit 4.3-3).

Exhibit 4.3-3: Perceived impact of ICT on competition: companies saying that competition has … due to ICT (2007)



The vast majority of firms in Europe (nearly 70%) say that competition has "somewhat increased" due to ICT, only about 25% say it has "significantly increased". While in Europe hardly any company feels that ICT has a decreasing effect on the intensity of competition, a higher share of US firms said so.[139] Otherwise, the pattern is similar – companies see a slight impact towards intensifying competition.

Base (100%) = companies saying that ICT has an impact on competition in their sector from 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) / in the USA.. N = 298 (EU-7) / 26 (USA)

Weighting: by employment ("firms representing x% of employment in the sector / country")

Source: e-Business Survey 2007 by the SeBW

In summary, these findings indicated that many companies in the CRP industries see ICT as one factor amongst others which drives competition in their sector. The following section explores whether intensive users of ICT is really more likely to experience growth of their market share.

ICT as a tool to support growth strategies

While ICT may in fact contribute to an increase in competition in the marketplace, it also presents a tool for individual companies to market their own services. Case studies in this report provide good evidence on the use of ICT for marketing purposes in the CRP industries. They confirm that there is no one-hat-fits-all approach, but that ICT usage has to be adapted to the business model. Large companies that trade with a multitude of customers and suppliers increasingly have to use different electronic channels in parallel, to comply with their various customers' requirements. The case studies of BASF and Elemica (see user examples within the case study) are clear proof of this trend and the importance of e-business for market growth. This is not to say that this goes without challenges. Highly specialised companies may experience difficulties in marketing their customised products through standardised sales platforms (see, for example, case study on Zandleven Coatings, Section 5.10). On the other hand, the good use of CRM technology can have positive effects on customer satisfaction and the number of customers (see case study on Probos in Section 5.6), which is normally a requirement for enabling market growth.

However, the use of ICT and e-business is only a tool to expand the market share or to enter new markets; there are many other factors that have an influence whether a company is successful in attracting new customers. This makes it difficult to establish a simple model for testing the impact of ICT. In order to get at least some empirical

[139] This results is based on only 26 observations and should therefore be used with caution.

evidence on whether ICT usage helps companies to grow their market share, the following hypothesis is proposed:

Hypothesis M.2: Companies that use more ICT than others are more likely to report an increase in their market share.[140]

This hypothesis does not claim to establish a simple causality in the sense that ICT endowment automatically leads to an increase in the market share. It just tests whether a statistically significant link can be established between the level of ICT adoption and the perceived market share development. To put it simply, the question is whether companies that feel they are growing (in terms of their market share) use more ICT than those that do not.[141]

The dependent variable accounting for the change of a firm's market share can accordingly take one out of three values, depending on : "0", if the market share decreased, "1" if the market share stayed the same or "2", if the market share increased in the last 12 months. The dependent variable controlling for the intensity of the ICT usage is a sum of answers to 14 questions about the use of network and software applications (see footnote). Thus, the variable can take values between "0" (if a company uses none of the applications) and "14" (if all applications are used). In addition, the regression includes also dummy variables controlling for firm size, age and country of origin. To analyse the relationship between the change in market share and ICT endowment, an ordered logit regression was run. Exhibit 4.3-4 shows the results of the regression which lead to the following conclusions:

- **Expanding firms use more ICT**: Hypothesis M.2 was confirmed. Although a direct causality should not be established, the pattern that companies in the CRP industry reporting a growth in market share happen to be more intensive users of ICT indicates at least that ICT is an important tool to achieve growth. A possible reading is that a company's success in the market and its ICT investments are driving and reinforcing each other.
- **Firm size and age are not correlated with the positive development of market share**: In contrast to other dependent variables such as innovation activity, and in contrast to ICT usage, firm size and age are not correlated with a positive change in market share.

[140] The hypothesis has been tested on the basis of data from the e-Business Survey 2007, using the following variables:

- Question G7: "Has the share of your company in this market increased, decreased, or stayed roughly the same over the past 12 months?"
- Index on ICT endowment, based on 14 component indicators on ICT usage: internet connection type (score between 1 and 4), the use of LAN, WLAN, WWW, Intranet, Extranet, ERM, SCM, CRM, the use of the internet to sell and buy goods and employing IT practitioners (one score for each positive answer).

[141] It is fully acknowledged that the concept of "market share" is highly complex. Ideally, the relevant market would have to be precisely specified in terms of products/services and in terms of the geographic scope ("which market"?). Since this issue was only one question in a telephone interview of 15-20 minutes, it was possible to engage in such a specific discussion with the interviewee. Thus, the question should rather be seen as a simple indication of whether a company feels it is growing and expanding (or not).

Exhibit 4.3-4: The intensity of ICT use and change in the market share

Independent variable [a]	Coefficient	Standard Error
ICT endowment (A2, A3, A4, A6, A7, B1, B3)	0.063***	0.020
Firm founded before 1998 (Z2b)	-0.270	0.174
< 249 employees (G2)	0.286	0.288
Model diagnostics		
N = 822		
R-squared = 0.03		
Note: Ordered probit estimates. Reference groups: firms with >250 employees (reference group for firms with <249 employees), firms founded after 1998 (for firms founded before 1998). [a] Codes in brackets refer to questions in e-Business Survey 2007. Dependent variable: G7 Significance levels: * 90%, ** 95%, *** 99%. Coefficients with no asterisk indicate no relationship.		

Source: Sectoral e-Business Watch, DIW Berlin (2008)

4.3.3 ICT deployment and outsourcing

Following transaction cost theory, decreasing costs of search, evaluation and monitoring of suppliers should benefit the establishment of marketplaces as a form of organising economic activity (Coase 1937, and Williamson, 1985). In fact, as part of the development of the information society in the late 1980s and 1990s, the expectations regarding the potential of ICT to introduce innovative ways of doing business, re-shaping firm boundaries and changing the constellations of value chains were enormous (see, for example, Johnston et al., 1988, Johnston et al., 1988a, Milgrom et al., 1990, Fulk et al., 1995). The availability of powerful and affordable ICT solutions was believed to increase the attractiveness of marketplaces (Malone et al., 1987 and Lucking-Reiley et al., 2001). However, in the CRP industries (as well as in other manufacturing sectors), 3rd party online marketplaces were less successful than anticipated; instead, a different business model emerged: service providers that specialise in providing a secure framework for B2B data exchanges, but not as "market makers" where buyers meet sellers (see Section 3.4 and case studies on Elemica and Acronis/OB 10). Companies outsource specific business processes (such as invoicing) to these service providers.

The focus on outsourcing was enhanced by strategic management approaches such as core competency (Hamel / Prahalad 1990) and BPO (Business Process Outsourcing) which became popular in the 1990s. ICT can be a facilitator of business process outsourcing. For example, specialised e-invoicing services providers (see case study on OB10 in this report) make use of the opportunities presented by ICT to develop new services to companies. In a way, they act as an agent for larger firms by facilitating the document exchange (in this case the invoicing process) between them and their many trading partners. The question arises whether companies with a more powerful ICT infrastructure are better positioned to gain from outsourcing. To test this, the following hypothesis is proposed:

Hypothesis M.3: Firms with a more powerful ICT infrastructure are more likely to outsource business activities.[142]

[142] The hypothesis has been tested on the basis of data from the e-Business Survey 2007, using the following variables:

The dependent variable can take a value "1" if a company outsourced any of its business activities in the last 12 months, or "0" if it did not (see footnote). The explanatory variable controlling for a company's ICT adoption level is an index that can take values between "0" and "14", depending on the number of ICT applications a company has adopted (see footnote). In addition, the regression includes dummy variables controlling for firm size, age and country of origin. To analyse the relationship between the change in market share and ICT endowment, a probit regression was run. Exhibit 4.3-5 shows the results of the regression which lead to the following conclusion:

- **ICT adoption is positively correlated with outsourcing**: The hypothesis was confirmed: companies with a more intensive use of ICT is more likely to have outsourced business activities in a period of 12 months prior to the interview. Again, as with other hypotheses in Sections 4.2 and 4.3, a simple causality should not be established. Still, since the regression analysis controlled for firm size,[143] the finding at least indicates some links between ICT usage and the propensity to outsource business activities. The facilitator function of ICT in the coordination with the external service providers is a possible and likely explanation.

Exhibit 4.3-5: The intensity of ICT use and outsourcing

Independent variable [a]	**Coefficient**	**Standard Error**
ICT endowment (A2, A3, A4, A6, A7, B1, B3)	0.060***	0.016
< 249 employees (G2)	-0.146	0.188
Firm founded before 1998 (Z2b)	0.125	0.126
Model diagnostics		
N = 910		
R-squared = 0.08		
Note: Probit estimates. Reference groups: firms with >250 employees (reference group for firms with <249 employees), firms founded after 1998 (for firms founded before 1998). [a] Codes in brackets refer to questions in e-Business Survey 2007. Dependent variable: G22 Significance levels: * 90%, ** 95%, *** 99%. Coefficients with no asterisk indicate no relationship.		

Source: Sectoral e-Business Watch, DIW Berlin (2008)

- Question G22: "Has your company outsourced any business activities in the past 12 months which were previously conducted in-house?"
- Index on ICT endowment, based on 14 component indicators on ICT usage: internet connection type (score between 1 and 4), the use of LAN, WLAN, WWW, Intranet, Extranet, ERM, SCM, CRM, the use of the internet to sell and buy goods and employing IT practitioners (one score for each positive answer).

[143] Otherwise, the result would simply be explained by company size, since large firms are more likely to outsource and have higher scores in the ICT endowment index.

4.3.4 Summary: ICT, rivalry in the market and outsourcing

Case studies in this report show clearly that ICT and e-business are becoming indispensable tools for market development and growth in the CRP industries, notably for large companies which operate in a global marketplace. On the other hand, the increase in competition in specific markets could be a major driver of ICT adoption, as companies are seeking opportunities to cut their operating costs to stay competitive. Although this assumption is a commonplace and reflects the findings of many case studies, it is difficult to prove by means of statistical analysis.

- **ICT adoption as a reaction to market pressure – no easy proof**: The assumption that a (perceived) increase in market rivalry triggers ICT adoption (as a measure to withstand the pressure) is difficult to verify by means of simple regression analysis. Companies from the CRP industries that experience an increasing intensity in market competition do not use more ICT than companies feeling that the degree of competition is stable. In the medium and long term, however, market pressure may well be a strong incentive for ICT adoption; such longer-term impacts could not be explored by means of analytical statistics here.
- **Perceived ICT impact on competition**: About 45% of companies (by share of employment) believe that ICT has an impact on competition in their sector. Most of them argue that competition has "somewhat increased" due to ICT.
- **Positive links between ICT usage and market growth**: Companies in the CRP industry reporting a growth in market share are typically more intensive users of ICT than firms with a stable or decreasing market share. This indicates that ICT is an important tool to achieve growth, even if a direct causality should not be established.
- **ICT adoption is positively correlated with outsourcing**: Companies with a more intensive use of ICT is more likely to have outsourced business activities in a period of 12 months prior to the interview. This indicates that ICT is a facilitator in the coordination with external service providers.

5 Case Studies

This chapter presents ten case studies of e-business activity in small, medium-sized and large companies from the CRP sector. The selection was made with the goal to achieve a balanced mix of cases in terms of countries, sub-sectors and company sizes, while at the same time linking the topics of case studies with the issues analysed in Chapters 3 and 4 of this report. Therefore, the selected cases are extremely heterogeneous in terms companies presented, ranging from the world's largest chemical company (BASF) with close to 100,000 employees worldwide down to a small manufacturer of lubricants with 15 employees (Unicorn). Still, there are common points even for the largest and smallest companies: ICT and e-business, if used in the right way, are key to managing information in today's economy. They help companies becoming more organised and controlled, whether it is about managing global operations or communicating with customers in the region.

Exhibit 5.0-1 provides an overview of the case studies, indicating the main ICT application areas studied and references to the sections in this report where the respective topic is dealt with. Cases (both in the overview and the subsequent sections of this chapter) are sorted alphabetically by the company name.

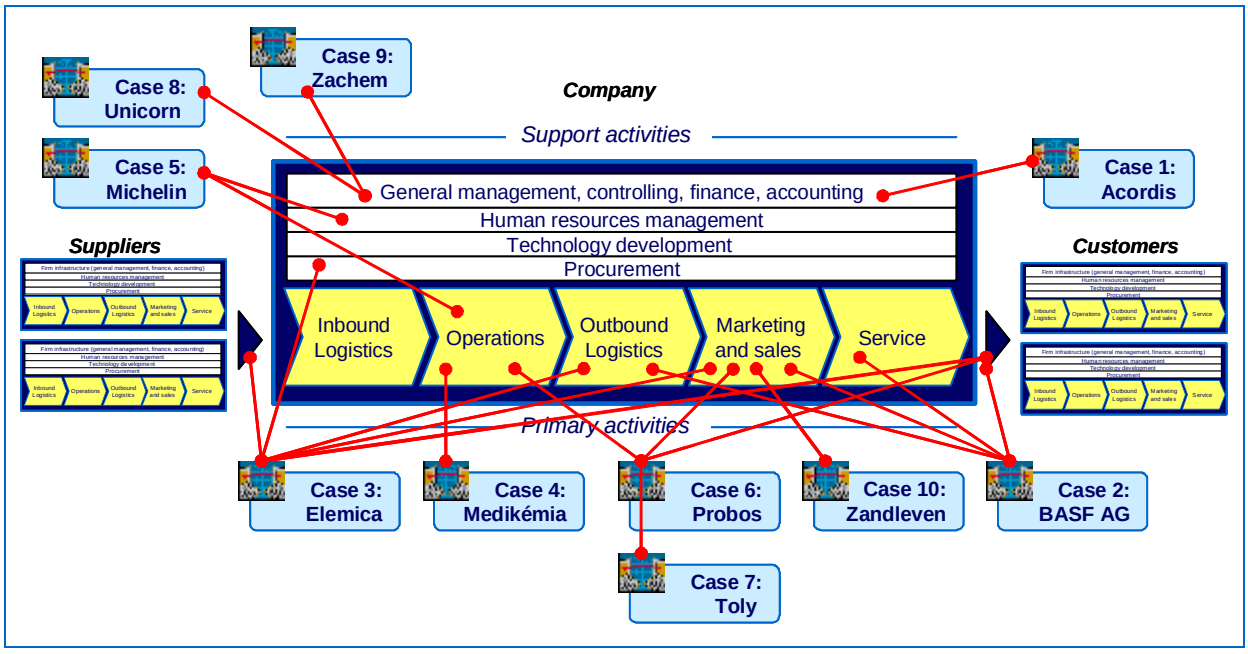
Exhibit 5.0-1: Case studies in overview (sorted alphabetically)

No.	Company name	Country	Sector (NACE 2)	Size	Topics addressed and main links with other sections in this report
1	Acordis / OB10	UK	20.1	Large	Business process outsourcing, e-Invoicing **à Section 3.4**
2	BASF	Germany	20	Large	Holistic e-business strategy of a global player **à Sections 3.2, 3.5**
3	Elemica	(various)	(various)	(various)	B2B connectivity, intermediaries, process efficiency **à Sections 3.3, 3.4.2, 4.3.4**
4	Medikémia	Hungary	20.4	Medium	ICT impact on employment and skills requirements **à Sections 3.3.3, 4.1**
5	Michelin	Germany	22.1	Large	RFID, Human Resources management **à Sections 3.3, 4.2**
6	Probos	Portugal	22.2	Medium / large	ERP implementation and analytical use for market development **à Sections 3.3, 3.5, 4.2**
7	Toly Products Ltd.	Malta	22.2	Large	CRM use **à Sections 3.3, 3.5**
8	Unicorn Ltd.	UK	20.5	Small	ICT for management information, impact on productivity **à Sections 3.3, 4.1**
9	Zachem	Poland	20.1	Large	ERP implementation **à Sections 3.3, 4.3**
10	Zandleven Coatings	The Netherlands	20.3	Small	Role of web-based online sales in a small firm **à Sections 3.5, 4.3**

Case studies from a business function perspective

The introduction to this study argues that Michael Porter's framework of the company value chain and the value system between companies (Porter, 1985) is a useful concept to understand the relevance of ICT and e-business for a company (see Section 1.2). ICT is a tool to optimise linkages within a firm's internal value chain and in its exchanges with suppliers and customers. In optimising these linkages, a firm can create competitive advantage. The following case studies can be seen as examples how companies use ICT to achieve this goal, focusing on different functional areas of the value chain. Exhibit 5.0-2 maps the ten case studies of this chapter against Porter's value-chain, thus showing the focus of each case study from a business function perspective. The graph is a simplified presentation, since many of the e-business activities described have direct or indirect effects on different functions. For instance, a company that optimises its outbound logistics or payment processes (direct effect) may leverage this improvement to provide a better service to customers (indirect effect).

Exhibit 5.0-2: e-Business focus of case studies according to Porter's value chain framework



5.1 Acordis / OB10 (UK)

Abstract

This case study evaluates Business Process Outsourcing (BPO) for the receipt of supplier e-invoices through a solution provider OB10, for an 'early adopter' chemical company, Acordis, in the UK. A manufacturer based in the UK, producing cigarette filter tow and acetate film, it was one of the early adopters of the new B2B tax compliant electronic invoice delivery service brought to the market by OB10 in 2001. The key drivers behind the decision to implement electronic invoice delivery with Acordis' supply base were a mixture of continuing to adopt best-in-class business processes, and helping Acordis to remain cost-efficient and therefore competitive in its core marketplace. Also, the wish to secure the supplier relationships ensuring that Acordis continued to pay Suppliers on time, without the problems and delays associated with a paper based process.

This study focuses on the BPO provider and how they undertook the project, what were the business and technological considerations and their projected customer benefits. This case study tracks the steps taken and overall adoption rates, and the main benefits seen by the company.

Case study fact sheet

■ *Full name of the company:*	*OB10*
■ *Location (HQ / main branches):*	*HQ in London, UK, with other main offices in Atlanta, USA and Kuala Lumpur, Malaysia. Support offices in Sofia, Bulgaria and Bangalore, India.*
■ *Main business activity:*	*B2B electronic invoice delivery services.*
■ *Year of foundation:*	*2000. Four founding partners, three are senior executives in OB10 as of Sept 2007.*
■ *Number of employees:*	*140 full time and about 50 contracted outsourced.*
■ *Turnover in last financial year:*	*OB10 - not available*
■ *Primary customers:*	*Any enterprise globally with more than ~100,000 inbound invoices per year.*
■ *Most significant geographic market:*	*Global*
■ *Main e-business applications studied:*	*The implementation of supplier e-Invoicing delivery by an outsourced business process for auto-matching, business process efficiency and supplier relationships to the UK division of a chemical company.*
■ *Case contact person(s):*	*Gary Benson, VP Corporate Development, OB10;* *Robin Welsby, Head of Purchasing and Supply, Celanese Corporation*

5.1.1 Background and objectives

This case study evaluates why Acordis decided to embark on the project of converting their suppliers' invoices into e-invoices, how the BPO supplier, OB10, worked with the company to design an implementation programme with Acordis, how the programme has progressed, some of the technological processes involved and the results and benefits so far. In particular,

- the marketing approach and projected benefits / ROI as promoted by OB10 are reviewed;
- the evaluated benefits and changes required within Acordis are reviewed.

Acordis was formed in 1999 by combining the Acetate businesses of Akzo Nobel and Courtaulds. It became part of the global Celanese Corporation in early 2007. The manufacturing facility based in Derby, England, using MFG/PRO[144] application and financial software, had over 1400 active suppliers, mostly UK based, representing over €300 million spend per annum in 2002.

With existing, efficient purchase order disciplines and 99% electronic payment already in place, the primary objective was to enrol the goods-for-production suppliers into electronic invoice delivery, automating the entire process and releasing staff from the tedium of data-entry, for more value added activities.

5.1.2 e-Business activities

Starting from paper based supplier invoice processing

Like most businesses worldwide, the process for paying a supplier's invoice was almost entirely manual, with potential for delay at any stage:

- Issue a Purchase Order from the MFG/PRO module
- Create an accrual in the finance module
- Receipt suppliers deliveries into MFG/PRO
- Daily mixed-mail deliveries to the post-room
- Mail opened and sorted into types and destinations
- Invoices taken to the Accounts Payable department
- Invoices, date stamped 'received'
- Vendor ID's looked up and added, by the AP staff to the paper invoices
- Invoices entered into the AP module
- Rejected invoices placed into a dispute workflow
- AP department taking calls from suppliers about invoices that never reached Acordis for payment

After carefully taking references about the OB10 service, Acordis contracted with OB10 in April 2003, to remove the paper invoices and replace with a compliant electronic service. In the early 2000-2001 time window, even if an enterprise was considering this step as a way of improving their Accounts Payable department productivity, the interactions with the myriad range and spread of their supplier base, regularly in thousands and across multiple continents, was often too daunting to contemplate. This was the niche that OB10 as a Business Process Outsourcing solution (BPO) recognised and offered to Acordis, an early adopter of new and innovative technologies. OB10 took away from Acordis most of the daily interfacing with Acordis' supplier community related to this project and managed the 'on-boarding' of the suppliers. Ideally OB10 would be trying to convert as many of the selected suppliers as possible into sending some form of electronic invoice for goods and

[144] MFG/PRO is a modular ERP software system for managing internal processes and exchanges with suppliers and customers, optimised for firms with 50+ employees.

services supplied to OB10 for Acordis. In turn OB10 undertook to convert the invoice format into that preferred by the Acordis financial system.

Exhibit 5.1-1: Acordis' actual e-Invoice project timeline with OB10

Date	Milestone
Jan. 2003	Acordis reviews BPO suppliers
Apr. 2003	Acordis awards contract to OB10
30 Apr. 2003	OB10 processes test invoices to Acordis
30 Jun. 2003	OB10 completes rigorous systems testing
Dec. 2003	~ 56% of in-scope suppliers' invoices are processed through OB10
Aug. 2007	~ 71% of in-scope suppliers' invoices are, or can be, processed through OB10

Electronic Invoice delivery implementation

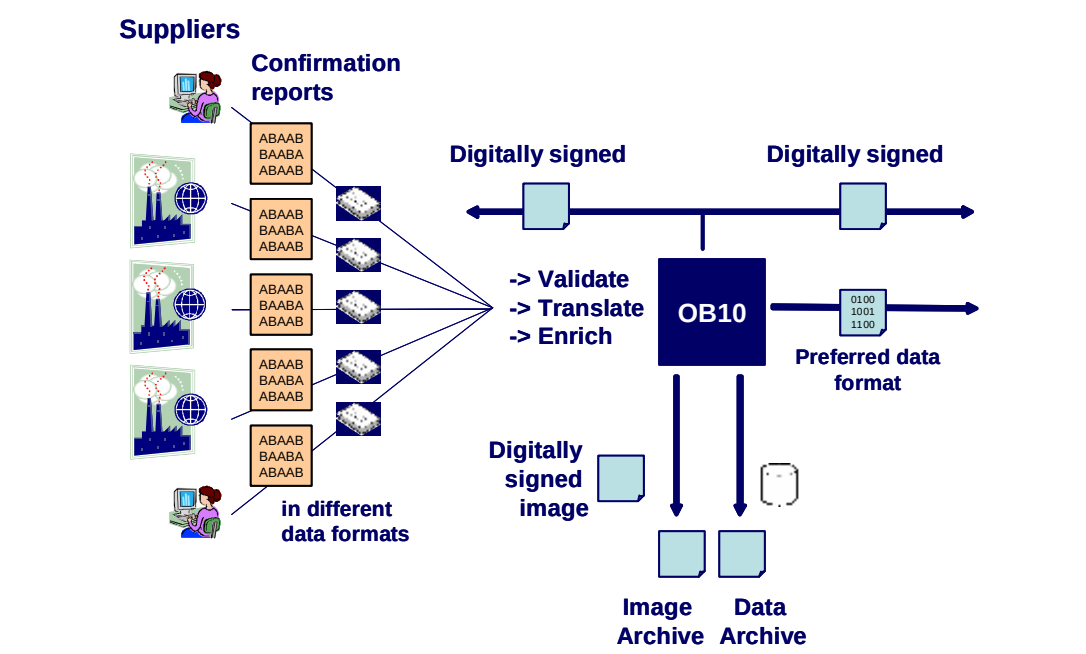
OB10 dedicated one of their Programme Managers to the Acordis project. The manager initiated two work-streams:

- Dialogue with the Acordis IT and Finance teams, establishing the appropriate automatic technical connectivity with Acordis AP system and the changes required to maintain Acordis VAT reclaim integrity.
- Understanding the metrics behind the Acordis existing supply-base and designing the most appropriate campaign to engage with their suppliers.

Acordis agreed the technical solution, embracing data-format and data-content, including providing a solution to PO (purchase order) line numbers and connectivity, then completed a rigorous testing schedule by late June 2003, with test invoices being processed as early as 30th April.

By this time Acordis were at an advanced stage of planning for supplier engagement. A detailed analysis of their existing supply-base was provided by OB10, identifying the distribution by material spend and volumes of invoices. This helped Acordis decide to focus on goods-for-production suppliers and their associated invoices.

Exhibit 5.1-2: B2B electronic invoice delivery



The supplier enrolment campaign

The campaign design was then finalised, with information and decisions on:

- which suppliers were to be enrolled;
- the associated value of spend and numbers of invoices;
- the agreed communication packs to be issued to the suppliers, explaining why Acordis was adopting electronic invoices and the benefits to all parties;
- dates for en-masse supplier forums at the Acordis manufacturing premises in Derby, UK.

With all of this agreed, OB10 then executed the supplier enrolment campaign and arranged to start once the summer holiday season was complete in September 2003. The main OB10 campaign steps were:

- Data-cleansing the Acordis suppliers contact details, bringing their records up to date;
- Issuing Acordis-signed and branded, invitation packs to the senior managers identified within each supplier;
- Following up the mailing with individual supplier calls within the following 10 days, assisting the supplier with any questions or concerns that they may have;
- Liaising with the Acordis project team, if any supplier was raising issues that Acordis could address;
- Presenting the OB10 service at the Acordis arranged Open Supplier Forums.

Cost structure and scope

The cost structure that OB10 specify is that both the invoice issuer (supplier to Acordis) and the receiver –Acordis– pay fees related to this Business Process Outsourcing.

- The **supplier** chooses the most appropriate solution from a range of service options offered by OB10, pays a nominal annual fee covering their first time connection / set up, and then a per document delivered charge. The delivery charge is a sliding scale based on volume per year. Their pricing policy is transparent as a supplier may be invited by more than one buyer to enter into this invoice delivery concept.
- The **receiver**, Acordis in this study, pays a negotiated fee based on an expectation of overall document movements and project scope.

Before Acordis commenced this project with OB10, they were receiving approximately 30,000 invoices per year from their supplier base within the project scope. The percentage of paper invoices exceeded 99%. The few which were electronic were in a basic / standard EDI / EDIFACT format.

OB10 feel they are strongly 'buyer-driven' in their marketing activities, i.e. when a buyer is ready to consider receiving e-invoices (i.e. their in-house Accounts Payable / financial systems can accommodate the proposed data flow) and they have recognised the ROI in such a project.

Acordis had a need to ensure that the solution they selected provided a fully legal and VAT tax compliant solution, as their trading partners could easily be cross-border within the European Union or from even outside Europe.

One of the key requirements from Acordis was that the delivery of electronic invoices from their suppliers would be error-free, with their selected partner. Additionally OB10 guarantee that a copy of the original supplier invoice in native format, plus a separate data file of the same information, would be archived at OB10 for the benefit of Acordis and the supplier.

Few projects secure 100% adoption by the suppliers, for a variety of reasons. They either refuse, or are technically incapable of forwarding to OB10 their invoices, despite the very wide range of data formats in which OB10 can receive the information. OB10 claim to be data standard agnostic and will receive the invoice from the supplier in any structured file format, such as CSV, EDI, XML and home grown variants on the above – in fact everything electronic, but no paper (but even this has changed in OB10's latest functionality expansion).

OB10 used a dedicated team to communicate with the Acordis suppliers. Through the use of a customised CRM software package (Customer Relationship Management), OB10 could monitor and track the progress of the supplier in getting ready for the conversion.

OB10 currently have over 30,000 suppliers connected from over 90 countries. Major contracts cover all industries, with HP, General Motors, DGSi, Kelloggs, Barclays and additional partnerships with IBM, GXS and the Santander-Abbey bank group. Recently OB10 have secured a further major chemical company contract with AIR Products.

OB10 Technology set-up

OB10 own their own systems hardware, but it is hosted by a specialist third party, Cable and Wireless in the UK. A second systems hardware centre is being created in the USA to support a US Federal contract where there is a contractual requirement for data processing / storage to take place solely within the USA.

OB10 feel it is critical that the suppliers have a reliable contact in a support / help desk where they can discuss major or minor details and problems in their own language, and also in their own offices hours. The spread of OB10's teams across the world and their flexible working times allow for that level of support. To further offer a support system to the buyer community, OB10 have launched a Buyer User Group who now meet and help guide developments of future OB10 functionalities.

OB10 have their main supplier enrolment services in London (European Supplier Enrolment, Global HQ), Sofia (European Technical Support), Atlanta (US Region Supplier Enrolment and Technical Support), Bangalore (Global Supplier Mapping) and Kuala Lumpur (Asia Pacific Supplier Enrolment).

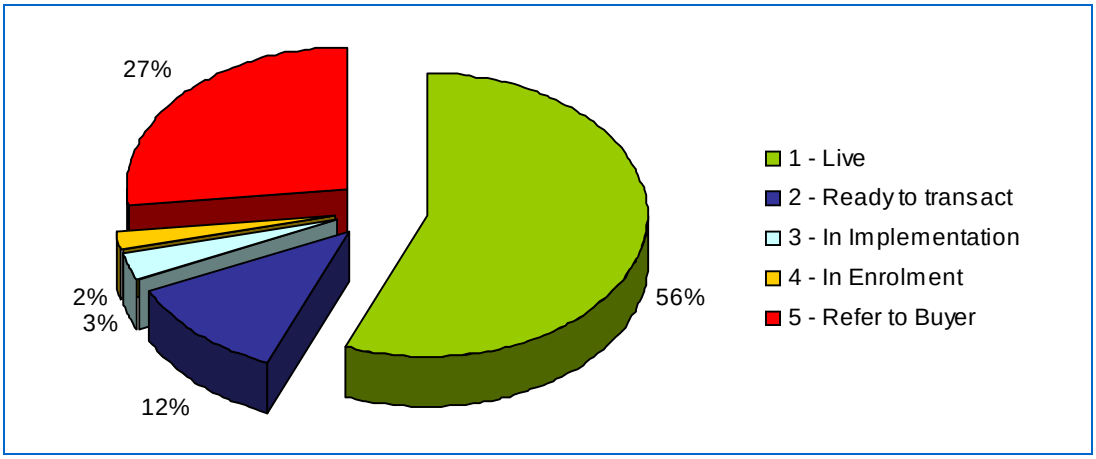
Results

By mid 2007, 56% of Acordis invoices in project scope are routinely delivered electronically by OB10, with a further 15% ready, or capable of adding their volumes as of September 2007. This is in partly because some of the other suppliers' clients have also asked them to send their invoices electronically, again using OB10, and the suppliers have agreed to include Acordis in their e-Invoice delivery.

The pie chart shows the percentages of the invoices being transmitted through OB10. In this case-history instance it would also be a broadly similar for the percentage of suppliers who joined Acordis in this service. This is not a usual match. OB10 state that a

more frequent distribution would be for example in another project, 75% of the total population of incoming invoices would come from ~50% of the company's suppliers.

Exhibit 5.1-3: Acordis Project – % Invoices via OB10



The benefit to the supplier (the invoice issuer) is that OB10 guarantee delivery of their invoices directly into Acordis' (the customer's) financial system, ready for processing. This removes the potential for lost in mail, delays or mis-keying upon entry into Acordis' financial system. Additionally suppliers are known to use their electronic invoice delivery capability as a marketing / sales tool when promoting their products to buyers.

5.1.3 Impact and lessons learned

Impact

In the project, Acordis had planned that it would take up to 18 months to on-board the 50% target pool of in-scope suppliers, but this number was achieved in approximately 6 months. For Acordis, using the services of OB10 had the following effects:

- **Impact on organisational structure**: The Acordis A/P department was able to be re-structured from 3 operational sites in the UK to two sites. Process efficiencies and productivities gained directly from this project were the main factors allowing Acordis management to make this move.
- **Improved supplier relations**: Acordis secured a stronger reputation with its vendor community as a reliable / on-time payer of its invoices, after implementing this project.
- **Automated processes**: The auto-matching function from OB10 where the received invoice is compared to the PO from Acordis helped reduce A/P department human interaction measurably.
- **No unwanted effects**: There were no changes to Acordis' production processes, or inventory management or logistics through the implementation of this project.

Lessons learned – from the perspective of Acordis

Once Acordis had established the solution of the issue of auto-matching PO lines to Invoice lines, the technical aspect of the service worked very well, with almost no further involvement from their internal technical people.

During the supplier enrolment phase, because Acordis were an early adopter and there was little 3rd party information available on OB10, or indeed the fundamental service of electronic invoicing, most of the Acordis suppliers contacted Acordis directly to discuss the request. These contacts were handled by the Acordis senior Purchasing and AP staff with considerable success. Initially, for the first 6 months, it was a regular feature of their daily work, but this gradually declined over months 7-12 of the project.

Acordis completed the initial scope of the project with OB10, for PO backed invoices, mostly in the category of goods-for-production within the planned timeframe as seen in the accompanying chart. Acordis did have plans to roll out this project to other groups of suppliers (e.g. MRO), but because of competing projects and other business priorities they were put on hold temporarily. Subsequently the acquisition of Acordis by the Celanese Corporation and a resultant conversion to a unified ERP system, plus the relocation of all Accounts Payable (A/P) into one location elsewhere in Europe, has resulted in not yet having initiated a similar campaign for other groups of suppliers.

Acordis had been able to specify in all tenders to new suppliers that the delivery of the invoice through OB10 be a condition of contract.

Acordis had a parallel project at the same time to remove paper from the requisition process. This did not impact the OB10 project, other than further reduce paper usage in the company facility.

One of the main visible benefits seen by Acordis was the reduction in A/P department sites from three to two; a major reduction in the number of invoice queries outstanding; a significant reduction in their photocopying costs; further, archiving costs of documents have now dropped dramatically as OB10 supply this functionality to Acordis.

Acordis stated that one of the biggest challenges with this project was the culture adjustment by their employees in the impacted departments (A/P) in not handling pieces of paper in their daily duties. Today the Acordis AP department is a very different place, with a lot less paper waiting for processing and the AP team dealing with invoice exceptions, and price or delivery queries predominantly. Because Acordis pay electronically, a high percentage of their complete transactions now process automatically, without any human intervention, to the satisfaction of all parties.

Acordis quoted that "*They felt they had done their homework carefully in selecting a near global, tax compliant vendor as partner for the project. By the time the project was up and running smoothly we were able to say that ALL our expectations were met, and there were no surprises, the best sort of project*".

Lessons learned – from the perspective of OB10

Today, at OB10 they recognise that if the Acordis campaign were to be executed in the current, more informed B2B climate, the project would be completed in an even shorter timeframe and therefore be considered more successful. OB10 has meanwhile executed hundreds of such campaigns, and the concept of an electronic invoice delivery service is well accepted in business circles, with OB10 being well represented. Acordis were within the first 10 buyers to adopt e-invoicing. This helped OB10 grow their credentials as a quality service provider bringing this innovative new service to the market.

5.1.4 References

Research for this case study was conducted by Dave Wallis, consultant, on behalf of the Sectoral e-Business Watch. Sources and references used include desk research plus:

- Interviews (face to face and teleconferences) with
  - Gary Benson, VP Corporate Development, OB10 (September 2007)
  - Robin Welsby, Head of Purchasing and Supply, Acordis (September 2007)
- Information from, and follow-up calls with both Gary Benson & Robin Welsby.
- Websites:
  - OB10 (www.ob10.com)
  - Acordis (www.celanese.com/acetate)

5.2 BASF (Germany)

Abstract

BASF is the world's leading chemical company headquartered in Ludwigshafen, Germany with production sites in 41 countries and customers in more than 170 countries worldwide. In response to growing requirements in all its businesses, BASF turned to modern e-business solutions to be available for the customer whenever needed. It has successfully implemented a customer focused global best-in-class e-solution programme using internet and extranet hub portals. Besides supply chain integration, information sharing and collaboration with the customer are focal points of the e-solution concept described here.

Case study fact sheet

■ *Full name of the company:*	*BASF SE*
■ *Location (HQ / main branches):*	*Ludwigshafen, Germany*
■ *Main business activity:*	*The portfolio ranges from oil and gas to chemicals, plastics, performance products, agricultural products and fine chemicals*
■ *Year of foundation:*	*1865*
■ *Number of employees:*	*about 95,000 (worldwide)*
■ *Turnover in last financial year:*	*58 billion euros (sales, 2007)*
■ *Primary customers:*	*Businesses from almost all industries in over 170 countries*
■ *Most significant geographic market:*	*Europe (56% of sales)*
■ *Main e-business applications studied:*	*Overall e-business strategy, e-sales, e-marketing, e-communication with customers, customer relationship management*
■ *Case contact person(s):*	*Dr Herbert Fisch, Director e-solutions*

5.2.1 Background and objectives

BASF is the world's leading chemical company comprised of the parent company, BASF SE[145] of Ludwigshafen, Germany, and 160 consolidated subsidiaries and affiliates. The company has customers in more than 170 countries and production sites in 41 countries. It reported sales of €58 billion in 2007. During this period, Europe accounted for 56% of sales, North America (which includes the United States, Mexico and Canada) for 21%, the Asia-Pacific region for 16%; and South America combined with Africa and Middle East for the remaining 7%.

BASF operates in six separate business segments: Chemicals, Plastics, Performance Products, Agricultural Products & Nutrition, Oil & Gas and others. These are linked in the "BASF Verbund" structure. "Verbund", which loosely translates into "network" or "group", encompasses far more than what is traditionally associated with backward or forward integration. The advantages of the Verbund are applied throughout BASF. Production

[145] In January 2008, BASF Aktiengesellschaft changed its legal form with its entry in the commercial register. BASF is now a European Company, a Societas Europaea (SE).

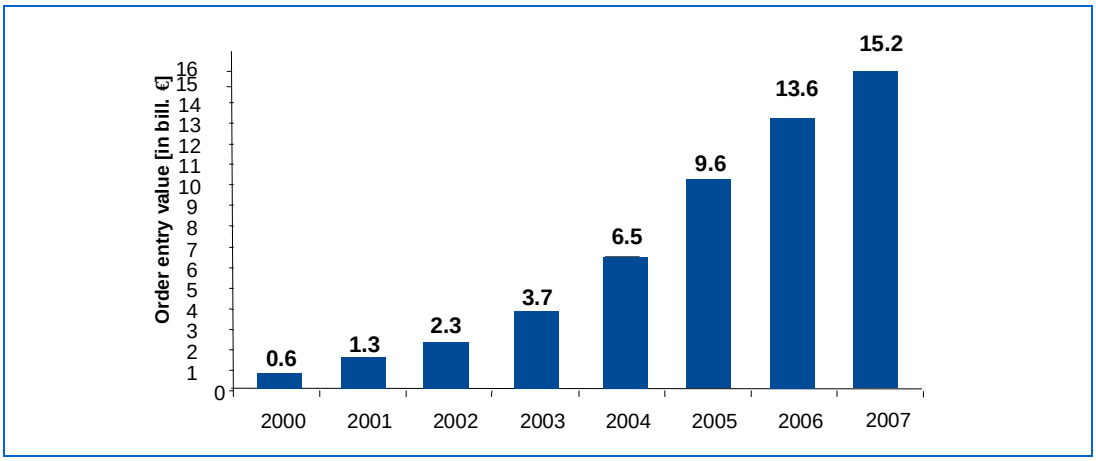
processes at Verbund sites use by products and heat from chemical reactions, that might otherwise have to be disposed of, as raw materials and energy for other processes. This positive integration concept is also being applied to other areas: from R&D, to purchasing, to customer connections, and of course to total supply chain integration.

As an evolution of BASF's previous strategy to the evolving global chemical industry, four strategic guidelines, along with a new logo and a new slogan ("BASF: The Chemical Company") were implemented. The strategic guidelines 2015 committing to earning a premium on cost of capital, helping customers to be more successful, forming the best team in the industry, and ensuring sustainable development, now guide all BASF business units. Through this vision BASF aims to actively capitalise both on the structural and technological changes that will affect the global chemical industry, and economy as a whole, over the next decade. Not surprisingly therefore, growth of customer focused e-business and industry leadership therein is a central part of the "BASF 2015" strategic response.

5.2.2 e-Business activities

Since 2000 BASF is massively involved in the world of e-business. Standardisation, connectivity or transactional performance were key success factors from 2000 – 2004. From 2004-2007 BASF achieved annual growth rates of the transactions processed via e-channels above 30 %. In 2007 BASF Group reached a turnover of over € 15 billion (see Exhibit 5.2-1). 40% of all orders were processed via e-channels. The utilisation of information increased accordingly by over 40%. Similar figures are valid for the e-purchase activities of BASF.

Exhibit 5.2-1: Global development of the e-sales volume since 2000



Source: BASF AG

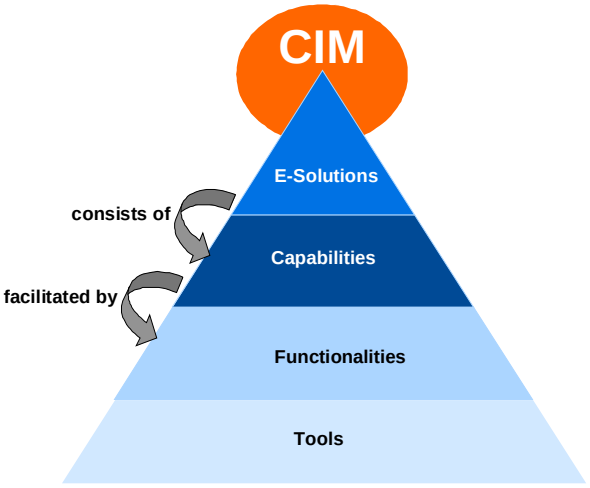
Although BASF is consequently working on improving the transactional performance with its business partners, additional abilities are required for further growth and customer loyalty. New technologies and/or functionalities like RSS feeds, pod-casts, search engines, web seminars are gaining broad interest. Information provisioning via WorldAccount as central customer portal developed significantly and will play a key role for e-business growth in the future.

In order to differentiate BASF e-business activities are focusing strategically on advertising a sound mix of products, services, markets including guidelines for the positioning. E-business within BASF is a business driven approach.

The E-Solution concept

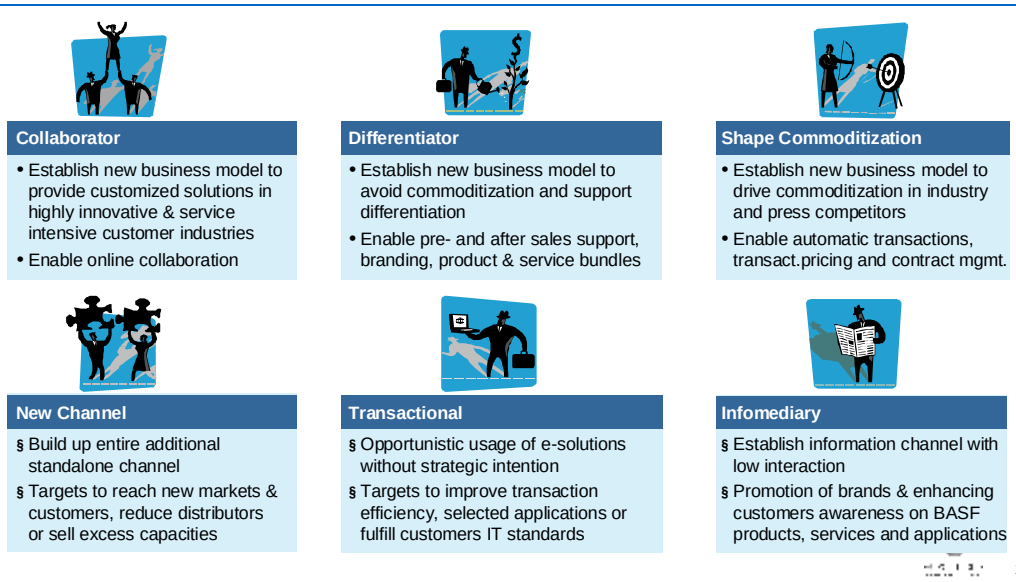
In 2006 BASF revised its strategic approach by taking the purely transactional e-commerce a step further to "e-solutions". This concept, summarised by the vision “BASF e-solutions – The easy way to do business”, is closely linked to the business strategy. Depending on the customer interaction models of the different business units it positions the e-activities very defined in the business context. It defines business solutions not IT solutions. Strategically the concept translates key business drivers for growth and efficiency into a comprehensive set of six e-solutions (see Exhibit 5.2-3).

Exhibit 5.2-2: The E-Solution Concept: The customer interaction model (CIM) defines the e-solution



Source: BASF AG

Exhibit 5.2-3: The six fundamental E-Solutions (to be adjusted according to Customer Interaction model)



Source: BASF AG

Strictly following the direction “Help our customers to be more successful” the customer interaction model plays a key role. The six e-solutions mirror certain customer interaction models. Based on this a set of nine agreed capabilities which can be fulfilled by combining functionalities of the IT tools in the background are prioritized and are finally implemented in line with the business model. The functionalities comprise far more than the pure transactional perspective and include e.g. e-marketing activities, pricing, collaboration and information sharing.

Basic E-Solutions tools

WorldAccount – the BASF global extranet platform

From early 2000, BASF introduced and successfully operated a variety of customer portals in Europe and North America. Since the launch of WorldAccount (www.worldaccount.basf.com) in 2001 BASF serves customers with a globally integrated extranet platform for sellers and buyers based on the latest XML technology. WorldAccount stands for more than 60 % of BASF's e-business.

WorldAccount bundles all product categories (except oil & gas) under one single internet presence. WorldAccount functionalities include: order placement, order status, e-reporting, access to certificates of analysis, material safety data sheets and a broad range of product information, as well as a great variety of options for personal contact and customer support, like certain calculation programs. The 24-hours-7-days-a-week service enables customers to make quick, transparent and cost efficient purchasing decisions around the clock by providing detailed product information and uncomplicated ordering procedures.

WorldAccount includes the option to order directly via the web or via a specific fax channel. The “fax to ERP” tool, being part of the order entry module of WorldAccount is able to automatically transfer order faxes from customers into the ERP systems with high recognition rates. In all cases the customer receives order related information about the individual transaction via WorldAccount.

After initial customer registration, all that is required for a variety of electronic trading opportunities with BASF is an ordinary PC with standard operating software, Internet connection and a browser. Strict confidentiality is assured through encryption and the use of firewalls.

The platform supports 11 languages including German, English, Spanish, French, Italian, Portuguese, Mandarine, Kantonese, Japanese, Thai and Korean.

Elemica

BASF's ERP is linked to Elemica Holding Ltd., a neutral electronic marketplace acting as a transaction hub for the purchase and sale of basic, intermediate, specialty and fine chemicals. For BASF the hub concept is a vital part of e-solutions. Via Elemica BASF reaches out to other industries like the agricultural industry via their hubs or standards or to the consumer packed goods industry. In addition to the full connectivity services of Elemica, BASF uses the Elemica Buyer Direct and the Elemica Seller Direct solution as a “lite” working channel towards small and medium sized companies. BASF was the first company to transact via Elemica in Europe, NAFTA, South America and Asia. Using the Elemica hosted solution it conducts both buy/sell relationships using VMI and SMI. In 2006 BASF was the top growing buyer on the Elemica network and ranked second in both buy-side and sell-side volumes. It is now expanding into new downstream industries in carpet, agricultural chemical industries and paper industry.

Vendor managed inventory (VMI) and direct system to system connections

Vendor Managed Inventory (VMI) or direct system to system are seen as add-on to the above described standard solutions WorldAccount and Elemica. BASF has launched its VMI solution which makes full use of the Chem eStandardsTM data structure and processes. Use of the proven Chem eStandardsTM functions such as order create, order response etc., have enabled the development of this application.

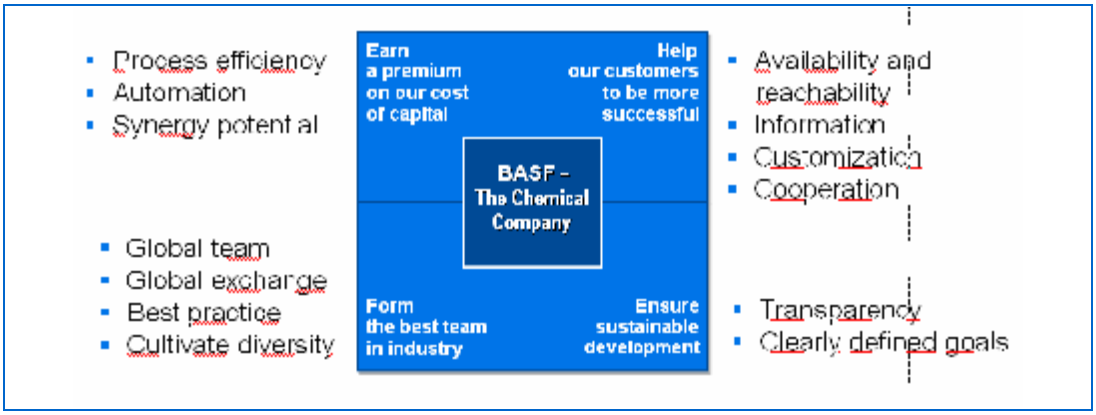
Standards and e-Invoicing

Process standardisation remains important for BASF to cope with the upcoming process requirements. The exchange of invoices and self bills via e-channels represents a specific challenge. Different legal and technical requirements of EU members and non members are obstacles to electronic invoicing and billing. Increasingly the standardisation efforts leave the boundaries of the chemical business itself and reach out into other industries, like automotive or consumer packed goods. BASF again copes with these trends via Elemica, offering interoperability between different industry standards and processes.

5.2.3 Impact and lessons learned

Within BASF e-business has become an important and well accepted channel to cooperate with customers. A constant engagement and commitment, the review of market requirements as well as a strong link into the overall strategy are key success factors for e-business (see Exhibit 5.2-4). Although e-business targets process efficiency and automation, direct customer interaction is a focal area of marketing & sales activities. BASF understands e-business including currently used options as another strong and modern link to their customers. The global set-up of the e-business activities is very important, as the business in many market segments requires worldwide support.

Exhibit 5.2-4: Linking e-business into BASF strategy



5.2.4 References

Research for this case study was conducted by empirica in cooperation with BASF AG. Sources and references used:

- Interviews with Dr Herbert Fisch (July 2007, January 2008) and e-mail exchange
- BASF e-solutions. The easy way to do business (company brochure)
- BASF annual reports and company website (www.corporate.basf.com)

5.3 Elemica

Abstract

Elemica (www.elemica.com) is a platform and network provider for the global chemical industry and related sectors, developed by 22 leading chemical companies in 2000. The service focuses on improving supply chain efficiency by offering browser-based and Enterprise Resource Planning (ERP) connectivity. Thus, Elemica is a an intermediary and "connectivity hub" that facilitates the structured data exchange between businesses. This case study provides some examples of companies from the chemical industries are customers of Elemica, exploring for which purposes they use this way of connecting with other companies, the benefits and issues that need to be considered when taking a decision whether to connect with Elemica.

Case study fact sheet

■ *Full name of the company:*	*Elemica, Inc.*
■ *Location (HQ / main branches):*	*Elemica, Inc., is headquartered in Exton, Pennsylvania, USA. Elemica International Inc. has major offices in Frankfurt, London and Singapore*
■ *Main business activity:*	*Provides B2B connectivity services as a "hub" that manages the data exchange between companies*
■ *Year of foundation:*	*1999*
■ *Number of employees:*	*(not available)*
■ *Turnover in last financial year:*	*(not available)*
■ *Primary customers:*	*Companies in the chemical industries, but increasingly also from other sectors*
■ *Most significant geographic market:*	*USA, Europe*
■ *Main e-business applications studied:*	*System integration with suppliers / customers, Supply Chain Management*
■ *Case contact person(s):*	*Nicola Hughes, Senior Vice President, Europe*

5.3.1 Background and objectives

Elemica (www.elemica.com) is a platform and network provider for the global chemical industry, developed by 22 leading chemical companies in 2000. The service focuses on improving supply chain efficiency by offering browser-based and Enterprise Resource Planning (ERP) connectivity. Elemica claims that it is not an "aggregator" of chemical purchasing, nor a "buyer," "seller," or "owner" of products, but a facilitator of transactions (order processing and supply chain management of contract and repeat chemical transactions). The similarity with marketplaces (such as ebay) and other intermediaries (such as credit card companies) is that Elemica is financed by transaction fees: for each transaction conducted by members through the Elemica network, a fee is charged.[146]

However, apart from this parallel, Elemica is a horizontal and vertical B2B intermediary which does not present itself as an e-marketplace in the sense of a trading platform that openly displays offers or demand. Essentially, it is an IT service company that promises

[146] Information about the transaction fees is confidential.

customers a more cost-efficient way of trading with business partners. The official company motto is "connect once – connect to all"[147], in contrast to having to maintain numerous point-to-point connections with trading partners (via EDI, for example). The goal is to offer customers a "one-stop" experience through browser-based and Enterprise Resource Planning (ERP) connectivity with their business partners.

In 2007 about €35 billion worth of transactions were handled through Elemica, involving over 1,800 industry trading partners.[148] Customers include companies in a variety of industries including chemicals companies and their customers and suppliers, notably from the automotive, consumer packaged goods, paper, plastics and pharmaceutical industries.

5.3.2 e-Business activity

Elemica offers a range of solutions, including light connectivity and more sophisticated forms of system integration. Smaller companies, notably those that do not have an ERP system, will typically opt for the light modules "Buyer Direct" and / or "Seller Direct", while larger customers may prefer the more advanced Elemica Connected Solution. The services portfolio includes the following options:

- **Elemica Connected Solution** ("Connect Once – Connect to All"): the most advanced type of connection, offering full ERP connectivity;
- **Elemica Buyer Direct**: the "light" integration connectivity for buyers or sellers;
- **Elemica Web Solutions** – **Elemica Seller Direct**: this complements standard ERP connectivity by supporting additional electronic message types; it functions as the technology bridge that allows a seller to receive and process orders from an ERP-connected buyer using a web browser interface;
- **Elemica Supply Chain Solutions**, such as supply chain planning, VMI (vendor managed inventory, and CPFR (collaborative planning, forecasting and replenishment).

By connecting with business partners through one of these solutions, companies expect to increase the efficiency and effectiveness of transaction processes. "Effectiveness" translates into a reduced error rate compared to manual or other non-standardised forms for data entry and transmission. "Efficiency" means in particular reduced processing times. Ultimately, these improvements are expected to turn into cost savings. Elemica claims that in sales companies can achieve an 80% reduction in order entry time and a 20% reduction in the number of order changes. In procurement, Elemica expects a 75% reduction in invoice errors, 60% in order processing time and 50% in payment processing time.[149] Even if these figures sound optimistic, the potentials for improving process efficiency and the resulting cost savings can be significant. Celanese, for example, one of the users of Elemica, is quoted to have realised cost savings of over US$ 700k by managing their logistics through Elemica.[150]

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147 See http://www.elemica.com/default.aspx.

148 The figure quoted by Elemica is US$ 50 billion. see http://www.elemica.com/About/History/page.aspx (accessed in January 2008).

149 Elemica – Connect once connect to all. Company presentation by Mike Mc Guigan, May 2007, p. 12.

150 ibid.

The following examples illustrate why companies decide to use Elemica, for which types of transactions, and the benefits to be achieved. The first two example are large enterprises in the USA: Air Products & Chemicals, and Rohm and Haas. The third example is BASF AG (Germany), one the founding members of Elemica.

Example 1: Air Products & Chemicals, USA[151]

Air Products & Chemicals, Inc., headquartered in Allentown, Pennsylvania, is a global provider of gases and chemicals with about 22,000 employees, annual revenues of US$ 10 billion and operations in over 40 countries. European headquarters are at Hersham, near London.

The challenge

In mid 2004, a major customer asked Air Products & Chemicals for online ordering. The customer wanted Air Products to log on to its new online portal every day and update delivery quantities, shipment arrival dates as well as railcar identifications. Air Products was of course committed to fulfil the customer's requirements for an improved data exchange of order-related data; however, the proposed method would have meant a considerable effort for both parties. Air Products was worried what would happen if every important customer began demanding this type of service. Still, the customer insisted that changes had to be made, pointing out that ordering by fax and e-mail was becoming obsolete.

The selected approach

Realising that both companies already were connected to Elemica, it was then considered whether Elemica's "supply chain hosted solution" (SCHS) could be used instead of the daily manual updating of data on the portal. SCHS is based on the Chem eStandards by CIDX. According to Simon Hardy from Air Product, the system has logistics and scheduling powers "that only are a step or two short from those of a full ERP system". Air Products proposed that path to the customer and managed to convince him that it was the more efficient route to implement the intended functionality.

One of the technical issues involved was handling the interfaces with the existing SAP system. For this purpose, the project team turned to Elemica's consulting services, and the task could be successfully accomplished.

Benefits

Taking the integrated approach to exchange order related data through Elemica had positive effects for both parties in this case. For Air Products, providing the requested data is much more cost efficient this way than in the initially proposed method (via the customer's portal). For the customer, the new transparency notably this led to a significant drop in safety stock, which (according to Air Products) saves the customer over US$ 100,000 per year. Moreover, emergency shipments became extinct.

[151] Source: Elemica customer case study, handed out to participants at the Elemica Roadshow in Spijkenisse, The Netherlands, 21 June 2007.

Example 2: Rohm and Haas, USA[152]

Rohm and Haas (in the following R&H) develops specialty and performance materials for customers in industries such as building and construction, electronics, food, packaging and paper. The company, founded in 1909 and headquartered in Philadelphia, PA (USA), employs more than 16,500 people and generated sales of approximately US$ 8,2 billion in 2006.[153]

The challenge

Charles Mirigay, Regional Procurement Manager, estimates that prior to the improvement programme, 20-30% of his company's procurement resources were dedicated to invoice processing, and that 20-30% of this effort was devoted to rework, i.e. fixing errors in the invoicing and payment process. The company analysed the main reasons of errors and found three main types: (i) suppliers provide incorrect inputs, such as the wrong quantity; (ii) there is a mismatch between items listed on the invoice and those held internally by Rohm & Haas, for instance in the remittance details or the price; and (iii) "the classic error" – the invoice is simply illegible.

The selected approach

Against this background, R&H decided in 2004/05 to automate receipt and payment of its more than 650,000 annual invoices by moving the related processes online and thus eliminating the manual re-typing of data as much as possible. The targets were to significantly reduce the error rate while also enhancing relationships with suppliers by fastening their payment. The company decided to use Elemica's electronic invoicing solution for this purpose.

To achieve this, R&H required all suppliers to move to electronic invoicing, which was not an easy step to take. R&H arranged and held a series of seminars for up to 200 suppliers at a time in order to make them familiar with the new process. The seminars started in 2005 in the USA and in 2006 in Europe. Suppliers were presented the Elemica solution and some related electronic tools which they would have to use. It was also made clear, however, that they would have to use them if they wanted to make business with R&H.

Already during the first year of implementation, by early November 2005, electronic invoices accounted for about 15% of total; by the end of 2006, the share was estimated at 60%.

Benefits

e-Invoicing has helped R&H to significantly reduce the error rate in processing invoices.[154] In addition, the introduction of e-invoicing had some positive side-effects, partly as a result of the intensive supplier-customer discussion during the implementation phase. Some inconsistencies could be levelled. For example, R&H discovered it was buying bottled gas from one supplier in four different ways, which was not efficient. The company has also worked with suppliers to standardise terms, for instance, units of measure and the way taxes and special charges are presented.

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[152] Source: "Cutting the bill-paying bill", case study made available by Elemica at the Elemica Roadshow in Spijkenisse, The Netherlands, 21 June 2007; additional information extracted from the website of Rohm and Haas (www.rohmhaas.com).

[153] see "History" section at company website http://www.rohmhaas.com (accessed in April 2008).

[154] Exact figures fort he reduction of the error rate are not available.

For suppliers, there is a financial incentive through reduced working capital. R&H estimate that, on average, e-invoices are paid more than twice as fast as paper invoices. For paper, total time to payment is usually 28 days, for electronic invoice it is 13 days.

Example 3: BP Acetyls & Aromatics, UK[155]

BP's Acetyls and Aromatics (in the following BP A&A) business …..

The challenge

BP A&A had adopted an internet based ordering solution already back in 2000 during the boom time of the new economy. However, five years later, it was felt that the system had noticeably aged and that it suffered from inefficiencies, such as requiring customers to double-key their orders. BP A&A decided that they needed a new, improved electronic solution that would enable them to receive and amend orders, without requiring double entries by either the customer or the supplier. Furthermore, the system should enable the notification of customers of order statues at critical stages of a transaction lifecycle, and make available documentation about the order status to customers.

The selected approach

BP A&A set up a project team with expertise in their business processes, e-commerce and IT. The team evaluated various options and finally decided to use Elemica Buyer Direct (EBD), and link it to TransLink, Elemica's logistics solution. They also agreed that the existing system had many good features that should be preserved.

As one of Elemica's founder members, BP had already been using Elemica's more integrated systems. Thus, it was familiar with Elemica's business approach. Furthermore, Elemica was seen as a good choice due to its international presence as a global provider of business automation within the chemicals industry, which was rapidly expanding into other industries. This was very important for a globally operating company such as BP A&A with multiple trading partners in different sectors.

Initially, EBD was suited to smaller companies with simpler, less-integrated IT systems. So the A&A project team linked EBD to Elemica's logistics hub, TransLink / TransDoc. This resulted in a secure, encrypted environment where BP A&A customers can view their order history and download related documents.

The implementation of the new system (in 2006) required some adaptations in the business processes, not only for customers. Indeed, change management had to start with BP A&A's internal staff. A senior Elemica manager presented the new system to A&A's sales force, "who intuitively bought into the concept," remembers BP A&A's Ruth Sanderson, Acetyls Market Manager. Subsequently, BP A&A invested considerable time with their account managers to enable them explaining the benefits to customers.

Complementary to online ordering, BP is sending electronic invoices to customers that use the Elemica platform. Customers already connected to Elemica can therefore maximise their B2B connection from order capture to invoicing, as information can be passed from system to system. To other customers, BP (in collaboration with Citibank) offers the option to access and download invoices from a web portal at their own pace.

[155] Source: "Ordering and tracking made easier", case study made available by Elemica online (http://www.elemica.com/Solutions/Case-Studies/page.aspx?cid=59); additional information extracted from the website of BP (www.bp.com / www.aromaticsandacetyls.com).

Finally, as a third option, BP is exploiting an SAP functionality to e-mail invoices to its customers in a PDF format.

Benefits

BP says that customer adoption has been extremely good, with "on-boarding" (i.e. the connection process) proving to be a smooth and efficient process. Figures about quantitative impacts are not available. However, a figure from the logistics part indicates the high deployment of orders being processed through Elemica at BP: "*With 98% of our road carrier bookings being managed through Elemica, our standardisation is a priority for us. It drives down unnecessary cost whilst eliminating time consuming double data-entry*," says Robert Elderfield, Acetyls Logistics Manager at BP.[156]

Example 4: BASF, Germany[157]

BASF is the world's leading chemical company headquartered in Ludwigshafen, Germany with production sites in 41 countries and customers in more than 170 countries worldwide.[158] BASF announced to start removing paper from its European invoicing as of December 2007. In a first phase, 50 customers were moved from paper to electronic bills using Elemica's electronic invoicing solution. In the second phase, which started in January 2008, it is planned that 500 customers will be converting from paper. Later in 2008, another several thousand customers shall go electronic.

BASF has tested the Elemica invoicing solution since July 2007. Elemica expects that this move will reduce costs at BASF by eliminating printing, postage, filing, and producing invoice reprints. In addition, Accounts Receivable are expected to experience fewer calls related to invoice disputes and better Days Sales Outstanding performance.

Elemica regards the processes of ordering and invoicing as closely related and points out that companies using Elemica's Order Management solution can eliminate errors prior to the invoice being created.

5.3.3 References

This case study was researched by empirica. It is based on the following sources:

- Elemica Roadshow, Spijkenisse, The Netherlands, 21 June 2007 (attended)
- Websites of Elemica and of the customer companies presented in examples.
- e-Mail exchange with Nicola Hughes, Senior Vice President, Europe

[156] see http://www.bp.com/sectiongenericarticle.do?categoryId=9010687&contentId=7019668.

[157] Source: "BASF starts paperless billing in Europe – via Elemica", Elemica news, 23 November 2007, www.elemica.com.

[158] For more information about the background, see case study in this report.

5.4 Medikémia (Hungary)

Abstract

Medikémia is a medium-sized manufacturer of cleaners for cars, housekeeping and PCs, aerosol paints, insecticides and pesticides, and ingredients for construction. The company was founded in 1967 and is located in Szeged, Hungary, with 100% Hungarian ownership. Medikémia sells its products mainly to wholesale traders both on the local and foreign market.

Medikémia uses ICT-based applications in all their organisational processes from manufacturing to selling. For example, they use ICT-based quality control, computer-assisted supply chain management and e-marketing. This case study tries to assess the impact which the increasing use of ICT and e-business has had on Medikémia's competitiveness, performance and organisation. Findings indicate that ICT-based innovation and e-business adoption have been essential to survive in the market. ICT enabled the firm to rationalise their intra-organisational processes, which lead to workforce reductions.

Case study fact sheet

■ *Full name of the company:*	*Medikémia Ipari és Kereskedelmi Zártkörűen Működő Részvénytársaság*
■ *Location (HQ / main branches):*	*Hungary, 6728 Szeged, Zsámbokréti sor 1/A*
■ *Main business activity:*	*Manufacture of products for maintaining and cleaning cars, aerosol paints, cleaners for housekeeping, insecticides and pesticides, ingredients for constructions and cleaners for PCs*
■ *Year of foundation:*	*1967*
■ *Number of employees:*	*136*
■ *Turnover in last financial year:*	*about €8 million*
■ *Primary customers:*	*Wholesalers, retail dealers and multinational companies*
■ *Most significant geographic market:*	*Hungary, Romania, Slovakia, Ukraina, Montenegro, Germany, Malta*
■ *Main e-business applications studied:*	*ICT and e-business impacts on employment and workforce composition*
■ *Case contact person(s):*	*Mr Attila Rózsa, Head of Marketing Department*

5.4.1 Background and objectives

Company profile

Medikémia is one of a few chemical companies in Hungary having 100% Hungarian ownership, being a profitable joint stock company, and dealing only with Hungarian products.

Medikémia was established in 1967. In the early years, its main activity was the production of medicinal balm. In 1976, Medikémia started developing car maintaining products (such as brake fluid and anti-freeze fluid) which were not available in the Hungarian market at that time. These products became highly successful. In 1986

Medikémia introduced a new brand, "Prevent", which unified all car products. In 1993 it changed its legal profile from a small co-operative (which was the only legal profile of private firms at that time) to a joint stock company. In 1993 many new products were introduced; by 1995, all products which the company sells today were established.

Medikémia produces about 450 kinds of products. 70% of the sales are in the Hungarian market. The remaining 30% of sales are exports, mainly to Romania, Slovakia, Ukraina, Montenegro, Germany and Malta. The main brands are:

- Prevent: car maintaining products
- Hippolit: housekeeping products
- Maestro: paint products
- Profix: construction and installation products
- Chip: electronic cleaner products
- Kentaur: store products.



The most important sales and distribution partners of Medikémia are wholesalers and large retail chains such as MOL, SHEL, CORA, METRO and TESCO.

Increase in competition since 2000

After 2000, Medikémia has been confronted with the biggest increase in competition ever, as several big multinational companies entered the Hungarian market. “Prevent”, the company’s most important product, is still market leader in the Hungarian market and probably in the Eastern European market as well. This product line does not really have serious competitors in the Hungarian market. All other products, however, are challenged by serious competitors. “Hippolit”, for example, is in competition with Caola and Comfort products. For “Profix”, the main competitors are Henkel, and “Chip” competes with 3M.

Medikémia does not directly sell to end users. Its main customers are wholesale traders, retail dealers, multinational companies and petrol stations. In these customer relationships, e-business is very important for marketing, sales and logistics. A key challenge for medium-sized producers as Medikémia in dealing with retailers is that they compete with big multinational brands which can offer better prices, in particular in electronic auctions.

Medikémia positions itself in the premium quality segment in the case of “Prevent” and “Maestro” products. In the case of products for housekeeping and construction, Medikémia always considers the best price/quality ratio. That is why Medikémia has lower prices for “Hippolit” or “Chip” products compared with, for example, competing products such as “Pronto” or “3M”. The “Kentaur” products are the cheapest products of Medikémia, and are equivalent for “Tesco” or “Winny” products in Tesco or Cora. However, as Mr. Rózsa, Head of Hungarian Marketing and Sales Department, says, the quality of Medikémia’s Kentaur product "*is in the medium range, which in Medikémia’s*

concept means that the product is not a bad one, but it just is not situated in the premium segment like 'Prevent'".

e-Business goals

The company has always tried to adapt to new challenges and requirements in the market, including the use of ICT. The company has used computers since the 1980s, and e-business was implemented step by step, when it was felt that the market demanded it. The company's ICT usage can be broken down into three main business areas with different strategic goals:

- **Support of production processes**: Production processes are largely controlled by an ICT-based quality control system. The goal in this field is to ensure the high quality of products.
- **Supply-chain operation**: As over the years the number of products has significantly grown, the introduction of a supply chain management system was essential for Medikémia. The goal in this area is to ensure flexible and fast delivery of products to the retail customers.
- **Marketing**: ICT-supported marketing strategies are used to ensure consistency in the presentation of the different product groups.

5.4.2 e-Business activities

Medikémia has used electronic databases since 1980. The first system they used was for manufacturing preparation; the databases were programmed in Basic. With the spread of personal computers, the company had to develop new systems. From this point of view, the company has some disadvantages in comparison with new firms. As Mr. Rózsa explains: "*New firms usually implement corporate management strategies that are closely linked with the main IT system they use, for example SAP. They will use that system during the company's life-time. This is the case in companies which have recently started their activity; they don't have such a big database as Medikémia. Medikémia's complex organisational system is a bit patched. On the one hand, we have MAGIC, which is a complex organisational system, and on the other hand, we have TM1, for controlling and reporting.*" One function of MAGIC is to collect data from Stock Subsystem and Material Accounting Subsystem. TM1 is mainly used for making reports in excel about the income, quantity, price, transactions etc. A subsystem of TM1, the TM1Web, can produce management reports and statistics (in MS Excel format) for usage on the intranet or internet within seconds. Both systems have been developed by Medikémia in house.

Introduction of e-business

The company took the first steps towards e-business at the end of the 1990s, in parallel with the broad deployment of internet connections in the Hungarian market. In those days, internet communication used to be slower and more cumbersome than nowadays, particularly in technologically less advanced regions such as Hungary (at that time). However, by using the best internet connection available at that time, the company was able to send price offers to those partners who were also connected to the net, which applied to most of the large retail chains.

Since then, the company has steadily modernised and upgraded its ICT infrastructure for doing business, but in an evolutionary way considering the budgetary limitations of a medium-sized company with fewer than 150 employees. Medikémia uses modern computers and broadband internet connection; many of the ICT-systems used for e-business in the company are self-developed. As outlined above, the company's e-business activity is focused on ICT-based quality control, supply chain management and e-marketing.

Costs

Medikémia reports that the maintenance and updates of the ICT-infrastructure, including hardware and software, exceeds €40,000 per year. With regard to hardware, Medikémia's policy is to procure high quality PCs and laptops. The company is prepared to spend more money than other comparable firms on ICT hardware in order to buy quality. Medikémia is also proud of its manufacturing line and believes that this may well be unique in Central Europe.

Technologies used

With the exception of the production department, almost all Medikémia employees use PCs, laptops or PDAs, a blackberry, internet connection and mobile phones. Medikémia has about 60-70 computers, and every computer has broadband internet connection. They currently use 15 PDAs, 8 laptops, 5 blackberries and almost everybody has a mobile phone.

Medikémia uses computer-based systems persistently during all work phases, such as production planning, production, formula management, accounting and finance, technology development and in logistics. They also have a management system (VIR) assisting the employees to pull off data they need.

The most frequently used computer-based systems are:

- MAGIC Complex Organisational System
- Warehouse Subsystem of Magic, for material-booking
- MS FOKONYV, for book-keeping. This software was developed in 1994 and it has continuously been refreshed since.
- S&OP, planning software, supports sales planning. This programme registers the market events and helps the sales department to plan the sales quantity 15 months in advance.
- APPLIX^{TM1}, for controlling, and reporting.
- Internal and external electronic communication is supported by Lotus Notes, web-mail client software such as IMAP and POP, messaging by news-groups, and safety authentication.

Skills requirements as a key issue

The most important requirement was the technological adaptation and the instruction of employees, i.e. the development of the internal ICT skills. Many of them had not used computers and the Internet beforehand. Even if they had, they needed to familiarise themselves with the newly developed software systems of the company. For this reason,

during the adaptation phase, those company's employees who were not receptive to computational knowledge had to be replaced with more skilled ones.

Data exchange with business partners

As usually in the chemical industry, an important application area for e-business at Medikémia is the **procurement** of direct supplies. In many countries, the shortage of resources in the regional or national market makes it necessary for companies in the chemical sector to procure direct supplies in other countries. Medikémia imports supplies for example from Israel, Italy, Russia and Slovakia. In data exchanges with suppliers, requests for offer are often initiated by e-mail. Medikémia does normally not use web-based services of suppliers for procuring primary material.

Another important internal user of e-business is the **sales department**, which has to plan sales activities 15 months in advance. Medikémia uses its own website for communication with customers, for example to inform about special offers. This is supported by direct e-mails to buyers.

Multinational clients of chemical products often prefer to use **web-based EDI** for exchanging data with sellers, in particular to enable a continuous monitoring of the stock. Medikémia maintains EDI-connections with almost all multinational stores in Hungary, such as Metro, Cora, Auchan, Tesco, Praktiker, Baumax and Obi. In total, the company is connected with about 140 stores by EDI. However, Medikémia regards it as a disadvantage of this system that it reduces the personal contacts between buyers and sellers, because it makes it more difficult for sellers to communicate specific information about the product (e.g. new aspects) or the availability of new products. On the other hand, EDI has been experienced as much more efficient and time-saving than any other data exchange system the company has used so far.

In connection with EDI, some business partners of Medikémia use **online tender systems** for price negotiations. This mechanism is very advantageous for the buyer, because the best price on the market for the desired product can be obtained very fast. However, the systems do not enable the seller to have information about prices offered. He is only informed whether his price was the best one or not. Again, sellers do not have the opportunity to communicate information about the product such as quality or specific components and aspects.

Medikémia has an online catalogue of products,[159] but this is rather a list of products and not a truly e-catalogue which is based on a widely accepted catalogue standard.

According to Medikémia, wholesale traders usually do not use e-business; they still prefer to make orders by telephone. While wholesale traders deal with own capital and are responsible for their own stock, they choose to contact the producer personally and to get as much information as possible about the product. Doing business in the traditional way (i.e. by personal contacts) is quite characteristic for the relation between wholesalers and Medikémia, not only in the case of establishing first contacts. This reflects that the chemical products market is a relatively small part of the overall Hungarian chemical industry, typically based on long-standing business relations between sellers and buyers. Wholesalers rather prefer to pick up the phone and ask their "acquaintances" if a certain is available, or when will it be available.

[159] See http://www.medikemia.hu/files/tiny_mce/Image/FTP/PREV_PREL.htm.

In general, the company feels that sales based on the pure e-sales model (e.g. orders from a website) increase the risk that people buy products on the grounds of some pictures, instead of being fully aware of the quality and features of the product. Therefore, the company still does not operate a web shop, but enables buyers to provide feedback on the web, which is frequently used.

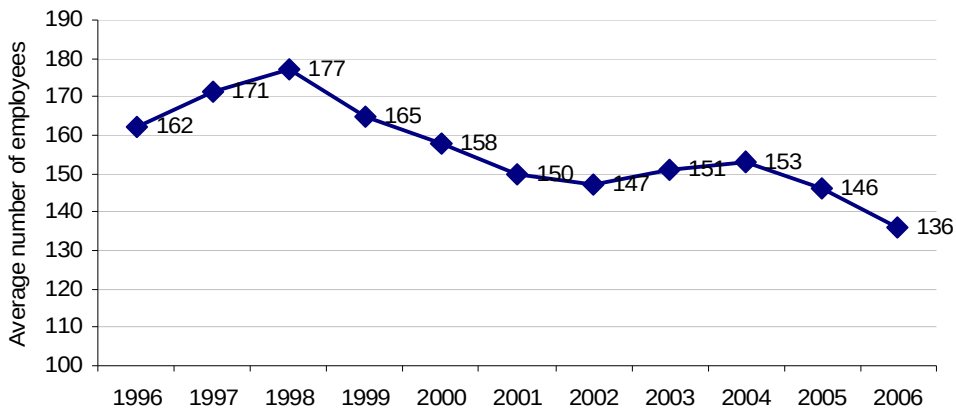
5.4.3 Impact

Impact on employment and skills

All on all, Medikémia's main hierarchical and functional characteristics have not changed much with the deployment of ICT. However, the impact of e-business on Medikémia is manifested in the development of employment and skills requirements.

Back in 2000, Medikémia had still almost 200 employees; since then, the number has decreased to 136 (2006). This is partly to be attributed to the efficiency gains stemming from ICT, which enabled the company to reduce human resources. For instance, many positions in administration like that of a typewriting secretary or an archivist were made redundant. In production, ICT has also helped to make processes more efficient and some of the workers could be dismissed. The most important step in this regard, however, was the modernisation of the stock-controlling system. With the (recent) introduction of a barcode system, the former workload of 4-5 workers can now be completed by only one person.

Exhibit 5.4-1: Average number of employees at Medikémia (1996 – 2006)



Source: Based on figures provided by Medikémia's Annual Report

On the other hand, the average qualification requirements of employees have increased, which translates into higher salaries to be paid. In this regard, company costs have significantly increased; but if output is considered, these costs are refunded.

Impact on processes and performance

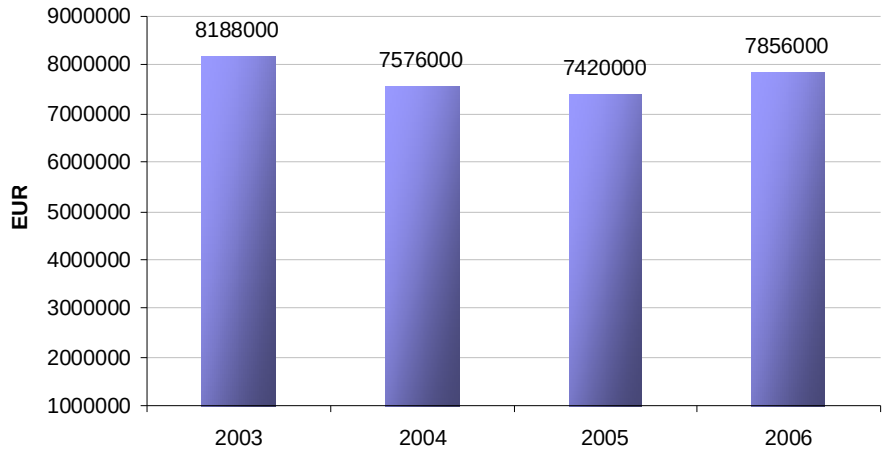
At the same time, processes became faster, in particular sales, marketing and acquisition processes, which are very important from the point of view of production.

Stock management has also been rationalised. In 2006, stocking was renewed with a barcode reader, making the stock control process much easier.

The company's website was relaunched in mid 2007. Constant updating of the website is essential for Medikémia, as it could lose clients if the information was not up to date and thus not satisfactory.

Concerning profits, e-business cannot be regarded as a "profit-generator" in the case of Medikémia as much as it is a "life-saving" strategy. The company could not answer to the challenges of the market and maintain its market position without using ICT as good as possible. The company's annual turnover has been quite stable for years at 7-8 million euros.

Exhibit 5.4-2: Sales turnover of Medikémia Zrt. (2003-2006, in euros)



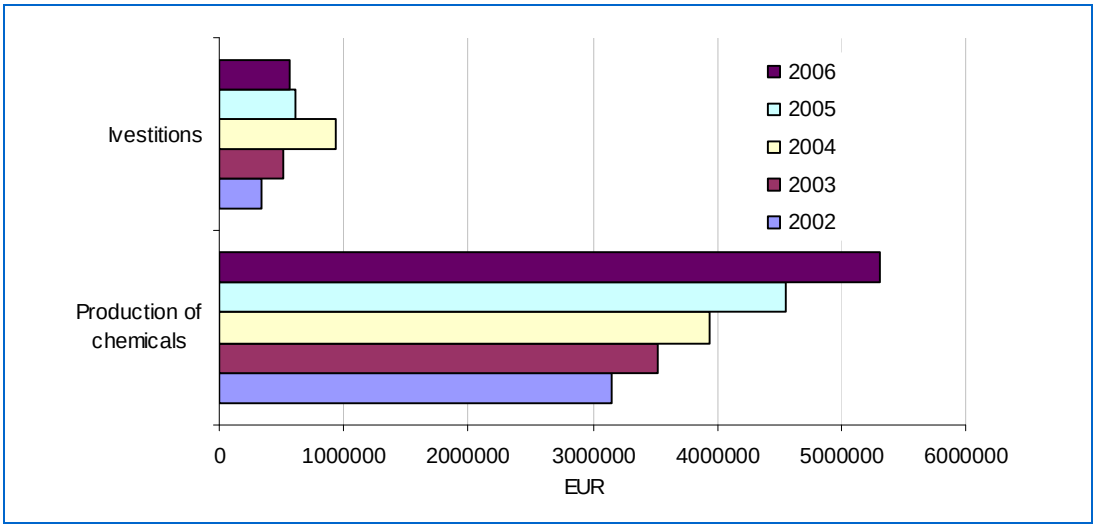
Source: Based on figures provided by Medikémia's Annual Report

Also, it cannot be said that the number of customers has increased due to ICT-based innovation and the use of e-business. Medikémia sees that the partners are loyal to the company because of its continuous efforts to innovate. If there was no such activity in the company, they believe they would lose partners, because orders could not be processed efficiently enough.

In 2006, the sales in the chemical sector in Hungary have increased by 5.4% compared to 2005. National sales increased by 7.3%, foreign sales increased by 3.1%.[160] While production on the national level has increased, the production of Medikémia has been rather stable.

[160] See Annual report of National Association of the Chemical Industry, www.mavesz.hu.

Exhibit 5.4-3: Production and investments in the chemical sector in Hungary



Source: National Association of the Chemical Industry (www.mavesz.hu)

5.4.4 Lessons learned

The case of e-business adoption and usage at Medikémia leads to the following conclusions:

- e-Business and profit: In special markets, the profit generated by introducing e-business can be hard to quantify. This impedes return-on-investment calculations.
- e-Business and business partners: In a comparatively small market such as Hungary, a medium-sized company like Medikémia, which does not directly sell its products to the end user, gains most of its significant customers and business partners (e.g. retail chains) through personal contacts.
- e-Business and market share: the market share has not significantly been increased by introducing e-business. However, ICT-based innovation and e-business, are nevertheless essential for medium-sized chemical companies for coping with new market challenges and, ultimately, surviving.
- e-Business and competition: Due to globalisation, competitors are increasingly the big multinational companies. These have a big advantage when competition is based on price rather than on quality, for example in electronic auctions. However, Central-European companies have good opportunities to extend their market into the East; it is essential that they do so fast, as companies in this segment normally gain competitive advantages if they are the first in a market. Through a suitable supply chain management, the foreign market could have a good and efficient provision of Hungarian products.
- e-Business and workforce: ICT has enabled the company to reduce the number of employees by substituting manual work processes. At the same time, the workforce needs to be better qualified.
- e-Business and globalisation: A strategic option for Medikémia would be to move its productive department to the Eastern countries, in order to reduce costs and increase its profitability in the short term. ICT and e-business would facilitate this

move. However, this would be at the cost of depriving the local market in Szeged, notably by taking away jobs from local inhabitants. For this reason, demonstrating a high degree of corporate social responsibility, Medikémia decided to stay in Szeged and remain a 100% Hungarian company.

5.4.5 References

Research for this case study was conducted by György Lengyel and Eliza Bodor-Eranus, Corvinus University of Budapest, on behalf of the Sectoral e-Business Watch. Sources and references used:

- Interview with Attila Rózsa, 7th of September, 2007, Szeged
- Quote source: Medikémia annual report
- Websites:
  - Medikémia, http://www.medikemia.hu/
  - National Federation of the Chemical Industry, http://www.mavesz.hu

5.5 Michelin Reifenwerke KGaA (Germany)

Abstract

Many people are familiar with the company mascot and trademark commonly known as the "Michelin Man", who was given the name "Bibendum". Worldwide, Bibendum and the company he represents stand for outstanding quality in tyres, road maps and travel guides for almost 110 years. The commitment of the tyre manufacturer Michelin in Germany also goes a long way back. In 1906, Michelin founded the first pneumatic corporation and in 1931, the first Michelin tyre plant in Germany started production in Karlsruhe.

This study explores how ICT and e-business contribute to Michelin's innovative strength. The case has two parts: both focus on the use of ICT for efficiency gains, however, in completely different functional areas and in two different locations of the company. Part I describes the use of RFID technology in production processes in the Homburg plant; part II shows how digital personnel records helped the personnel department at the location in Karlsruhe to cope with increasing challenges in document management.

Case study fact sheet

■ *Full name of the company:*	*Michelin Reifenwerke KGaA (Michelin Tyre Plants KGaA)*
■ *Location (HQ / main branches):*	*Michelin Group is headquartered in Clermont-Ferrand, France. The German plants in Karlsruhe, Homburg, Bad Kreuznach, Hallstadt and Trier belong to Michelin Reifenwerke AG & Co. KGaA.*
■ *Main business activity:*	*Manufacture of tyres*
■ *Year of foundation:*	*1906*
■ *Number of employees:*	*Michelin Group employs close to 116,000 worldwide, and about 8,600 in Germany*
■ *Turnover in last financial year:*	*16.4 billion euros (sales 2006)*
■ *Primary customers:*	*Vehicle manufacturers, distributors, fleets*
■ *Most significant geographic market:*	*Europe*
■ *Main e-business applications studied:*	*RFID; Internal process automation by means of digital personnel records*
■ *Case contact person(s):*	*Joachim Schmuck (Homburg plant)* *Renate Haessler (Karlsruhe HQ)*

5.5.1 Case part 1: RFID usage at the Michelin tyre plant in Homburg

Background and objectives

Founded in 1971, the Saarland Homburg plant is one of the most complex plants within the Michelin group. It produces new tyres, retread REMIX tyres, rubber mixtures, steel cord mesh and tyre fitting. Around 1300 employees work at the plant location; if external service providers are included, about 1800 people are typically working on the factory premises. The company is constantly making investments in further modernising the

production plants. Product and process innovation is a top priority, with ICT playing an important role. One example for ICT-enabled process innovation is Michelin's self-developed system for replacing the existing barcode in tyre retreading[161] which is based on RFID technology.

Michelin Reifenwerke in Homburg started dealing with the subject of RFID already in 2001. "*Everything pretty much started with dirty bar code labels. As a result of the unavoidable soiling, handling effort of tyres increased, because the automatic scanning station could no longer recognise many of the tyres*", explains Mr Joachim Schmuck, the engineer in charge of the RFID project. As a result, a lot of data had to be collected and processed manually all the time. The old labels had to be removed and replaced with new ones. But even apparently intact, clean labels bear the risk of non-readability, for example, in case of a defective dot (e.g. a single printer dot or pixel of the thermo-transfer print head). In fact, bar code labels could only be directly read by the scanner at isolated stations in only about 50% of the cases.

Exhibit 5.5-1: Barcode etiquettes

Automatic identification (Auto-ID) procedures have been quickly adopted in different functional areas in the past few years, for example in procurement, logistics, trade, production and for supply chain processes. The function and objective of Auto-ID can be to provide information about the movement and location of goods, people or animals. The widespread barcode paper strips, which caused a revolution in identification systems many years ago, are increasingly found to be no longer sufficient to enable modern business to cope with high expectations on efficiency. Barcodes are cheap, but their have several shortcomings, notably the low information storage capacity and a lack of flexibility in the sense that they cannot be re-coded.

Against this background, Michelin Reifenwerke carefully observed the technical development of RFID right from the start, realising the high potential of this technology for their purposes. "*The beginning was difficult*", remembers Mr Schmuck. "*We went to fairs and talked to a lot of manufacturers, but none of them had a solution that fit exactly our purpose at the time.*" After almost three years, however, the time had come. The company took the decision to replace the existing barcode systems for production control by an RFID-based system.

e-Business activity

The main goal was to improve process efficiency in the handling of tyres by replacing the barcode labels on tyres with transponder labels, based on the assessment that this was a more reliable and flexible means to identify and track tyres during the production flow. In essence, this project is a good example of process innovation.

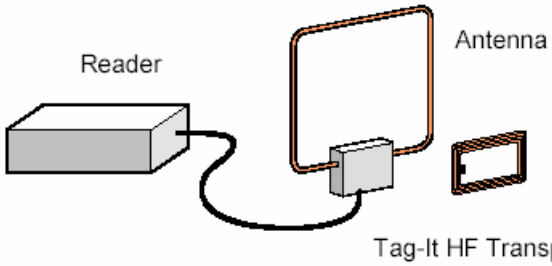
Technical specifications

[161] the process of renewing used tyres

RFID solutions consist of two main components (see Exhibit 5.5-2):

- the transponder (tag), which represents the actual data carrier of an RFID system, and which is usually made up of a coupler/connecting element and an electronic microchip;
- the capture or reading device (which includes one or several antennas); this device can either be a read-only or a read-and-write device, depending on the type and technology used. Outside of the range of the reader, the transponder behaves completely passively, since it does not have its own power supply.[162]

Exhibit 5.5-2: Reader and transponder – the basic components of every RFID system



Advantages of RFID technology:	Challenges of RFID technology:
• high storage capacity of the tag • low error rate with readout • longevity and resistance of the tags against physical influences • time saving through the simultaneous capturing of several objects • no intervisibility between tag and reading device is required • rewritable tags • faster data exchange • high data security • objects can be located	• the health impacts of the electromagnetic radiation are still being investigated; • the functionality of the tags can be influenced by the presence of metal objects; • the price of the labels in the 13,56 MHz range are relatively high.

A major challenge associated with RFID is still the higher costs of tags compared to barcodes. As Michelin Reifenwerke planned to use tags at the item and not only at the pallet level (i.e. to equip each single tyre with a tag during the production process), this was a big issue. However, the project team found a smart solution to solve this problem: „*Since the optical contact did not play a role anymore, it was now only a matter of putting the RFID tags into the tyres. (…) Attaching the labels with the transponder directly to the tyres would lead to costs of half a million euros for 500,000 tyres per year, as they could not be removed and reused when the production process has been completed. This is why we created a carrier that can be inserted into the tyres. At the end of the manufacturing process, it can be removed and reused,*“ explains the project manager.

[162] For a technical description of RFID technology and an introduction to its different application areas, see the Sectoral e-Business Watch study on implications of RFID adoption (2008), available at www.ebusiness-watch.org.

Exhibit 5.5-3: Saving costs by reusing RFID tags

The attachment of the transponder is accomplished through a flexible tag carrier in the tyre, which can be easily pushed aside when the tyre undergoes repairs. The tag carrier is necessary to enable reutilisation of the tags.

The labels with the tags must fulfil several requirements: They have to operate according to ISO 15693 with a frequency of 13,56 MHz. The chip must have a minimum storage capacity of 128 bytes. Furthermore, the labels must be flexible, so that they can adjust to the shape of the tyre. The transponder must be self-adhesive, in order to simplify the attachment to carriers. Since the size of the antenna has a direct influence on its capturing range, a minimum size of 45 mm x 70 mm was necessary.

Further components of the RFID solution included:

- A **Long Range Reader** to read or write a tag from a distance of up to 500 mm.
- **The antenna:** The first antennae were installed above and below the bands, so that the labels that are positioned parallel to the antenna could be read. The size of the antenna had to be of at least 800 x 600 mm (this also determines the range). Furthermore, it had to be designed for a capacity of at least 4 W. Three additional reading stations were installed to enable a better product control within the band control.
- **The hand-held-scanner:** The RFID-hand reader is used at all manual work-stations. It is possible to either convey the reading results over a keyboard loop directly to the attached terminal, like with the barcode reader, or to connect to a communication module of the programmable logic controller. In a broad expansion step, it would be conceivable for example to exchange the hand reader against a stationary device, which would have advantages of further automation.

Implementation time line and costs

The project has been planned and conducted in three phases, two of which have been accomplished:

- the planning phase, with a duration of approximately 1.5 years (completed)
- the implementation phase (approximately 1.5 years, completed)
- the optimisation and development phase (ongoing, to be completed by the end of 2008)

The costs for the replacement of stationary devices as well as the substitution of the manual measuring devices amounted to about € 60,000.

Impact and lessons learned

With the introduction of the RFID-System, Michelin Reifenwerke in Homburg was able to optimise the work flows in tyre retreading. A major advantage of the RFID system over the former barcode system is that RFID tags are re-writable, i.e. additional data can be entered (or data changed) during the production process, and not only in advance. This

increases significantly the flexibility of the system. For this reason, no read-only tags are used in this project.

The company has eliminated the use of barcode labels in most areas of tyre retreading. RFID-reading devices were installed at all stations in this business area. Intervisibility for reading is no longer a requirement, and additional information can be stored. The company feels that this has had a very positive influence on the management and control of the production process. During the implementation phase of the project, special antennae have been developed for the Long Range Reader, which further improved the readability of the transponder and is expected to reduce costs.

5.5.2 Case part 2: Use of Digital Personnel Records at the personnel department in Karlsruhe

Background and objectives

Personnel departments are often confronted with a challenge that is typical of office work: mountains of paper files have to be processed and archived, with inherent difficulties such as missing pages or misplaced files. At large companies, where personnel records of thousands of employees have to be managed, good document management becomes critical. The central personnel office of Michelin Reifenwerke in Karlsruhe has experienced significant challenges in this regard. Files were not available because they were lent out to other departments or sent as a copy, or it was not possible to access documents from different locations by several employees at the same time.

"*We had the problem that people, documents and other information sources were located at different places. Over time, this situation became increasingly difficult to manage*", says Ms Renate Haessler, the human resources platform director. "*Then we were confronted with a situation where many employees went into retirement within a short period of time. All of a sudden, we had to process mountains of retirement files, and we just did not know how to cope with this flood of documents. Moreover, a lack of space worsened the problem. Finally, this was the motivation to start exploring whether a digital document management solution could improve the situation.*"

The replacement of traditional personnel records through a "mixed mode", i.e. using digital information from existing IT systems while keeping extensive paper files in parallel, is a common practice in many companies. However, this is often not a satisfactory solution. Laborious searches for information or documents are common symptoms that slow down personnel processes. As a result, notably decentralised organisations have a demand for systems that enable a faster and more transparent access to those documents that contain information about "the most important resource of a company – the employees". In this situation, companies often start to search for modular, IT-supported personnel management system with a central instrument.

The personnel department started to prepare its ICT project in 2004. The project was then implemented in 2005 within a period of about six months.

The ICT solution: Digital Personnel Records

After scanning the software market in Germany, Michelin Reifenwerke soon identified an e-business solution that promised to help the company solve its problems: the "digital personnel record", based on the SAPERION ECM SUITE by Henrichsen AG, offers the

possibility to merge contracts, digital documents and objects and whole electronic archives. The solution thus promises to integrate all personnel-related data and actions within one record. "*Our solution –the Digital Personnel Record– was complemented with additional functions through the collaboration with Michelin. The customer has dealt with the topic very intensively, contributing their own inputs and ideas. By implementing the requested additional functions, the needs of the employees in the personnel department could be optimally met. As a result, the solution was soon implemented in all Michelin tyre plants in Germany*", says Mr Klaus Boos from Henrichsen AG, branch manager of the Freiburg office.

The new software solution is the core element of the new digital personnel management. The company confirms that the management of extensive data from the personnel sector has been greatly facilitated. All documents relating to a particular employee are now stored in the file and archived in an auditing-proof certified system. The document management functions have proven their usefulness in practice.

Different channels for the data input are possible, for example using standardised interfaces (such as payroll) or scanning of paper documents. A high level of comfort for indexing documents was achieved by using an essentially automated index allocation. The searching for documents can be made according to the company's usual criteria; it was supported by the illustration of a filing plan. Moreover, Michelin Reifenwerke established a gateway to the accounting department (yearly and monthly billing). The personnel records can be easily accessed using the quick index search or via the filing plan.

Benefits

The introduction of digital personnel records offers the company the following advantages:

- Audit-proof archiving of documents, compliant with the legal obligation to archive data in a certified ECM system
- Adjustable rights management for any specific document
- Location-independent availability of all personnel records, such as contracts, credentials, proof of training, salary increases, warnings, data from payroll accounting, vacation management, assessments, application documents, remuneration agreements, and retirement claims
- Comfortable handling of files with integrated viewing and previewing functions
- Flexible file structures with a high file recognition factor
- Document management adapted to the department (administration, distribution, and forwarding of information)
- Comfortable scanning of paper documents
- Integrated archiving of e-mails and office documents

Lessons learned and conclusions

This examples illustrates the increasing importance of ICT systems in support functions such as administration and human resources management, notably in large enterprises. In this case, Michelin Reifenwerke uses an electronic document management system to digitally process and store personnel records and company pensions for over 6000 active employees and 5000 retirees. Files that were previously accessible only from one branch office can now be accessed by other personnel departments at different locations when

needed. In larger companies with several establishments, this is a huge advantage compared to the area of paper-based exchanges. The amount of documents and files that have to be posted or faxed between establishments has been substantially reduced; this leads to reduced costs, faster processing of documents, and reduced errors (such as misplaced files or missing pages as a result of sending documents back and forth). Still, there is a potential for further improvement, and the users of the system continue thinking about how the system can be expanded.

"*Meanwhile, there are thoughts about how accounting and the call centre could also profit form this solution. However, there is another challenge that has to be solved first, namely how to protect confidential data contained in the personnel records from unauthorised access*", says Ms Haessler.

One of the lessons learned is that it is necessary and worth adapting software solutions to the specific needs of a company. The ICT market rarely has solutions readily available that fully match a company's requirements. However, with the right software (or hardware) partners, the "right" solution can normally be developed in cooperation with the customer and prospective user. The involvement of the actual users of a software plays a very important role to ensure smooth processes. In this case, the good collaboration between the software company and the customer in developing the final product has led to excellent results.

5.5.3 References

This case study was conducted by Miglena Hoelzer on behalf of the Sectoral e-Business Watch. Sources and references used:

- Interviews with Mr Joachim Schmuck, Michelin Homburg Reifenwerke, in Homburg on 11 March 2008 (face-to-face); Mr Klaus Boos (Henrichsen AG) on 12 March 2008 (by telephone); Ms Renate Haessler, Human Resources platform director at the Michelin Reifenwerke plant in Karlsruhe, on 24 and 28 March 2008 (by telephone)
- "Rapport RFID-Technology", Michelin Reifenwerke Homburg (June 2004)
- General documentation "Digitale Personalakte" by Henrichsen AG (2007).

5.6 Probos (Portugal)

Abstract

The Portuguese company Probos manufactures high-quality plastic edge bands which are used in the manufacture of chipboards, medium density fibreboards (MDF) and similar products. This case study describes how Probos uses ERP (and some integrated CRM) both as a front-office tool to better serve customers and as an analytical tool: by systematically analysing order records, the company has been able to better anticipate future demand and identify market trends. Since the CRM software was introduced two years ago, the efficiency of production and sales has increased, with positive effects on market growth and customer satisfaction.

Case study fact sheet

■ *Full name of the company:*	*Probos – Resinas e Plásticos, S.A.*
■ *Location (HQ / main branches):*	*Mindelo, Portugal*
■ *Main business activity:*	*Plastic edge banding*
■ *Year of foundation:*	*1997*
■ *Number of employees:*	*about 260*
■ *Turnover in last financial year:*	*about €34 million*
■ *Primary customers:*	*Distributors of accessories and components for the furniture industry and furniture manufacturers*
■ *Most significant geographic market:*	*Portugal, Spain, U.K., Europe, South and North America, New Zealand, Middle East*
■ *Main e-business applications studied:*	*Enterprise Resource Planning (ERP)* *Customer Relationship Management (CRM)*
■ *Case contact person(s):*	*Mr Paulo Moutinho (pmoutinho@promotor.pt)* *Mr Francisco Assis (fassis@promotor.pt)*

5.6.1 Background and objectives

Probos – Resinas e Plásticos, founded in 1997, manufactures high-quality (ISO 9001 certified) plastic edge bands which are used in the manufacture of furniture made of chipboards, medium density fibreboards (MDF) and similar products. Its headquarter is located in Mindelo, Portugal, with branches in Brazil (Proadec Brazil, Lda), UK (T. & A. Carter, Ltd) and the USA (Edging Plus, Inc.). Probos is one of the top three producers in Europe in this market. Products are sold under the Proadec brand. They are mostly made of PVC, ABS and PS/B; however, the company has been diversifying its products and now also manufactures bandings in natural wood and melamine resin.

Manufacturing sites are located in Portugal and Brazil, whereas the UK and USA branches are primarily distributors. Besides having a direct presence in these four countries, Probos –through international partnerships– maintains a distribution network that covers more than sixty countries. As a result, over 90% of the production go to international markets.

The company sells its products primarily on a client-order model (production-to-order), and as such it has only few standardised product packages. Typically, a client places an

order for a set of bandings (specifying the types, features and quantity). Probos will then manufacture the bandings according to the request specifications. Probos also has an ex-stocks service, the "Express Line" catalogue. The catalogue offers a comprehensive selection of edge bands that are available for immediate delivery in minimum quantities as a single roll.

Relevance of e-business

As Probos works on the production-to-order model, the need to keep track of the specific requests of each client, as well as the ability to anticipate future orders based on a client's order record, is of paramount importance. Another critical requirement in this business model is the need to keep a client constantly informed about the status and progress of his order. This requires a tight integration of production with management processes.

These requirements can only be effectively and efficiently met by using advanced Enterprise Resource Planning (ERP) software tools, with integrated Customer Relationship Management (CRM) functionalities. This means that the ERP tool does not only support the company in keeping track of its current orders, but enable it to order records and thus predict future demand ("analytical ERP"). The use of advanced ERP functionalities supports is beneficial to several parties involved:

- **Sales** staff can keep track of the state of each client order and better anticipate future orders from existing clients; they can identify and contact possible future clients based on market trends detected by analysing the global order history;
- **Production** managers can consult existing or even predicted orders to organise production in a way that maximises throughput;
- **Clients** receive up-to-date information about the progress of their orders.

5.6.2 e-Business activities

Rationale for the e-business project

Originally Probos used a generic and rather simple commercial application to manage the relationship with its clients. When the volume of orders increased, the lack of advanced functionalities for specific manufacturing and asset management limited the company's ability to efficiently respond to orders. Furthermore, clients became more demanding to have access to information about the status of their orders at any time; this, however, required a closer integration between sales and manufacturing. Against this background, Probos concluded that they needed a more sophisticated and specialised ERP software that is capable of performing these tasks.

Project implementation

After screening the market for available and suitable solutions, they decided to buy an ERP solution from Intentia Lawson (now: Lawson Software),[163] a Swedish provider of high-quality ERP, CRM, supply chain and asset management software solutions.

[163] Intentia was bought by its US competitor Lawson in 2006 and is now operating under the name of Lawson Software for a price of about USD 480 billion. The joint company (Lawson Software) has its headquarters in St. Paul, Minnesota, while international operations are run from Stockholm. Cf. heise online, news, 3 June 2005 (www.heise.de/newsticker/meldung/60228).

In 2006 Probos purchased the ERP software Movex M3, which was adapted to Probos' specific needs. This customisation concerned mainly the interface with the existing Manufacturing Resource Planning (MRP II) system used by Probos, in order to enable the precise tracking of orders.

The implementation phase, including the customisation of the software package, took about three months. The system reached full operational status soon afterwards. It has been in use since then, with some minor upgrades, but no major change.

Probos does not release information about the costs of the ERP system, neither for the initial investment (purchase of the system) nor for maintenance services provided by Intentia (Lawson Software). Probos stated that it was a standard price associated with the respective software products and services of the provider.

The ERP system runs on an IBM AS/400 computer, under the Windows Server 2003 operating system. The ERP software itself is based on Java technology and uses an integrated DB2 database to store all the client and order information.

Design requirements

The Intentia ERP solution was chosen because it best fulfilled the specific requirements of Probos. The most important of these requirements were:

- functionalities to store detailed information about every client company, including its order record;
- functionalities to provide detailed information about existing orders (including their status) as well as expected (i.e. virtual) near-future orders;
- integration of the ERP system with the MRP II computer system used in the production process, in order to enable an automatic updating of the order status;
- enabling clients to check the current status of their order(s), either by receiving an optional automatic e-mail when their order goes to the next phase ("push" mechanism), or by making a request by entering their order number in the extranet of Probos, i.e. a reserved area for clients at Probo's website (www.probos.pt), thus consulting the order status manually ("pull" mechanism);
- analytical tools that are capable of linking information from different clients and orders, with the objective to predict future orders and to analyse market trends that help Probos identifying potential new clients.

Organisational requirements

The implementation of the ERP system did not require any significant changes in the overall work organisation or structure of Probos. However, some employees had to adapt their working routines in order to effectively use the functionalities of the new ERP software. For example, **employees in production** had to insert more information than before during the production process into the MRP II system, so that this system can better "feed" the ERP system with the relevant information, notably the exact processing status of each order.

The **sales staff** had to adapt to the requirement of answering more client requests than before, as clients quickly became aware of the improved opportunity to get information about the status of their orders and made actively use of this option. The sales staff also had to learn how to use the new analytical tools to better predict future orders and potential clients.

Finally, **production managers** had to get used to the increased amount of order information which enabled them to schedule production processes more efficiently.

Thus, the various ERP tools are used by a large number of employees in different functional units of the company, for front-office purposes (customer communication) and for back-office processes (forecasts and planning, marketing strategy development), as well as (indirectly) by clients.

Situation today

The tool has now been in use for about two years and is fully deployed at all levels of Probos' headquarters facilities. It is considered to be fully reliable and mature. No significant changes in the software architecture have been made in this period other than minor upgrades.

The Brazil branch does not yet use this ERP software; the option to also install it there is currently being considered. Probos believes that this would facilitate the coordination of production processes in both countries. Currently, the Brazil branch supplies the Latin and North-American markets; it works mostly independently from Portugal's facilities. Thus, the decision whether to use the ERP tool in the Brazil branch as well is linked with general strategic considerations whether and to what extent production at the two sites needs to be coordinated.

5.6.3 Impact and lessons learned

Impact

Once the ERP system was technically fully deployed, usage quickly spread to all Probos employees that are directly involved in production and sales. The company believes that this has sizably increased their efficiency. Probos says that it is very difficult to quantify this increase, but mentions some examples to demonstrate the impact:

- Salesmen report a significant **increase in the number of queries** and requests (by about a third) from clients waiting for orders, as their direct access to their current order status allows them to have a more direct involvement in the manufacturing process. This has led to visibly higher levels of **client satisfaction**.
- The number of **new customers** has increased by about 8% since the tool was introduced. Most of these had been identified with the support to the integrated analytical CRM features.
- **Production efficiency** has increased by about 15-20%, most of which due to the greater ease to schedule order manufacturing based on the tool's information, which includes the ability to help salesmen to predict possible near-future orders. Probos estimates that about three quarters of the predictions turned out to be accurate.

Lessons learned

The case study demonstrates that the capacity to better predict potential near-future orders can have a sizable impact on manufacturing processes and customer service, in particular in a business that is based on production-to-order.

- Probos learned that the systematic analysis of their order history turned out to be a more important function of the new ERP/CRM system than originally expected.
- Giving the clients access to up-to-date information on their order status has increased their involvement in the manufacturing process. Ultimately, this led to greater levels of client satisfaction.
- The ability to have instant access to up-to-date information on every step of the production environment brings significant advantages not just to managers, but to other stakeholders as well (notably salesmen and clients), creating synergies and learning effects. For example, the greater client involvement in the manufacturing process has led to a more direct contact with salesmen, which in turn led to greater expertise in predicting potential future orders.
- The initial levels of acceptance of the new tool were unexpectedly uneven. While salesmen started using the new features almost immediately, there was some resistance among employees in production, as they initially perceived it mostly as a burden of additional work (entering more data into the system than was needed before) to be done besides their main business. In retrospect, more effort should have been devoted to explaining and discussing the benefits of the system with all employees (and in particular with production staff) in advance.

5.6.4 References

Research for this case study was conducted by Inova+, on behalf of the Sectoral e-Business Watch. Sources and references used:

- Questionnaire and e-mail exchanges with Paulo Moutinho, Commercial Director, and with Francisco Assis, System Analyst
- Company website of Probos: http://www.probos.pt

5.7 Toly Products (Malta)

Abstract

Toly Products is a global supplier of high-quality plastics packaging components for cosmetic products sold around the world by leaders in the cosmetic, fragrance and skin-care industries. In 2006, Toly celebrated 35 years of successful operations in Malta and Toly has also recently opened a new manufacturing plant in China. This case study focuses mainly on the impact of ICT on customer service within the company. e-Business has helped Toly to reduce costs and the workload, by enabling the company to be more efficient in its business processes. This ultimately translated into a more efficient and better customer service.

Case study fact sheet

■ *Full name of the company:*	*Toly Products Ltd.*
■ *Location (HQ / main branches):*	*Malta*
■ *Main business activity:*	*Luxury packaging manufacturer*
■ *Year of foundation:*	*1971*
■ *Number of employees:*	*400*
■ *Turnover in last financial year:*	*Toly Products Ltd. - not available*
■ *Primary customers:*	*Cosmetics, fragrance and skin care industries*
■ *Most significant geographic market:*	*Global*
■ *Main e-business applications studied:*	*Customer Relationship Management*
■ *Case contact person(s):*	*Ing. Robert Frendo, Toly Products Ltd.*

5.7.1 Background and objectives

Toly Products is a privately-owned company and fast becoming one of the world's leading luxury packaging manufacturers in the cosmetics, fragrance and skin care industries. Their clients include Chanel, Estee Lauder, Avon, Boots, Guerlain, Coty and Sephora.

In 1956, Dr. Zoli Gatesy, a toolmaker, escaped his native country Hungary for the UK as a refugee. Ten years later, he established his own company in the UK, building tools and injection moulding for the toy industry. However, in 1969 he decided to look for alternative manufacturing solutions and in 1971 Toly Products was founded in Malta. A few years later, a corporate decision was taken to specialise in the production of compacts for face powders, blushers and eyeshadows. However, in the early nineties, Toly invested in new state-of-the art technology in order to bring in-house a U.V. lacquering line. As a result, Toly started diversifying into fragrance packaging. Andy Gatesy took over as Toly's Chairman and CEO in 1991. Over the past 15 years, he has transformed the company to be a highly competitive group with offices around the world. In 2005, Toly also opened a joint venture manufacturing plant in Shenzhen China, of which Toly has 40% shareholding.

Managing order requests from various sales offices in different countries and time zones is a complex challenge. Senior management at Toly Products found that the original systems for sharing and managing data transfers were not capable of meeting the rising demands of an international business. Without a specialised Customer Relationship

Management (CRM) system to deal with information flows between the manufacturing plant and sales offices, the company's ability to respond quickly and accurately to customer needs was challenged.

5.7.2 e-Business activities

The challenge

Dealing with multiple sales offices with the previous system was time-consuming, and providing comparative reporting between business units was difficult and slow. Any process requiring data to and/or from sales offices necessitated a number of phone-calls, e-mails and faxes to the respective parties. Besides, there were also concerns about the consistency of data since practices differed from site to site. Standardisation of processes was non-existent, and paper-based CRM not only was cumbersome and resource-hungry, but also constricted the enterprise-wide decision-making and reduced internal efficiency.

Against this background, Toly figured out the following scenario: If users could share, use and rely on a central system, administrative time and costs could be reduced, management reporting made easier, and most importantly customer service performance improved. Toly decided that the most efficient solution was to establish a common platform and provide a vehicle to bring all sales-office information flows to a single focal point.

A need for standardised information flows

Since they were already using Lotus Notes and Domino for e-mail and calendaring purposes, the idea was that of building a central Lotus Domino database which could be accessed across the group network. The Toly Products team engaged Intertek, an IBM business partner, to consider the design and implementation of a centralised CRM solution for use across its sales offices operations. The aim was to introduce standardised information flows and to enable an audit trail of all correspondence to and/or from different sales offices.

The IT department at Toly Products worked hand-in-hand with the various departments concerned to come up with standardised templates for regular queries, received at the Malta plant from the various sales offices, on the part of customers. Regular queries included sales orders and enquiries, project quotation requests, complaints, and sample requests. It was made sure that these standardised templates included all the necessary fields so that there would be no waste of time in obtaining missing information. Design requirements were defined in 2000 and this was followed by development testing and end-user training. The system was up and running in 2001.

How the system works – the business process

Sales orders and enquiries are the much sought after information by sales offices. Following this development, sales offices would send the completed one-page sales order or enquiry template by e-mail through Lotus Notes. This would include basic details such as the name of the customer, the product code, the order quantity, as well as from which sales office and the date in which the template has been issued. The product description is uploaded as soon as the product code is inputted. Sales offices also have

the facility to insert the manufacturing tolerance of the ordered quantity, that is, the maximum acceptable variance in percentage terms.

Once the customer's name and sales office fields are entered into the template, the customer's invoice address and shipping invoice address are uploaded into the template respectively. This is because Toly Malta does not simply forward the ordered products to the sales offices, but it rather invoices the sales offices at cost-price to cover all expenses from their end and then it would be the sales offices which mark-up the price, sell the final product to the customer and eventually make a profit. In the Commercial Details section of the template, the price at which the product will be sold to the sales office, and the price at which the sales office would be selling the product to the customer, will be inputted by the particular sales office, in the Buy field and Sell field respectively. These fields are inputted after checking the costings data previously prepared by the production sales order processing officer.

In the Production Schedule of the template, the sales office would put forward a Delivery Request indicating the week number it would preferably receive the order, and the quantity of that particular order it would like to receive by that week. The production scheduling department would then see whether it can manage to deliver the order by that particular week. If no slot is found, they would try to schedule the order at the earliest possible date.

Once a delivery date is established, the purchasing department would check raw-materials availability. During this process a red button would appear next to the Factory Proposal (a field just below the Delivery Request received by the sales office) indicating that Toly Malta is still working on the order request and cannot give any feedback at that stage. When a consensus between the production scheduling department and the purchasing department is found, Toly Malta would input the Factory Proposal onto the template indicating by when the order would be delivered and the quantity at that stage. The red button next to the Factory Proposal would instantly turn into a green button indicating that Toly Malta has provided its feedback on the delivery request. It would be then the sales office, on the part of the customer, that decides whether to proceed with the factory proposal or otherwise.

Toly Malta has also invested in a custom-made Microsoft Access and VB.net ERP applications using an SQL Back-end Database called WISDOM. This consists of various interrelated modules that include operations management, logistics and quality assurance modules. As to sales orders, through the Lotus Notes Sales Order Importer module, the system imports data from the Lotus Notes database every hour. WISDOM, through the Navision Accounts Package Importer module, gives the facility to invoice as well as issue the sales offices with a customer invoice by e-mail once the sales order is imported in the database. This is still undergoing the test phase however, and currently has only been introduced between Toly Malta and the UK sales office.

The system also allows for the automatic generation of credit notes to sales offices when there are short shipments for a particular week. The process by which Toly Malta schedules production is still done manually using a number of Excel spreadsheets. However, work is currently being done on introducing a Production Planning module in the WISDOM database so that when orders are received this module automatically finds a slot for the production of such order request. Following this development, customer service will be improved further.

Effective processing of customer complaints

A template was also developed for customer complaints. Processing complaints effectively can turn an unsatisfied customer into a loyal one. By inputting the product code in the customer complaint template, information on the shipment traceability is uploaded instantly. The quality department at the Malta plant would decide on whether it is more viable to sort the products in Malta or abroad and action will be taken accordingly. A process is currently underway which can help in identifying the source of a potential problem instantly.

At present, machine operators are being given training on a Barcoding System. Since most of them are not computer literate and find it hard to use complicated technologies, they are each being provided with a bar-coded sheet and a barcode scanner. Different barcodes on the sheet represent different actions done by the machine operators or incidents that might happen during the shift, such as machine breakdowns. Whatever the circumstance, the machine operator would scan the respective barcode with the barcode scanner, which information would be instantly recorded in the system.

Through a linkage between the Customer Complaints System and the currently tested Barcoding System in the WISDOM database, once a complaint is filed, personnel at Toly Malta could enter the product code and they could easily trace who was working on that order, when and on which machine. This would help the manufacturing plant to identify the source of the problem at their earliest and take the required action to avoid any related complaints in the future.

Processing quotations and sample requests

Since the cosmetics industry adapts continuously to changing trends, quotations are rarely pre-established. One has to taken into consideration the type of tooling needed, whether it is available or whether it has to be tailor-made to the customer's request, the type of material needed, the decoration and coatings and so forth. Through the project quotation request template, sales offices simply have to fill in the details in the respective fields as requested by the customer.

Similarly, a sample request template is used when customers require a sample of a particular product. In this case, the sales office personnel would fill in the sample request form with all the required details relating to the sample; whether it is an existing sample or a custom sample that has to be produced from scratch. The sales office also states whether the sample is to be sent to the sales office, the customer or both. Once all the delivery information is entered and agreed upon, Fed-EX or TNT courier dispatch forms are printed automatically at reception for collection together with the samples by the courier agents.

Security measures

As to security measures, access is managed centrally with a username and password login. This ensures that although such data can be viewed by everyone in Toly Malta, changes can only be made by appropriate users. Besides, while at the Malta plant, information about all sales offices is readily available, different sales offices only have access to the audit trail of their own information flows. Substantial investment has also been made in equipment to securely manage for backup and recovery. This includes

daily full backups of data on to hard drives and tapes, a redundant backup server site and fault tolerant servers with automatic replication clusters and automatic fallback options.

The IT department at Toly foresees a browser-based access to the WISDOM database in the future. This will not only provide a simple user interface, but can be accessed any time on any internet-connected computer.

5.7.3 Impact and lessons learned

Impact

The new solution allows for central reporting and analysis without delays in information gathering. It allows Toly Malta's personnel to collate and analyse data very rapidly, compare performance at different sales offices, and significantly reduce both workload and costs. This has not only helped to cut administrative costs but, more importantly, it contributed to improvements in performance. In fact, whereas before, following a sales order request, it would have taken Toly Malta approximately one week to send feedback to the respective sales office, it now takes less than twenty-four hours. In fact, today Toly processes five times more orders than they did 10 years ago.

In the past, much of the data was stored in individual paper files or on one computer and far too much time was spent simply trying to find information. By having a single place for information and reporting, the company can now focus more on priority areas and suggest ways to improve performance, all of which contributes to group productivity. Further modifications to the system are expected to further improve performance leading to a better and more efficient customer service

Lessons learned

As to lessons learned from this whole process, the IT department is quite satisfied with what they have achieved so far. The current system involved a lot of work and effort to get it up and running and the ultimate aim is that of having a fully functioning enterprise resource planning (ERP) system. It would have been easier to buy an ERP system off-the-shelve and customise it, but it would have never given Toly the flexibility that their current system has.

Besides, all the current systems have cost Toly less than €120,000. In 1999, when they decided to switch from the old system to the new one, an off-the-shelf solution for manufacturing was at least 10 times more expensive. The only disadvantage was that it took quite a long time to get the system up and running in terms of programming and delivery of applications. However, since the system has been started from scratch, it is designed on the way that Toly operates; meeting more effectively end-user needs.

5.7.4 References

Research for this case study was conducted by Sara Buttigieg, Malta Federation of Industry, on behalf of the Sectoral e-Business Watch. Sources and references used:

- Interview with Ing. Robert Frendo, 12 September 2007, at Toly Products (Malta) offices.
- Website of Toly Products (www.toly.com)

5.8 Unicorn Ltd. (The UK)

Abstract

Unicorn Chemicals is a company specialised in supplying manufacturing chemicals to the automotive and utilities sectors. Its advantage stems from developing and manufacturing highly specialised solutions, which address particular customers' unique needs. The firm realised that knowledge about customers' problems combined with the knowledge of their purchasing patterns could generate cross-selling opportunities and increase revenues. However, its existing accounting system was unsuitable to support this. Thus, in 2003, the company decided to replace it with a new business management software. The system benefited the firm by helping it to reduce inventory levels and purchasing costs and to generate additional revenues.

Case study fact sheet

■ *Full name of the company:*	*Unicorn Chemicals Ltd.*
■ *Location (HQ / main branches):*	*Blackpool, UK*
■ *Main business activity:*	*Manufacture of lubricants and specialised chemical solutions*
■ *Year of foundation:*	*1971*
■ *Number of employees:*	*15*
■ *Turnover in last financial year:*	*€2.2 million*
■ *Primary customers:*	*Companies in the automotive and utilities sectors*
■ *Most significant geographic market:*	*UK / Europe*
■ *Main e-business applications studied:*	*ICT for management support, impact on productivity*
■ *Case contact person(s):*	*Mr Tim F. Kilpatrick, Managing Director*

5.8.1 Background and objectives

Established in 1971, Unicorn Chemicals is a small company based in Blackpool, UK. It specialises in manufacturing and supplying chemicals mainly for the automotive and utilities sectors. Its share in the UK market is around 3%. In contrast to many companies from the chemicals sector, Unicorn Chemicals' advantage does not rest in its scale of operations. Instead of producing chemicals in large quantities, it focuses on manufacturing highly specialised solutions, which address unique problems of particular customers. Then, after formulating a chemical solution, it produces and delivers it in small quantities.

Unicorn Chemicals' business model requires from it to closely cooperate with its customers in order to understand their problems and needs. To meet this requirement, Unicorn Chemicals dedicates considerable technical support devoted to working in close partnership with its customers and suppliers to identify requirements and specify solutions. Over the years, this approach allowed the company to develop a broad range of unique specialist products and solutions.

One of the most challenging issues Unicorn Chemicals faces when operating this way is the need to understand its customers. Extensive knowledge of customers' problems does not only allow the firm to develop appropriate solutions, but to generate and benefit from

cross-selling opportunities. This, in turn, translates into higher revenues and, consequently, growth.

5.8.2 e-Business activities

In early 2003, Unicorn Chemicals realised that its accounting operations were inefficient for two reasons. First, the existing accounting system, TAS Books, was becoming increasingly unstable and unsuitable for the company's requirements. Second, because finance functions were outsourced, the firm felt that it did not have accurate and up-to-date information on its business. Consequently, it realised that it was missing opportunities and chances for growth. To address this issue, Mr Tim F Kilpatrick, Unicorn Chemicals' Managing Director, decided to look for new applications, which "would allow the firm to track customers' purchasing profile, industry analysis and control stock."

System selection

With the above in mind, Mr Kilpatrick began to scan the market in search for a suitable application that would replace the legacy system and help the firm develop a better understanding of its customers and the solutions they buy. He knew that a number of its customers used standardised industry applications developed by SAP. In the course of informal talks with their representatives, he asked about their experience with the solution they used. Having gathered positive feedback, he contacted an SAP representative with a request for detailed information.

The interest in SAP software was strengthened by its proliferation in the chemicals industry. Thus, taking into account interoperability issues, the firm wanted to operate an application that has acceptance by its customers. "*Regarding our company support of the integration of companies into our business with the help of ICT, as a small organisation we generally respond to our customers' requests and let them take the project lead*," says Mr Kilpatrick.

The firm signed a contract with Yuma, a local SAP implementer, for implementing SAP Business One ERP and CRM modules. Although the system's modules cover nearly all business activities ranging from finance to human resource management, Unicorn Chemicals opted for a version that would match their immediate needs. Consequently, the primary focus was on supporting inventory management and sales and purchasing activities. Despite the fact that such modules as sales opportunities or production were equally attractive and appealing, the firm took a thoughtful approach and decided to wait until it had developed a concept to effectively use them and integrate into its business.

Implementation process and system cost

The implementation team had to install the application within a very short period of time. Because the financial year began on the 1st of October, Unicorn Chemicals insisted that the system went operational by then. Thus, considering that the implementation work began only a few weeks before, the time schedule was extremely tight.

Beginning in September 2003, the system provider implemented the software within 3 weeks. During this time three IT specialists worked at Unicorn Chemicals' premises and accomplished the following tasks:

- System configuration,

- Product and customer data migration,
- Staff training.

As planned, on the first of October 2003, Unicorn Chemicals began to use the new system. However, in order to guarantee a smooth transition from the legacy system to the new one, the firm decided to run both applications in parallel until the end of the year. Although employees used those three months to get familiar with the system and its functionalities, it turned out that no unexpected problems emerged and the application was relatively quickly adopted in the day-to-day business practice.

Despite the fact that the system became an integral part of the company, Mr Kilpatrick admits that **time and money constitute major barriers to the deployment** of ICT. "*If we were starting the project today, we would take more time in implementation. This is particularly important because even today, four years after the system launch, we learn to use more processes of the system. This is a continual development,*" says the firm's managing director.

The initial cost of hardware and software was €32,000. The running costs including IT consultancy and annual maintenance amount to €29,000. One of the new costs is an IT manager, employed to maintain the application. Apart from buying a new server, the firm did not have to make any technological adaptations to match system requirements.

5.8.3 Impact and lessons learned

Impact

Soon after implementation, the company began to experience positive effects of this decision. According to Mr Kilpatrick, "the system had significant impact on the work organisation. The work has become more organised and controlled. Furthermore, documentation and tracking functionalities proved very important."

The most important outcome of this project is the fact that the application made all information relevant for the firm's sales strategy available immediately. This enabled Unicorn Chemicals to achieve its primary objective defined before the project started, i.e. to effectively use customer information to create cross-selling opportunities. As a result, the firm realised the following benefits:

- **Increased sales efficiency**. The firm is able to analyse sales trends and identify sales opportunities that were not seen before.
- **Reduced overall purchasing costs**. Having got a greater grip over its sales activities, the firm can plan its purchases more efficiently, which considerably improved its purchasing operations. Furthermore, it gained a new ability to analyse suppliers, which additionally increases the efficiency of purchasing decisions.
- **Reduced inventory by 30%**. Accurate and up-to-date overview of company's sales and purchases improved control and visibility of stock. Furthermore, by immediately seeing which customers buy which offers, the firm can make special offers on redundant stock.

By integrating all relevant information on sales activities and allowing management immediate access to it, the system gave the firm more control over its operations and, therefore, allowed it to use it in a strategic way. This resulted in more efficient sales,

purchasing and inventory planning. However, all this was not solely achieved by adopting the new application. An important element that facilitated the above outcomes was to in-**source accounting and to recruit a finance manager**. Thus, only the combination of using the system and bringing the firm's accounting back in-house led to such positive results.

As mentioned above, the use of the system is a continuous learning process. Thus, not everything works smoothly all the time. Making the most out of the system functionalities still requires **effort and creativity**. For example, according to Mr Kilpatrick, "*Changing to a stock controlled system still gives us issues, but this is due to human error mainly*." This confirms only the general conclusion of the research on IT projects that companies benefit the most out of their IT investments when they combine them with other intangible investments such as training and organisational change.

Lessons learned

There are three issues that emerge from the current case study and are worth mentioning:

- **Clear objectives**: The management of the company clearly defined problems that were to be solved by the new system. This allowed it to stay on track despite limited resources and a tight implementation schedule. As a result, it procured only those system modules, which it could efficiently integrate into its business at the time.
- **IT compliance with business**: The decision to implement an IT solution is only half of the success. The other half is to integrate the system with the company's targets and strategy.
- **Continuous development**: The creative use of IT systems does not end once it is implemented, but it actually starts there. Re-discovering the system's functionalities and deploying them in a new context guarantees an efficient use of the applications.

5.8.4 References

Research for this case study was conducted by Aneta Herrenschmidt-Moller (aneta@hmoller.com), on behalf of the Sectoral e-Business Watch. Sources and references used:

- Interviews with Mr Tim F. Kilpatrick, Managing Director at Unicorn Chemicals, August/September 2007.
- Yuma, IT provider: Unicorn Chemicals – Unlocking sales opportunities with SAP Business One. http://www.yuma.uk.com/ (last accessed on 1 September, 2007).
- Unicorn Chemicals company website: http://www.uchem.co.uk/ (last accessed on 1 September, 2007).

5.9 Zachem S.A. (Poland)

Abstract

Zachem S.A. is a large company supplying organic and inorganic chemical products to the chemical and power industry. The case study illustrates how a large state-owned company was confronted with changing market conditions. The main challenge in the new environment was to abandon a complex and inflexible organisational structure and create an efficient information management system. The effort made to adapt to this new reality was the creation of a telecommunication infrastructure connecting all business units and an implementation of a business management system. These created a new information culture and led to the digitalisation of all business documents.

Case study fact sheet

■ *Full name of the company:*	*Zachem SA*
■ *Location (HQ / main branches):*	*Bydgoszcz, Poland*
■ *Main business activity:*	*Manufacturing organic and inorganic chemical products and intermediate products*
■ *Year of foundation:*	*1948*
■ *Number of employees:*	*about 1,400*
■ *Turnover in last financial year:*	*about €25 million*
■ *Primary customers:*	*Companies in the chemical and power industries*
■ *Most significant geographic market:*	*Poland (65%), worldwide exports (35%)*
■ *Main e-business applications studied:*	*Enterprise Resource Planning (ERP)*
■ *Case contact person(s):*	*Mr Robert Kalinowski, Director of the IT Department at Zachem*

5.9.1 Background and objectives

Established more than 50 years ago, Zachem S.A. is one of the most important chemical enterprises in Poland and one of the biggest companies of the north-western part of the country. The company specialises in manufacturing organic and inorganic chemical products and intermediate products for the chemical, cable and power industries. Its main products include flexible polyurethane foams and toluene diisocyanate (TDI), polyurethane epichlorohydrin (EPI) and allyl chloride (AC). Furthermore, it is also an established producer of a wide range of PVC-compounds and a number of inorganic products, such as hydrochloric acid, sodium hydroxide, and sodium hypochlorite.

Founded as a state company, the firm was of strategic importance for chemicals production in the complex state-controlled industry system. As a result, it evolved into a large centrally-managed conglomerate producing various types of products in large batches. However, due to the political and economic transformation starting in 1989 Zachem S.A. was confronted with new challenges and had to adapt to new market conditions. It became clear that the firm was not able to maintain its large size and extensive scope of operations. The company needed to become more efficient and flexible in order to survive in the new competitive environment.

Another legacy of past times the firm had to deal with was the lack of accurate information for taking management decisions, which would enable it to react faster to changing conditions. According to Robert Kalinowski, Director of IT Department at Zachem, "*an information infrastructure hardly existed in the company back then, and the development or implementation of a management system that could support such a large organisation was out of reach as well*." Consequently, one of the main points of the restructuring programme was a structural transformation. In 1992, Zachem S.A sold its explosives manufacturing unit and adopted a holding structure, i.e. the firm was split into five units with separate sales, marketing and accounting divisions. According to the company speaker, this change of structure enabled the firm to significantly reduce the reaction times and enabled it to survive the turbulent times.

Although the new organisational structure worked well, new problems emerged. In 1998, the company realised that information from the various units was not collected centrally and did not give a holistic picture of the company's operations and condition. Thus, the management board decided to build an information infrastructure and implement an enterprise resource planning (ERP) system. The case study describes this process.

5.9.2 e-Business activities

Telecommunication infrastructure

Including 60 buildings, Zachem's industrial complex was the second largest in Poland. Thus, considering that it had to start from scratch in order to create an information infrastructure and implement a business management system, the computerisation project involved considerable costs. In order to build such an infrastructure the firm needed to lay down 34 km of fibreglass and connect all buildings within the company's new telecommunication network. This network was, however, a precondition for further development of the ICT infrastructure.

ERP system selection

The firm began working on specifying its requirements for a business management system in 1998. According to Mr Kalinowski, the system was to support production, sales, distribution and accounting operations of all five conglomerate units. Zachem S.A. considered three main offers made by IFS, BAN and SAP.

Zachem gives several reasons for finally selecting the offer from SAP. The main reason was the positive feedback the company got from two business partners: Petrochemia Płock S.A. and Zakłady Azotowe Kędzierzyn S.A. The first one is one of the largest refineries in Poland and, according to Mr Kalinowski, has a structure similar to the one of Zachem S.A. "*Having seen positive outcomes of the system implementation at Petrochemia Płock S.A., we believed that we could replicate their success in our company. Furthermore, their employees gave us positive feedback after the system launch, which additionally encouraged us to go ahead with the plan.*"

The second company, Zakłady Azotowe Kędzierzyn S.A., is one of the leading Polish producers of polyamides, acetal copolymers and fluorine plastics. It implemented an identical ERP system as the one planned by Zachem S.A. in 1997/98. "*Due to the fact that Zachem S.A. maintained very close links with this company, we could benefit from its experience. One of the directors of Zakłady Azotowe Kędzierzyn S.A. served us as a*

consultant at the time when we did not know the system and had no idea which direction the entire project was to go. He was basically leading us by hand," says Mr Kalinowski.

In addition to recommendations from business partners, the selection of the particular application provider was driven by its reputation. "*We wanted to install an application that was recognised worldwide. This was an important requirement considering that we anticipated that sooner or later we were going to be privatised and/or taken over by another company. We anticipated that the system in place would have an impact on the company value. This was confirmed when it came to the privatisation and estimating the value of the firm,*" says Mr Kalinowski.

System implementation

The implementation work began in February 1999. As mentioned above, the system covers five business units. An project team with selected employees from the respective units was built. They were assigned to sub-teams, organised along the system architecture, i.e. the following modules:

- Controlling
- Finance
- Sales
- Distribution
- Asset management

Out of every module team, two persons were selected who took the leading roles for the particular module. These persons were responsible for mapping the existing process structure and then developed implementation blueprints. These blueprints served later as a road map for the implementation of the system. Ten months after the project launch, the system went live.

Altogether, 120 of Zachem's employees and 30 external consultants were involved in the project. Nearly 300 employees went through training on system functionalities.

System usage

The ERP system together with the new ICT network created an information infrastructure, which unifies operations of the five units. Today, all data and information on their activities, from input supply, controlling to sales, is centrally stored and available to the management. As a result, the company has a clear overview over all key business processes.

According to Mr Kalinowski, the system supports only internal activities. Electronic integration with suppliers and customers has not taken place and is not considered by the management at the moment. "*One needs to understand that our holding has five manufacturing units with own organisational structure and, moreover, unique production system*", explains Mr Kalinowski. "*Consequently, all of them are various requirements and have different suppliers and customers.*" This heterogeneity prevents Zachem S.A. from using a single IT platform supporting collaboration with external partners.

Products and markets specificities place additional constraints on integrating with external firms. "*For example, there is no single market for dyes or foams. Consequently, in order to account for unique characteristics of every project, creating an inter-firm data exchange system would require costly customisations*", says Mr Kalinowski. Furthermore, most of the production takes place in large batches and is based on long-term contracts.

"*For example, EPI is ordered in advance and then sold in a few-tone batches. Thus, all production steps and necessary inputs for the unit producing it are planned and ordered at least one year ahead. Further integration and electronic exchange of data with suppliers or customers would be superfluous,*" explains Mr Kalinowski.

Concluding, due to the specificities of Zachem's production and operations, the company primarily concentrates on ICT use to support internal operations. Electronic integration is not considered at the moment not because it is technically impossible, but because of the specificities of the market in which the firm operates.

5.9.3 Impact and lessons learned

Impact

The ERP system, together with the new telecommunication infrastructure, created an integrated information system, which delivers up-to-date information on processes taking place in all business units. According to Mr Kalinowski, "*the system completely transformed the company's information culture. Beforehand, all information was transferred in paper form and the company did not make any use of electronic mail or the internet. Since 1999, all white-collar workers use these tools on a daily basis. Furthermore, considering that all data is available online, company management can access it anytime and anywhere.*"

Having had a positive experience with the introduction of ICT tools, Zachem S.A. continued to invest in new applications. The ERP project triggered, for example, the creation of an intranet. This enabled the company to substitute paper-based processes and documents by paperless documentation. An example of such a paperless project was the implementation of management practices based on ISO standards. "*Compared with the past, we turned into a completely new firm. Even in comparison to other companies in our sector, we are perceived as an example of business computerisation,*" says Mr Kalinowski.

Lessons learned

Mr Kalinowski names the following lessons the company learned during the project:

- *"Due to the large size of the company, the firm had to incur considerable costs. However, considering that we had to start from scratch, the main cost was caused by the lack of knowledge and expertise. Nearly 300 employees went through extensive training programmes, which often dealt with simple and basic issues. Today, with this knowledge we could definitely carry out a similar project without spending so much resources."*
- *"I must admit that the large investments made in human capital constitute the main source of the added value that came from the system."* This confirms the necessity of investments into assets complementary to the technology.

5.9.4 References

Research for this case study was conducted by Aneta Herrenschmidt-Moller (aneta@hmoller.com), on behalf of the Sectoral e-Business Watch. Sources and references used:

- Interviews with Mr Robert Kalinowski, Director of IT Department at Zachem, September 2007.
- BCC, IT provider: Zakłady Chemiczne Zachem SA. Wdrożenie systemu SAP. http://www.bcc.com.pl (last accessed on 21st of October, 2007).
- Zachem SA company website: http://www.zachem.pl (last accessed on 21st of October, 2007).

5.10 Zandleven Coatings (The Netherlands)

Abstract

As a producer of coatings for the Dutch national market, Zandleven is known for its flexibility and ability to deliver on demand. The order management is merely supported by traditional channels such phone and fax. Since 2002, customers can place orders through the Zandleven website. The customers' web-input is transferred by e-mail to the internal planning system. Until 2007, however, this 'loosely-coupled' web-order application has only been used as an additional order channel. Both the customers and planners at Zandleven prefer phone and physical contact as the way to do business. The usage of an online sales channel at Zandleven is a good example of how e-business will only function as an additional tool if an industry has built strong traditions of local, flexible and ad-hoc supply chain processes.

Case study fact sheet

■ *Full name of the company:*	*Zandleven Coatings*
■ *Location (HQ / main branches):*	*Leeuwarden, The Netherlands*
■ *Main business activity:*	*Production of coatings for use on metal and concrete surfaces*
■ *Year of foundation:*	*1869*
■ *Number of employees:*	*30*
■ *Turnover in last financial year:*	*Approximately €10 million (2006)*
■ *Primary customers:*	*Contractors in the building and marine sector*
■ *Most significant geographic market:*	*The Netherlands*
■ *Main e-business applications studied:*	*Web-based ordering*
■ *Case contact person(s):*	*Ing. G.J. Noordhuis*

5.10.1 Background and objectives

Zandleven Coatings focuses on the production of coatings, typically for use on large metal, steel and concrete surfaces which are exposed to oxygen and water. Examples are bridges, football stadiums, yachts and other types of large objects of construction.

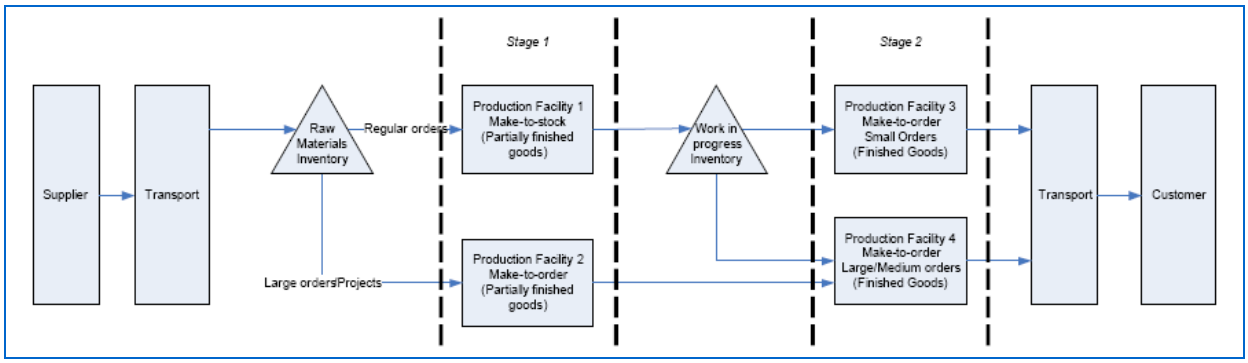
The (B2B) market in which Zandleven operates is of a relatively traditional and stable type. More than often, customers contact Zandleven with orders to be delivered within 24 hours. Zandleven is able to deliver products in a large array of colours. Their supply chain strategy has shifted from made-to-stock to make-to-order. The organisation is currently key-focused on flexibility and production in very small batches.

Zandleven has the lion's share of its sales in the Netherlands (estimated at 99%). consisting of about 500 loyal customers. Due to the high flexibility in demand, the market has a limited geographical footprint. Within the Dutch B2B market for coatings, Zandleven has three main competitors. Each of the four competing firms has approximately 25% market share. The competition is mainly on price and delivery period.

It was after the year 2000 that Zandleven made the transition from make-to-stock to make-to-order. The main drivers were the exceeding costs of warehousing and the increasing number of customers that demanded high flexibility in their ordering. As a

consequence, Zandleven needed to redesign its supply chain in order to significantly reduce the switching points and changeover times within their primary processes. Their current production process is schematically displayed in the figure below.

Exhibit 5.10-1: Schematic overview of the production process of Zandleven



Next to the changes in the production and supply chain process, Zandleven also implemented an ERP system to support the order management, production planning, billing and financial control. In addition, ideas emerged to implement a web-order application in order to leverage the website and to support order and sales processes. The owner of the company was the main initiator and sponsor of the subsequent IT and e-business investments at Zandleven.

5.10.2 e-Business activities

Background

The web-order application was initiated about five years ago as an extension of a larger automation and digitisation process, including the implementation of an ERP system. The costs of the project were about €10,000. The application was developed by an external service provider. No industry standard was used for the design of the order forms. As far as Zandleven knows, their competitors do not have or use this type of application yet.

The application was developed as a 'loosely-coupled add-on' to the ERP system. The online orders are sent to the planners of Zandleven who receive them by e-mail. After that, the orders are validated, manually checked and eventually discussed with the customers by phone or e-mail. Although the application was not designed as a full and integrative e-business solution, it turned out that the consequences of using the system for the Zandleven internal work organisation were underestimated during the implementation.

The external alignment of the application towards customers

In practice, Zandleven receives 40 to 80 orders a day. The largest part of the customers sends their orders by phone, fax or e-mail. Only about 10% of customers use the web-order application. From the perspective of the production planners at Zandleven, the added value of the application is therefore quite limited. It does not make a large difference – so they say – whether they receive an order directly via e-mail or by an automatically generated e-mail when a customer has entered his order into the web-based order form.

Moreover, many customers who order online on the web want to confirm their order by making a phone call. This is caused by the fact that many orders consist of very specific information that cannot be included fully and easily in the online form. A typical example of such information are the specific (and unusual) times and places of delivery of the different products. In nearly all cases, customers want to be absolutely sure that the ordered products will arrive at the right spot and at the right moment. Hence, to assure that Zandleven received the web-order, they call the production planner by phone.

Zandleven's customers prefer the use of telephone for other advantages as well. Quite often, phone calls are used to negotiate the price of a product. By tradition, customers especially want to negotiate when dealing with large orders. In addition, both customers and planners at Zandleven prefer to exchange information regarding minimum efficient scales for production and logistics by phone or face to face.

Web-based orders are mainly placed by customers who have a well organised and advanced planning system, i.e. by companies that are able to order their products several weeks in advance. However, there is another – less business-driven – criterion which determines usage of the system by customers: the age of the customer's employee who actually places the order seems to have a significant predictive value for the choice between placing orders in a more 'traditional' way (by phone, fax or e-mail) or placing them online. The older buyers hardly ever use the web-based system, while the younger generation quite often does.

The internal alignment of the application towards production planning

The customer demands and related flexibility of Zandleven's production process implies a production planning on a daily, even hourly basis. To optimise the use of the scarce production capacity, planners have a lot of direct contact with their customers. Besides processing the short-term and ad-hoc orders, they try to anticipate on what customers exactly need at which moment. A typical example may help to illustrates this point: a customer orders 10,000 litres of blue epoxy protective coating and wants it delivered within 24 hours. By calling and negotiating with the customer, the planner is able to re-specify the order. For example, it is agreed that – instead of delivering the full order within a day – 1,000 litres are delivered for 10 days in a row, starting by tomorrow. In this way, Zandleven is able to stay flexible, keep customers satisfied and stay in touch with the market.

However, the option of directly linking the web-order form to the ERP system to create a fully integrated sales application is a subject of consideration at Zandleven. Currently, the company still takes the position that this would actually reduce its flexibility. A prominent struggle is between a service system to satisfy every single customer directly if necessary, and a planning system that satisfies all customers on a collective level. For sure, low flexibility would lead to longer delivery times – and unhappy customers. Furthermore, each type of production planning will be sub-optimal, leaving expensive machinery and scarce production capacity unused. Zandleven therefore chooses to base their production process planning primarily on individual orders, as this is the key value adding of the company. Exceptions are made, though, for orders which have to be delivered several weeks in the future. These orders can easily be planned by the automated (ERP) system.

5.10.3 Impact and lessons learned

Impact

As can be derived form the above descriptions, the web-order application only has a limited impact both on internal processes (such as sales, work organisation, production processes, inventory management) and on external domains (such as business relationships with suppliers and customers and logistics). It appears however, that the application nevertheless has positive effects on the image of Zandleven as an innovative and flexible organisation.

This is indicated by the significant number of customers that appreciate and use the online ordering system. Although their proportion is relatively low yet (approximately 10%), these customers can be considered as early adopters. If the number of customers with automated planning systems increase, as well as the number of repetitive orders, the share of orders that will be processed through the web application is going to increase.

From an internal alignment perspective, the application has made all employees at Zandleven aware and better accustomed to the concepts of web-based sales and e-business in general. Consequently, future operations in the field of e-business could have fewer organisational resistance.

Lessons learned

Mr Noordhuis, the technical manager interviewed at Zandleven, acknowledges the limited use of the web-ordering application, but says that this was to be expected, because the application was intended to be deployed at a low level of ambition. The costs of development and implementation were accordingly relatively low. Nevertheless, he says that a main learning point is that the application has positive effects for customers and for the organisational awareness towards e-business within Zandleven.

Another important learning point is the observation that a fully integrated and used online sales application could be in conflict with the core-competence of the company, i.e. their made-to-order and flexible (on-demand) planning system. Zandleven has currently found a good balance between customer fulfilment and production optimisation, commencing the web-order application for specific customers and orders only. Obviously, this balance might be adapted if future needs of customers or other parties change.

Companies similar to Zandleven can learn a number of things from the results of this particular case. First of all, they should assess how an online sales applications matches their primary planning processes, i.e. their current production and order management system. Secondly, the customer perspective must be considered: what exactly is the incentive for customers to place orders online? What is the proper mix with using phone calls, fax and e-mail? Can these channels eventually be integrated? Customers often want to exchange additional information or just to confirm that the order is actually received and processed. This case study shows that it is a challenge to explore what e-business applications can do and cannot do, in order to align them internally and externally and become successful.

5.10.4 References

Research for this case study was conducted by ir. ing. Reg Brennenraedts, Dialogic innovatie & interactie, on behalf of the Sectoral e-Business Watch. Text by ir. ing. Reg Brennenraedts and dr. Ronald Batenburg. Sources and references used:

- Interview with ing. G.J. Noordhuis, 24 September 2007, Leeuwarden
- Website of Zandleven: http://www.zandleven.com

6 Outlook and policy conclusions

6.1 Outlook: scenario for e-business developments in the sector

6.1.1 The big picture – ICT as a "general purpose technology"

General purpose technologies and the (ending) 5th Kondratieff cycle

ICT is often classified as a "**general purpose technology**" (GPT). Economists use this term for technologies which are so pervasively used in all business areas that they have a profound effect on the entire economy rather than just causing incremental innovation (cf. Bresnahan and Trajtenberg 1992; Helpman and Trajtenberg 1998). The findings of this study support the view that ICT is indeed becoming a GPT in the chemical, rubber and plastics industries. However, it is a process that still unfolds itself and is far from being completed; the way how ICT is used in business is not only becoming more and more pervasive, but is also progressing toward more advanced and sophisticated forms of data exchange. The real technological disruption (in the sense of the GPT concept) comes with automated data flows within and between companies, enabled by connected ICT systems. These –more advanced– forms of e-business are now being widely practiced by large companies in all manufacturing sectors, but the digital divide toward the small firms is still hampering the full deployment (see Sections 3.3-3.5). Thus, while ICT can already be seen as a GPT, it is not the end of the story.

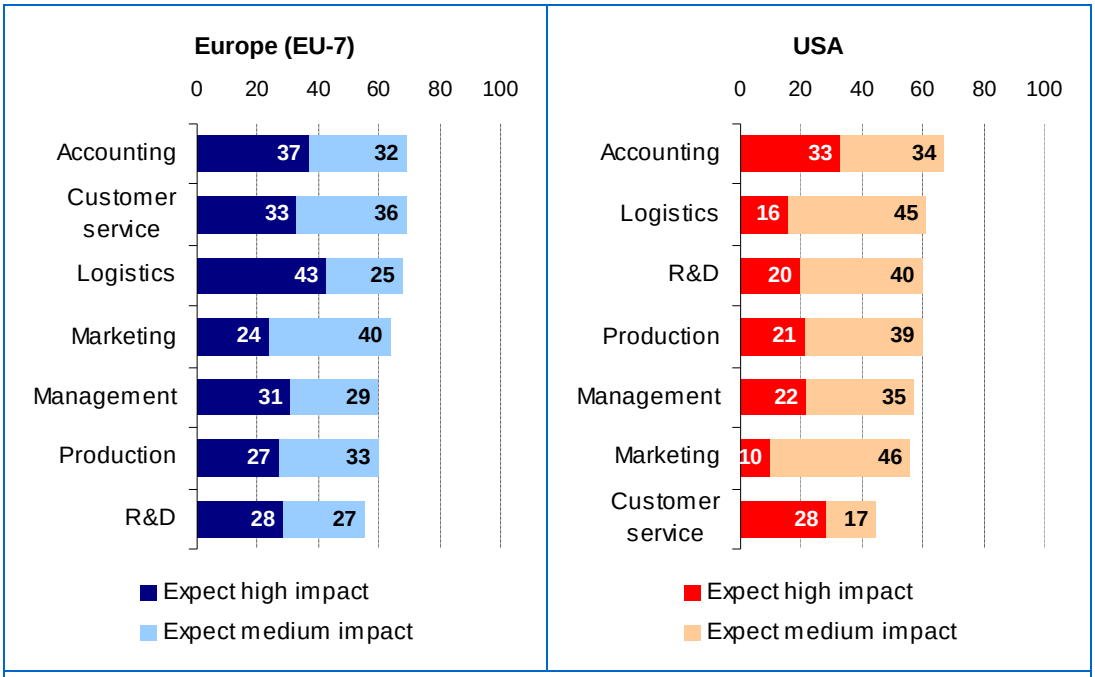
Another "big picture" model could help to frame the overall development. The concept of GPT bears similarity to Kondratieff's model of long waves of economic development,[164] which also stresses the importance of technological innovation as a key determinant for economic developments. It is frequently argued that ICT have been the driver and key technology of the **5th Kondratieff cycle**, starting in the 1980s with an expected life-cycle of about 40 years. If the model holds true, however, the current wave of economic development has reached (or is close to reach) its turning point. If so, the next phase would typically be characterised by economic downturn, recession and even depression, before a new economic style emerges. The current crisis of the financial markets and its severe implications for the economy as a whole could be seen as a writing on the wall. Moreover, the urgency of environmental issues, such as the pending impact of climate change and the growing scarcity of non-renewable natural resources, suggest that technologies supporting **sustainable development** are gradually becoming the key technology of the next economic cycle. ICT will continue to play a role in this context but will probably no longer constitute the technological paradigm of the new era in itself. The energy-intensive chemical industries could be a prime example to study the change of economic paradigms. ICT will continue to be important, but the real issue and challenge for this sector for the years to come will be sustainability.

[164] Nikolai Dmitrijewitsch Kondratieff (1892 - 1938), a Russian economist, proposed a theory (1935) that Western capitalist economies have long term (40-60 year) cycles of boom followed by depression. The deployment of new cycles is triggered by technological innovation. Today, these cycles are referred to as "Kondratieff waves".

Where companies expect ICT to have an impact in the future

However, this does not mean that ICT will become insignificant any time soon. In fact, companies in the CRP industry expect that ICT will actually have an important impact in the years to come in practically all areas of business, as the e-Business Survey 2007 demonstrates. Companies were asked to rate the expected impact of ICT for several primary and support activities of their value chain. For all business functions, companies representing more than 50% of the sector's employees anticipate a "high" or at least a "medium" impact of ICT, which further supports the concept of ICT as a "General Purpose Technology". The areas where most European companies anticipate a "high impact" are logistics (43% by their share of employment), **administration and accounting** (37%), customer service (33%) and management and controlling (31%) (see Exhibit 6.1-1).

Exhibit 6.1-1: % of CRP companies expecting that ICT will have a high/medium impact on … in the future (2007)



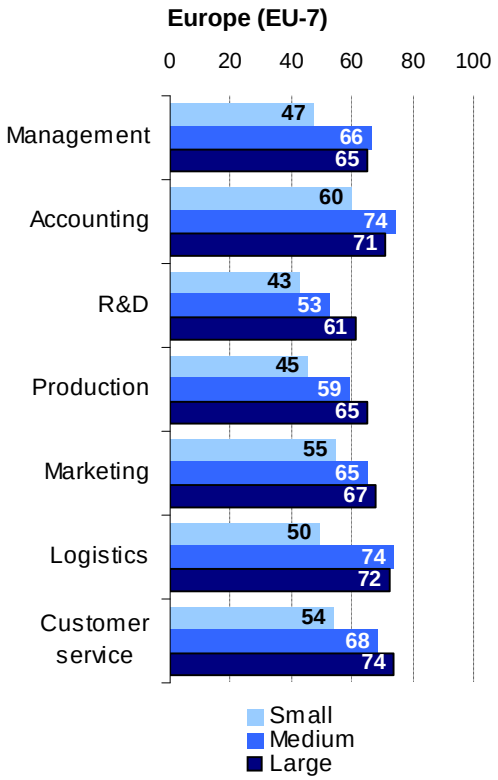
Base (100%) = CRP companies using computers from 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) / from the USA. N (2007) = 811 (EU-7) / 100 (USA).
Weighting: by employment ("firms representing x% of employment in the sector / country")

Source: e-Business Survey 2007 by the SeBW

By and large, the picture is similar for **European and US enterprises**, with two exceptions: first, US companies are somewhat more hesitant to say that they expect a "high" impact of ICT, but rather opt for the "medium impact". Second, and this comes as a surprise, US companies in the CRP industries appear to be less convinced about the impact of ICT on marketing and notably on **customer service** (see Exhibit 6.1-1). While the latter ranks second among European companies with nearly 70% of firms expecting ICT to have a noticeable impact in the future, apparently only about 45% of US firms see customer service as a relevant field of application. This is somewhat in contrast to the finding that relatively more US CRP companies sell their products online (65%) than European companies (33%) – see Section 3.5.1.

The world's largest chemical company, BASF, would not subscribe to the sceptical attitude of US firms in this area. BASF is absolutely convinced that customer service is not only an important application area for ICT, but possibly *the* single most important one in the future. "Being available for the customer whenever needed" is the firm's credo (see case study in Section 5.2), and e-business is supposed to be the instrument to achieve this goal. The study supports this perspective. All evidence found study indicates that BASF got the mission statement for its e-business strategy right.

Exhibit 6.1-2: % of CRP companies expecting that ICT will have a high or medium impact on … in the future – by size-band (2007)



It is clear, however, that the importance of ICT increases with the complexity of operations that have to be managed, and therefore a global player will have to place more emphasis on its e-business strategy than small firms, in particular if they operate in well-defined, structured markets. Reflecting this principle, more large companies anticipate ICT to have an impact on their business than smaller ones (see Exhibit 6.1-2). There is hardly a difference between medium-sized and large enterprises in the perceived future impact, however, and even the gap toward the small firms is not very pronounced. All in all, results point at a high level of awareness for ICT-related issues in the industry. A majority of firms, in particular among medium-sized and large ones, is convinced that ICT will be important for them.

Base (100%) = CRP companies using computers from 7 EU Member States (DE, FR, IT, ES, PL, SE, UK). N (2007) = 811.

Weighting: in % of firms (from the respective size-band)

Source: e-Business Survey 2007 by the SeBW

6.1.2 A life-cycle perspective of e-business developments

The views of ICT as a general purpose technology (which is widely diffused and used) and as a technology that will be important in the future are not contradicting each other, as it might seem at first sight. The apparent paradox can be solved if ICT-enabled innovation in business is regarded as a **sequence of innovation processes**, each with its own life-cycle, driven and enabled by technological progress and the resulting e-business applications and practices. Such a **technology life-cycle** can be structured into four phases:[165]

[165] See, for example, Gerpott 1999 and Wamser 2001.

1. Phase: **Emerging technologies** (or "question mark technologies" are in an early state of the product life cycle and not yet widely diffused. Their competitive potential often remains unclear. Investments in such applications require companies to take a certain risk. Early adopters believe that the technology will reach critical mass in the future and that they can benefit from first-mover advantages. An example of such a technology could be RFID a few years ago.
2. Phase: **Pacemaker technologies** are not yet widely used, but show high growth rates in diffusion. They are expected to have significant competitive potential. Firms should seriously consider investments in these technologies, as the risks of non-adoption have to be weighed against investments risks. RFID can currently be regarded as a pacemaker technology in some sectors.
3. Phase: **Key technologies** are in an advanced state in the product life cycle (growth or maturity stage) and already quite widely diffused. They can help companies to create competitive advantage or can even be indispensable. Adoption of such technologies can be a must for many companies. In the field of e-business, ERP systems could be regarded as a key technology for medium-sized and large manufacturing companies.
4. Phase: **Basic technologies** or applications are widely diffused in the industry and do no longer have much strategic potential for companies. They are either routinely embedded in business processes, or they could phase out by being gradually replaced by a substitute technology (with a higher competitive potential). The maintenance of base technologies should be a routine activity for firms and not require major efforts. Having internet access is a basic technology for at least 98% of companies today.

These phases can be displayed as an S-curve diffusion path (cf. Rogers 1962) or, alternatively, can be arranged in a four-field matrix which has been adapted from the Boston Consulting Group matrix for analysing business portfolios.[166] In this technology life-cycle matrix, the vertical axis represents the **strategic potential** of a technology or application, the horizontal axis the **degree of adoption** (measured as % of firms using this technology). The four fields can be attributed to the four phases described above. The matrix can then be used to **map the maturity status of ICT-based applications** and for e-business practices. Furthermore, the matrix allows to show differences between sectors or companies of various sizes in terms of the deployment status and strategic potential of the respective applications and practices.

Exhibits 6.1-3 and 6.1-4 summarise the results of this study for companies from the CPR industries, differentiating between small, medium-sized and large firms. The graphs suggest that basic ICT infrastructure is indeed becoming a commodity, while more advanced e-business practices can be viewed as pacemaker or key technologies with a higher strategic potential for firms, in particular for SMEs.

[166] The business portfolio matrix was created by Bruce Henderson for the Boston Consulting Group in 1970 as a strategic tool to support companies in analysing their business units. In this matrix, business units (or products) are positioned according to their relative market share (horizontal axis) and their growth rates (vertical axis).

Most companies in the CRP industries, including the smaller ones, have adopted **basic ICT infrastructure**. They have internet access (increasingly broadband), use e-mail to communicate with their business partners, have a website and have connected their computers internally at the site (see Section 3.2). There is little strategic potential to be gained from this type of ICT infrastructure in itself, as it has become a basic technology for doing business.

By contrast, more **advanced forms of e-business** are not yet as widely deployed (see Sections 3.3-3.5); they have not yet reached the status of basic technologies and thus hold a higher strategic potential for many companies, notably for SMEs. Practices such as the exchange of standardised data with suppliers and customers, and the integrated processing of data between different segments can be means to gain competitive advantage. Technologies and applications supporting these processes can be expected to become key technologies for SMEs in the years to come.

Exhibit 6.1-3: Basic ICT infrastructure from a technology life-cycle perspective

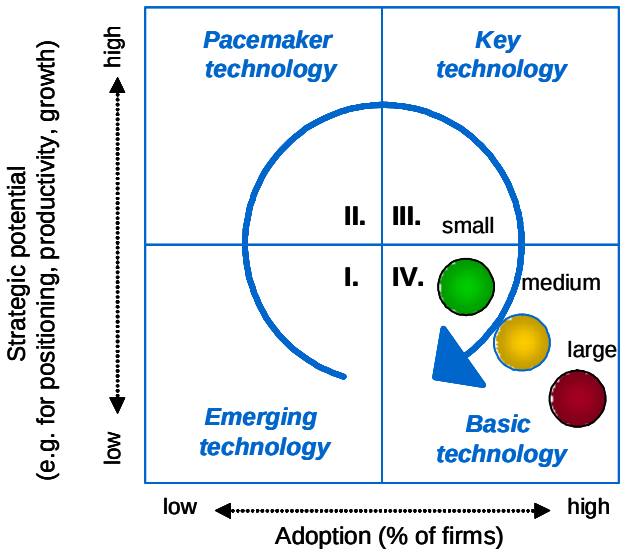
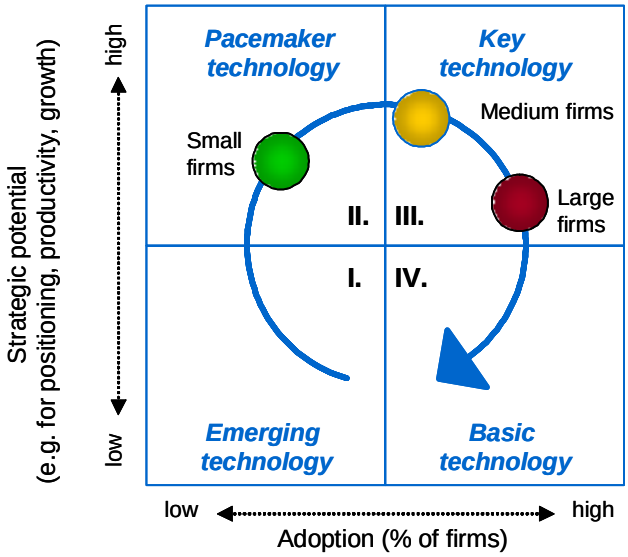


Exhibit 6.1-4: Advanced e-business processes from a technology life-cycle perspective



Source: empirica (2008)

Using this model as a framework, a possible objective of industrial policy could be to accelerate the innovation process, notably the progress of SMEs along the innovation path. The main argument is that those economies where companies are faster in going through this innovation cycle can achieve comparative advantages (e.g. in terms of productivity growth) and begin the next cycle of ICT-enabled innovation –whatever the new applications will be– earlier than others (see Section 6.2 – Policy implications).

6.1.3 Trends to watch – new applications

"Customer service 24/7"

One of the overall trends emerging from this study is the increasing importance of e-business applications for providing optimal **customer service** (see also Section 6.1.1). Companies realise that e-business is not only for facilitating business transactions (e.g. placing orders, invoicing and making payments), but also for providing related information (e.g. product information about chemicals) at any time the customer needs it. ICT offer enormous opportunities in this regard (see Section 3.5), enabling companies to provide information 24 hours a day.

The web can be used as a cost efficient channel for information provision, while internal information management systems (e.g. ERP-based modules) deliver the required data. However, it remains to be seen to what extent new ways of using the web for interacting with customers will be relevant for traditional manufacturing companies such as chemical companies. In the e-Business Survey 2007, about 20% of the companies said that they considered **Web 2.0** to be a relevant topic for them, but only very few considered it to be highly relevant (see Exhibit 6.1-5). Interestingly, US companies are much more convinced about the future importance of Web 2.0. Here, more than 40% said it was a relevant development.

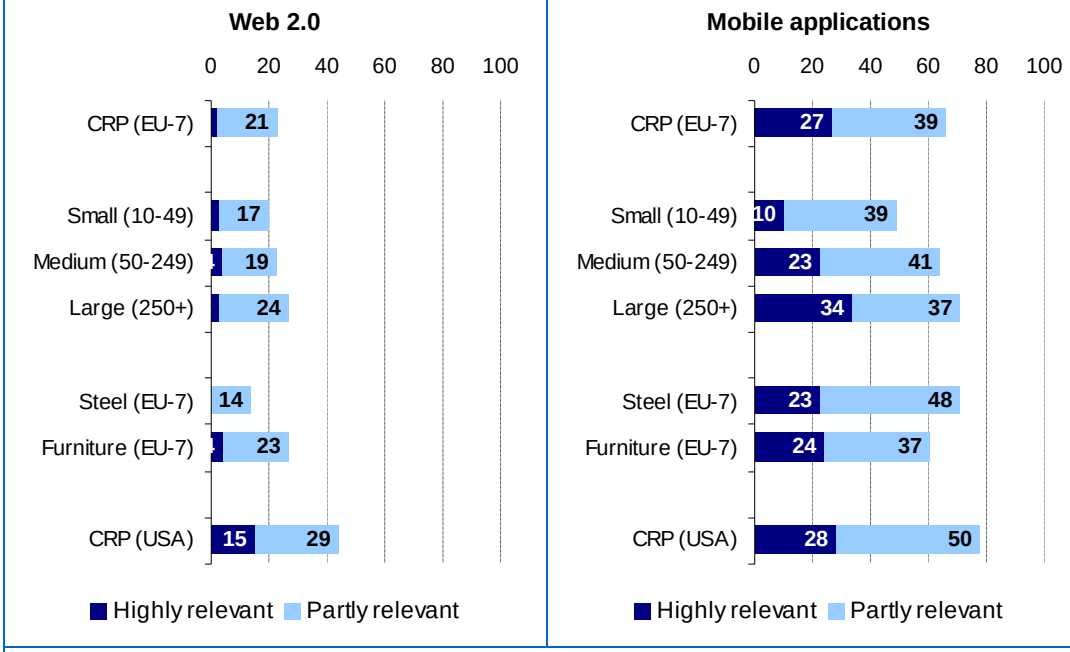
"Web 2.0" is a buzz word and highly fashionable topic in business conferences. The term describes a concept of using web technology for information sharing and collaboration among communities. In particular, it relates to web-based tools such as social-networking sites, wikis[167] and blogs[168]. The business model of many Web 2.0 applications is based on the principle that the content is mostly contributed by the users themselves (i.e. by the community), while the service providers establish and maintain the technical platform and control that it is not abused. The term should not be misunderstood as a "technical upgrade" to a new version of the web in terms of technical specifications. It relates to changes in the ways how service providers and users interact.

The question is whether and how companies in the CRP industry can exploit this concept for their own marketing purposes. For example, large companies that maintain extranet portals (see Section 3.5) could consider whether their customer portals could be enhanced with Web 2.0 functionality by giving customers a platform to interact with each other (e.g. by placing testimonials on their satisfaction with a given product). Obviously, this is risky and a new terrain for most companies, as they would no longer be in full control of the communication. On the other hand, there are opportunities as well; for example, if customers are given the opportunity to provide "technical support" to each other on a well-managed company wiki (where customers can insert questions on products as well as respond to questions of other customers), this could greatly enhance customer service (and reduce the work load of the customer service departments). However, this is future thinking, with considerable uncertainties.

[167] A wiki is a software that enables users not only to read content on the web, but to edit it and make their own contributions. It has some similarities with traditional encyclopedia, the major difference being that the entries are made by the user community themselves.

[168] A blog (short for "web log") is a website, often maintained by an individual, where the author(s) regularly enters comments, descriptions of events or other material. Typically, it is focused on a specific topic. Blogs are normally entered with a date, similar to the way a diary is kept.

Exhibit 6.1-5: % of CRP companies saying that … is a highly / partly relevant topic for their business (2007)[169]



Base (100%) = CRP companies using computers from 7 EU Member States (DE, FR, IT, ES, PL, SE, UK) / from the USA. N (2007) = 811 (EU-7) / 100 (USA).

Weighting: Figures for sector totals and countries are weighted by employment ("firms representing x% of employment in the sector / country"), figures for size-bands in % of firms.

Source: e-Business Survey 2007 by the SeBW

In contrast to Web 2.0 applications, **mobile applications** are already widely used by companies. This is reflected by the survey, where more than 60% of the companies (in particular medium-sized and large firms) said that mobile applications were relevant or highly relevant for their company. For instance, sales people use mobile devices to connect with the company's system from abroad.

[169] Survey question: "How relevant are the following technological developments for your company? Is the topic of (…) very relevant, partly relevant, or not relevant for you? (a) Voice-over-IP, that is telephony via internet protocol, (b) mobile applications, for example data communication via mobile devices, (c) Web 2.0, for example blogs and social networking technologies?"

6.2 Policy implications

This chapter discusses implications of ICT and e-business trends and impacts for policy. Suggestions are derived from the empirical findings of this study in the previous sections. A special effort was made to present these suggestions from a **systemic perspective**, i.e. to place them into a larger policy framework in order to indicate possibly synergies and links with ongoing initiatives. The choice was to use the current policies of the European Commission's DG Enterprise and Industry as the main reference framework.[170] After presenting the –mixed– evidence for and against policy intervention, and outlining the relevant EU policy framework (see Section 6.2.1), some specific areas of possible actions are proposed (see Section 6.2.2).

6.2.1 General considerations

Is there a need for ICT policy in this sector?

The empirical findings of this study do not allow straight forward conclusions whether and to what extent there is a need for ICT-related policy initiatives specifically for the chemical, rubber and plastics industry. There is **mixed evidence** in this regard.

Some of the findings do not support specific policy attention on ICT. An economic analysis based on productivity and growth accounts (macro data) did not find convincing evidence for substantial productivity or growth effects of ICT capital in this sector (see Section 4.1). Non-ICT-capital investments were found to contribute to a higher extent to value added growth in the CRP industries than those in ICT-capital, even if ICT-capital also contributed positively in most of the Member States for which data were available. Also, the key driver for labour productivity growth (measured as gross production value per working hours) was found to be intermediate inputs intensity, rather than ICT capital.

Furthermore, the chemical industry is confronted with urgent and highly complex challenges that are not directly related to ICT, such as the rising costs of raw materials and energy, the compliance with new environmental regulations, and increasing global competition (see Section 2.2). These challenges pose, by all measures, more direct concerns for industrial policy than the use of ICT, even if ICT and e-business may play a certain role in these contexts (see, for example, Section 3.3.3 – ICT to support REACH compliance).

On the other hand, case studies and the firm survey conducted for this study (i.e. micro-data evidence) indicate a dynamic development of e-business in the sector. ICT have become a general purpose technology that is widely used across all business functions. e-Commerce transactions have significantly increased, and e-business solutions are becoming indispensable tools to meet customer expectations and to do enter new markets (see Section 3.5). In short, the smart use of ICT matters for the competitiveness of companies in this sector, and the importance of an adequate e-business strategy will probably further increase. Moreover, a majority of the companies interviewed for this study are convinced that ICT will actually have an impact on the way they do business in the years to come, in practically all areas of business (see Section 6.1.1). They also

[170] see DG Enterprise and Industry: "Our policies at a glance" (http://ec.europa.eu/enterprise/key_issues/index_en.htm), accessed in June 2008

confirmed the importance of ICT for innovation (see Section 4.2). In short, ICT and e-business are clearly relevant issues on the agenda of companies.

But how can this **apparent paradox** be explained? Why does the "birds' view" (based on macro-economic analysis) deviate to some extent from the micro-perspective based on firm level data? And which perspective should prevail for policy decisions? As to the paradox, there are two major factors that help to understand the differences between the macro and micro perspective.

- **"ICT capital" – definition issues**. The macro-economic analysis focuses on the contribution of ICT capital stock to productivity growth and industry growth. ICT capital is a stock, i.e. goods that are owned by the company and whose total value can be estimated at a point in time. It is measured as companies' investments in ICT products and software (based on respective NACE classes). It is evident that not all e-business activities are easily measurable by this concept. For example, software can be rented (SaaS[171]) and thus create expenditures which are not considered as investments. Furthermore, the important role of embedded ICT (for example technical components in chemical plants or in other technical equipment used in production) may not be fully accounted for. The micro-data evidence, on the other hand, considers activities which may not be reflected in a change of ICT capital stock.
- **Different time series**. The micro-data evidence focuses on ICT adoption and e-business activities in 2007 (with a comparison of the situation in 2003), while the macro-analysis covers the period from 1985-2004. Thus, the macro-analysis has the advantage of covering a longer period, but fails to provide evidence on the recent e-business impacts. The strategic importance of e-business has probably increased in recent years, as the underlying technologies have matured, enabling more advanced forms of data exchange between companies. Therefore, impacts in 2007/08 could differ to those in the 1980s or 1990s.

In conclusion, both perspectives (micro vs. macro) are relevant for drawing conclusions, but the differences in what they can explain should be kept in mind. The micro data (survey, case studies) indicate that e-business activity is important for many firms to support their operations, while the macro data show that an increase in ICT capital by itself does not automatically drive productivity or growth.

Even if e-business is important, however, this does not automatically imply a need for direct policy intervention. To a large extent, the development of e-business occurs in an evolutionary way, and the study has not found any convincing evidence of a market failure in this process which could be expected to cause undesirable effects. Therefore, policy could decide to just leave e-business adoption in the CRP industries to the market.

Nonetheless, from a European perspective, the rising importance of e-business for the competitiveness of companies and, ultimately, industries, should not just be ignored. It can be argued that evolutionary **ICT-enabled innovation processes** (see Section 6.1.2) **should be accelerated** by appropriate measures, in order to sustain and enhance the – still existing– competitive advantage of the European CRP industry. ICT infrastructure and e-business can be seen as an important "**factor condition**" for an economy **to achieve competitive advantage**,[172] in particular in the emerging knowledge economy.

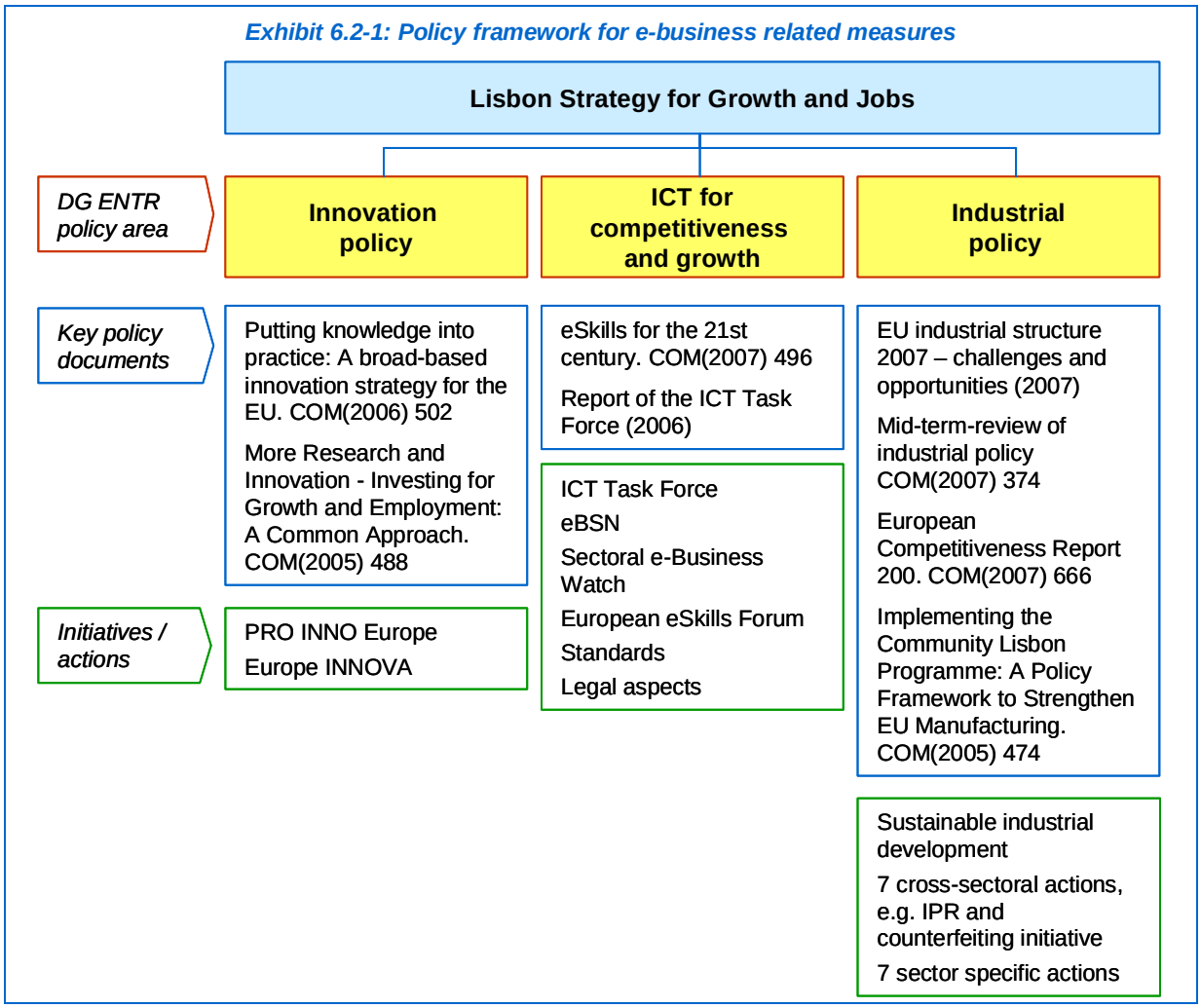
[171] Software as a service

[172] cf. Porter 1990

ICT-related measures as part of a broader industrial policy framework

Policy measures in this field should be embedded within the broader policy framework of the European Commission's DG Enterprise and Industry for promoting **sustainable industrial development** and the **competitiveness** of European industry, in which **innovation** plays a central role (see Exhibit 6.2-1).[173] This reflects the fact that innovation (in particular organisational and process innovation) and ICT usage in companies are inseparably linked with each other, as clearly demonstrated by this study.

Exhibit 6.2-1: Policy framework for e-business related measures



Source: developed by the SeBW, based on information available on the website of DG Enterprise and Industry (http://ec.europa.eu/enterprise/index_en.htm)

[173] Important reference documents for the industrial policy approach of the European Commission include the following communications: "Mid-term review of industrial policy. A contribution to the EU's Growth and Jobs Strategy", COM(2007) 374. "Implementing the Community Lisbon Programme: A policy framework to strengthen EU manufacturing - towards a more integrated approach for industrial policy", COM(2005) 474 final; "Common Actions for Growth and Employment: the Community Lisbon Programme", Communication of the European Commission, COM(2005) 330; "Working Together for Growth and Jobs: a New Start for the Lisbon Strategy", Communication of the European Commission, COM(2005) 24;

Sector specific recommendations of the High-Level Group

In line with this broader framework, innovation has been identified as a key success factor specifically for the competitiveness of the chemical industry by the High Level Group (HLG) on the Competitiveness of the European Chemicals Industry.[174] The HLG was set up by the European Commission in June 2007 to analyse the competitive scenario of the sector in Europe. It recommends that, in order to maintain the world-leading position of the European chemical industry, four main objectives should be pursued and proposes concrete measures to be taken to achieve these objectives:[175]

Exhibit 6.2-2: Recommendations of the HLG on the Competitiveness of the European Chemicals Industry

Objectives	Measures to be taken
Strengthening innovation networks	• industry, in cooperation with governments, should set up topical innovation networks to promote key strategic innovations; • industry and public authorities at all levels should strengthen clusters which facilitate co-operation across sectors and across borders, with the aim of further stimulating and facilitating cross-cutting innovations throughout the value chain; • the technology platform SusChem should explore opportunities to extend its scope of work to include innovation leadership issues.
Increased spending in Research and Development (R&D)	• the private sector should accelerate its efforts to speed up innovation, because the chemicals industry has a strategic interest in occupying high-knowledge-based segments assuring higher long-term growth and profitability; • the public sector should provide effective support in this context.
Better development of human resources	• EU member states should step up promotion of chemical and science education starting with the primary schools; • chemical engineering faculties should define the profiles of new professions in cooperation with industry • the industry should intensify efforts to forecast their requirements of human resources at various locations and regions.
Improvements in information and communications	• the chemicals industry needs to develop a more effective dialogue with society based on mutual understanding and trust; • the Commission and Member State authorities should improve communication with industry and other stakeholders to facilitate proper understanding and observance of regulatory requirements; • the Commission should ensure that impacts on innovation and any further research needs are addressed in impact assessments accompanying new legislative proposals where appropriate.

While there is no explicit mention of ICT and e-business in the recommendations made by the HLG, the **relevance of ICT for the proposed measures** is obvious. The following suggestions (Section 6.2.2) are therefore to be considered as inputs to the existing framework as well as the work of the HLG. The proposed action lines should be regarded

[174] for more information about the HLG, see http://ec.europa.eu/enterprise/chemicals/hlg/index_en.htm (download in June 2008)

[175] High Level Group on the Competitiveness of the European Chemicals Industry. Conclusions and recommendations of the 2nd meeting on 18 December 2007. See http://ec.europa.eu/enterprise/chemicals/hlg/meetings_en.htm (download in June 2008)

as possible contributions and instruments to address the specified objectives. At the same time, they express a concern that some of the central policy documents may not adequately reflect the importance of ICT for industrial competitiveness in general and the close links between innovation and ICT usage in particular.

6.2.2 Policy suggestions

Against these general considerations, the study findings suggest four priority areas for policy measures to further support ICT-enabled innovation. Except for the last point (ICT and REACH), these areas are more **horizontal** than sector-specific, which is in line with the Commission's commitment "*… to the horizontal nature of industrial policy and to avoid a return to selective interventionist policies*."[176] All suggestions should be considered as part of a general industrial policy in which innovation plays a central role. Innovation (notably organisational and process innovation) and ICT usage in firms are inseparably linked with each other, as this study shows; therefore, any specific measures to create a favourable framework for ICT adoption should ideally be embedded in a larger innovation policy framework.

The study proposes four lines of possible action to enhance and exploit ICT-driven innovation potential in the CRP industries:

- **e-Business skills in SMEs**: strengthening the e-skills base in the sector by supporting the managerial understanding of e-business among smaller companies.
- **e-Business skills for large firms**: ensuring the supply of ICT and e-business professionals by establishing innovative educational schemes.
- **Removing legal uncertainty and risks**: focus on further harmonising the regulatory framework for e-business in Europe – particularly considering issues in cross-border trading and payments.
- **Enhance specific ICT opportunities for process efficiency**: explore opportunities to facilitate REACH compliance by use of ICT.

The following section explains the rationale for these proposed action lines, indicates possible activities that could be considered and identifies the key stakeholders that need to get involved.

e-Skills related actions (I): improving the managerial understanding of e-business among smaller companies

The study confirms that there is still a "digital divide" between large and small companies in e-business practices, notably when it comes to advanced forms of data exchange (see evidence in Sections 3.2-3.5). This hampers the network effect of e-business and reduces the potential of productivity gains on the aggregate (industry) level. Case studies demonstrate that, in smaller companies, the **understanding and commitment of the management** is a critical factor for introducing ICT-based innovation in the firm. This indicates that a key leverage to accelerate sector wide e-business adoption is to target owners and managers of smaller companies.

[176] COM(2005) 474 final, p. 3

There is a wide range of instruments to raise awareness and to promote the understanding of e-business concepts among this target clientele. However, studies underline the importance of preparing and delivering information resources in an adequate way for decision makers: they need the right amount of information (neither too detailed or technical, nor too shallow). Some examples of measures which have been proven successful in initiatives[177] are indicated in the following table.

Possible measures:	• Collection and dissemination of best e-business practices among SMEs in the sector • Grant schemes for SME projects, ideally combined with documentation of best practices afterwards • Establishment of peer-to-peer platforms where SMEs can exchange their experiences • Digital value chain projects to pilot digital business processes and exchange formats, involving large companies (and their network of suppliers)
Stakeholders to be involved:	• Regional and national e-business policy makers • Industry associations in the chemical, rubber and plastics industry • Business advisors working with SMEs • SME support centres with a dedicated role to promote the knowledge transfer (e.g. e-competence centres) • Other intermediaries such as chambers of commerce • Large companies from the sector (in order to leverage their relations with suppliers)
Links with DG Enterprise industrial policy:	• Work of the eBSN: The e-Business Support Network is actively supporting the dissemination of best SME e-business practices • "Small Business Act" for Europe[178]: one of the 10 action lines focuses on "upgrading the skills in SMEs". • The High Level Group (HLG) on the Competitiveness of the European Chemicals Industry (set up by the EC) recommends that "developing human resources" should be a priority measure to ensure the sector's competitiveness

e-Skills related actions (II): strategies and new educational schemes to ensure the adequate supply of ICT and e-business professionals in Europe

e-Skills are also an important issue for large companies, but in a different way. Here, the critical issue is to ensure access to ICT and e-business professionals. Europe faces the risk of a shortage in the supply of "e-professionals". IDC, an ICT market research company, estimates that there is already a shortage of some 500,000 full time ICT professionals in the EU, that this is growing by up to 10% per annum, and that almost half of Europe's organisations are facing difficulties hiring staff, with implications for growth.[179] This shortage affects not only the ICT industry itself, but also larger companies in the ICT using sectors: first, they face difficulties in finding professionals for their own IT

[177] see eBSN study on "Benchmarking Sectoral e-Business Policy Initiatives" (2007)

[178] European Commission (2008): "Think Small First". A "Small Business Act" for Europe. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the regions. COM(2008) 394 final. Brussels, 25.6.2008.

[179] Presentation by Marianne Kolding, IDC, at the e-Business Watch Conference 2008 ("Understanding the e-Economy"), Brussels, 19 May 2008.

departments and e-business operations.[180] Second, a shortage of professionals among ICT service providers negatively affects the quality of the services offered to their customers.

This is a horizontal issue which concerns practically all sectors. The two main action lines to address this challenge are to develop innovative curricula in ICT training and to promote these training schemes among young people to attract talent. This requires close cooperation between policy, educational organisations and the ICT industry, typically in the form of "multi-stakeholder-partnerships".[181]

Possible measures:	• Develop, promote and implement national strategies for e-skills in EU member states, including provisions for multi-stakeholder partnerships (MSPs) • Encourage and support the launch of industry-led initiatives on e-skills • Monitor and assess existing MSPs and support the transfer of good practices between EU countries, e.g. by developing guidelines and templates for the promotion of MSPs, based on good practices • Develop a European e-competence framework in cooperation with key stakeholders • Set up e-skills information exchange and observatory mechanisms at EU and national levels
Stakeholders to be involved:	• Ministries in EU member states (in particular those responsible for education) • Employers' associations and trade unions • ICT industry and their associations / federations • Universities and other educational institutions
Links with DG Enterprise industrial policy:	• ICT for competitiveness and innovation – e-Skills policy (see, for instance, "eSkills for the 21st century – Fostering Competitiveness, Jobs and Growth", COM(2007) 496; study by DG Enterprise and Industry on "Multi-stakeholder-partnerships for e-skills", 2007) • Recommendations of the European e-Skills Forum and the ICT Task Force (2006)

Further harmonisation of the regulatory framework for e-business in Europe – particularly considering issues in cross-border trading and payments

In specific areas, existing regulatory frameworks can be difficult to apply to new ways of electronic data exchange, which can lead to legal uncertainty for business and hinder innovation. It is the main responsibility of policy to address such issues and thus create a favourable overall framework for ICT usage.

A primary example in recent years has been the legal uncertainty with regard to e-invoicing (see box). The European Commission is well aware of this challenge and has taken action to solve the problem. An informal Task Force on e-Invoicing which was set

[180] This was confirmed by experts interviewed for this study, including the case study interviewees.

[181] A study by the EC, DG Enterprise and Industry, on "Multi-stakeholder-partnerships for e-skills" (2007) has assessed different approaches, identified best practices and made recommendations how to establish and sustain MSPs.

up to address the issue submitted its final report in July 2007.[182] This report confirmed that "*… regulations on e-invoicing … do not adequately provide legal certainty for businesses*" (p. 29) and mentions that e-signature implementation is hampered, inter alia, by a lack of transparency concerning the grounds for acceptability of an e-signature from other EU countries (p. 30). Further studies such as a "Legal study on functioning of the Invoicing Directive (2001/115/EC)" are expected for the end of 2008, and concrete actions to follow the recommendations are anticipated. Thus, the issue is well taken care of; the recommendation in this study should be seen more as a reminder that confirms the importance of solving the existing problems, as companies interviewed for this study are still concerned about it.

Examples of issues to be addressed:	• Consider harmonisation of the way that the Electronic Signatures Directive has been transposed by Member States • Remove legal uncertainties as to whether different practices of e-invoicing are in compliance with (national) taxation regulations, e.g. by means of stakeholder consultations with tax authorities
Stakeholders to be involved:	• EU and Member States (in close consultation with industry federations, chambers of commerce and business associations)
Links with DG Enterprise industrial policy:	• Actions on improving the framework for e-invoicing, including the work of the eBSN in this field • SEPA – Single Euro Payments Area

Explore opportunities to facilitate REACH compliance by use of ICT

The final suggestion is highly sector specific: careful consideration of the potential of ICT to make the technical implementation of the REACH regulation as efficient as possible – for both sides, the companies and the regulatory authorities. This study provides examples of ICT service providers that have developed specific modules for managing REACH in companies. To ensure that these solutions meet the requirements and are widely used by enterprises, including SMEs, policy could consider stakeholder coordination initiatives (involving the ICT industry and federations from the CRP sector) and provide targeted information about opportunities to SMEs.

ECHA, the European Chemicals Agency has already implemented a "REACH-IT portal" on its website as the main channel for companies to submit data to ECHA (see http://echa.europa.eu/reachit_en.asp). The portal supports the creation of company accounts in REACH-IT. It also supports online entry and submission of pre-registrations for single substances. It should be ensured, however, that companies can link their internal systems with this channel in order to automate the registration procedure as much as possible.

[182] European Electronic Invoicing – Final Report of the Informal Task Force on e-Invoicing, Version 3.2 final, July 2007.

Possible activities:	• Stakeholder coordination, e.g. agreement on processes and interfaces for registering chemical substances online in close cooperation with ICT vendors • Provide information to SMEs about available software solutions that support REACH requirements
Stakeholders to be involved:	• EU (notably represented by ECHA, the European Chemicals Agency) • European and national industry federations, large companies from the sector • ICT service providers
Links with DG Enterprise industrial policy:	• Technical implementation of the REACH regulation, including work of ECHA (REACH-IT portal) • Sustainable industrial policy

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Interviews

Fazilet Cinaralp, Director ETRMA – European Tyre & Rubber Manufacturers, 29 November 2007

Herbert Fisch, Director eCommerce Global, BASF AG – eSolutions, 30 August 2007

Marko Lange, Solution Management, Industry Business Unit Chemicals, SAP AG, 29 February 2008

Dave Wallis, self-employed consultant with long-standing experience in the oil and gas industry, liaison with CEN/ISSS, 13 July 2007

Company interviews conducted for case studies: see references in case studies, Section 5.

Research at conferences and trade fairs

Elemica Roadshow, Spijkenisse, The Netherlands, 21 June 2007

Systems 2007, Munich, 23-26 October 2007

CeBIT 2008, Hannover, 4-9 March 2008

Annex I: The e-Business Survey 2007 – Methodology Report

Background and scope

The Sectoral e-Business Watch collects data relating to the use of ICT and e-business in European enterprises by means of representative surveys. The e-Business Survey 2007, the fifth in a series of surveys conducted in 2002, 2003, 2005 and 2006, was based on 5,325 telephone interviews with decision-makers from five industry sectors in nine EU countries and the USA. Interviews were carried out from August to October 2007, using computer-aided telephone interview (CATI) technology. The overall survey was divided into four separate projects (each using a separate questionnaire) focussing on different sectors and specific topics (see Exhibit A1-1). This document contains methodological notes for Projects 1 and 2, which accounted for 4,369 of all interviews conducted.

Exhibit A1-1: Components ("projects") of the e-Business Survey 2007

Survey project	Focus	Sectors covered	No. of interviews
1	e-Business in manufacturing	• Chemical, rubber and plastics • Steel • Furniture	2121
2	e-Business in retail, transport & logistics	• Retail • Transport & logistics services	2248
3	RFID adoption	• Manufacturing sectors • Retail • Transport services • Hospitals	434
4	Intellectual Property rights in ICT SMEs	• ICT manufacturing • ICT services • Software publishing	683

Questionnaire

The questionnaires for Projects 1 and 2 contained about 70 questions which were structured into the following modules:

- A: ICT Infrastructure and e-Business software systems
- B: Automated data exchange (Project 1) / e-Business with customers and suppliers (Project 2)
- C: e-Standards and interoperability issues (Project 1)
- D: Innovation activity of the company
- E: ICT Skills requirements and ICT costs
- F: ICT Impacts, drivers and inhibitors
- G: Background information about the company

Some of the questions were the same or similar to those used in previous surveys in order to highlight trends in the answers (notably in previously surveyed sectors such as the chemical and retail industries). Other questions were introduced or substantially modified, in order to reflect recent developments and priorities. The survey placed special focus on the degree of process automation in companies, i.e. to what extent paper-based and manually processed exchanges with business partners had been substituted by electronic data exchanges. Some questions were filtered, such as follow-up questions dependent on previous answers, and no open questions were used.

The questionnaires of all e-Business Watch surveys since 2002 can be downloaded from the project website (www.ebusiness-watch.org/about/methodology.htm).

Population

As in 2005 and 2006, the survey considered only **companies that used computers**. For the first time, a cut-off was introduced with regard to company size. When surveying the manufacturing sector in Project 1, only companies with at least 10 employees were interviewed. For the retail and transport sector in Project 2, the population also included micro-companies with fewer than 10 employees, reflecting their important contribution (see Exhibit A1.2). Sector totals are therefore not directly comparable between the two projects.

The highest level of the population was the set of all computer-using enterprises (and, in Project 1, with at least 10 employees) that were active within the national territory of one of the eight countries covered, and whose primary business activity was covered by one of the five sectors specified in the NACE Rev. 1.1.[183] Evidence from previous surveys shows that computer use can be expected to reach 99% or more among medium-sized and large firms across all sectors.

Exhibit A1-2: Population coverage of the e-Business Survey 2007

No.	Sector name	NACE Rev. 1.1 activities covered	Population definition	No. of interviews conducted
Project 1 – Manufacturing				
1.1	Chemicals, rubber & plastics	24, 25	Companies which have at least 10 employees and use computers	911
1.2	Steel	27.1-3, 27.51-52		449
1.3	Furniture	36.12-14		761
Project 2 – Retail and transport				
2.1	Retail	52	Companies that use computers	1,151
2.2	Transport services and logistics	60.10, 60.21+23+24 63.11+12+40		1,097

Sampling frame and method

For each sector, the sample was drawn randomly from companies within the respective sector population of each of the countries surveyed. The objective of this approach was to fulfil minimum strata with respect to company size-bands per country-sector cell (see Exhibit A1-3).

Exhibit A1-3: Strata by company-size

Size-band	Target quota specified	
	Project 1 Manufacturing	**Project 2 Retail & transport**
Micro enterprises (up to 9 employees)	--	up to 30%
Small companies (10-49 employees)	up to 40-50%*	at least 30%
Medium-sized companies (50-250 employees)	at least 40-45%*	at least 25%
Large companies (250+ employees)	at least 10-15%*	at least 15%

* depending on sector

[183] NACE Rev. 1.1 was replaced by the new version NACE Rev. 2 in January 2008. Nonetheless when the survey was conducted, sectors still had to be defined on the basis of NACE Rev. 1.1 because business directories from which samples were drawn were based on the older version.

Samples were drawn locally by fieldwork organisations based on official statistical records and widely recognised business directories such as Dun & Bradstreet (used in several countries) or Heins und Partner Business Pool.

The survey was carried out as an enterprise survey: data collection and reporting focus on the enterprise, defined as a business organisation (legal unit) with one or more establishments. Due to the small population of enterprises in some of the sector-country cells, the target quota could not be achieved (particularly in the larger enterprise size-bands) in each country. In these cases, interviews were shifted to the next largest size-band (from large to medium-sized, from medium-sized to small), or to other sectors.

Fieldwork

Fieldwork was coordinated by the German branch of Ipsos GmbH (www.ipsos.de) and conducted in cooperation with its local partner organisations (see Exhibit A1-4) on behalf of the Sectoral e-Business Watch. Pilot interviews prior to the regular fieldwork were conducted with about ten companies in each sector in Germany in August 2007, in order to test the questionnaire (structure, comprehensibility of questions, average interview length).

Exhibit A1-4: Institutes that conducted the fieldwork of the e-Business Survey 2007 and number of interviews conducted per country (total for Projects 1 and 2)

Country	Institute conducting the interviews	No. of interviews conducted
France	IPSOS Insight Marketing, 75628 Paris	551
Germany	IPSOS GmbH, 23879 Mölln	555
Italy	Demoskopea S.p.A., 20123 Milano	553
Poland	IQS and Quant Group Sp.z.o.o, 00-610 Warszawa	546
Spain	IPSOS Spain, 28036 Madrid	549
Sweden	GfK Sverige AB, 22100 Lund	542
UK	Continental Research, London EC1V 7DY	548
USA	Market Probe International, Inc, New York, NY 10168	525
TOTAL		**4,369**

The two sector surveys had a total scope of 4,369 interviews, spread across eight countries and five industries. In each of the eight countries, all five sectors were covered. The target was to spread interviews as evenly as possible across sectors; however, due to the comparatively small population of companies in the steel and (in some countries) in the furniture industries, some interviews had to be moved either between countries (within a sector) or between sectors (i.e. from steel or furniture to larger sectors, such as the retail industry). Exhibit A1-5 shows the final distribution of interviews across sectors and countries.

Exhibit A1-5: Interviews conducted per sector and country:

Sector Country	DE	ES	FR	IT	PL	SE	UK	USA	Total
Project 1 – Total	**305**	**290**	**235**	**303**	**254**	**170**	**264**	**300**	**2,121**
1.1 Chemical	100	120	135	105	120	105	126	100	**911**
1.2 Steel	100	50	20	87	24	30	38	100	**449**
1.3 Furniture	105	120	80	111	110	35	100	100	**761**
Project 2 – Total	**250**	**259**	**316**	**250**	**292**	**372**	**284**	**225**	**2,248**
2.1 Retail	120	131	166	126	151	184	148	125	**1,151**
2.2 Transport	130	128	150	124	141	188	136	100	**1,097**

Non response: In a voluntary telephone survey, in order to achieve the targeted interview totals, it is always necessary to contact more companies than the number targeted. In addition to refusals, or eligible respondents being unavailable, any sample contains a proportion of "wrong" businesses (e.g., from another sector), and wrong and/or unobtainable telephone numbers. Exhibit A1-6 shows the completion rate by country (completed interviews as percentage of contacts made) and reasons for non-completion of interviews. Higher refusal rates in some countries, sectors or size bands (especially among large businesses) inevitably raise questions about a possible refusal bias: that is, the possibility that respondents differ in their characteristics from those that refuse to participate. However, this effect cannot be avoided in any voluntary survey (whether telephone- or paper-based).

Exhibit A1-6: Interview contact protocol, completion rates and non-response reasons

		DE	ES	FR	IT	PL	SE	UK	US
1	Sample (gross)	6188	6435	6538	3071	10642	3016	8246	15862
1.1	Telephone number not valid	541	31	53	299	645	38	611	1811
1.2	Not a company (e.g. private household)	82	209	6	36	327	2	57	431
1.3	Fax machine / modem	19	0	72	9	300	33	69	389
1.4	Quota completed **à** address not used	973	2018	1531	101	2492	84	1087	193
1.5	No target person in company	992	267	264	129	975	101	662	821
1.6	Language problems	4	0	6	1	77	6	6	72
1.7	No answer on no. of employees	0	8	0	1	9	1	6	24
1.8	Company does not use computers	35	75	32	76	35	5	110	398
1.9	Company <10 employees (manufacturing only)	90	30	7	0	78	0	670	21
1.10	Not targeted sub-sector (transport only)	0	16	0	3	4	3	14	24
	Sum 1.1 – 1.10	2076	2654	1971	655	4942	273	3292	4184
2	Sample (net)	4112	3781	4567	2416	5700	2743	4954	11678
2.1	Nobody picks up phone	65	462	1061	0	440	147	112	2280
2.2	Line busy, engaged	0	0	37	0	54	479	82	99
2.3	Answering machine	0	0	1022	0	168	14	86	1655
2.4	Contact person refuses	1546	0	136	435	2207	236	1960	2242
2.5	Target person refuses	1666	2540	932	351	338	573	1558	3363
2.6	No appointment during fieldwork period possible	63	0	97	70	392	477	352	0
2.7	Open appointment	170	88	692	988	1384	261	140	1514
2.8	Target person is ill / cannot follow the interview	1	0	13	3	33	2	4	0
2.9	Interview abandoned	46	142	17	17	138	4	112	0
2.10	Interview error (**à** interview cannot be used)	0	0	9	0	0	8	0	0
	Sum 2.1 – 2.10	3557	3232	4016	1864	5154	2201	4406	11153
3	Successful interviews	555	549	551	553	546	542	548	525
	Completion rate (= [3]/[2])	**13.5%**	**14.5%**	**12.1%.**	**22.9%**	**9.6%**	**19.8%**	**11.1%**	**4.5%**
	Average interview time (min:sec)	**20:16**	**20:12**	**19:50**	**16:51**	**20:417**	**18:17**	**18:21**	**21:25**

Feedback from interviewers

No major problems were reported from the fieldwork with respect to interviewing (comprehensibility of the questionnaire, logical structure). The overall feedback from the survey organisations was that fieldwork ran smoothly and that the questionnaire was well understood by most respondents. The main challenge was the fulfilment of the quotas, which was difficult or impossible in some of the sectors, in particular among the larger size-bands. More specific comments from fieldwork organisations, which point to difficulties encountered in the local situation, are available in the detailed field-report from Ipsos, which can be downloaded from the e-Business Watch website at www.ebusiness-watch.org/about/methodology.htm.

Weighting schemes

Due to stratified sampling, the sample size in each size-band is not proportional to the population numbers. If proportional allocation had been used, the sample sizes in the 250+ size-band would have been extremely small, preventing any reasonable presentation of results. Thus, weighting is required so that results reflect the structure and distribution of enterprises in the population of the respective sector or geographic area. The Sectoral e-Business Watch applies two different weighting schemes: by employment, and by the number of enterprises.[184]

- Weighting by employment: Values that are reported as employment-weighted figures should be read as "enterprises comprising x% of employees" (in the respective sector or country). The reason for using employment weighting is the predominance of micro-enterprises over other kinds of firms. If the weights did not factor in the economic importance of different sized businesses, the results would be dominated by the percentages observed in the micro size-band.
- Weighting by the number of enterprises: Values that are reported as "x% of enterprises" show the share of firms irrespective of their size, i.e. a micro-company with a few employees and a large company with thousands of employees both count equally.

The use of filter questions in interviews

In the interviews, not all questions were asked to all companies. The use of filter questions is a common method in standardised questionnaire surveys to make the interview more efficient. For example, questions on the type of internet access used were only asked to companies that replied affirmatively to having internet access. The question of whether a company has internet access thus serves as a filter for follow-up questions.

The results for follow-up questions can be computed on the basis of enterprises that were asked the question (e.g. "in % of enterprises with internet access") or on the basis of all companies surveyed. In this report, both methods are used, depending on the indicator. The basis (as specified in footnotes of tables and charts) is therefore not necessarily identical to the set of companies that were actually asked the filter question.

Statistical accuracy of the survey: confidence intervals

Statistics vary in their accuracy, depending on the kind of data and sources. A 'confidence interval' is a measure that helps to assess the accuracy that can be expected from data. The confidence interval is the estimated range of values on a certain level of significance. Confidence intervals for estimates of a population fraction (percentages) depend on the sample size, the probability of error, and the survey result (value of the percentage) itself. Further to this, variance of the weighting factors has negative effects on confidence intervals.

Exhibit A1-7 gives some indication of the accuracy that can be expected for EU-7[185] industry totals (based on all respondents) according to the weighting scheme used. The confidence intervals differ depending on the industry and the respective value; on average, they represent a 5 percentile fork around the results (in both weighting schemes). Confidence intervals for employment-weighted data are highest for the steel industry, due to the small number of observations and because this sector's structure makes it more sensitive to data weighting (i.e. large firms dominate in a comparatively

[184] In the tables of this report, data are normally presented in both ways, except for data by size-bands. These are shown in % of firms within a size-band, where employment-weighting is implicit.

[185] The EU-7 are composed of those countries which were covered by the survey. To ensure data comparability, only interviews from these countries are included in the aggregated "total" values.

small population). Employment-weighted data for this industry therefore have lower statistical accuracy than for the other sectors.

The calculation of confidence intervals is based on the assumption of (quasi-) infinite population universes. In practice, however, in some industries and in some countries the complete population of businesses consists of only several hundred or even a few dozen enterprises. In some cases, every enterprise within a country-industry and size-band cell was contacted and asked to participate in the survey. This means that it is practically impossible to achieve a higher confidence interval through representative enterprise surveys in which participation is not obligatory. This should be taken into account when comparing the confidence intervals of e-Business Watch surveys to those commonly found in general population surveys.

Exhibit A1-7: Confidence intervals for the sector surveys (EU-7)

		Confidence interval								
	Survey result	if weighted as "% of firms"			if weighted by employment			unweighted		
Sectors (aggregate, EU-7)										
Chemical, rubber and plastics	10%	**8.0%**	**-**	**12.4%**	**6.5%**	**-**	**15.0%**	**8.4%**	**-**	**11.9%**
Steel	10%	**7.5%**	**-**	**13.2%**	**4.8%**	**-**	**19.6%**	**7.7%**	**-**	**13.0%**
Furniture	10%	**8.0%**	**-**	**12.5%**	**7.1%**	**-**	**14.0%**	**8.2%**	**-**	**12.1%**
Retail	10%	**7.0%**	**-**	**14.0%**	**7.0%**	**-**	**14.1%**	**8.6%**	**-**	**11.7%**
Transport & logistics	10%	**7.0%**	**-**	**14.1%**	**7.4%**	**-**	**13.4%**	**8.5%**	**-**	**11.7%**
Sectors (aggregate, EU-7)	**30%**									
Chemical, rubber and plastics	30%	**26.8%**	**-**	**33.5%**	**24.0%**	**-**	**36.8%**	**27.4%**	**-**	**32.7%**
Steel	30%	**25.8%**	**-**	**34.5%**	**20.3%**	**-**	**42.0%**	**26.1%**	**-**	**34.2%**
Furniture	30%	**26.7%**	**-**	**33.5%**	**25.0%**	**-**	**35.5%**	**27.1%**	**-**	**33.0%**
Retail	30%	**25.0%**	**-**	**35.6%**	**24.9%**	**-**	**35.7%**	**27.7%**	**-**	**32.4%**
Transport & logistics	30%	**24.9%**	**-**	**35.7%**	**25.7%**	**-**	**34.7%**	**27.7%**	**-**	**32.4%**
Sectors (aggregate, EU-7)	**50%**									
Chemical, rubber and plastics	50%	**46.3%**	**-**	**53.7%**	**43.0%**	**-**	**57.0%**	**47.1%**	**-**	**52.9%**
Steel	50%	**45.2%**	**-**	**54.8%**	**38.2%**	**-**	**61.8%**	**45.6%**	**-**	**54.4%**
Furniture	50%	**46.3%**	**-**	**53.7%**	**44.3%**	**-**	**55.7%**	**46.8%**	**-**	**53.2%**
Retail	50%	**44.2%**	**-**	**55.8%**	**44.1%**	**-**	**55.9%**	**47.4%**	**-**	**52.6%**
Transport & logistics	50%	**44.1%**	**-**	**55.9%**	**45.1%**	**-**	**54.9%**	**47.4%**	**-**	**52.6%**
Sectors (aggregate, EU-7)	**70%**									
Chemical, rubber and plastics	70%	**66.5%**	**-**	**73.2%**	**63.2%**	**-**	**76.0%**	**67.3%**	**-**	**72.6%**
Steel	70%	**65.5%**	**-**	**74.2%**	**58.0%**	**-**	**79.7%**	**65.8%**	**-**	**73.9%**
Furniture	70%	**66.5%**	**-**	**73.3%**	**64.5%**	**-**	**75.0%**	**67.0%**	**-**	**72.9%**
Retail	70%	**64.4%**	**-**	**75.0%**	**64.3%**	**-**	**75.1%**	**67.6%**	**-**	**72.3%**
Transport & logistics	70%	**64.3%**	**-**	**75.1%**	**65.3%**	**-**	**74.3%**	**67.6%**	**-**	**72.3%**
Sectors (aggregate, EU-7)	**90%**									
Chemical, rubber and plastics	90%	**87.6%**	**-**	**92.0%**	**85.0%**	**-**	**93.5%**	**88.1%**	**-**	**91.6%**
Steel	90%	**86.8%**	**-**	**92.5%**	**80.4%**	**-**	**95.2%**	**87.0%**	**-**	**92.3%**
Furniture	90%	**87.5%**	**-**	**92.0%**	**86.0%**	**-**	**92.9%**	**87.9%**	**-**	**91.8%**
Retail	90%	**86.0%**	**-**	**93.0%**	**85.9%**	**-**	**93.0%**	**88.3%**	**-**	**91.4%**
Transport & logistics	90%	**85.9%**	**-**	**93.0%**	**86.6%**	**-**	**92.6%**	**88.3%**	**-**	**91.5%**

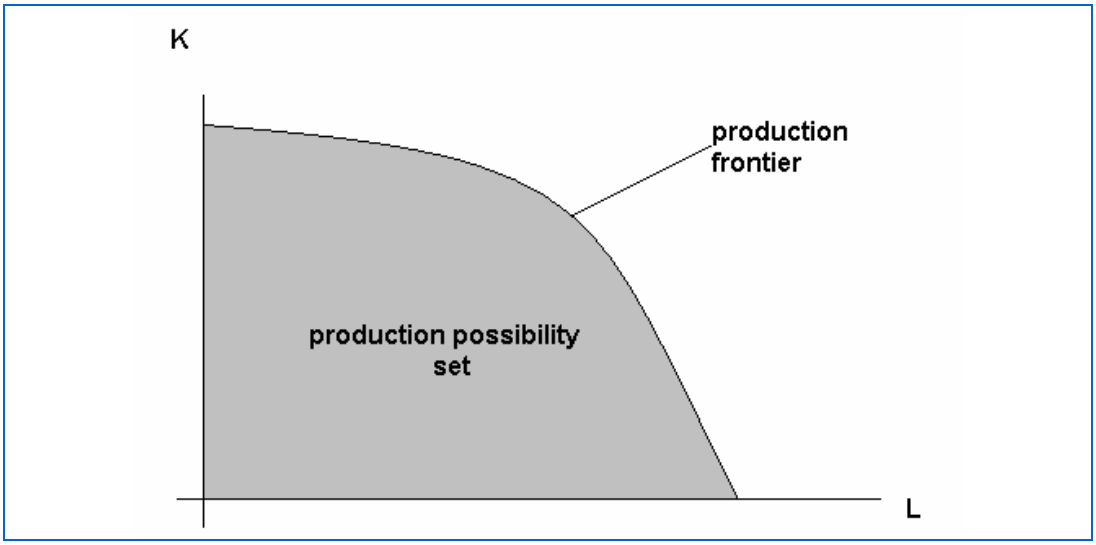
confidence intervals at α=.90

Annex II: Econometric methodology

Common stochastic possibility frontiers approach

A production frontier indicates the maximum possible production in a given period of time, using a given amount of production factors. The frontier may for example refer to a particular country or industry. The production possibility frontier approach, in contrast to the more traditional production function approach, allows to disentangle the overall productivity growth[186] into two components: first, the rate of technological progress expanding the frontier, and second, the movements of decision-making units (e.g. firms and, on an aggregate level, industries and countries) towards the frontier, i.e. towards optimal usage of production factors (see Exhibit A-II-1).

Exhibit A.II-1 Production possibility set and frontier



The stochastic production possibility approach is not a method for directly estimating impact factors on labour productivity. However, through modifying the variables, i.e. through dividing them by total working hours (TWH), a constellation can be created that allows to draw conclusions about the contribution of single variables on labour productivity.

If, given the factor input set, the produced output level stays below the potential maximum level, then the respective inefficient use of resources indicates indirectly that the whole production system or, at the micro level the single producer, faces an inability to match the best available practice. Farrell (1957) was the first to distinguish between technical and allocative efficiency. Technical efficiency reflects the ability of a firm to obtain maximal output from a given set of inputs. Allocative efficiency is used for the ability of a firm to use the inputs in optimal proportions, given their respective prices. The combination of both gives a measure of the total economic efficiency.

[186] Measured as changes in the ratio of total output produced over all inputs used in the production process.

Assuming log-linear production function where i countries produce their output given the technological parameter b , the stochastic production possibility frontier is now determined by two types of random errors. The always positive inefficiency random variable u_i **,** and the new random error term v_i, which has the usual properties of identical independent normally distributed errors with a mean value of zero and a constant variance, s_v^2 .

$$\ln(y_i) = b_0 + \sum_{j=1}^{m} x_{ij} \cdot b_j + v_i - u_i \qquad \text{for} \qquad i = 1,...,N$$

The production frontier is therefore determined by the deterministic part plus a stochastic part consisting of a mixture of two probability distributions: a non-negative one, for instance a positive truncated normal distribution, and the usual normal distribution of the error term. Estimating a stochastic production possibility frontier therefore involves estimating the parameters of the two probability distributions simultaneously.

The stochastic frontier function is accordingly bounded from above by

$$\ln(y_i) = b_0 + \sum_{j=1}^{m} \ln x_{ij} \cdot b_j + v_i \qquad \text{for} \qquad i = 1,...,N \ .$$

The model equation can be estimated by using standard maximum-likelihood methods. This approach requires explicit assumptions on the underlying probability distributions of the two random variables. However, the estimation function cannot be derived explicitly, so the maximum likelihood (ML) function has to be optimised numerically. This is achieved here by the Frontier 4.1 programme (see Coelli, 1996). For the exact specification of the ML-function see Battese and Corra (1977). They showed that the ML-estimators are consistent and asymptotically efficient (Aigner, Lovell, Schmidt, 1977).

The model is not limited to a Cobb-Douglas function estimation; it could easily be adjusted to a more flexible functional form of a translog production function.[187]

$$\ln(y_i) = b_0 + \sum_{j=1}^{m} \ln x_{ij} \cdot b_j + \sum_{j=1}^{m} \sum_{k=1}^{m} b_{juk} \cdot \ln x_{ik} \cdot \ln x_{jk} + v_i - u_i \qquad \text{for} \qquad i = 1,...,N$$

One-sided generalised likelihood-ratio-tests for such estimators were derived in later research (Coelli, 1995).

In this study, the stochastic production possibility frontier approach was used **to measure the degree of inefficiency of factor inputs** between industries in different countries. Since we do not estimate a single frontier for each country's industry separately but instead assume a common production possibility frontier, this approach is referred to as a common stochastic production possibility frontiers approach (see e.g. Berger, Humphrey 1997). The production possibility frontier approach does not explain the causes of the inefficiencies studied. It only indicates that a certain combination of factors is used

[187] In our econometric analysis translog specification were estimated but the results are not included in this report due to limited space. They will be published separately in a forthcoming working paper. By incorporating the cross-terms of a translog function or other flexible functional form one is able to determine variable substitutions elasticities between the different factor inputs. Assuming a Cobb-Douglas specification one assumes constant unity substitution elasticities between all different factor inputs.

inefficiently. Organisational or institutional failures are not revealed as they are not explicitly included in the estimation of the stochastic production possibility frontiers.

For this analysis a panel-data approach was used because of the low number of countries sampled. The only way a cross-section approach could be used would be by pooling industry and country data. Further trends can be drawn from the stochastic production possibility frontier model although a complete analysis is beyond the scope of this study.

To incorporate intermediate inputs in the analysis, the gross production value was used, gpv of the respective industry instead of the gross value added, gva, as the output variable. This enables us to estimate the output elasticities[188] for intermediate inputs.

$$\ln(gpv_i) = b_0 + \sum_{j=1}^{m} \ln x_{ij} \cdot b_j + v_i - u_i \qquad \text{for} \qquad i = 1,...,6$$

$$\text{with} \quad x_{j.} \in \{imi, ict, nict, hswh, mswh, lswh\}^{189}$$

Combining the industries production possibility frontiers for each country to one common production possibility frontier for an industry across all countries, we obtain a multi-country data panel with a common stochastic production possibility frontier.

$$\ln(gpv_{j,i}) = b_0 + \sum_{j=1}^{m} \ln x_{ijj} \cdot b_j + v_i - u_{j,i} \qquad \text{for} \qquad i = 1,...,6 \qquad \text{and} \qquad j = 1,...,12$$

To impose constant returns to scale we normalised the production possibility frontier by subtracting the natural logarithm of total working hours from both sides of the equation. This normalised common production possibility frontier equates the gross production value labour productivity in working hours on the left hand side with respective factor intensities such as ICT-capital intensity on the right hand side.

$$\ln(gpv^*_{j,t}) = b^* + \sum_{j=1}^{m} \ln x^*_{ij,t} \cdot b^*_j + v_i - u_{j,i} \qquad \text{for} \qquad i = 1,...,6 \qquad \text{and} \qquad j = 1,...,12$$

To include Harrod-neutral technical change in the multi-country industry common production possibility frontier a time trend variable is also included. The respective parameter value b_7 measures the average TFP-growth rate. The long-term rate of Harrod-neutral technological progress therefore determines the outward shift attributed to a steady technical change in the common production possibility frontier.

$$\ln(gpv^*_{j,t}) = b^* + \sum_{j=1}^{m^*} \ln x^*_{ij,t} \cdot b^*_j + b^*_7 \cdot t + v_i - u_{j,i} \qquad \text{for} \qquad i = 1,...,6 \qquad \text{and} \qquad j = 1,...,12$$

[188] An output elasticity is a dimensionless measure for the ratio of marginal percentage changes of output with regard to a particular input variable, i.e. a 1% increase in the input variable changes the output variable by x%.

$$e_{o,x} = \frac{\partial \ln o_t}{\partial \ln x_t} = \frac{\partial o_t}{o_t} \Big/ \frac{\partial x_t}{x_t} = \lim_{\Delta \to 0} \frac{\Delta o_t}{o_t} \Big/ \frac{\Delta x_t}{x_t}.$$

[189] The symbols used denote the following: imi - intermediate inputs, ict – ICT-capital stock, nict – Non-ICT-capital stock, hswh – high-skilled total working hours, mswh – medium-skilled total working hours, lswh - low-skilled total working hours.